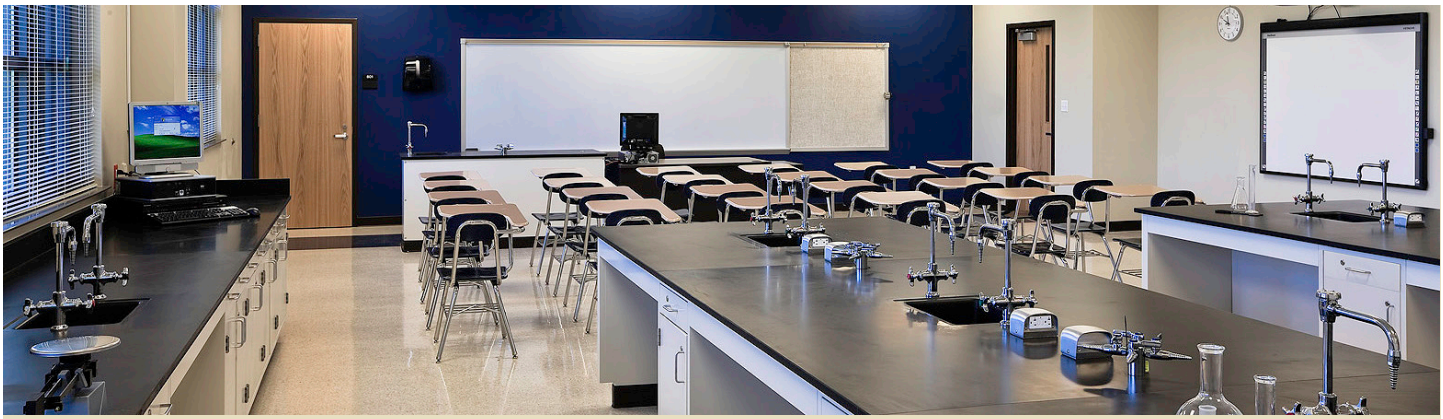

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In This Issue

Articles

Reflective Essays on Professional Leadership and Policy

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About the Journal

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Letter from the Editors

The ethical, economic, and political burden on educational leaders in the current milieu may be heavier than it has been during any other historical period in American higher education. As the baby boomers prepare for a coming exodus from the professions and as the demands for professional newcomers sophisticated in science, mathematics, engineering, and technology (STEM) increase, our college and universities face the daunting challenge of producing large numbers of highly knowledgeable graduates who can think critically, creatively, quantitatively, and ethically; who can communicate using not just traditional language and literacy practices and processes, but also technical codes, mathematical systems of thought, and digital algorithms; who can collaborate and problem solve and synthesize new meanings; and who have made a commitment to civic engagement and social justice. To achieve this ambitious yet non-negotiable end, the system must engage in serious and deep organizational learning to provide access and success to millions of students who, in times past, would never have dreamed of going to college. Transformational leaders are needed now more than ever. This issue of *JTLPs* includes a collection of articles targeted specifically for up-and-coming as well as established higher education leaders looking to preserve California's commitment to serving its diverse student population while increasing the quality of learning that takes place on our campuses.

JTLPs seeks to include articles on STEM education and is pleased to offer two studies that give us an opportunity to stop and think about the pipeline spanning from K-12 schools to community colleges to baccalaureate institutions. Liang and Heckman's study of the consequences of California's Algebra for All policy provides evidence of the ways in which good intentions, acted upon in the absence of good evidence, can backfire. While fully recognizing the central role of Algebra in the intellectual development of young people, these researchers also demonstrate the significance of a developmental perspective. Transformational leaders interested not just in Algebra, but in all aspects of the curriculum can take a lesson from this study: One size does not fit all - learners are not widgets on an assembly line. MacDonald and Gomes's study of the failure of the science curriculum in high school and in college to promote deep understanding and knowledge about genetic expression underscores Liang and Heck's message: The readiness is all. It is not enough to provide classes and test for recall of information; conceptual development of complex ideas and the associated vocabulary takes years to develop and requires coherent instruction. We hope these studies will be read so that the larger lessons pointing to the need for more profound professional development among teachers at all levels is not lost on educational leaders.

Readers and prospective authors ought to take note of Hansen's study of the impact of African American Learning Communities on this segment of the student population for several reasons. First, the study illustrates that *JTLPs*, though dedicating a portion of each volume to STEM education, has not narrowed its scope to the degree that more general articles of interest to educational leaders are excluded. Second, the study makes the argument quite forcefully that even transformational leaders would do well to look to the past for answers. Hansen studies existing learning communities for which evidence of a positive impact exists and finds important insights useful not just to those working in classrooms, but for leaders working in boardrooms. Third, this study illuminates the profound importance of readiness—pedagogical readiness on the part of instructors as well as social and cultural readiness on the part of learners. It is not enough simply to open the doors of the classroom and invite in underrepresented students. Preparation must be made for them to succeed.

JTLPs offers in this volume what we believe may be a new genre in the scholarship of leadership: The professional reflective essay. Nancy Shulock, a policy researcher studying the ecology of the community colleges to shed light on issues of importance to

Letter from the Editors

decision-makers, tells her own compelling, personal story of transformation during a time of tumult for the colleges. Her essay gives us all insights into the difficult role of a researcher as change agent. It could become assigned reading in any number of doctoral courses where leaders are being groomed to take on these challenges in the future. Brice Harris, our new Chancellor of the California Community Colleges, offers a glimpse into his personal and professional development and the incredible complexity of serving as a leader in a loosely structured system where mandates from the top cut against the grain and are often counterproductive. Like the articles on *Algebra for All* and on genetic expression, these two articles make a perfect pair: one about what it means to try to help the college system from outside, and one about what it means to be on the receiving end of such help.

We hope our readership finds these five offerings as thought provoking, inspirational, intellectually stimulating, and useful as we have found them.

Carlos Nevarez, Executive Editor
Terry Underwood, Editor

An Examination of *Algebra for All* through Historic Context and Statewide Assessment Data

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ABSTRACT

Since 2003, California has enacted a policy through its education accountability system that encourages schools and districts to place all 8th grade students into algebra courses and therefore, be tested in algebra in the statewide assessment program. Ten years later, there are a great many more 8th graders taking algebra now. However, there are also many students repeating algebra, instead of going on taking higher level mathematics tests. This article aims to provide the historic context of this policy, previous and recent studies on 8th grade algebra, and our study based on the California Standardized Testing and Reporting (STAR) data. We analyzed 8th grade algebra test-taking and the following years' higher level mathematics test-taking to examine the college preparation course taking pipeline. Our longitudinal study compared two groups of students' performance on 9th grade algebra between those who previously scored below proficient on algebra at 8th grade and those who scored proficient or above on general mathematics at 8th grade. Further, another longitudinal study linked 7th grade mathematics sub-scores to 8th grade algebra achievement. The results show that "algebra for all" policy increased the number of students taking algebra at 8th grade and subsequently, taking higher level mathematics tests. However, the pipeline of the college preparation course taking has a significant leak because the number of students taking higher level mathematics decreased dramatically after algebra. Longitudinal study shows that students who pass the general mathematics test at 8th grade have a 69% greater chance to pass the algebra test at 9th grade compared to their peers who failed the algebra test at 8th grade. We also find that the sub-score rational numbers is a strong predictor of 8th grade algebra achievement. Alternatives to help all students achieve in mathematics learning are also discussed in addition to recommendations for future research.

Historical Context of the *Algebra for All* Policy

Algebra has fit into the edifice of mathematics education in American secondary schooling in various ways for over a century. However, the focus on algebra in the stream of mathematics' curriculum reforms during the 20th century, and, thus, in today's 21st century, represent struggles about standards, including questions about who developed the standards and the focuses of the standards, the fluctuating influence of mathematicians, and views of students and their future prospects. In particular, these struggles involve Herbert Spencer's question, what knowledge is of most worth? The struggles also extend to questions which students various reforms in mathematics will benefit: all, or only

those who are to go onto college? And, finally, do the presumed benefits accrue to the students for whom the reforms are intended to benefit? Understanding these struggles in historical context and being clear that it is the enacted thoughts and actions behind the classroom doors that will matter the most if students are to benefit provide an important backdrop for the data we analyze in this study to make a difference.

During the past 100 plus years, several critical periods of curriculum reform have brought attention to different focuses for mathematics in the school curriculum. One of those periods occurred at the turn of the 20th Century. Then, like now, concerns about immigration, dramatic developments in the economy and industry, the influence of the subject disciplines, such as mathematics, and the educational expectations held for different students attending schools arose. These concerns influenced the creation of commissions and study groups during the first two decades of the twentieth century. The commissions considered these factors and developed curricular reforms to respond to those concerns at that time. For example, the secondary school curriculum had special relevance as reflected in the work of the Committee of Ten, which began its work in 1892. It was comprised of university presidents and a faculty member, principals, and the United States Commissioner of Education. It focused on developing a common curriculum for all students who would attend secondary schools, not just the college bound students. As Cremin (1955) notes:

> … its conception of the secondary school is here all-important. The secondary school is viewed as an institution designed to prepare a small segment of American youth "for the duties of life" by improving their intellectual abilities. The Committee saw absolutely no conflict between this conception and that of the high school as a college-preparatory institution, for the task of improving intellectual abilities centered squarely in the studies of the college (p. 296).

While Cremin points to the Committee of Ten's reform in the secondary schools at that time as one about influencing only a small segment of students who would be going onto college, there was an indirect expectation that the reform would also influence the intellectual abilities of all students. That twin hopes have remained with us since that time. Nonetheless, algebra has remained a focus for the small group of college bound students. For example, in 1895, the National Education Association's Committee on College Entrance Requirements recommended algebra as a 9th grade course (George, 2007). However, since then, during the past century, and now during the first decade and more of the 21st century, efforts have fluctuated between having students focus on the knowledge and skills related to college preparation, like algebra, and those that would relate directly to student's preparation for life, which in turn would advance their knowledge and skills as citizens and in various occupations and careers that students might pursue after high school. For example, despite that early effort in 1892 to have algebra as a course for all students, schools developed programs in which students' focuses in mathematics shifted to more practical matters, in courses like business math, applied math, and others related to arithmetic content for students who were not on a college preparation track. Algebra "for all" was often dropped and replaced by courses such as general mathematics for students who were not directly college bound (Tyack & Cuban, 1995). As a result, in the 1920s, participation in algebra had dropped from 57% of students taking algebra in 1910 to only 40% taking algebra in 1922 in Ohio, for example (Stanic & Kilpatrick, 1992).

Other subsequent curriculum reform efforts sought more dramatic changes in the secondary school curriculum after that time. For example, in the 1930s and into the 1940s, the Progressive Education Association undertook the Eight-Year Study. It involved 30 high schools in advancing progressive educational practices. In their study efforts, those schools addressed the following concerns about high schools: the lack of purpose, limited attention to citizenship and community life, the lack of intellectual challenge, weak personal connections to students, and ineffective classroom learning conditions (Aiken, 1942).

The remedies that arose in these 30 schools to address these issues can be summed in this way:

> The schools [those involved] were confident

> that this could be done, … by basing the secondary school curriculum upon the needs of the youth in our society. If the high school helped students to find the meanings of their life experiences, they would go on to college to seek deeper and broader meaning in their maturing experiences. To the end, traditional studies would have to be revitalized and re-oriented: much new content would have to be included in the curriculum of school and college. … These schools took their eyes off of the college gates and looked to the fruitful fields beyond (p. 23).

Here again, another effort to have a school curriculum do both – have students prepared for college and have a productive life beyond schooling.

Despite the success of the schools' efforts involved in the Eight-Year Study (Chamberlin, Chamberlin, Drought, & Scott, 1942), eventually, national attention then turned to advancing "Life Adjustment" goals, related to and different in degree from the efforts in the 30 schools of the Eight-Year Study. These reforms emphasized, "active and creative achievements as well as an adjustment to existing conditions; it places a high premium upon learning to make wise choices, since the very concept of American democracy demands the appropriate revising of aims and the means of attaining them" (Cremin, 1964, p. 336). While the Life Adjustment curriculum succeeded in gaining attention and implementation in many schools in the country, it, too, waned under predictable criticisms revolving around the abandonment of conventional subjects and courses (Cremin, 1964, p. 339). Yet, as before, algebra and similar courses prevailed for those going to college. For those not going on to college, the debate continued. On what should these students focus with respect to mathematics in high school?

For example, in 1957, Sputnik was launched into the sky, and on the horizon a new focus for mathematics reform – an update to the mathematics and science curriculum so that the United States would overtake the perceived technological superiority of the Soviet Union. Yet, even before the launch of Sputnik, during the 1950s, university mathematicians worked again to rethink school mathematics and involve themselves in school mathematics curriculum reform. Max Beberman, for example, created the New Math, with his colleagues on the University of Illinois Committee on School Mathematics (UICSM). Like the School Mathematics Study Group (SMSG) that followed UICSM, it focused on algebra and the integration of concepts like "structure and proof in algebra", "treatment of inequalities along with equations", and "integrated algebra and trigonometry" into the school mathematics program (Herrera & Owens, 2001). These refocuses would create a pathway to college and college preparation as well as success in mathematics for other students to benefit them beyond schooling (Stanic & Kilpatrick, 1992).

University mathematicians in particular once again entered the arena of curriculum reform, attempting to bridge the gap between the existing school mathematics' curriculum and the discipline of mathematics underway in universities. Attention to the interests of university mathematicians moved reform in mathematics farther away from methods of learning and the centrality of students, as expressed in the curriculum being advanced in the Eight-Year Study and the Life Adjustment movements during the 1930s and 1940s. It again re-emphasized mathematics' content and courses. Stanic and Kilpatrick (1992) explains this rejection of the earlier curriculum changes and the responses to Sputnik in this way:

> … a previous overemphasis on method was by many held responsible for the neglect of content because the university mathematicians who dominated the modern mathematics movement tended to be specialists in pure rather than applied mathematics, they saw pure mathematics, with an emphasis on set theory and axiomatics, not only as the content that was missing from the school curriculum, but also as providing the framework around which to reorganize that curriculum (p. 412).

This refocus on the discipline of mathematics did not persist for too long or affect much of life behind classroom doors in mathematics for students or teachers (Goodlad, Klein, & Associates, 1970). The advocacy for basic skills for most students had returned this time

in the form of competency-based education (Cooney, 1988). By the 1970s, the new curriculum manifestations of the discipline of mathematics focused only on the gifted and advanced students. For all other students, general mathematics and basic skills remained the menu of the day. Tracking was fully embraced with differentiated educational goals and curriculum being enacted for students with different backgrounds and experience (Oakes, 1985; Oakes, 1990; Oakes and Guiton, 1995; Ravitch, 2000).

After the mid-1980s, *A Nation at Risk* became the policy reform text of the day, despite consisting of fewer than 25 pages of analysis and recommendations. Nevertheless, it called for educational reforms for achieving a more competitive stance towards other nations, similar to the responses that arose in the late 50's to the orbiting Sputnik satellite (The National Commission on Excellence in Education, 1983). Mathematicians, again, entered the educational reform scene, emphasizing this time the ways of knowing in the academic discipline of mathematics and adding attention to insights from cognitive sciences for a more powerful kind of mathematics learning for all students.

In 1989, the National Council of Teachers of Mathematics (NCTM), as a result of the "standards movement," which grew out of *A Nation at Risk*, decided to use its own organizational resources to draft a set of standards determined by the profession – mathematics educators in P-12, university level mathematicians, teacher educators, and practicing teachers to name a few of the interests involved. As a result of their work, they produced an enumeration of standards for practice. At least two other documents articulating related standards for teaching and standards for assessment emerged in 1991 and 1995 (Hiebert, 1999).

These efforts established a set of goals for mathematics education. The goals centered on several emotional and conative aspects of learning in mathematics – valuing mathematics and having confidence in undertaking mathematical thinking and problem solving. The remaining goals centered on the qualities of problem solving and reasoning as mathematicians accompanied with the skill of communicating clearly as a mathematician about these qualities. Romberg (1992) notes the intended focus of classroom learning for students:

> …encourage them to value the mathematical enterprise, to develop mathematical habits of mind, and to understand and appreciate the role of mathematics in human affairs; that they should be encouraged to explore, to guess, and even to make and correct errors so that they gain confidence in their ability to solve complex problems; that they should read, write, and discuss mathematics; and that they should conjecture, test, and build arguments about a conjecture's validity. The opportunity for all students to experience these components of mathematical training is at the heart of our vision of a quality mathematics program (p. 424).

Like other mathematics' curriculum reform efforts during the century, this one, too, sought these focuses in order to accomplish the twin goals of preparing students for college and advancing student success beyond their school years. As before, critical reactions followed. The evidence suggested that having these goals enacted in classrooms was not a foregone conclusion (Herrera & Owens, 2001). But having all students attend to a mathematics that would do both – advance college preparation and life preparation – followed as the 20th century came to a close.

For example, in 1994, the New York City public school system decided that all of its 9th grade students would take algebra as part of a college preparation curriculum (Bradley, 1994). The Chicago public schools followed in 1997 with a similar requirement (Viadero, 2009). Other national groups have also agreed with this emphasis on college preparation mathematics and science. For example, the College Board's "Equity 2000" program expands algebra courses to high school freshmen nationwide (2000). After 2000, when the California legislature passed a bill (Senate Bill 1354) requiring high school candidates for graduation to successfully complete an algebra course (*California Education Code*, Section 51224.5), algebra became a required course for all California high school graduation candidates.

Algebra is now widely considered to be a gateway course for college preparation (Riley, 1997; Moses,

Kamii, Swap, & Howard, 1989). In the "A-G" subject requirements for admission to the University of California (UC) and the California State University (CSU), algebra is designated as the first of a sequence of three courses (algebra I, geometry, and algebra II) deemed necessary for college preparation (University of California, 2007).

Algebra for All as a Civil Right and a State Policy

In the last three decades, all over the United States, "algebra for all" has become a mantra in the movement to disrupt the tracking system, and advance the twin goals that we have been discussing. Early in 1987, Civil Rights crusader Robert Moses took the notion of "algebra for all" to the 7th grade through his Algebra Project in Cambridge, Massachusetts. He worked with an inner-city school community, modeling his thinking on some of the successes he had in the Civil Rights Movement in Mississippi. Specifically, he urged parents to enroll minority students in algebra courses in 7th grade, recommended that teachers develop a curriculum that makes algebra more relevant for the students, and encouraged students to believe that achievement resulted from hard work rather than innate ability (Moses, Kamii, Swap, & Howard, 1989).

The success of the Algebra Project inspired many educators nationwide to move more algebra courses into grades 7, 8, and 9 classrooms; and students took these courses in increasing numbers. However, it was the publication of *Mathematics Equals Opportunity* (Riley, 1997) that turned 8th grade algebra into a policy issue in education reform. The white paper prepared by then U.S. Secretary of Education Richard Riley reported that students who "begin to study algebra during middle school are at a clear advantage of going to college and completing college" (p. 16).

Many studies using the National Center for Educational Statistics' (NCES) National Education Longitudinal Study (NELS: 88) data (McLaughlin, Cohen, & Lee, 1997) concluded that, by taking algebra in 8th- grade, students had a greater chance of going to college (Spielhagen, 2006; Smith, 1996; Stevenson, Schille, & Schneider, 1994). Smith (1996) concluded that "early access to algebra had a sustained positive effect on students, leading to more exposure to advanced mathematics curriculum and, in turn, encouraging higher mathematics performance by the end of high school" (p. 148). Spielhagen (2006) found that "students who completed algebra in 8th grade stayed in the mathematics pipeline longer and attended college at greater rates than those who did not" (p. 35). He suggested greater access to algebra in 8th grade as a means of closing the achievement gap in math.

Although California's public school curriculum frameworks did not specify algebra as an 8th grade mathematics standard, the 2003 California assessment and accountability system deemed algebra to be an end-of-course (EOC) test for students in grades 8 through 11. The state's education accountability system penalizes schools and districts for not testing 8th- and 9th-grade students in algebra or higher mathematics EOC. Since then, the percentage of 8th-grade students taking algebra has risen from 34% in 2003 to 59% in 2011 (California Department of Education, 2003; 2011). Also, since 2006, when California started allowing 7th-grade students to take the California Standards Test (CST) for Algebra I, the number of students in grade 7 taking the algebra CST has increased from 22,000 in 2007 to 38,000 in 2011, which is 4.4% and 8.1% of the state's 7th-grade population, respectively (California Department of Education, 2007; 2011). On July 9, 2008, the California State Board of Education (SBE) decided that within three years all schools would be assessing their 8th-grade students in algebra.[1]

Unintended Consequences of the Policy for Student Achievement

These nationwide and statewide educational endeavors during the past several decades have greatly increased the numbers of students enrolling and succeeding in algebra classes (Bozick & Owings, 2008). However, this unprecedented access to algebra courses has brought with it a widened spectrum in learning achievement. Test results led to the charge that enrolling more students in algebra classes did

1 After the SBE's decision, the Association of California School Administrators (ACSA) and the California School Boards Association (CSBA) filed a law suit against the SBE on the decision. The plaintiffs later were joined by the California Teachers Association (CTA) and Superintendent of Public Instruction Jack O'Connell. On December 19, 2008, a superior court judge issued a preliminary injunction which required the SBE to cease action associated with its July vote to mandate all eighth graders take the Algebra I California Standards Test.

not improve California students' overall mathematics achievement (Center for the Future of Teaching & Learning, 2005). Many educators speculated that placing more and more 8th-grade students into algebra courses would only increase the failure rate, as reflected in scoring *proficient* or above on the CST for Algebra I, and, then, inevitably increase the number of students repeating algebra in 9th grade. Students who repeated algebra would do a lot worse than those students who take algebra for the first time.

As shown in the state's Superintendent of Public Instruction's test results release in 2012, only 25% of students scored *proficient* or above in repeating the CST for Algebra I compared to 38% of students, who took the CST for Algebra I for the first time (Torlakson, 2012, August 15, Table 6). In 2007, 44% of California 9th-grade students took algebra over again after first taking it in 8th grade, largely due to their previous year's below-proficient scores on the CST for Algebra I (Liang & Guo, 2007). According to a recent report by the Brookings Institute, 120,000 8th-grade students nationwide have been misplaced in algebra classrooms (Loveless, 2008). Loveless found that some of the misplaced students were functioning about 7 grade levels below peers enrolled in the same courses according to NAEP scale scores (p. 7).

From Access to Outcome: Asking Hard Questions

Policy makers often see "algebra for all" as a way to address the equity issue for students of minority and low-income families. Allowing these students access to college preparatory courses democratizes 8th-grade algebra and promotes social justice (Loveless, 2008, p. 3). However, as accountability has shifted from access to outcomes, focusing on student achievement to determine the policy's effectiveness is a matter of increasing concern (Shulock & Moore, 2007). As the No Child Left Behind (NCLB) law aims at closing the achievement gap between minority and poor students on the one hand and white and middle class students on the other, educators and policy makers are facing a tough question: Is it appropriate to place in algebra courses those 8th-grade students, who appear to be not prepared and likely to fail, considering that there are not sufficient resources and effective academic support to advance their success?[2]

Of course, there is also the issue of whether the "algebra for all" policy translates into teacher action and classroom practices reflecting the intent of the policy. W.W. Charters, Jr. and John E. Jones (1973) raised a concern about the risk of appraising non-events in program evaluation because implementations of policy could be "more fictional than factual" (p. 5). For example, remedial mathematics courses have not disappeared from those same districts, where the "algebra for all" policy has been embraced, even as the trend to push algebra into 8th-grade classrooms has become noticeable (National Center for Education Statistics, 2005). According to the California Basic Education Data System (CBEDS)[3], for example, remedial math still exists in many classrooms of the numerous California school districts that adopted "algebra for all 8th graders."

While a great many teachers and students are making enormous efforts to teach and learn algebra in 8th-grade classrooms, the staggering performance of these students on the statewide assessment forces educators to ask the hard question, whether providing the access to those students that algebra was a far reaching subject actually benefits them if they are not achieving the learning success. Educators must make tough choices to balance students' access and learning outcomes as schools and districts in California are under increasing pressures of raising students' test scores to meet the state and federal accountability requirements.

In this new climate, policy makers and educators are confronted with many other questions related to this "algebra for all" policy. Several studies based on California's Standardized Testing and Reporting (STAR) program from the state's middle schools and high schools shed light on the effect of increasing 8th-grade algebra test-taking. Kriegler and Lee (2006) studied over 100 middle schools in Southern California. They found that placing students who scored below basic

2 In August, 2009, California then Superintendent Jack O'Connell proposed the "California Algebra I Success Initiative," which called for $3.1 billion to build the infrastructure for California schools to prepare all California 8th graders to succeed in algebra. Yet, this initiative was never funded.

3 A database collected by the California Department of Education. The online access is at this link: http://www.cde.ca.gov/ds/sd/cb

or far below basic in mathematical proficiency on their 7th-grade CST in 8th-grade algebra courses is ineffective because a large number of these students failed the CST for Algebra I. Their study concludes that a *proficient* or above score on the 7th-grade CST for Mathematics is a strong indicator for 8th-grade algebra success (p. 10). Waterman (2010) investigated 8th- and 9th-grade mathematics classes in eight school districts in Northern California's Bay Area. He found that many students repeated algebra and that repeating did not yield better results in 9th grade. A more recent comprehensive study on middle grade mathematics performance by Williams, Haertl, Kirst, Rosin, and Perry (2011) concluded that "placing all 8th graders into Algebra I, regardless of their preparation, sets up many students to fail" (p. 3).

Outside of California, Allensworth et al. (2009) studied data from Chicago schools. They found placing all 9th graders in algebra had few benefits. They concluded, "Although more students completed 9th grade with credits in algebra…, failure rates increased, grades slightly declined, test scores did not improve, and students were no more likely to enter college" (p. 367). Clotfelter and his colleagues (2012) reported on the negative impact of 8th-grade algebra in the Charlotte-Mecklenburg schools in North Carolina. They noted that, "students affected by the acceleration initiative scored significantly lower on end-of-course tests in Algebra I, and were either no more likely or significantly less likely to pass standard follow-up courses, Geometry and Algebra II, on a college-preparatory timetable" (p. 1). Finally, as noted earlier, in *The Misplaced Math Student: Lost in Eighth-Grade Algebra*, Loveless (2008) found that 120,000 students nationwide were misplaced in 8th-grade algebra classrooms.

Two Elements of Algebra Success: Placement and Preparation

This paper then aims to provide empirical evidence in two critical elements of algebra success for all: student placement and algebra preparation. We make use of our most recent studies to answer three questions (Liang, 2009; Liang, Heckman, & Abedi, 2012). First, regarding both placement and preparation, we looked at whether the increase in the number of California 8th-grade students taking algebra has achieved the goal of the "algebra for all" policy, namely, increasing the overall college preparation course-taking pipeline. We discovered that the answer is yes, but this pipeline has a significant leak in it. Second, regarding preparation, we asked what are the differences in both 9th-grade test taking rate and performance between (a) those students who took the CST for Algebra I at 8th grade and scored below *proficient,* and (b) those students who took the CST for general mathematics at 8th grade and scored *proficient* or above? We discovered that students who are proficient in General Mathematics at the end of 8th grade do better in algebra in high school than do those students who take algebra but do not do well. Third, regarding placement, we wanted to know what subset of the content domain of mathematics, its knowledge, and skills account for 8th-graders' algebra scores. Our hope was to provide a means whereby educators could more accurately place 8th-grade students in the level of course more likely to benefit their mathematical development.

Method

The data sources for this investigation are the students' test results from the California Standardized Testing and Reporting (STAR) program. We used two data sources: one is the aggregate data reported by the California Department of Education from 2003 to 2011[4]; the other is the STAR student level data files administered in 2006 and 2007. These data files were obtained from the California Department of Education in November, 2007. Several factors guided us to choose these two years for the study. First, year 2006 is the last year that all 7th-grade students take the CST for Grade 7 Mathematics. Starting 2007, students in grade 7 who took algebra courses are allowed to take the CST for Algebra I, instead of CST for Grade 7 Mathematics. Second, after 2007, the California Modified Assessment (CMA) was developed for students with disabilities who have an individualized education program (IEP) and meet the criteria for taking the CMA. With the CMA, many students who would have taken the CST are no longer in the data files. Last but not the least, the use of Statewide Student Identifier (SSID) was first implemented in 2006, though on a voluntary basis, with

4 These data can be retrieved at http://www.star.cde.ca.gov

a participation rate (over 95%) sufficient for this study. The SSID, then, became mandatory in 2007. The SSID enables researchers to conduct longitudinal studies by matching student records from year to year.

We used the SSID to produce two cohorts. The first cohort (Grades 8-9) consists of 8th-grade students who took various CSTs mathematics, mainly the CST for General Mathematics and the CST for Algebra I in 2006. These cohort data were investigated for the differences between the 8th-grade CSTs for General Mathematics and Algebra I scores and students' performance on their following year's CST for Algebra I. The second cohort (Grades 7-8) consists of 7th-grade students who took the CST for Grade 7 Mathematics in 2006 and the CST for Algebra I at 8th grade in 2007. These cohort data were analyzed to determine predictive factors among 7th-grade CST mathematics sub-scores of the 8th-grade algebra achievement.

In the STAR program, most students take the sequence of CSTs for Algebra I, Geometry, Algebra II, and Summative High School Mathematics. In order to examine this college preparation pipeline, we analyzed students' participation in taking these CSTs between 2003 and 2011. We chose three cohorts of students, each with test-taking patterns for four year periods. Each cohort took the CST for Algebra at 8th grade, and, subsequently, they then took the CST for Geometry at 9th grade, Algebra II at 10th grade, and Summative High School Mathematics at 11th grade. These three cohorts provide the CST data for the analyses of this study from each of these years, 2003-2006, 2005-2008, and 2008-2011.

In the latest STAR report in 2012, 49% of 8th graders scored *proficient* or above on the CST for Algebra I (California Department of Education, 2012). The large failure rate of 8th graders on the CST and the studies that reveal misplacement of students in 8th-grade algebra courses (Kriegler & Lee 2006; Loveless, 2008; Taylor, 2011; Waterman, 2010; Williams et al., 2011) led us to investigate better pathways for algebra success. We took a close look at 8th-grade students and linked their 8th-grade test-taking and performance to their 9th-grade test-taking and performance with a longitudinal analysis. The majority of 8th-grade students constitute four subgroups: (1) those who took the CST for Algebra I and scored *proficient* or above; (2) those who took the CST for Algebra I and scored below *proficient*; (3) those who took the CST for General Mathematics and scored *proficient* or above; and (4) those who took the CST for General Mathematics and scored below *proficient*.

Our focus is on the two marginal subgroups. We consider that group 1 is rightly placed in algebra and succeeds, and group 4 has little chance of succeeding in algebra because they failed a test that is much easier than algebra. We, then, name the groups in the middle on which we focus as (a) 8th-graders who scored below proficient on the CST for Algebra I and (b) 8th-graders who scored proficient or above on the CST for General Mathematics. We analyzed their 9th grade test-taking and performance.

In the quest to improve students' success in 8th-grade algebra, the overreaching question becomes what are the conditions for learning algebra and how do they relate to increasing students' success in learning algebra? One can address this question by examining the specific variables that predict students' algebra achievement. Our study focuses on such an investigation by examining variables of students' prior year's CST mathematics sub-scores. We were especially interested in finding out what prior year's scores on mathematics knowledge and skills might contribute to students' success in 8th-grade algebra. We identified specific sub-scores that reliably predict this success. Though outside the scope of our study, we acknowledge that some of the conditions for algebra success may include many other factors, besides those we examined, including the student's cognitive development (Gagné, 1963; Piaget & Garcia,1989), their motivation (Middleton & Spanias, 1999), peer influence (Bulotsky-Shearer, Fernandez, Dominguez, & Rouse, 2011), school and community influence (Keck-Staley, 2010; Nasir, Hand, & Taylor, 2008; Cobb & Hodge, 2002), students' self-identity (Solomon, Lawson, & Croft, 2011; Nasir, 2002), and language proficiency (MacGregor & Price, 1999).

Historically, algebra has been a 9th-grade high school mathematics course (George, 2007), usually for students going to college and at other times for all students. It has also been viewed as a difficult subject to master (Heppel, 1895). Educators and policy makers have focused on academically preparing students to succeed in algebra, specifically and recently

through curriculum standards reform. In adopting the *California Mathematics Framework* in 2005, the State Board of Education approved a new list of standards, the Algebra Readiness Program, consisting of 16 California mathematics content standards. Among these standards, thirteen are grade 7 content standards and three are algebra I content standards (California Department of Education, 2006). The Algebra Readiness Program, recommended as a remedial course for students in grades 8 and 9, was designed to rebuild the foundational skills and concepts that might presumably be missing from students' academic learning in the early grades.

In March of 2008, the U.S. Department of Education released *Foundations for Success*, the final report by the National Mathematics Advisory Panel. The report lists the benchmarks for specific mathematics concepts and skills by grade level, which according to this report make up the "critical foundation of algebra" (U.S. Department of Education, 2008). The report calls on the nation's schools to provide "effective preparation of students for the study of algebra" (p. 15). According to the report, these concepts and skills are derived mainly from the following sources:

> 1) The Grades 1–8 curricula of the highest-performing countries on [Trends in International Mathematics and Science Study, added] TIMSS (Singapore, Japan, Korea, Hong Kong, Flemish Belgium, and the Czech Republic), sometimes called the "A+ countries," 2) National Council of Teachers of Mathematics Curriculum Focal Points for Prekindergarten through Grade 8 Mathematics: A Quest for Coherence (hereinafter Focal Points), 3) Grades K–8 in the six highest-rated state curriculum frameworks in mathematics, 4) a 2007 American College Testing (ACT) survey, and, 5) a Panel-sponsored survey of 743 teachers of introductory Algebra across the country who were asked what students need to learn to be prepared for success in Algebra. (p. 17)

Critics charged that the National Mathematics Advisory Panel's report lacked the empirical research to back up its recommendations. As Thompson (2008) pointed out, those curricular content areas recommended by the panel were "based on the professional judgment of panel members, not on empirical research into teaching and learning algebra" (p. 582), and not on current research in learning and cognition, the science of learning. Therefore, studies are needed to explore the relationship between algebra experiences in courses, as seen in the necessary knowledge and skills to be learned, and algebra success. Specifically, it is of interest to examine the empirical links between students' prior content knowledge and skills and their learning success. In this study, we search for such a link, seeking answers to the question: What specific mathematics content knowledge and skills predict 8th-grade algebra achievement?

Again, we performed a longitudinal study with the data we earlier described, including a cohort of students when they were in 7th grade in 2006 and in 2007, when they were in 8th grade. As we have mentioned, we chose the data for these two years because 2006 is the last year when all 7th graders took the CST for Grade 7 Mathematics. This makes those CST scores for the year of Grade 7 Mathematics a complete data set. We matched the students in 8th grade who took the CST for Algebra I and found 208,043 matched records. We performed a linear multiple regression analysis using students' grade 7 CST sub-scores as independent variables and their CST for Algebra I raw scores as the dependent variable. There are 6 sub-scores (also called reporting clusters) in the CST for Grade 7 Mathematics:
(1) *rational numbers*;
(2) *exponents, powers, and roots*;
(3) *quantitative relationship and evaluating expressions;*
(4) *multistep problems, graphing, and function*;
(5) *measurement and geometry*; and
(6) *statistics, data analysis, and probability*.

Results

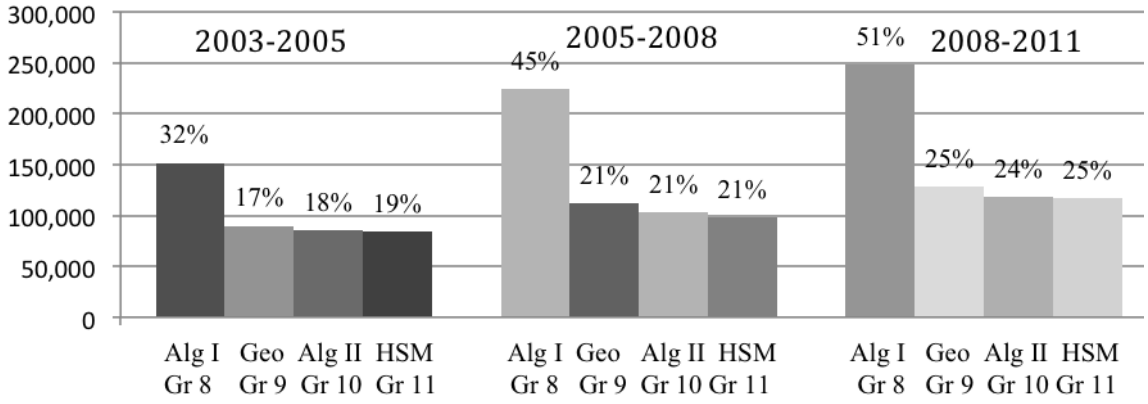
Question 1: The Impact of 8th-Grade Algebra on the College Preparation Pipeline

Figure 1 shows numbers and percentages of students in grades 8 through 11 of three cohorts taking the California Standards Tests.

Two trends emerge from the chart: There are increases in the numbers of students taking algebra

Figure 1

Numbers and Percentages of Students in Grades 8 Through 11 of Three Cohorts Taking the California Standards Tests.



and higher level CSTs across grade levels from 2003 to 2011, and the increases in the numbers of students in 9th through 11th grades taking higher level CSTs for mathematics are much smaller than the increases in the number of students in 8th grade taking the CST for Algebra I. For example, in 2003, 151,714 8th-grade students took the CST for Algebra I. By 2008, 248,155 8th-grade students took the CST for Algebra I. This increase involved an additional 96,441 students (about an additional 19 percentage points) of 8th-grade students taking the CST for Algebra I from 2003 to 2008. A more moderate pattern of increases exists for 9th- through 11th-grade students with regard to their participation in taking other higher level mathematics' CSTs between 2004 and 2011. For example, there are an additional 33,151 (about a 7 percentage points increase) 11th graders taking the CST for Summative High School Mathematics between 2006 and 2011. The existence of these two trends suggests that the desire of policy makers to increase attention and participation in algebra and higher-level mathematics appears to be having a desired effect.

Yet despite the impressive increases in 8th-grade students' taking the CST for Algebra I, there is not a corresponding increase in the numbers of students taking CSTs for higher mathematics. This fact suggests that these policies may be engendering increases in students' involvement in algebra, but not in the study of higher level mathematics in general. Students may not be able to or want to move beyond this entry-level of higher mathematics' experience. While there have been increases in the numbers of students taking higher-level mathematics CSTs, they are not nearly as large as the increase in numbers of students taking the CST for Algebra I.

This deterioration between the number of 8th-graders CST for Algebra I takers and the number of 9th graders CST for Geometry takers signifies a decline and leads us to suggest that there may be a leak in the pipeline. It appears that simply encouraging more students to take 8th-grade algebra may not, by itself, lead to significantly more students taking advanced mathematics in high school.

The fact that the leaking pipeline of students' success in mathematics, beginning with 8th-grade algebra, shows deteriorations in the increase of higher level CSTs participation suggests that more has to be done than simply requiring a course or designating a set of knowledge and skills to be learned. Such encouragement for students to take courses is certainly necessary, but it is not sufficient for realizing students' understanding and encouraging their motivation to continue to learn higher mathematics.

The reductions in gains in students' participation in higher level CSTs for mathematics as well as the less than dynamic student performance on the CSTs students (not shown in the figure) through their high school grade level advancements led us to examine more closely student participation in 8th-grade mathematics classes, their passing or failing the CST,

Table 1

Percentages of Students Scoring Proficient or Above in 9th-Grade Various CSTs Between Students who Scored below Proficient on the CST for Algebra I (subgroup A) and Students who Scored Proficient or Above on the CST for General Mathematics (subgroup B) at 8th Grade

CST	Sub-group A %	Sub-group B %	Difference
General Mathematics	1.01	8.13	7.12
Algebra I	9.61	31.46	21.85
Geometry	2.72	1.27	-1.45
Total	13.67	41.01	27.34

and the correlations of these factors with higher scores on CST for Algebra I among 9th grade students.

Question 2: Failing Algebra versus Passing General Mathematics at 8th Grade as Preparation for Higher Level Mathematics Study

The majority of our two subgroups of students took the CST for Algebra I at 9th grade: 64% in subgroup A of the students scoring below *proficient* on the CST for Algebra I at 8th grade and 82% in subgroup B of the students scoring *proficient* or above on the CST for General Mathematics at 8th grade (not shown in the table). The second largest group of students in the rest of subgroups A and B took CST for General Mathematics with 8% and 12%, respectively; CST for Geometry with 27% and 4%, respectively. Table 1 shows the percentages of students scoring *proficient* or above in 9th grade on various CSTs between students in subgroup A and subgroup B.

As shown in Table 1, our subgroup B students outperform their peers in subgroup A significantly. Students who scored below *proficient* on the CST for Algebra I at 8th grade have much less chance of passing the CST for Algebra I at 9th grade compared to those students who scored *proficient* or above on the CST for General Mathematics (9.61% vs. 31.46%). In other words, those students who failed the CST for Algebra I at 8th grade and retook the same test at 9th grade had a 69% (1-0.0961/0.3146) less chance of passing the test compared to those students who passed the CST for General Mathematics at 8th grade and took the CST for Algebra I at 9th grade for the first time. This striking failure rate is highlighted in a California Department of Education press release that stated that for grades 8 through 11, only 15% of students repeating the CST for Algebra I scored *proficient* or above compared to 26% of first time algebra test-takers in all grades for the 2007 test administration. More recent data from the 2012 test administration show that 36% of first time Algebra I CST takers scored proficient or above compared to 24% of the re-takers scoring *proficient* or above (Torlakson, 2011, August 15, Table 6). The difference between first time algebra test-takers and repeaters in success rates and the fact that it appears to be continuing through 2012 raise serious questions about giving algebra one year sooner to those students, who scored below *proficient*. These rates also suggest that such a practice may not help them succeed in algebra in following years. If course placement can play a key role in providing students an appropriate education program and therefore lead to better success for their learning, we can then turn our attention to the conditions necessary for students' algebra success.

Question 3: Linking Prior Year's Mathematics Knowledge and Skills to 8th-Grade Algebra Success

Table 2 shows the multiple regression analysis of 8th-grade Algebra I's raw score using the CST for Grade 7 Mathematics' 6 reporting cluster sub-scores as predictors.

As indicated in Table 2, the sub-scores of 6 reporting clusters contributed 62% of the variance of the 8th graders' CST for Algebra I raw scores. If the CST for Grade

Table 2

Multiple Regression Analysis of 8th-Grade CST for Algebra I's Raw Score Using the CST for Grade 7 Mathematics' 6 Reporting Cluster Sub-scores as Predictors (N=208,043)

Variables	B	SE(B)	*β*	*t*	*Sig. (p)*
Rational numbers	.858	.008	.225	104.34	<.0001
Exponents, powers and roots	.963	.011	.165	86.53	<.0001
Quantitative relationship	.958	.010	.179	92.48	<.0001
Multistep problems and graphing	.502	.009	.128	58.57	<.0001
Measurement and geometry	.730	.008	.184	87.22	<.0001
Statsitics and analysis	.640	.015	.075	42.69	<.0001

$R^2 = .620$

7 Mathematics sub-scores predicts 8th-grade algebra achievement with great reliability, then, what subsets of skills and knowledge might contribute to this strong prediction? Our model indicates that the sub-score of the reporting cluster *rational numbers* is the strongest predictor, contributing 48% (not shown in the table) of the variance of the 8th-grade CST for Algebra I scores, with a Beta (β) value of .225. That is, a one-unit *standard deviation (SD)* increase in the CST for the sub-score of *rational numbers* results in .225 SD units' increase of the CST for Algebra I. The second strongest predictor is the sub-score of *quantitative relationships and evaluating expression*, contributing 8% (not shown in the table) of the variance of 8th-graders' CST for Algebra I scores, with a Beta value of .179.

According to the California Department of Education (California Department of Education, 2009), the *rational numbers* reporting cluster of the CST for Grade 7 Mathematics assesses whether students "know the properties of, and compute with, rational numbers expressed in a variety of forms" (p. 2). The various forms of these rational numbers include integers, fractions, decimals, and percents (California Department of Education, 2006). In the released test questions 1-20 (California Department of Education, 2009, pp. 7-12), one can observe that the subset of *rational numbers* tests students' ability to manipulate fractions, decimals, and percents.

One statistical concern is that all the sub-scores in the six reporting clusters are highly correlated. This multicollinear relationship of the sub-scores could be seen as inflating the variance and distorting the relationship between predictor variables and criterion. However, this multicollinearity factor is monitored by the variance inflation factors (VIF), which range from 1.7 to 2.6 (not shown in Table 2) for the sub-scores of the six reporting clusters in the prediction model. Being smaller than ten, these VIF of the sub-scores do not affect the predicted values because only VIF numbers larger than ten are considered large enough to affect the predicted values (SAS, 2004).

Discussion

The CSTs results from our analysis show that the increase in the numbers of 8th graders taking algebra has indeed expanded the college preparation pipeline in high schools. However, this pipeline has a significant leak in it. In the efforts to focus on improving students' learning in middle schools and high schools, we must look at each and every one of the students we serve and the empirical and theoretical evidence to determine the most effective learning conditions for enhancing student learning.

Our study, and many others, has shown that placing all 8th-grade students into algebra courses does not help all of them in their subsequent year's of learning (Clotfelter, Ladd, & Vigdor, 2012; Liang, Heckman, & Abedi, 2012; Loveless, 2008; Taylor, 2011; Waterman, 2010; Williams, Haertel, Kirst, Rosin, & Perry 2011; Williams, et al., 2011). Our study also indicates

that students who scored below *proficient* on the CST for Algebra I at 8th grade have a 69% less chance to score *proficient* or above on their CST for Algebra I at 9th grade compared to their peers who scored *proficient* or above on the CST for General Mathematics at 8th grade. Our regression model reveals that, among the content subject area, *rational numbers* is a strong predictor of algebra achievement.

This finding about the importance of rational number sense fits with other studies of learning conditions that support student understanding of mathematics. Scardamalia et al. (2012) concluded that, "proportional thinking or rational number sense is more fundamental and more skill-enhancing than mastering (or not quite mastering) a number of rational number algorithms" (p. 233). The reason for this admonition and consideration has been known and argued for in the research literature for some time. Davis (1994) noted the following:

> What seems to be the newly emerging view is that the goal of teaching mathematics deals primarily with how students think about various kinds of problems, and with providing students with enough meaningful (and often concrete) experience so that students can build up, in their own minds, a large and powerful repertoire of basic metaphors or precursors of mathematical ideas (or, if you prefer, assimilation paradigms). These are the mental tools that make it possible for students to build mental representations or problem situations, and representations of possibly helpful knowledge. In short, these are the building blocks with which a student can think mathematically. (p. 613)

It is important to point out that our study is only based on the data of test results. We do not know students' educational programs, nor do we know their efforts and their teachers' efforts in classrooms, other than their demographic characteristics. The algebra curriculum that is being taught in the schools across California and the nation today is, by and large, a curriculum of classical algebra that has changed little from the one taught in American high schools in the late 1800s. The difference today from that of the late 19th century is that all of the students are being asked to succeed on tests in algebra. In the California STAR data, there are many students repeating the CST for Algebra I, once, twice, three times, and in extreme cases, four times. It is highly possible that some of these repeaters failed the courses within the same educational settings and with the same curricula that have been repeated many times. In order to improve the much weaker chance of success in the second time trying the CST for Algebra I, as indicated in our study, educators and policy makers need to turn their attention to a broader scope, such as educational settings, curricula, and pedagogy and allow alternatives to the ones our students have experienced without much success. One of the alternatives to these persistent practices is in the creation of educational settings and conditions for Indigenous Invention (Heckman & Montera, 2009), which encourages educators and students with whom they work to be creators, inventors, and innovators. The alternative curricula that arise in such an endeavor unleash teachers' creativity and students' funds of knowledge (Gonzales, Moll, & Amanti, 2005).

A recent educational movement in the nation, as well as in California, is the adoption of the Common Core State Standards (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). The new standards list algebra as part of high school standards. Standards for grade 8 mainly focus on arithmetic and pre-algebra. In 2010, when the California Academic Content Standards Commission adopted the common core standards, it added California 8th grade Algebra I standards (California Department of Education, 2010). The commission recognized that not all California 8th graders would be successful in algebra and prescribed duel standards for 8th grade. However, a new bill (SB 1200), signed by Governor Brown in September, 2012, allows the state to approve or modify the common core academic content standards in mathematics (California Education Code, Section 60605.11(a). The law also specifies "One set of standards is adopted at each grade level" (California Education Code, Section 60605.11(b)(3). While critics charge this is a backward move, the President of State Board of Education Michael Kirst stated that SB 1200 "marks a critical step forward in California's efforts to

implement the Common Core Standards and to ensure algebra is accessible to every student" (Fensterwald, 2012, September 28). Dr. Kirst also clarified this point in an Education Week article (Robelen, 2012, October 24), as saying that the new law, "allows the state to clarify that it will provide two course pathways, one for students ready for algebra at grade 8 and another for those who take it a year later" (p. 11).

In January 2013, the State Board of Education adopted a revision of California Common Core Standards. This revision stripped California's Algebra I standards from the state's 8th- grade math standards (Fensterwald, 2013, January 17). In the current development of California mathematics framework, the state will create curriculum options to accelerate math-taking in middle school and high school and to leave it up to local districts to determine who's eligible for them. One month later, the advisory committee to the Public School Accountability Act (PSAA) recommended dropping the API penalties for schools and districts that do not test 8th grade students in algebra (Fensterwald, 2013, February 13). In March 2013, the State Board of Education approved the elimination of the penalty of testing 8th and 9th graders in general mathematics for schools and districts accountability (State Board of Education, 2013). By doing so, it ended the California 8th grade algebra for all policy.

Our findings suggest that questioning the basic frameworks that have guided the development of learning in school mathematics and the policies for advancing student achievement in mathematics would make greater contributions to student learning success than creating requirements that are based on unwarranted claims. Without empirical evidence, what works and what does not work in educational reform appears to depend then on arguments based in beliefs and unwarranted claims. Instead, we recommend further investigations that will permit a better understanding of the limits and the range of opportunities for our diverse students in California and their success in this very important and critical area of mathematics. It is not enough to use carrots and sticks in making students trudge through a presumed list of important knowledge and skills and learning activities that do not yield the promises given to them. We are better than that as a State, as educators, researchers, and citizens.

Author Note

The opinions expressed by Jian-Hua Liang are of the author alone and do not reflect opinion or policy of the California Department of Education.

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Evaluating Student Preparedness and Conceptual Change in Introductory Biology Students Studying Gene Expression

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ABSTRACT

Conceptual difficulties experienced by introductory college biology students studying gene expression are explored in this empirical study. We used an open-ended assessment instrument and a pre-test/post-test design to measure prior knowledge and conceptual change over the course of one semester. Our findings suggest that introductory biology students struggle with the basic terminology necessary to understand complex biological systems at the molecular and genetic level. While conceptual growth from the beginning to the end of the semester was less than expected, learning gains were significant for all concepts examined by our assessment strategy. Qualitative evaluation of pre- and post-tests further highlighted the difficulty students have articulating their knowledge using scientific language. In our discussion, we emphasize the importance of assessing conceptual understanding, developing instructional strategies to promote conceptual change, and the need for closer alignment of curriculum between and within institutions. Ultimately, educational and institutional resources to support faculty development in the area of teaching and learning are critical for the retention and preparation of a diverse student population in the biological sciences.

Introduction

Many students entering Introductory Biology classes designed for majors arrive underprepared for the college curriculum. Few biology departments offer remediation or preparatory courses, as is standard in other disciplines such as math, chemistry and English. Furthermore, most Introductory Biology courses cover a substantial amount of material at a superficial level and rely heavily on traditional lecture and assessment strategies. These practices continue despite mounting evidence that "depth over breadth" and a student-centered learning environment with frequent and formative assessment is more effective (e.g., Freeman et al., 2007; Handelsman et al., 2004; Knight and Wood, 2005; Udovic et al., 2002). Many have linked these short-comings to the high dropout rate, academic failure, and overall dissatisfaction among Science, Technology, Engineering and Math (STEM) majors (Seymour and Hewitt, 1997; Tinto, 1993; Tobias, 1990; Vision and Change, 2007). This is particularly true for under-represented minority groups, which currently represent only 9% of college graduates entering the STEM workforce (NAS, 2010). As faculty teaching introductory biology courses, we can begin to address these problems by 1) understanding what prior knowledge and preconceptions our students bring to the classroom, 2) identifying the concepts that pose the greatest difficulty through frequent and formative assessment, and 3) designing curricula using evidence-based strategies shown to facilitate deep learning and

conceptual change.

Genetics is part of the core curriculum for biology majors, and understanding gene expression, how genes get turned on and off, is fundamental to understanding how all cells, tissues, and organisms function. The Biology-Online.org dictionary defines gene expression as:

"The conversion of the information from the gene into mRNA via transcription and then to protein via translation resulting in the phenotypic manifestation of the gene." In the Introductory Biology course at our institution, an appraisal of exam scores and responses from student surveys indicated that the concept of gene expression routinely posed great difficulty for students. Fundamentally, in order to understand this definition, students must first understand the nature of genes, mRNA, transcription, proteins, translation and phenotypes.

Several validated assessment tools are available to gauge students' conceptual understanding of genetics (Bowling et al., 2008a; Smith et al., 2008); however, like the dictionary's definition above, these diagnostics assume a working knowledge of basic genetics terminology. In this study, we sought to discover whether students at the introductory level had sufficient prior knowledge of the basic concepts needed to understand gene expression, monitor learning gains, and ultimately inform the development of curriculum focused on the conceptual difficulties observed. While we report data on students' knowledge in a specific area of genetics, we believe our results highlight a more pervasive problem related to student preparedness for the college science curriculum.

Theoretical Framework

There is a wealth of knowledge from the fields of cognitive psychology and science education to suggest that conceptual change for students studying science is difficult (reviewed by Zirbel, 2004). The most well-known model of conceptual change in science education espouses confronting students with a conflict between their beliefs and those held by the scientific community, and then supporting their learning as they construct new knowledge (Strike and Posner, 1992). Franke and Bogner (2011) report success using this approach with a constructivist, hands-on curriculum for high school students studying gene technology. However, even when such strategies are used effectively, research suggests that students have difficulty changing their beliefs, and subsequently retaining these new beliefs (Mazur, 1997). Chinn and Brewer (1993) suggest that "peripheral conceptual change" is most common as students create a new hybrid conception that combines their deeply-rooted beliefs with the new ideas obtained from instruction. Smith and Knight (2012) also report difficulties with conceptual change in a population of college students studying genetics. The authors identified a set of Most Common Incorrect Answers (MCIAs) related to specific concepts on a genetics conceptual assessment. An examination of student response patterns found that if a student selected the MCIA on the pre-test and then missed the same question after instruction, it was likely that the student would select the same MCIA during the follow-up assessment. They concluded that some incorrect ideas are more difficult to correct than others. Experts further agree that conceptual change is slow and iterative, requiring considerable effort by the learner and instructor. Therefore, learning gains made by students exploring complex systems may not be substantial during the course of one unit or even one semester, and this may be particularly true for terms and concepts that are unfamiliar to students prior to instruction (Chi et al., 1994; Ohlsson, 2009).

While multiple perspectives regarding the most effective way to promote and analyze conceptual change have emerged, there is considerable evidence to suggest that traditional approaches are less effective than a variety of student-centered, active learning methods (reviewed by Banet and Ayuso, 2000; Duit and Treagust, 2003). Additionally, the ascertainment of students' prior knowledge and misconceptions through classroom assessment techniques is a crucial part of these strategies (Angelo and Cross, 1993; Sundberg, 2002; Tanner and Allen, 2004). In a literature review on the effect of prior knowledge on learning, Roschelle (1995) claimed that a large body of research concluded that "Learning proceeds primarily from prior knowledge, and only secondarily from the presented materials." This suggests that the most carefully designed instruction may be ineffective for addressing incorrect ideas and supporting conceptual growth

when prior knowledge is not considered, as students will interpret the curriculum through their personal knowledge, beliefs, and attitudes.

Literature Review

A 2005 report indicated that 10% of all students graduating from two and four-year institutions were choosing careers in the life sciences or healthcare fields (National Center for Education Statistics, 2005). Yet, according to an earlier report, only 30% of high school seniors could correctly answer questions related to genetics (National Center for Education Statistics, 2000). A number of genetics misconceptions have been identified for both high school and college students (e.g., Browning and Lehman, 1988; Marback-Ad, 2001; Orcajo and Aznar, 2005; Smith and Knight, 2012). It has been suggested that many of these originate early in middle and high school (AAAS, 1993) as a consequence of conceptual difficulties that K-12 teachers have with the material (Cakir and Crawford, 2001). These difficulties likely relate to the fact that genetics requires a solid foundation of the molecular nature of biological systems, which draws upon an understanding of physics and chemistry. K-12 science teachers rarely master these disciplines during their training (Klymkowsky, 2010). In addition, some of the difficulties students encounter with genetics are not actual misconceptions, but instead may result from incomplete understandings and confusion regarding the relationships between different concepts (Tanner and Allen, 2005; Lewis et al., 2000; Marback-Ad and Stavy, 2000).

While the reasons for the difficulties are varied and complex, it is clear that students at all levels struggle with genetics concepts (Marbach-Ad, 2001; Longden, 1982; Stewart, 1982; Hildebrand, 1991; Lewis and Wood-Robinson, 2000; Smith and Knight, 2012). These findings have serious implications for biology instructors and curriculum developers. Faculty teaching Introductory Biology courses are often faced with highly diverse student populations. These include students from high schools with Advanced Placement (AP) biology training or inadequate science programs, as well as non-traditional students that are returning to college years after high school graduation. Furthermore, with few or no course prerequisites, the introductory classes enroll students possessing a broad range of interests and aptitudes for the biological sciences. The student diversity in the introductory courses makes assessment of prior knowledge, skills and disposition crucial to planning effective instruction. However, most college level biology courses continue to evaluate student knowledge exclusively through summative assessments that measure achievement for the purpose of assigning grades at the conclusion of a lesson (Tanner and Allen, 2004).

In response to the need for diagnostic instruments, a variety of tools have been developed by the science education community to measure student learning and identify misconceptions across several scientific disciplines, including physics (Hestenes et al., 1992), chemistry (Landis et al., 2001), geology (Libarkin and Anderson, 2005), general biology (Garvin-Doxas et al., 2007) and others (reviewed by Libarkin, 2008, D'Avanzo, 2008). When used in a pre-test/post-test design (Dimitrov and Rumrill, 2003; Sundburg, 2002), these conceptual assessments (or concept inventories) can be effective methods for gauging both prior knowledge and conceptual change. In recent years, several tools have been developed and validated to measure student learning in the field of genetics (Bowling et al., 2008a; Smith et al., 2008). Bowling and colleagues (2008a) developed a Genetics Literacy Assessment (GLA) to evaluate student understanding of 17 concepts central to genetics through 31 multiple-choice questions. While the GLA was designed and validated for non-majors, Smith and colleagues (2008) developed a Genetics Concept Assessment (GCA) consisting of 25 multiple-choice questions covering 9 genetics concepts, intended for both majors and non-majors. This instrument has been employed to distinguish the most and least difficult genetics concepts and identify incorrect ideas that students have the most difficulty changing. While these instruments have been carefully designed and validated, and are simple to administer and score, there are measurable limitations to their use for classroom assessment (Smith and Tanner, 2010). Most concept inventories are comprehensive, but don't allow for the examination of specific topics in depth. The inventories are generally inflexible in their content and structure, and while instructors may choose to select or eliminate specific questions, the validity and

interpretation may be compromised. Furthermore, while the multiple choice answers have been carefully written to include common misconceptions, this format does not allow for the identification of additional misunderstandings. The concept inventories described above were designed as standardized tools for widespread use, but others have designed their own classroom assessments, tailoring them for a particular population or around one or more specific learning outcome (Nazario et al, 2002; Elrod, 2008). For our study, we chose an instrument that afforded us the flexibility to select specific terms related to gene expression and provided rich data from written students' response. Limitations of this instrument included the need to develop a rubric and train scorers, as well as the time-consuming nature of the scoring.

Purpose and Research Questions

The overall purpose of this study was to evaluate both the prior knowledge and conceptual change of introductory level biology students studying concepts related to gene expression. With regard to a select set of terms/concepts, we sought to understand:

1. What prior knowledge do students possess upon entering college Introductory Biology?
2. How much conceptual change can occur over the course of one semester?
3. Which terms present the greatest and least difficulty?

Methods

Participants: A total of 120 introductory biology students from a four-year comprehensive, public university participated in this study during the Spring 2011 semester. The Introductory Biology course, BIO 2: Cells, Molecules and Genes, is a 5-unit class composed of two seventy-five minute lectures, one three hour lab and one two-hour activity per week. It is the second of two lower division courses required for Biological Sciences and related majors (e.g., Biochemistry, Environmental Sciences) as well as students applying to post-baccalaureate health professions programs. The assessment and methodology for this study conformed to, and was approved by, the Institutional Review Board (IRB) of the researchers' institution (Protocol #11-12-116).

Assessment Instrument: The assessment tool used in this study is an open-ended response instrument called the Ten Word Test, developed by Dr. Terry Underwood at California State University, Sacramento, for evaluating a collaborative project between the English department and Center for Community Engagement (personal communication, 2010). We modified the test to investigate students' prior knowledge and conceptual development around the concept of gene expression. The following ten terms were selected for inclusion: DNA, RNA, exon, gene, mutation, transcription, translation, epigenetics, protein and phenotype. The Ten Word Test is comprised of three parts, which examine students' 1) self-assigned confidence rating of each term, 2) ability to define or describe each term, and 3) ability to construct an essay in which they use some or all of the ten terms to explain the main concept.

In Part I, students' rated their confidence or level of comfort with the ten terms on a scale from 1-3, using the following guidelines:

1 = you know little to nothing about the term.

2 = you have "some knowledge" about the term but cannot fully explain it to others.

3 = you know "a lot" about the term, and feel you can define and explain it fully to others.

Parts II (description) and III (essay) were scored on a scale of 1-3, with scorers using the following guidelines:

1 = Answer provides little or no evidence of understanding of the term(s); answer is inaccurate or vague to gauge understanding.

2 = Answer indicates a basic understanding of the concept, but may be lacking in detail, level of complexity or sophistication.

3 = Answer provides a nuanced or complex description of the term. When appropriate, both the structure and function of the term are accurately and thoroughly described.

In addition, the numerical scores in Part II were further characterized with a quality identifier to justify the score. The following quality identifiers were applied: B = Blank (or no evidence of knowledge), I = inaccurate description, V = vague description (lacks clarity). For a score of 2, the quality identifiers are L = limited definition, P = partially correct (this allows for small inaccuracies in details, as long as the primary

description is accurate), N = novice language used (but otherwise, accurate).

Study Design: To validate the Ten Word Test for content and clarity and to develop the rubrics for scoring the tests, we conducted a pilot study on a subset of students enrolled in the BIO 2 introductory course during the Fall 2010 semester. Rubrics were developed in alignment with the course curriculum, and in consultation with two faculty members (other than the lead researcher) from the Department of Biological Sciences. Pilot results from aggregate data on 44 samples indicated minimal prior knowledge and moderate learning gains; however, the pilot tests were anonymous, preventing the comparison of the pre- and post-tests for the same individuals. Findings from the pilot guided the refinement of the Ten Word Test instructions and scoring rubrics used in this study.

For the current study, we used a mixed methods approach employing a pre-test/post-test repeated measures strategy to evaluate students' prior knowledge and learning gains over the course of one semester. Identical pre- and post-Ten Word Tests were administered in the first and last weeks of the 15-week semester. Students took the tests during the regular class period, and were given ample opportunity to complete all three parts. Tests were anonymous, but student-selected numbers were used for the purpose of linking pre- and post assessments. The standard course curriculum was the intervention for the purpose of this study. During the Spring 2011 semester, when these data were collected, instruction for the molecular genetics units that directly related to the terms on the Ten Word Test spanned six weeks, but some of the terms (e.g., DNA, gene, RNA, protein) were used regularly throughout the entire semester.

Data Analysis: All tests (n=240 pre and post) were consolidated into a single batch, blinded, randomized and assigned a unique identification number. The scorers used ten tests for norming and agreement on the use of the rubric. Due to the time-consuming nature of the analysis, a random sample of 60 was chosen for in-depth analysis. Each survey in this sample was scored by at least two trained individuals, and a third was consulted in the case of disparate scores. Inter-rater reliability was determined to be > 80%.

Of the 60 tests analyzed, 32 could be matched to their corresponding pair, and met criteria for inclusion in the statistical analyses. The corresponding pairs that were not included in the set of 60 were pulled from the batch of 240, blinded, randomized and scored, resulting in a final dataset of 32-matched pairs. Allowing students to select their own identifying numbers proved to be a limitation of the design, as we were unable to match some of the pre- and post-test student-selected numbers. Microsoft Excel for Mac 2011, Version14.1.2, was used for data management and to calculate frequency and percent distributions and SPSS, IBM SPSS Statistics, Version 19, was used to compare pre and post-test scores for the 32-paired samples using the Wilcoxon Signed Ranks Test. Statistical significance was assigned to a p value of < 0.05. For the purpose of this study, we focused our data analysis on Part II of the Ten Word Test, first looking quantitatively at general trends of prior knowledge and learning gains and ranking terms in order of their difficulty. We then performed qualitative analysis on student descriptions of the terms in order to gain a deeper appreciation for the alternative conceptions that students hold and the language students use to explain their understandings.

Results

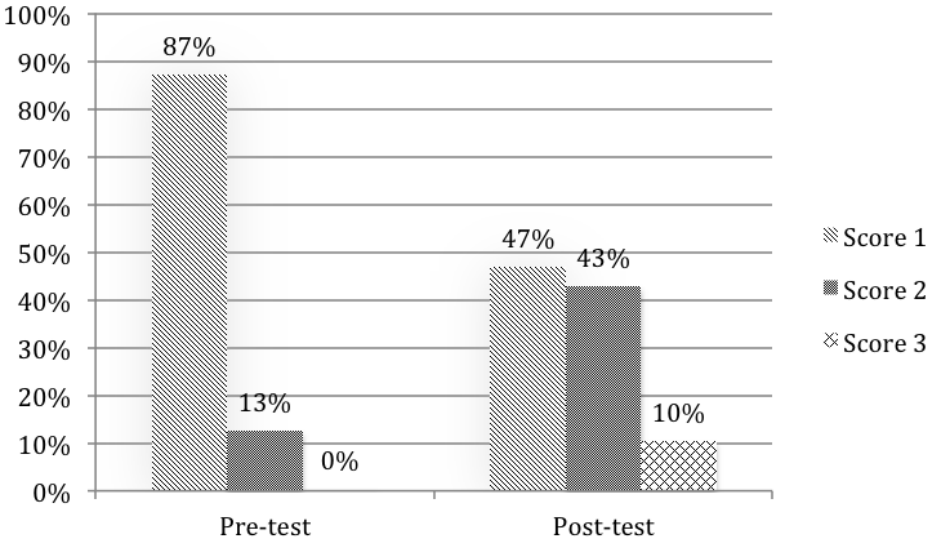
The overall percent distribution of scores assigned to students' descriptions of all ten terms combined is illustrated in Figure 1. For the pre-test, the lowest score (Score = 1) was assigned 87% of the time, indicating that most students were unable to provide adequate descriptions of the terms at the beginning of the semester. A score of 2, representing a basic level of knowledge, was achieved 13% of the time, and a score of 3 was assigned only once on the pre-tests. The aggregate data clearly show improvement from the pre to the post-test, as the percentages of scores of 1 (47%) and 2 (43%) were nearly equal, and there was a significant increase in the number of descriptions assigned a score of 3 (10%). While learning definitely occurred, the prevalence with which students received the lowest score on the post-test remained high, indicating that they were still struggling with basic terminology at the end of the semester.

The quality identifiers (Table 1) provide an explanation for the scores in Figure 1, and are informative in suggesting some general problems

Figure 1

Percent Distribution of Pre- and Post-test Scores.

Data are reported as relative frequencies of scores assigned to student descriptions for the ten terms evaluated in aggregate (n=64 tests, 32 matched pairs with 10 terms per test).



students experienced describing the terms. On the pre-test, it was clear from the number of answers left "Blank" (37%), that students often had no familiarity or were unable to articulate their knowledge of the terms. Some students indicated that they had heard of the term, but could not remember what it meant. The number of "Blanks" decreased to 5% on the post-tests, indicating that most students had enough knowledge to attempt an answer; however, their descriptions were often vague (24%) or inaccurate (21%). The number of descriptions earning a score of 2 that were accurate, but incomplete (limited), increased from 8% on the pre-test to 31% on the post-test. The high percentage of limited answers on the post-test are consistent with the findings of Marbach-Ad (2001), who reported a tendency for high school 12th graders to describe genetics concepts with vague or incomplete explanations on open-ended assessments.

To determine which concepts presented the greatest difficulty for students, we calculated percent distributions of scores for each term individually (Table 2). The difference in the pre- and post-scores was significant for all terms (p-value < 0.05), indicating an improvement in student performance from the beginning to the end of the semester. Of the 32-paired samples evaluated, only 4% of all post-test scores showed a significant decrease compared to their matched pre-test scores, whereas 46% of scores increased from pre- to post-test, and 50% were unchanged, indicating no improvement from pre-test to post-test (data not shown). All of the terms except Epigenetics are found in high school biology textbooks and curricula; however, instruction can vary among courses with regard to the time and depth devoted to each. As predicted, 100% of descriptions for Epigenetics were scored as a 1 on the pre-test, with a large percentage (78%) of students leaving the term blank. While learning gains were observed, only 16% of students scored a 2 (and there were no 3s) for descriptions of Epigenetics on the post-test. This was not surprising, as this concept is complex and only covered briefly in the Introductory Biology curriculum.

In addition to Epigenetics, students showed the greatest difficulty with the terms Exon, Transcription and Translation on the pre-test, often leaving the fields blank. This was not surprising for Exon, as it requires a more nuanced understanding of gene structure; however, we did expect more students to be capable of

providing a basic description of Transcription (i.e., the production of an RNA molecule from a DNA template) and Translation (i.e., the production of a polypeptide or protein from an mRNA molecule). Notably, while these terms were most challenging for students at the beginning of the semester, students demonstrated considerable improvement on the post-tests, with roughly half the number of scores of 1 on the post-test

Table 1

Percent Distribution of Quality Identifiers.

Quality identifiers were assigned to student descriptions scored as a 1 or 2 (n=64 tests, 32 matched pairs with 10 terms per test). There were no quality identifiers for a score of 3. Data are reported as relative frequencies for the ten terms evaluated in aggregate.

Score	Quality Identifier	Pre-Test	Post-Test
1	Blank	37%	5%
1	Vague	29%	24%
1	Inaccurate	21%	21%
2	Novice	4%	7%
2	Limited	8%	31%
2	Partial	1%	4%
3	N/A	0%	8%

Table 2

Percent Distribution of Pre- and Post-Test Scores for Individual Terms.

Relative frequencies of students' descriptions receiving a Score of 1, 2 or 3 are displayed for each of the terms evaluated. Pre- and Post-test scores for 32-paired samples are significantly different (p-value < 0.05) for all ten terms as measured by the Wilcoxon Signed Ranks Test. Due to rounding, percentages of all terms do not add to 100%.

Concept	% Pre Score 1	% Post Score 1	% Pre Score 2	% Post Score 2	% Pre Score 3	% Post Score 3
DNA	72	41	28	47	0	13
Epigenetics	100	84	0	16	0	0
Exon	100	53	0	31	0	16
Gene	78	56	22	44	0	0
Mutation	72	31	28	56	0	13
Phenotype	72	9	28	59	0	31
Protein	91	44	9	44	0	13
RNA	91	50	6	41	3	9
Transcription	100	57	0	41	0	3
Translation	97	44	3	50	0	6

as the pre-test.

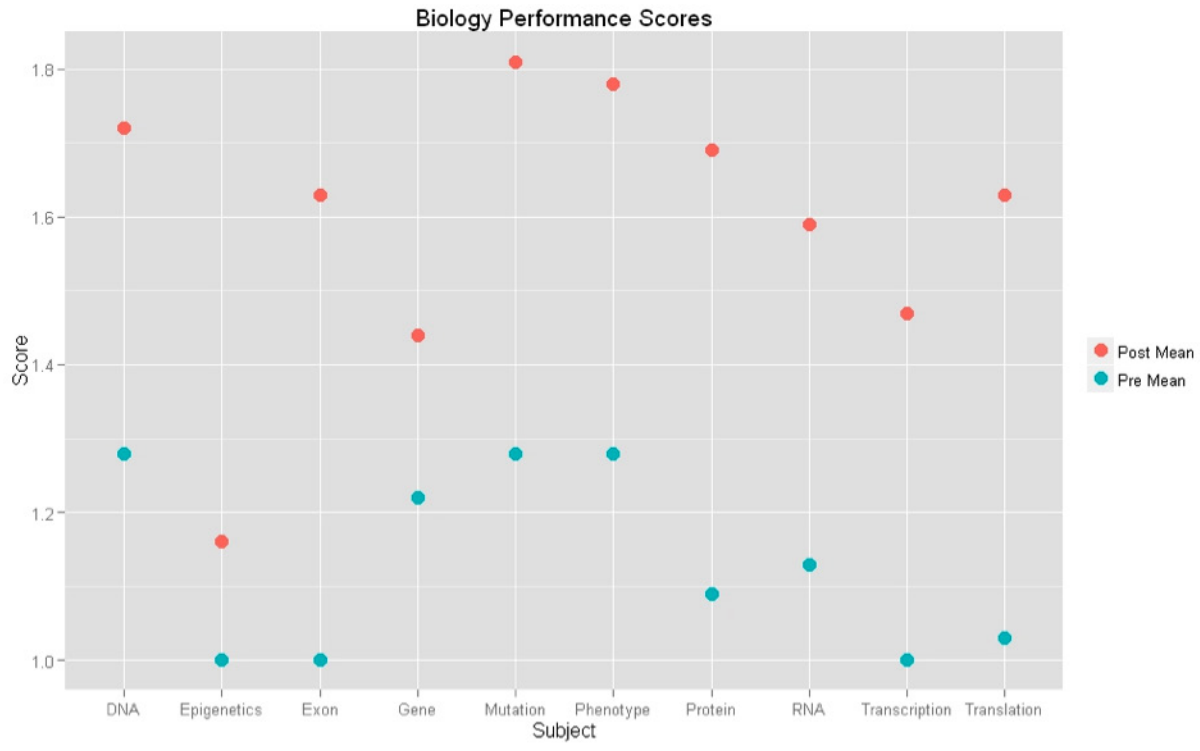
For six terms – DNA, Mutation, Phenotype, Protein, RNA, and Translation - students scored a 2 or 3 on the post-test 50% or more of the time, with the highest post-test scores being achieved for Phenotype and the second highest for Mutation (91% and 69% of scores were equal to a 2 or 3, respectively). Mutation and Phenotype were two terms in which students displayed the greatest prior knowledge; however, only 28% of students demonstrated sufficient knowledge to score a 2 on the pre-test for these two terms, and there were no pre-test scores of 3. Students also showed some knowledge of the terms DNA and Gene on pre-tests, yet low scores on the post-test remained relatively high (41% and 56% score=1, respectively).

Calculating the average score for each term on the pre- and post-test provided another means of comparing the relative difficulties of the individual terms and visualizing the learning gains for each (Figure 2). In general, students scored highest at the end of the semester for terms with which they had the greatest prior knowledge. While post-test averages for all terms fell short of a 2.0, moderate gains were observed for most. The exception was for the term Gene. The narrow spread between pre- and post-test scores for this term was completely unexpected and encouraged us to investigate student understanding of this concept in more detail.

Students' understanding of the concept of a gene was of interest for several reasons. It is a concept covered in the high school curriculum and pre-test scores indicated moderate prior knowledge (22% scored a 2 on pre-tests) relative to the other terms. Furthermore, it is a term that students hear and even use in everyday life, and it is introduced early and used frequently throughout the introductory biology curriculum. Nonetheless, in the relative rankings it proved to be one of the more difficult terms for student to describe at the end of the semester. These data indicate that students may have made less gain in their understanding of a gene compared with other concepts. Only Epigenetics, which is highly complex and covered only briefly, ranked lower. This observation prompted us to wonder how many students were

Figure 2

A Comparison of Average Scores on Pre- and Post-tests for Individual Terms (n=64, 32-matched pairs)



progressing in their understandings, yet not making sufficient advancements to justify an improvement in score based on our rubrics. To answer this question, we examined each of the matched pairs that received a score of 1 for the description of a Gene, on both the pre- and the post-test, looking for changes in language that would indicate student learning. Out of the 15 matched pairs that met this criterion, over half demonstrated some degree of improvement on the post-test, either with regard to detail, clarity or use of scientific language. Three of these were Blank on the pre-test, so for these samples simply making an effort was recognized as improvement.

Several examples of student descriptions are shown in Table 3. Student 1 provides a simple, functional description of a gene on the pre-test; yet, there is no indication that the student understands what the "code" is composed of (chemically) or how the gene is able to influence characteristics at the organismal level. As a result, this description was scored as a 1 due to lack of detail or clarity. On the post-test, the student provides greater detail using more scientific vocabulary in the description. The student demonstrates an understanding of biological complexity, explaining that a protein may be "functional or dysfunctional" and a gene "may or may not be expressed," but overall, the student demonstrates confusion as he or she attempts to relate the concept of the gene to RNA, proteins and operons (which are unique to prokaryotes). The second example also demonstrates positive change, as the student recognizes that genes "code for specific mRNA, polypeptides," in the post-test description. However, it appears that the student is uncertain of the role that genes play on the X and Y chromosomes, and they do not appreciate that some genes code only for RNA (and not mRNA or polypeptides).

Collectively, the qualitative analyses uncovered several trends. First, students appeared more comfortable with the functional than the structural aspects of a gene, which is consistent with the findings of others (Marbach-Ad, 2001). On the pre-tests, students were most likely to define a gene with regard to its role in determining a trait or phenotype within an organism. Some also described the transmission of genes from parents to offspring, but rarely did students demonstrate knowledge of the structural or compositional characteristics of a gene. Furthermore, a thorough and accurate structural and functional explanation, required to earn a score of 3, was not observed in any of the pre- or post-tests. Student learning outcomes and the course curriculum emphasize the relationship of structure and function in biological systems, and we were looking for students to incorporate both dimensions in their descriptions. In some cases, it was suspected that the students might have possessed greater comprehension than they articulated. In other cases, however, it was unclear as to whether students were simply repeating a term they had heard frequently, or whether they were using it intentionally and truly understood its meaning. For

Table 3
Examples of Student Descriptions of a Gene on Pre- and Post-tests.

	Pre-test description of Gene	Post-test description of Gene
Student 1	A code that determines the characteristics of an organism.	The coding part of RNA. It is translated into a functional or dysfunctional protein that may or may not be expressed by inducible or reversible operons.
Student 2	Forms DNA, building block of life needed for tRNA, rRNA, and mRNA to form other DNA, organelles, and RNA.	Codes for specific mRNA, polypeptides and makes up human genetic make-up if on X and Y chromosome.

example, the term "code" was often used in students' descriptions of genes, but it was used in alternative ways. In the example in Table 3, a gene "is a code," "is the coding part" and "codes for" something else. We have limited our discussion to the challenges students had describing a gene; however, the lack of attention to structure and function (when applicable) and the difficulties with language use were observed for the majority of the terms.

Discussion

Genetics is a rapidly changing field of biology with a growing impact on healthcare, policy and society. In order to adequately prepare students for careers in the field or simply equip them with a degree of literacy required to be knowledge citizens, the concepts and principles of genetics are taught throughout the biology curriculum, from introductory to advanced courses across all sub-disciplines. Our study originated as a classroom assessment strategy to provide Introductory Biology instructors with insight into the nature of the difficulties that students have understanding concepts related to genetics. Our data suggest that many of our students enter Introductory Biology courses having retained minimal knowledge of genetics from prior coursework. We did not expect our students to be capable of detailed explanations of the underlying mechanisms or regulatory patterns of gene expression. However, we did assume them capable of constructing accurate descriptions of some basic genetics terms such as DNA, RNA and gene. This assumption was partly based on our knowledge of the high school state standards, one of which states that "Students know that the central dogma of molecular biology outlines the flow of information from transcription of ribonucleic acid (RNA) in the nucleus to translation of proteins on ribosomes in the cytoplasm." Eight of the ten terms in our study are explicitly cited in the state standards and gene expression appears multiple times throughout. Furthermore, communication with high school teachers and educators in our region confirmed the inclusion of these concepts in the actual curriculum taught to general biology students.

So the question is, why do introductory level college students perform so poorly on a basic assessment of knowledge they allegedly acquired in high school? The explanation is certainly complex, but my queries have pointed to several key factors. First and foremost, K-12 teachers are held accountable for their students' standardized test scores. As a result, most have taken a direct instructional approach in order to cover all of the material in the standards at only a superficial level. For many, this has greatly reduced or eliminated the time spent performing laboratories or other discovery and inquiry-based activities that promote student engagement and deeper long-term learning. In addition, the current science standards are largely fact-based, resulting in instruction delivered as discontinuous facts, rather than complex conceptual ideas and coherent themes. This emphasis on teaching facts, over teaching students how to think like scientists, has been a major criticism of science educators for years, but until teachers are held accountable for the latter, real reform in the K-12 system will gain little momentum. Lastly, a large percentage of students in our state perform below the proficiency level on the state's standardized tests for biology, indicating that they are leaving high school with an inadequate knowledge of the subject. Genetics comprises approximately 20% of the 10th grade biology test and only 43% of students scored proficient or higher in the 2011-2012 school year. The End-of-course scores for the same academic year indicated only 52% of graduating seniors were proficient or advanced in biology. The scores are lower than the state average for many of our urban, high poverty schools (some of which report 0% of students scoring proficient or above in biology), and it is important to note that a significant number of these schools serve as feeders to our institution (California Department of Education, 2013).

The state standardized test scores reflect the fact that urban low-income, culturally and linguistically diverse (LI/CLD) students are at a particular disadvantage when it comes to science education. They often have little or no access to science courses until high school, either because they are remediated to math and English courses at the expense of science, or because their schools have inadequate resources, including properly trained science teachers. The overall number of US STEM graduates is low, at only 6% of 24-year-olds surveyed in 2008. However, the number drops to 2.7% for African-Americans and 2.2% for Latinos, despite

the fact that interest in a STEM field is equal for these populations upon entering college (Mervis, 2010). This disparity continues in the workforce, where Hispanics, African Americans and American Indians made up only 9% of the STEM workforce, while comprising 26% of the US population, according to a 2008 report (National Science Board, 2012). The lack of diversity in the STEM workforce is concerning, as there are well-known benefits to having varied backgrounds and perspectives when it comes to global competitiveness (Ferrini-Mundy, 2013). However, until every child has the opportunity to engage in high quality science throughout their early education, we will continue to see a disproportionate number of LI/CLD students that are unprepared for, and often discouraged from pursuing, advanced STEM training and careers.

The new Common Core State Standards and Next Generation Science Standards present an opportunity for teachers, administrators, and policy makers to affect systemic change and potentially address some of the problems inherent to K-12 science education. With a new emphasis on college and career preparation as well as critical thinking and reasoning (Stage et al., 2013), these standards ensure "fewer, clearer, and higher" standards (Commission on Mathematics and Science Education, 2009). They are promising in their alignment with research on teaching and learning and their intentional coordination between literacy, math and science and engineering (Stage et al., 2013). While there is plenty of optimism surrounding the new standards, successful implementation will require significant investment from districts and administrators in long-term teacher professional development and support. Access to appropriate, high-quality training is often a challenge, and a recent survey from the National Science Teacher's Association (NSTA) indicated that science teachers report less access to discipline-specific compared with general professional development (Luft et al., 2009). These problems can be overcome with the growing number of online and virtual environments that allow teachers to interact and collaborate at a distance. The effectiveness of collaboration has been demonstrated with the "Lesson Study" approach commonly used in the Japanese educational system, and additional data from education research in the US report student learning and testing gains associated with teachers that have the time and support to work in teams (Rosenholtz, 1989; Jackson and Bruegmann, 2009; Markow and Pieters, 2010). Some other interesting models are emerging, including the advent of the "Teacherpreneurs," a name given to expert teachers that split their time between the classroom and working in leadership roles to influence policy, assist administrators and mentor colleagues (Berry, 2013).

Our observations that learning gains over the course of one semester are relatively small for our topic under study highlight the need for science education reform at the post-secondary level as well. Our modest gains should not be surprising, given that conceptual change by many accounts is both difficult and slow. Others using a pre- and post-test design observed small to modest learning gains over the course of one semester, especially when the concepts evaluated were abstract in nature (Bowling et al., 2008b; Elrod, 2008). Students cannot see or touch genes, as they can a plant or a skeleton, making it difficult for them to visualize or create mental models of the biological processes inherent to genetics. Furthermore, the ability to communicate using scientific language is a relatively advanced skill that takes both time and practice to develop (Elrod, 2008), which may result in an underestimation of student knowledge using an open-response format like the Ten Word Test. The findings described in our study create ongoing problems for students as they progress through the curriculum. Just as Introductory Biology instructors assume students have learned and retained a basic level of genetics knowledge from high school, most faculty teaching upper division courses expect students to have gained significant knowledge of gene expression by the time they arrive in their courses. Yet all too often, faculty teaching these upper division courses find themselves forced to review the basics or forge ahead, leaving a portion of students to fall further behind.

To improve student learning, we, as college faculty, also need to undergo a conceptual change in the way we approach teaching and learning. Curriculum should be designed to help students with abstract and complex concepts, and this generally requires breaking from the lecture and infusing instructional methods in which students actively engage with the material and each other (reviewed by Allen and Tanner, 2005;

Udovic et al., 2002). In addition, faculty can benefit from the use of frequent and formative assessment that is aligned with their learning outcomes and instructional activities to provide an indication of which techniques/ curricula are most effective (reviewed by Tanner and Allen, 2004). Information on prior knowledge and conceptual understanding can also be used to carefully select the material that students learn on their own, saving valuable class time for problem-solving and critical thinking exercises.

While additional data collection and analysis on a larger and unrelated population of students is necessary to draw generalizable conclusions, our findings have already prompted several curricular changes within the Introductory Biology course at our institution. First, we have increased the number of weeks devoted to the concept of gene expression in lecture from six to eight, allotting more time for students to build and synthesize the distinct concepts before encountering the more challenging material. In addition, we have re-designed an independent research project in which students apply the molecular and genetics concepts covered in lecture to a single gene disorder that they chose to study. This project now allows additional time for hands-on activities, including some that guide students in the development of conceptual models to explain the molecular basis of the disease they are researching. Instructors are also integrating more active learning exercises in lecture, and formative assessments are being employed to guide curriculum development and revision.

With the proper tools and training, K-12 teachers and college faculty can positively impact student learning at the course-level. However, it is necessary to work beyond the borders of our individual courses because the construction of scientific knowledge is a slow, progressive process. To support conceptual growth and the development of scientific thinking, we must coordinate and align curriculum and teaching practices between high schools, community colleges and university courses. This approach would allow students to construct scientific knowledge with curriculum that builds and reinforces at each level. These curricular and structural reforms are difficult and time-consuming, and the impacts on student learning are not always immediately recognized. These changes will rely on district and institutional support in the form of professional development, time and resources, and greater incentives for devoting time and energy to teaching and learning. In our opinion, these reforms are critical at all levels of education if we are to prepare students for the exciting changes and scientific challenges of the 21st Century.

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"This Is Where I Want To Be:" Pedagogical and Integrative Practices of African American Learning Communities and Their Impact on Students

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ABSTRACT

This qualitative study explores pedagogical practices and student responses in three community college learning communities targeting African American students. Using classroom observations, instructor and student interviews, and student focus groups, the study examines how instructors teach in race-based programs and how students respond to these pedagogies. The study uses a conceptual model that integrates retention theory, critical race theory, and integration of instruction and student services theory.

The study finds that culturally responsive pedagogical and classroom management techniques result in enhanced student perceptions of themselves as capable learners. Students also report developing a sense of African American identity through the experience of the curriculum and the racially homogeneous community of learners.

This research has implications for policy and practice at community colleges by providing evidence that race-based programs are crucial for the academic and social integration of African American students into academia. The study also recommends that structural changes be made to community college practice, including integrating the role of student service professionals into curriculum design.

The issue of educational achievement of African Americans has been, and continues to be, a persistent problem within all segments of the American educational system. Table 1 is a snapshot of the ways in which African American students lag behind their white, Asian, and Latino counterparts in significant ways.

In general, what the above statistics show is that African American students perform in both secondary and higher education at rates much lower than their white, Asian, and Latino counterparts. When looking at bachelor's degree completion, 37% of whites 25 or older have completed a bachelor's degree or higher, and almost 70% of Asians in this same age group have at least a bachelor's degree. Within the African American population, this number drops significantly, to just 19% of blacks 25 or older having completed at least a bachelor's degree.

Persistence numbers show that African American college students do not succeed at the same rates as other students. When looking at the students who began in a four-year institution in 2003 and who stayed enrolled (or achieved a degree/certificate) within three years, African American students lag behind their white and Asian counterparts by 10 and 16 percentage points, respectively. The same gap exists for students in two-year institutions where after three years only 47% of African American students are still enrolled (or have achieved a degree/certificate) in three years, compared to 56% of white students and 67% of Asian students.

What all of these statistics point to is a pervasive problem in the American higher educational system

Table 1

Statistics on African American Educational Achievement (Source: NCES, 2012, except as noted)

Educational Attainment Measurement	White	African American	Latino	Asian/ Pacific Isander
High school graduation[1]	81	63	65	90
Enrollment in college[2]	74	62	58	85
Bacherlor's degree completion[3]	62	38	50	69
Bacherlor's degree attainment[4]	37	19	13	62
Persistence in college–4-year institutions[5]	83	73	76	89
Persistence in college–2-year institutions[5]	56	47	54	67
Taking remedial courses[6]	31.3	45.1	43.3	38

[1] Average freshman graduation rate from 2008-09
[2] Percentage of 2004 high school graduates immediately enrolled in a post-secondary institution
[3] Graduation rates of post-secondary students receiving Bachelor's degrees within 6 years (2004 cohort)
[4] Percentage of adults ages 25-34 whose highest educational attainment in a Bachelor's degree
[5] Percentage of students still enrolled or with certificate/degree after three years, 2003 cohort (ACE, 2010)
[6] Percentage of first-year undergraduate students who took any remedial course, 2007-08 cohort (ACE, 2010)

in educating African American students. One promising initiative for African American students is the development of retention programs in community colleges that blend skill improvement, ethnic cultural development, and an array of student support services. Research has identified practices that structure the first year of college activities to improve retention, academic performance and student satisfaction (Engstrom and Tinto, 2007). This study focuses on identifying the pedagogical and integrative practices of successful programs for African American students in the community college system. The results of the study will inform researchers and practitioners on strategies to narrow the achievement gap between African Americans and other ethnicities in higher education.

Purpose of the Study

This study highlights three community colleges with programs that address African American students' college success , examining the pedagogical and support service practices in these programs so that scholars and practitioners might be aware of alternate teaching and support service strategies that focus on the needs of African American students. Specifically, the study focuses on the pedagogies and teacher behaviors present in the learning community classrooms and the interactions between instruction and student services within the learning community design. The study employs a qualitative approach in order to illuminate the perceptions and experiences of students and faculty with respect to the pedagogy and student services practices in the learning communities.

In a resource-scarce climate, this study provides suggestions on how the practices of the three programs studied could be broadened to be applied to a larger audience without compromising the essence of such programs. Looking at program components that are scalable may inform educational leaders about practices that they too can employ to increase the success of their students.

Research Questions

This study addresses the following research questions: (a) what pedagogical practices are present in the classrooms of learning communities designed for African American students?; (b) what are student perceptions of the various pedagogies used in the classrooms?; and (c) to what extent do the learning

communities integrate instruction and student services?

Conceptual Framework

The conceptual model of this study is grounded in two theories: retention theory and critical race theory, and the intersection of the two. The earliest retention theoretical construct is found in the work of Tinto (1975) who posits that "academic integration" and "social integration" most influence a student's decision to persist in college. Academic integration occurs when a student connects to the faculty, classroom, and institutional policies in order to establish a bond with the college. Social integration occurs when a student connects to individuals and activities outside the classroom. According to this model, both conditions are necessary to ensure the student's retention in college.

Challenges to Tinto's model have been raised by scholars who critique the model for its failure to take into account the experiences of minority students (Bensimon, 2005; Braxton, et al, 2008; Braxton, Hirschy, & McClendon, 2004; Guiffrida, 2006; Tierney, 1999). Specifically, Tierney likens Tinto's model to "cultural suicide" (p. 85) in which students divorce themselves from the communities and cultures in which they were raised in order to assimilate to the college culture. Tierney argues that students are more likely to persist in college if their identities are affirmed and incorporated into the college culture.

When discussing the pedagogies most likely to lead to student success, researchers cite authentic pedagogy (Braxton, Jones, Hirschy & Hartley, 2008; Darling-Hammond, 2008; McHugh Engstrom, 2008) as a key component of student persistence. In her study of community college students and professors, Cox (2009) cites the need for teachers who have high standards and confidence in students' abilities to achieve those high standards.

Moving from retention theory, the study focuses on critical race theory to explore particular needs of African American students in college. This theory sets the foundation for the pedagogical practices that cite the need for culturally responsive pedagogy, the practice that takes critical race theory into the college classroom. Finally, the study uses the integration of instruction and student services as a theoretical grounding, citing the importance of a unified college collaboration to enhance the success of African American students.

Critical race theory is based upon the premise that racism is an everyday ordinary occurrence and is the common shared experience of people of color in this country (Delgado and Stefancic, 2001; Lopez, 2003; Yosso, et al, 2009). According to Delgado and Stefancic (2001), critical race theory had its beginning in law, but is used today in education to understand the issues of "school discipline and hierarchy, tracking, curriculum, and IQ and achievement testing" (p. 3). In a review of critical race theory literature and adult education, Closson (2010) describes the theory in education as the use of race in a systematic analysis of educational inequality. As such, critical race educational theorists are interested in changing the current educational system, to move from disparate educational attainments of students of color to a system that educates all students equally.

Using critical race theory, researchers in higher education are taking educational theorists to task for their failure to account for the experiences of students of color in highly racialized climates (Delgado and Stefancic, 2001; Yosso, 2009). Many educators feel that race is an area that has been under-researched in higher education. Johnson-Bailey & Lee (2005), however, argue that in fact, we have excellent studies of the way race affects the academic experience of African Americans and the way race can operate in higher education classrooms. Critical race theorists argue that rather than using race as a demographic variable, race and racism should be central to the analysis of lack of success and achievement of African Americans (Closson, 2010).

In addition to the pedagogy of the classroom, researchers have argued that an integration between instruction and support services is necessary for success of all students, especially basic skills students and students of color. The RP Group (2007) argues that counseling is an essential component of basic skills programs, and that counselors must work alongside faculty members to ensure that students get consistent and frequent academic advice, rather than just ad hoc advising, as is still usually the case. Frost et al. (2010)

argue that the "curricular and co-curricular" must be in partnership in order for student success to be enhanced. Further research needs to be conducted on the ways in which critical race theory and culturally responsive pedagogy are present in such partnerships.

Justification and Significance

Researching programs that target the success of African American college students is important for a number of reasons. The economic impact of low college success in the African American population is causing an economic gap in our country between the "haves" and the "have-nots" (McKinsey, 2009). Since college success is generally seen as necessary for economic mobility, the lack of success for African American college students is negatively impacting the African American community. According to the National Center for Education Statistics (2010), the median salary in 2009 for a person with a bachelor's degree is $46,930, whereas a person with only a high school diploma is $27,380. This large discrepancy indicates that there is a significant economic advantage to earning a bachelor's degree; therefore, in order for there to be economic opportunities for African American students, the educational system needs to do a better job of graduating these students from college.

In addition, this lack of success is having an economic impact on the country at large. Again, according to McKinsey (2010), the country's gross domestic product (GDP) is negatively affected by the achievement gap between black and white students. It is estimated that about two to four percent of the GDP is lost due to the lack of education attainment by blacks (and other minorities) in this country.

Very little research has been conducted on the various models in place at community colleges with African American learning community programs. While there have been studies on other programs targeting underrepresented students, such as Puente (Rendón, 2002) and Extended Opportunities, Programs & Services (Scott-Skillman, 1992), there are few studies on programs that specifically target the success of African American college students, with the exception of those studies conducted at Historically Black Colleges & Universities (HBCUs). Thus, this research will be breaking new ground as it describes the pedagogical components and integration of support services of a program specifically designed for African American community college students.

Finally, in addition to the implications this research has for educational equity issues, the study could also have an impact on colleges across the nation. This study identifies the key underlying pedagogical and support strategies in learning community classrooms that can be replicated on a large scale. Thus, colleges and instructors interested in increasing the success of all students could potentially adapt the pedagogical practices of these instructors so that all students, regardless of race or ethnicity, can succeed. In addition, colleges can potentially adapt the integration model to create a connection between pedagogy and support services to further enhance student success.

Design and Methodology

A case study methodology was used to explore the research questions, keeping in mind that a case study method is appropriate for understanding a real-life situation in depth and within the contextual conditions of the situation (Yin, 2009). In keeping with the case study design, evidence was collected from multiple sources: semi-structured interviews with instructors in the learning community classrooms; interviews and follow-up focus groups with students; direct observations of classroom teaching; and physical artifacts gathered from the instructors. Of the three instructors observed and interviewed, two were African American and one was white. Of the 19 students interviewed individually and in focus groups, 16 self-identified as African American.

The use of these multiple sources of data provided the opportunity to develop a "convergent line of inquiry" (Yin, 2009, p. 115). In triangulating the data employing this methodology, for example, it became evident how culturally responsive pedagogy played out in the learning communities and how students perceived its use in the classroom. Convergence of data is a major strength of conducting case study analyses (Yin, 2009). The use of multiple sources provided the opportunity to triangulate the data and to determine from a variety of perspectives the ways in which the pedagogies, teacher behaviors, and integration of instruction and student services impacted the students.

Role of Researcher

As an English instructor in a community college for 20 years, I am a practitioner/researcher. My experience in the classroom and my extensive experience with learning communities targeting underrepresented groups provided me with an easy rapport with the instructors I interviewed. I did not interfere in the classroom sessions in any way; however, my extensive experience as a classroom instructor gave me the ability to listen not only to what the teachers said, but also to interpret how they interacted with the students. I had no previous contact with the instructors or the students before conducting the study.

Setting and Sample

Currently, ten of the 27 California community colleges with African American learning community programs are located in the Bay Area. To determine which colleges to include in the study, a purposive sample of colleges was selected based on local college data that shows the programs to be successful in terms of helping African American students succeed in developmental and college-level classes. Capstone College was chosen because it has the longest-running learning community, which began in 1994. In addition to Capstone, the programs at Landscape and Silicon Colleges were chosen for their long-standing, successful programs targeting African American students.

In addition to their successful student outcomes, the three colleges were chosen for inclusion in this study for their variety of characteristics. Landscape College is a medium-sized suburban community college with a low percentage of African American students. Capstone College is a medium-sized college located in a densely populated area with the percentage of African American students equal to that of the surrounding area. Silicon College is a small community college located in an urban area. These colleges represent a solid range of community colleges in Northern California; therefore, the results of this study are likely to be generalizable to a variety of community colleges in California.

Data Analysis

To analyze the data collected, the interview questions were organized into specific categories, which helped in synthesizing the teachers' and students' ideas about different topics. Based on these specific categories, a coding system was developed (Bogdan & Biklan, 2007) focusing primarily on the perspectives held by the teachers and students interviewed. The codes were developed along with the interview protocols and thus could be described as "selective coding" (Glaser & Strauss, 1967). In the same way, the observation notes for the classroom observations were similarly divided into topics that were coded and organized. An Excel spreadsheet, developed by Dr. David Wick (2011) was used to organize the data, enabling the researcher to code and search the specific themes.

The data were systematically analyzed as follows. The researcher conducted: 1) an "intelligent reading" of the transcripts to get a holistic sense of the data; 2) a "microanalysis" or line-by-line reading of the transcripts to gain an understanding of the relationship between the codes; and 3) a "constant comparison" process to refine the codes chosen. Using notes from the observation, incidences of culturally responsive pedagogy in each classroom were charted. Subsequently, responses to questions about culturally responsive pedagogy were compared between the students and teachers, and the observations of such pedagogy were compared to students' and teacher's responses.

Because the study is a cross-case analysis, a technique that Yin (2003) calls "cross-case synthesis" was used. Data from the three colleges were aggregated as outlined above. A "word table" (Yin, 2003, p. 158) to synthesize the data across the colleges was used to discover patterns among them. For example, the topic of "nurturing relationship" emerged from the interview protocols of the individual teachers. A generalization about the presence of such a pedagogical strategy in the three programs could then be made.

Findings

Learning Community Pedagogical Practices

To think about pedagogy is to consider two aspects of teaching: the methods or strategies that a teacher uses in the classroom and the behaviors of the teacher him/herself. It is often difficult to separate methods from behaviors and attitudes because how a teacher acts is linked closely to the strategies she chooses. For example, if a teacher is a proponent

of active learning, she is often moving around the classroom being physically active herself. Likewise, a teacher who practices authentic pedagogy is likely to reveal aspects of his own humanity to the students. For the purposes of this study, the teaching techniques the teachers chose are analyzed separately from their specific behavioral characteristics. This is an important separation because the personas teachers present in the classroom add a different dimension to the class from the teaching practices they employ.

Authentic Pedagogy

Cranton and Carusetta (2004) define authentic teachers as "being genuine, showing consistency between values and action, relating to others to encourage their authenticity, and living a critical life" (p. 7). What this definition highlights is the personhood of the teacher in the classroom. Authentic teachers behave in a manner that integrates their values with their teaching methods.

The English teacher from Capstone College very much integrated his values with his teaching. In his interview, LaSalle described what he does as "live learning" as in learning that is alive.

> There's lots of ways to express "live learning," but some of the basics I guess are that you walk into the classroom, you have something in mind basically ... but you don't make the meaning. They make all the meaning. And you facilitate the meaning, but if you want to up it because you think it would be more abstract, more translate to academic work, or just more get closer to their pain, then you can up it, but it's organic because it's right in what they're talking about.

What LaSalle is describing here is a type of improvisation that a teacher who actively engages his students must be willing to participate in. In keeping with the notion of improvisation, LaSalle took his cues from the students and spontaneously changed his agenda to fit their needs. By its very nature, improvisational teaching requires an integration of the teacher's philosophy of teaching and his knowledge of the subject matter. It is this integration that creates the authenticity so apparent in the classrooms of these African American learning communities.

The idea of full disclosure was apparent in the math class taught by Sue Davis at Landscape College. In outlining the content of the upcoming test, the instructor listed exactly what she expected her students to know:

> I gotta stick some equations on there. Gon' stick some factoring on there. Gon' stick some parabolas on there. Some factoring and some quadratic formulas … Gon' have a couple word problems

Not only is the teacher's agenda transparent, she purposively designed assessments that allow students to learn and to apply the concepts in authentic ways.

To illustrate that her teaching approach is grounded in a philosophical belief, Sue Davis describes her teaching strategies:

> I will take the mathematics and I will not put it in mathematic jargonese. I will explain it because my purpose is for you to understand … I can train a monkey to do something, I want you to understand. This ain't about coming in here and passing quizzes. This is about understanding mathematics so when you walk out of here, you'll know what you're doing.

And the students respond positively to this full disclosure. As Tre said:

> Ms. Davis is the truth, I tell you. Ms. Davis, she's the truth. I mean she's one of the hundred percent teachers that are real on campus, and she'll tell you if you don't get yourself right, you're not going anywhere.

In this heartfelt description of Ms. Davis as "the truth," Tre indicated that he trusts his teacher to be honest with him no matter what.

Echoing the idea of honesty, Tanaya describes the honesty she gets from her English teacher at Capstone College:

> LaSalle is kinda like the best part of [the program], just the way he teaches … especially 'cause he's Caucasian 'cause he tells the truth. You know how some people they'll tell you something, but they're not telling the full story? LaSalle gon' tell you the full story.

In this comment, Tanaya expressed her trust that Mr. LaSalle will be honest "especially 'cause he's Caucasian." Tanaya is one of two students who mentioned Mr. LaSalle's racial identity as they described their experiences with him. Both students who referred to LaSalle's being White mentioned his race in the context of discussing their trust in him. In his interview, Dashawn described his skepticism about being taught by a white teacher:

> When I first met him, I was kind of cautious about him because you know he was a white male teacher in an African American class, and the first thing that hit in my head was "What can he teach me?"

LaSalle's authenticity, his fundamental belief in his students, turned Tanaya and Dashawn from skeptics into believers.

Teachers in this study are strategic in their thinking about African American students; they are aware of their students' cultural differences and their differing needs. Within this context, the teachers must devise ways to engage African American students with substantive ideas. As a white man, the English teacher at Capstone certainly is aware of the cultural identity his students bring to the classroom, and he uses his knowledge of them to engage them in discussions about African American writers and issues. Thus, despite his identity as a white man, the students trust his authenticity as a teacher and as a human being.

Othermothering

In summarizing the tradition of othermothering in the African American community, Guiffrida (2005) traces the practice to the first African American slave communities wherein women assumed the role of mother figure for children whose fathers were absent and/or whose mothers had died or had been sold. This tradition of taking on mothering responsibilities continues in African American schools and historically Black institutions where teachers are interested in more than just the academic development of their students but their emotional and spiritual developments as well.

The students in this study described the teachers' demanding natures as evidence that they have the students' best interest at heart. Guiffrida (2005) calls this quality "othermothering" taken from the traditional African American role of a mother figure who takes over the role and responsibilities of a mother. A student at Landscape College, Sonny understands the approach his teacher takes because he has lived it. He explains:

> Ms. Davis really isn't for everybody. You gotta be able to handle a lot. She's tough, but you gotta know how to deal with those type of personalities … they'll push me, just like a parent. They push you to do harder, to do better."

In a particularly poignant moment in an interview session, Sonny describes the fundamental quality of his learning community teachers:

> What makes them different from every other staff and faculty is the heart for the kids. … The heart makes the difference that will make the kids do the extra amount because they know at the end of the day … they care for us!

All of the teachers interviewed expressed in their own way their deep care for their students as whole people, not just their academic development. Sue Davis describes the pride she feels in seeing students move from being scared to confident in their math abilities:

> And I mean I swell up sometimes thinking about the number of students who walked in there, head held down, scared as hell to do anything in mathematics...And it's gotten to the point where they've forgotten their fear. I gotta get them to the point where [they] don't accept anybody else's answer, go try to figure

> it out for yourself. And believe it or not, the next thing I hear, "I want to be like Ms. Davis." No, girlfriend, you don't want to be like me. You want to be like you. Take that confidence and run with it.

Her methods may be unorthodox; it may be true that, as she says, "If you can survive Ms. Davis, you can survive anybody on this campus." But underneath the "hittin' and cussin' and fussin'" is a teacher who truly cares that her students succeed. And she is maternally possessive of these students. "They're my kids," she says. "That's it."

Rob LaSalle expresses his care for his students when he describes the necessity of education for these students:

> I think that for me, the African American students…it's very, very palpable what's at stake. I could tell you the stories of those students in that classroom and the proximity to jail, homelessness. I have maybe two middle-class students in there, and the rest are just absolutely on the edge. And that makes you a different kind of teacher. You know your pedagogy changes. It's not just your heart, but your pedagogy.

The teachers and counselors care for these students, and the students not only see it and appreciate it, the care motivates them to succeed. In the focus group, Calvin remarks:

> And so when my teachers would kind of push you know, "Ok we want you to pass and this is what you need to do." And it kinda showed a passion for our success, which kinda fueled my passion for my success.

What these students are responding to is the teacher's genuine care for them, not just as college students, but as human beings as well. When the students in this study say that their teachers actually respond to them and that they are "always there" for them, the students are describing a care for the whole student that is created, cultivated, and maintained in a concerted manner by the teachers who love the students as their own.

Warm Demander

The students in both the interviews and the focus groups report that while their teachers in the learning communities are caring and focused on their success, the teachers are also quite demanding in their expectations of the students' success. Ware (2006) uses the term "warm demander" to describe the pedagogical stance taken by teachers on African American students. Describing this style as a "tough-minded, no nonsense approach" (p. 436), Ware points out that students perceive this style as evidence that the teacher cares deeply about them.

The math teacher at Capstone College is a prime example of the warm demander personality. Throughout the class session observed, she laughingly chided the students when they hesitated on answers she thought they should know. When telling the students that their tests were due on Tuesday, the math instructor said, "I don't want nothing late, and don't be emailing me at the last minute talking about my car broke. Leave the car, bring my test. I'm serious, ok?" Her use of African American Vernacular English ("don't want nothing") gives her a connection to the students, but her insistence that they perform no matter what illustrates her demanding nature. She refuses to believe that her students could not perform, so they did.

A student at Capstone College, Calvin stresses that the learning community teachers demand exceptional performance from the students. He describes his teacher this way:

> I think he would prefer that we ask questions rather than not ask anything at all … 'cause he talked to everybody yesterday about how he feels like certain people in the class aren't necessarily chasing knowledge … just like how a lot of us are just going through the motions in the class instead of really trying to get more than just what he's trying to teach us, but to also get something that we can carry on in life.

In Calvin's experience, the teacher wants the

students to "chase knowledge" not just be passive learners. A student from another college, Astra, remarks that being pushed hard has positive results on her achievement:

> Sometimes she'll kind of like yell at me like, "Oh you're not doing good," and then I'll be like, "Oh I can do better." Then I do better, or I'm trying and then she'll see that and she'll kind of like ease off of me, but more than half the time she helps me push myself to levels I didn't think I could get to sometimes.

All of these students cite their teacher's harsh manner and demanding nature as difficult, hard to get accustomed to, but essential to their academic achievement. The motherly nature of the teachers in this program convinces the students that the instructors care; the demanding, harsh language compels them to succeed.

Culturally Responsive Pedagogy

Researchers have long noted the connection between students' embracing of racial identity and academic performance (Carter, 2008; Carter Andrews, 2009; Fife, Bond, & Byers-Winston, 2011; Fries-Britt & Turner, 2002; Palmer & Gasman, 2008). According to these studies, validating a student's identity, including his or her racial identity, is an important step in making that student feel competent to succeed in college. Gloria Ladson-Billings's seminal work (1995a) and (1995b) lays out the precepts of culturally relevant pedagogy: the achievement of educational success on the part of African American students through the development and maintenance of their cultural competence. Gay (2010) best describes culturally relevant pedagogy as validating and affirming. By acknowledging the legitimacy of the cultural backgrounds of different ethnicities, students are to connect what they learn in school with what they live at home. Culturally responsive pedagogy uses a wide variety of teaching strategies for connecting to a variety of learning styles. Finally, by incorporating multicultural information in all the subjects taught, culturally responsive pedagogy teaches students to value their own and each other's cultural heritages.

The students in this study were recipients of culturally responsive pedagogy, and they speak of how the learning community helped them deepen their understanding of themselves as African Americans in terms of understanding their history and strengthening their sense of racial identity.

Understanding History

One means by which the programs helped the students understand themselves as African Americans was the way the classes taught them about African and African American history. The students learned about important contributions African Americans have made to American history, and this knowledge gives the students a sense of pride in their heritage.

As Chantel says of her classes in the program:

> It's based on African studies. So there's a lot of things that I did not know about that I learned in college. Because in my history books, there's just this big gap that I didn't understand … and now I do.

Chantel's statement reveals that her understanding of African American history has become a part of her. Dashawn also discusses how the topics discussed in the learning community affected his understanding of his racial background:

> Because it taught me a lot about my background and my history. And a lot of things that I didn't know that I was able to learn about myself and to where that I'm just as equal as everybody else … So that helped me give me a little boost to my self like about, "OK if I really have that desire, then I really can. All I gotta do is do it."

From Dashawn's perspective, it is clear that his understanding of African American history has increased his self-confidence. When he says, "All I gotta do is do it," he illustrates how a student's understanding of the past can affect his present. What all of these programs have in common, then, is that they use African American writers and/or topics for the students to read and respond to. The use of culturally responsive

pedagogy is a primary goal for these programs.

More important than the use of such materials, however, is the students' reactions to this curriculum. While some students mention that the assignments are difficult, most of the students express a connection to their identity, a deepening of their understanding of themselves as African Americans. In the African American learning communities in this study, the African American culture is emphasized even in classes that may not seem lend themselves to cultural perspectives, such as mathematics courses. By including their culture in the curriculum, the teachers send the students the message that their history – and by extension, they – count.

Culturally Responsive Pedagogy and Racial Identity

Another positive outcome to culturally responsive pedagogy is the connection to identity and the strengthening of African American identity. One outspoken student in this study, Sekena, explains:

> [The program] helps you broaden your mind. It's just like you can do anything; you can be anything. That's just what this program makes you feel like.

When Sekena talked about being a Black female in society, she discussed her connection to the larger community of African Americans and how this connection makes her feel "like you can do anything."

In describing what it's like to be in a program made up of primarily African American students, Manny says:

> But I see all these people from backgrounds, hard backgrounds, some you know cool backgrounds, and seeing them all come together and doing good, helping each other, assisting each other, it feels good to be African American and knowing I have other people, peers, especially peers who come from all kinds of backgrounds doing good and trying to do good.

In discussing the diversity of the African American community, Manny appreciates how the program has given him examples of success across the spectrum of the community. In a particularly eloquent statement, Manny went on to explain the impact of a particular piece of culturally responsive pedagogy. Manny says:

> It showed me how unfair the justice system is and how unfair the world is. When you don't experience things like that, you think the world is fine, but when you see somebody who's coming from your same background experience something like that and not be treated fairly, it makes you think that could happen to anybody. That coulda been me or my dad. so those assignments like they really change my perspective on who I am and where I come from and how the world looks at me.

In this quote, Manny recognizes himself in the literature; he understands that he or someone he knows could have been the victim of racial injustice. And in connecting with the curriculum, he found his voice.

Another student Malik expresses his experience with the learning community as finding a place where he belongs:

> Comfort. I say comfort just because you can sit in class and you can sit in two class periods, you can sit in the morning class, you can sit in your own class and you can sit through the tutoring process, you're just there the whole day and it just makes you feel like, "Ok this is where I want to be." This is your stress level away from the outside world.

From these comments, it's clear that Malik has found his place at the college. He is at home with the classes, the other students, and the learning environment.

The findings in this study correlate with those of the body of literature on culturally responsive pedagogy and the developing of racial identity among students. This study illustrates from the students' perspective just how tight a connection there is between curriculum and identity.

Culturally Responsive Pedagogy and Finding a Voice

Another way in which culturally responsive

pedagogy is said to help students of color is by helping them find a voice in the classroom and in the academy. In Teaching to Transgress (1994), bell hooks sees validating student voices as empowering the students' presence in the class. In her insistence on listening to the voices of students, hooks encourages teachers to cultivate their students' voices so that the students themselves can serve as challenges to the system that seeks to silence them.

Echoing the idea of deep understanding of racial identity, Sukutai describes the culturally responsive pedagogy as empowering her to succeed:

> It makes me feel powerful. It makes me feel like we really have to stand up and do something. Because the stories we read were like kids our age that really stood up back in the day and we could still do the same to make it better.

A student in the same cohort, Chantel, talks about how the culturally responsive assignments helped her find her voice:

> We had to relate the book, it was about the Little Rock Nine kids, to our experiences with schools. And it's different when you have those thoughts in your head, but when you lay them out, and you figure out how to format things right, it's just it's nice to see that.

Carmen describes her struggle with writing and how an assignment on a Boots Riley poem helped her discover her ideas:

> Well at first I was like "oh my gosh, I don't want to do this." But then like once you think about it, you're like "Ok I understand it. I do want to write." And once you start writing, you don't want to stop. So I think the essay was like two pages, and he said don't go above that. I tried not to, and it was so hard because you want to keep writing.

It is the newly found sense of confidence that is apparent here. Carmen and the rest of the students see themselves as having a voice, that they have something to say, and that they are worthy of being listened to.

When asked about the most valuable part of the program for him, Dashawn reflects much of what the other students say:

> The most valuable thing about [the program] is that I was able to be successful. I was able to express my opinions. I was able to ask questions … so it just opened up a whole lot of different views and it was like my stairway to success. When I first got to English, a 2-page paper made me shiver. And now I got an 8-page paper [assignment] and I said, "Oh that's it?" And I had written a 10-page paper and had to cut it down because I wrote too much.

Dashawn has been transformed from a student who dreaded even the smallest writing task to a student who is not fazed by a lengthy assignment. He has truly found his voice.

In her study on the relationship between racial identity and school achievement, Carter (2008) describes how connectedness to the Black community and awareness of racial discrimination prove significant to the development of Black students' critical race consciousness and shape their attitudes about the usefulness of schools. The students in her study believed in the positive outcomes of school because of their positive racial self-conceptions, belief in their abilities to be successful, and critical race consciousness. The implications of Carter's study and of the current study are clear: the more racially developed the identities of students are, the more likely they are to succeed in school.

Integration and "Intrusion" of Instruction and Student Services

Since the seminal collaboration between the American Association for Higher Education, the American College Personnel Association, and the National Association of Student Personnel Administrators (1998), colleges have been considering ways of integrating academics and student services in order to enhance student learning. The learning

communities studied here appear to put this theory of integration into practice.

The counseling, financial aid, and tutoring services at the colleges I observed are what the student services field calls "intrusive services." They are intrusive because they are not simply offered to students; rather, both the instructors and counselors in the programs require that the students use the services. At Landscape College, the counselor herself makes the counseling appointment for the students; the teacher requires that the students submit a progress report detailing the current grades in all their classes and personally supervises tutorial sessions five days a week. At Capstone College, the teacher uses class time to inform students of available services. At Silicon College, the students take college tours as a group, have academic counseling sessions, and regularly attend required math tutorial sessions. All the instructors integrate the services into their classrooms, taking instructional time to introduce the students to the services and to require that the students use them. Bringing the services to the students, taking out instructional time to present services, and requiring that students use the services are the keys to intrusive services.

The important aspect to the integration of student services and instruction is that both instructors and counselors think that achieving student success is a joint effort. No one creates a line of demarcation that indicates a separation of duties; both feel responsible for the holistic development of the students.

Implications for Community College Policy and Practice

Structural Changes

The findings from this study suggest that success in learning communities is reliant upon a new structure of pedagogy and classroom experience. Thus, it is recommended that colleges consider structural changes to the ways they offer classes and programs.

In particular, instructors and student services staff should reconsider their roles, and that these new roles be supported by the administration of the institution. In this study, the students succeeded in part because they used the support services available to them, specifically financial aid and tutorial services. They were made aware of these services because both teachers and counselors were willing to take on each other's roles. Teachers used class time to discuss support services, and counselors visited the classroom to meet individually with students. Such a reimagining of traditional roles could be replicated by the institution as a whole to encourage collaboration among instructional programs and student services across campus.

Another structural change would be to reevaluate curriculum development and design. Traditionally, instructional faculty members are solely responsible for curriculum development. Including student service professionals in curriculum design would ensure the education of the whole student instead of merely focusing on the student's academic development.

Finally, colleges need to consider how to offer students important services in one convenient location. One of the reasons the students in the learning communities so effectively used the support services is that the services were accessible and intrusive. Colleges should, therefore, consider ways to ensure that students who need such services have easy access to them; indeed that they are required to access them. From this study and others, developmental students and students of color are in the most need of student support services. Therefore, colleges should commit themselves to requiring these students to use these services, even if it means making the difficult decision to limit access to services for other students.

Race-Conscious Programs

Institutionalized racism has led teachers to have negative perceptions about the abilities of their African American students. Costner, Daniels, & Clark (2010) surveyed over 200 community college faculty and found that while the faculty expressed willingness to teach African American students, they were not willing to use teaching strategies that have been found to increase the success of African American students. In fact, the instructors were overwhelmingly predisposed to colorblind attitudes towards their students, an attitude that Irvine (1990) describes as "cultural aversion." According to Irvine, cultural aversion is the reluctance of teachers and administrators to discuss race and race-related issues, such as ethnicity, culture, prejudice, equality, and social justice. If we are averse

to talking about our students' cultures, then we are averse to our students.

Therefore, it is recommended that our institutions re-evaluate the colorblind policies that have been in place and start to implement race-conscious programs, such as the learning communities described in this study. Institutional leaders should acknowledge that race and racism are at the center of the achievement gap between African Americans and their White and Asian counterparts. Once we acknowledge the problem, we can begin to put programs into place to solve it.

Instructional leaders, both faculty and Academic Senate leaders, must also re-evaluate their colorblind policies. To pretend that we do not see color, to claim that we treat every student the same, is to ignore the different needs of our racially mixed student population. Treating students equally is not the same as treating students the same. We should not assume that a "one size fits all" approach to education will serve all students well.

Another key finding from the studies shows that the racial component of the learning communities was a key part of the students' success. The culturally responsive pedagogy and the sense of community gained by being in a classroom of majority African American students gave the students in this study a deepened sense of their identity as African Americans. They felt proud of their history, and they felt accountable to and for the other students in the cohort.

It is for this reason that it is recommended that all colleges implement race-conscious programs for their African American and Latino students. It is clear that racial identity matters in terms of the support students receive from ethnic-specific programs. When students feel that their racial identity is validated, they reflect a strong engagement with the cohort and, by extension, with the college. Engagement and retention literature indicates that such connections result in higher persistence and success rates among students of color.

In addition to programs that target specific ethnic groups on campus, it is recommended that culturally responsive pedagogy be integrated into the curriculum of all courses. African American and Latino studies courses should be offered to students early in their educational careers. Instead of these courses serving as electives that students take at the end of their coursework, students should take these courses at the beginning of their studies so they benefit from the identity development these courses offer.

Recommendations for Future Research

As a researcher, I am aware of the limitations of this study. The population sample was relatively small (19 students from three California colleges) and the students themselves included only those students who had succeeded in the learning communities. Future studies, then, could focus on a larger selection and wider diversity of students by including part-time students and students who dropped out of the program before finishing. The students in this study were chosen by the teachers and counselors in the programs, often as convenience samples from students available at the time. Further research could be conducted on a more carefully selected sample of students.

Another area for further research is to study how long the impact of the learning communities lasts for students. In other words, what happens to students once they leave the learning community and begin taking classes by themselves in other parts of the college? Do they transfer to a four-year institution, and what happens to them after that? An ethnographic study could be conducted to see how the cultural capital and identity development the students gain from the African American learning communities translates into future academic success for the students.

Such an ethnographic study would also help answer the question: how long should a college nurture a student before it expects the student to be fully self-sufficient? It would be interesting to know if the year-long program of building self-confidence and attaining academic and social integration is sufficient to help the students overcome the obstacles they continue to face throughout their college careers.

Reflections

As I consider what I have learned from this project, I reflect on the following topics: (a) race and teacher biases; (b) re-imagining the roles of instructional and student services personnel; and, (c) the lasting impact of the experience on students.

Race and Teacher Biases

Again looking at the problem of African American student retention through a racial lens, I wonder whether we can require teachers of all ethnicities to care about African American students the way they care about other students. As our society is paradoxically getting more diverse and more segregated than ever, how do we get teachers, administrators, and college staff to set their stereotypes aside to educate a population they may not be familiar with? Beverly Daniel Tatum (2007) refers to unconscious racism in terms of living in a smoggy city. When you live in smog, you breathe dirty air. So it is with race and racism, she says. When you live in a racist society, you can't help but internalize some of that racism. So if we truly want to look at how to teach our teachers to retain African American students, we have to first ask them to see their own place in this smoggy city, to examine their unconscious biases, and then to understand and truly care for their students of color.

Re-Imagining Traditional Roles

Here I offer some suggestions for redefining the roles of community college instructors and student services personnel. Four-year institutions have long-standing traditions of having faculty serve as academic advisors for students. Not only does this academic advising help students and faculty develop relationships outside the classroom walls, but such advising also instills a sense of responsibility for student success on the part of the faculty. While I understand that asking community college instructors to be academic advisors has labor negotiation implications, it is important that teachers be pushed to think about students outside of the traditional relationship.

I also argue that student services personnel should be rethinking their own traditional roles. Perhaps counselors should no longer offer 20-minute appointments on a first-come, first-served basis. Perhaps instead selected students should be given longer individual appointments while traditional students be given group-counseling appointments. Perhaps, too, counselors should be cross-trained in giving advice on matters other than academics, for example, financial aid counseling for students. Finally, I suggest that the traditional model of funding for student services needs to be re-evaluated. If counselors do begin to offer group-counseling sessions, perhaps these sessions could be weekly student contact hour (WSCH)-generating so that student services budgets are not constantly at the mercy of instructional budgets.

In the words of Tavis Smiley, an African American talk show host and political commentator, African American students are "too important to fail." The student voices in this study convince us as educators to pay particular attention to the ways our structures can change to help our students succeed. I would argue that it's not enough for us to simply care about the students we serve; we need to be willing to change some fundamental assumptions about the ways we create curriculum, structure class time, and offer support services to students who need them. Without such changes, we are simply conducting business as usual and achieving the same disheartening results.

About the Author

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From Perceived Adversary to Critical Friend to Partner in Reform:

A Policy Professional's Reflection on Her Experiences as a Policy Researcher and Change Agent in California's Higher Education Community, 2006-2013

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In the office of IHELP (Institute for Higher Education Leadership & Policy) at Sacramento State, an institute with the mission to enhance leadership and policy through research, we read the official email blast with disbelief and trepidation. A colleague had forwarded us the e-missive that California Community College system officials had sent to each and every faculty in the then-109-college system, complete with "talking points" to help those contacted by the media to attempt to discredit our most recent research.

We were supposed to be the "white hat" guys, the IHELPers, placing the blame for low completion rates in the community college system squarely on the infrastructure of state policies, not on the shoulders of the dedicated administrators, faculty, and others who serve our state and our students well through their work in this system. Our report, in fact, conveyed our convictions in its very title and subtitle: Rules of the Game: how state policies create barriers for student completion in the California Community Colleges. We understood that a wide range of policies force colleges to focus on how many students they serve, and how they spend their money far more than on how many students succeed and what outcomes they achieved from the money they spend.

A few weeks earlier, another research institute had been the first to report completion rates in the community college system, which had until then fended off such computations on the grounds that completion was an invalid measure of success for community colleges. The press release that accompanied that earlier report had struck a negative tone – seemingly blaming the faculty and staff of the colleges for the poor outcomes.

Our study not only employed superior methods for computing completion, but also absolved the colleges of blame, reflecting our belief as policy professionals that statutes and regulations set the "rules of the game," which rational individuals working in all institutions naturally follow. If colleges are funded based on course enrollments in the third week, for example, how can we blame them for maximizing third week enrollment? If colleges face strict limitations on what they may spend on student services, how can we fault them for not providing adequate support to students who need a lot of it? If large numbers of students pay no fees to enroll in courses, how can we expect colleges to ensure that students will plan carefully before enrolling in or dropping out of classes? If under-staffed colleges are made to follow onerous protocols before they can exercise academic judgments about setting prerequisites for college-level courses, how can we fault them when under-prepared students fail to complete college courses? The answer that we gave in our report was: we can't blame the colleges; blame should instead be aimed at state policies – at the rules of the game. Those of us seeking different outcomes should work to change the rules.

So imagine our surprise when we saw that the system officials had skewered our report. The email blast across the system included these statements to underscore their objection to our use of "completion" to examine student outcomes in community colleges:

- "This is another typical 'university view' of our

community colleges written by people who have no experience in our institutions."

- The authors seek to "remake community colleges into another elite university system."
- "It is clear that the authors have little or no understanding of our colleges or our students and their work is not helpful…."
- "The study is insulting to community colleges."

Flash forward almost exactly five years to a press release from the Community Colleges Chancellor's Office, which recounted the Chancellor's testimony to a joint committee of the California legislature at which he praised the California Community Colleges Board of Governors' unanimous endorsement of the final recommendations of the Student Success Task Force:

> SACRAMENTO, Calif. – California Community Colleges Chancellor Jack Scott told a joint legislative committee today that recommendations developed by the Student Success Task Force will help more students reach their educational goals on time and help close the achievement gap for disadvantaged students in the 112-college system.
>
> "This is a comprehensive plan that will result in more students completing certificates and degrees and transferring to four-year institutions," said Chancellor Scott, who oversees the nation's largest system of higher education. "Completion matters. It matters for students – whose earnings increase as they become more educated – and for our state as a whole. Our economy is increasingly demanding college-educated workers."

For me, as Executive Director of the Sacramento State Institute for Higher Education Leadership & Policy and someone without the thickest of skin, the professional journey across those five years has been painful, frightening, challenging, inspiring, rewarding, humbling, and exciting – in approximately that order. The story that I am about to tell is my individual story, but it offers lessons to other academics with a penchant for bringing research to bear on policy. One lesson has already been illustrated: prepare to be misunderstood. Others will be pointed out as the tale unfolds.

It is important for me to say that I feel privileged to have directed IHELP during a period of substantial change that bodes so positively for the future of California. I have the utmost respect for those in the community colleges who have worked through the "careful what you wish for" scenario of wanting the colleges to receive more attention and respect from policy makers but fearing attention that is unaccompanied by sufficient knowledge of community colleges, their missions, and their challenges.

As I reflect on my experience as a policy professional working to improve student success in the community colleges, I see three distinct phases over which my professional role, vis a vis the community colleges, has evolved: from perceived antagonist to critical friend to partner in reform. In each stage the role of our research in influencing public policy has been different. Across the three stages I have learned a great deal about being a policy professional. Although these stages of development may not parallel the stages of development in the relationship of all researchers inclined toward policy, the lessons learned may be worth sharing.

A Perceived Antagonist - or being "Shulocked"

The political environment into which we released our Rules of the Game report was especially charged because the community college system was sponsoring a ballot initiative to carve out its own protected funding within the Proposition 98 K-14 funding guarantee. A system leader told me that even though he understood we were blaming policies, not colleges, the general public would not make that distinction and the system could not afford to let any apparent criticism of the colleges go uncontested. Hence the email blast, the general designation of me as enemy of the community college system, and the coining of the phrase "to be Shulocked" - meaning attacked by an enemy. Ironically, being viewed as one with the capability to Shulock someone gave me plentiful opportunities to get out and explain our research and its motivation – an essential ingredient in making policy research useful and influential if readers are counting lessons learned during this tale.

I traveled up and down the state, by invitation, giving presentations to, in effect, defend myself.

Unfortunately, I discovered that some in the audience had not read our reports, but had simply been prepped to feel attacked and insulted. In an effort to discredit our completion rate finding, for example, I was routinely accused of not realizing the most basic fact about community colleges – that many students enroll for purposes other than to earn a certificate or degree or transfer. That was an easy one: I would refer to the graphic on the first page of Rules of the Game that displayed the 40 percent of entering students we had determined were indeed not seeking a credential and had omitted from our computation.

More difficult for me was to convince hostile audiences that my motivation for studying the community colleges was to highlight their importance to California and point to ways that better policies could produce better results. From its founding in 2001, IHELP's mission has been to focus on community colleges as a partial antidote to the disproportionately skewed policy attention given to UC and CSU, which together serve but a quarter of the state's public enrollments. But as a CSU faculty member, my motivations were understandably suspect within the community college world. Why would I, in my work at IHELP, want to steer policy attention away from my own institution and fix it on another institution?

Herein lies a big lesson for me and, I suspect, for others. Anyone interested in doing educational research and bringing its light into policy making on the front lines must be prepared to have allegiances questioned. Education in general, especially higher education, has a long history of turf warfare that extends to the policy arena as well.

My greatest challenge, and as it happens, best memory from this stage, was the keynote address I was invited to give to an annual summit of academic senate leaders from all of the colleges. Drawing on all that I had learned from a recent series of workshops on communication, I appealed to the faculty leaders on the basis of shared values and shared goals, and concluded with what I thought was a compelling vision of the future role and stature of the colleges that they could help bring about. The first person to be called on in the Q and A said (and I recall the exact words years later): "You're not at all like I expected you to be."

The lesson I took from this was that policy researchers cannot rely on their work being mediated effectively to intended audiences. Nor can they rely on audiences reading policy briefs, however short and compelling. Although there is a crucial role for publication of full and complete research reports, to make a real difference, policy researchers must get out and make their own case as directly as possible. I was fortunate to have had the opportunity to do so, and in the case of the Academic Senate, much credit is due to the then systemwide senate president, who felt that faculty needed to be exposed to our research, however controversial it was at the time.

I am happy to be able to say that, during this period, our work contributed to the framing of a different kind of policy discourse around student completion, and we at IHELP helped call attention to how vital the community college system is to the future economic and social health of California. Yes, we had made specific recommendations about the policies that needed to be examined, but the time for specific policy discussions would come. The system had circled the wagons to protect against unwelcome intrusion by outsiders who were not trusted to have good intentions. It would take more such outsiders and courageous insiders, whose numbers were growing, to press ahead with the new policy conversation before specific policy reforms might result.

A Critical Friend - or Getting "Rehabilitated"

Over the next few years our institute released some new research, in which we tried hard to adopt a more positive tone, having developed more highly attuned "tone radar," and to apply the edict of communication professionals that "what you say is not necessarily what they hear." It may have helped me attain what people referred to as my "rehabilitated" status with the college system that our newer work was easier to interpret as positive and even helpful. We documented the intermediate "milestones" that students reach in community colleges as well as the academic behaviors that predict successful forward progress. This line of research allowed us to offer recommendations about the kinds of college practices as well as state or system policies that would likely help more students succeed. It also called attention to the progress that students do make – rather than the failure of so many to finish. In this

period we also examined the state's community college transfer policies, broadening our focus to include the California State University, and further emphasizing the extraordinary role that the community colleges play in educating Californians.

Gradually, I got less anxious at the prospect of walking into the Chancellor's Office building in downtown Sacramento – a place that had felt like hostile territory for a while. Our reports became standard reading for those engaged in the student success agenda, including the Futures Commission of the League for California Community Colleges, the foundation-funded leadership training program for the colleges, and the Student Success Task Force, a high profile effort that was established via legislation to consider ways to improve student outcomes. The strongest indicator of my rehabilitation was when I received a phone call from then-Chancellor Jack Scott inviting me to serve as one of five external members on the Task Force.

The commitment of the Task Force to student success was manifest, and it produced an impressive set of recommendations, which were unanimously approved by the Board of Governors. Some of the recommendations were promptly incorporated into legislation, sponsored by the Chancellor's Office and enacted into law. Other aspects of the student success plan are being implemented administratively. The Task Force report was highly reflective of the positions we had taken in our research, and the views of the several national experts who were invited to present to the Task Force. The system was catching up to the leading states in embracing the student success agenda. In view of the size and complexity of the California community college system, its decentralized governance structures, and the myriad stakeholder groups with stakes in the status quo, I was personally surprised and professionally delighted with the outcome.

This second phase of my professional role vis a vis the colleges saw the possibility open for the consideration of how different policies might encourage different outcomes. Disagreements were about means to the end, not about the end goal of improving student completion of college certificates and degrees. Activity was growing across the college system to find better ways to help students succeed – better approaches to helping students acquire needed basic skills, better internal data collection, more proactive support services for students, and more focused use of resources on students who seek college credentials. Serving on the Student Success Task Force was instrumental in my evolution from perceived adversary to critical friend in part because Task Force members found themselves considering many of our ideas, and in part because I found myself more convinced than ever that the system was committed to re-booting some critical aspects of its operations to produce better results.

If there is any lesson in my Task Force experience, it is this: regardless of the size of the playing field, those among us who want to use educational research as a tool to shape better policies for schools and students must do more than publish research reports and speak to audiences about their findings. At some point, they must become civically engaged and participate in a substantive way in policy-making processes. My experience happened to be at the state level. Others could have these experiences at the county or district or even school or community levels.

A Partner in Reform

As a professor of public policy, my understanding of, and commitment to, policy as a tool for reform stems from a belief that policies create incentives and that, particularly when finances are involved, rational people – students, faculty, and staff alike – respond to incentives. This is what motivated our initial work on community college student success, generally. We became convinced that the policy infrastructure created incentives that were misaligned with the goal of completion. In 2010 we extended that line of inquiry, turning our attention to the career technical education (CTE) mission of the colleges. Our hypothesis was that the policy infrastructure for the college system was inadequately supportive of CTE, reflecting the system's strong and historic commitment to its transfer mission. This lack of alignment of policy with the CTE mission, we surmised, was preventing CTE from flourishing and meeting the workforce and economic development needs of the state.

Over the last year I have developed a strong partnership with the vice chancellor for workforce and economic development at the Chancellor's Office who

has an ambitious agenda to reform the operation of her division to "do what matters for jobs and the economy." Coming from outside the system, from industry, she has a strong sense of how to accomplish reform administratively, but she is looking to IHELP to assist her in elevating the stature of CTE within the system and identifying policy change options that would create conditions more supportive of the change she seeks. She invited me to testify with her to the Board of Governors on our research to "tee up" CTE issues for emphasis. Later, she invited me to participate in her opening plenary session to the annual conference of CTE educators in the system to alert them to the kinds of policy recommendations we are likely to make.

What a change from the time when the system feared our research to a time when she, and others, are waiting for our recommendations to provide a menu for possible system-sponsored legislation. I recently participated in a Capitol briefing at which we presented our research-in-progress to an audience of legislative staff and others interested in CTE. The deputy vice chancellor, also on the panel, publicly referenced my transition from "critical friend" to "partner." She explained that her division was pursuing administrative changes as best they could under current policies but that they viewed policy alignment as critical to taking their reforms to scale. A college president on the panel echoed that sentiment, describing the heroic efforts she has put in place, but decrying the lack of state support, via fiscal and other policy, for these efforts.

Numerous faculty and staff from across the college CTE community assisted us as informal advisors in this work. Through conference calls, interviews, and surveys for providing reactions to draft policy documents, they helped us understand these highly complex issues. There was a great mutual benefit to this partnership. IHELP gained substantive knowledge, credibility, and support for our recommendations. The CTE community gains by having us raise the profile of their mission and advocate for policies to better support it. Whereas the first stage of our work saw a reframing of the policy discourse to "student success," and the second stage saw a search for ideas to modify practices and policies that allowed us to have a literal seat at the table, the third (and current) stage is seeing us more directly set the agenda for policy reform as it affects one significant aspect of the college system. We turned our attention to CTE soon enough so that when the new vice chancellor sought help understanding how state policy could help her cause, we had something already underway and could become a partner in policy reform.

To be sure, this is my story and the story of IHELP during a period of policy upheaval in California. But it is also a story with lessons for others interested in educational research and policy. Most important, it stands as testimony that policy researchers can find a seat at the table and ultimately become partners in policy making if the research is sound and the researchers can communicate it effectively. Throughout the five years of this story, the potential for our research to affect policy would have been destroyed had anyone been able to discredit it – and surely some tried. So perhaps the most important lesson of all is that the prerequisite for a researcher to be a player is the quality of the research. My story certainly underscores the critical role of communication. Policy researchers must expect to be misunderstood and mistrusted. They need to find ways to represent themselves and their findings so those who might benefit from policy changes recognize the value in the findings. To build effective skills affording both quality policy research and effective communication, leadership programs at the doctoral level have emerged showing promise of building a robust scholarly community committed to change.

Not at All "Academic"

My own doctoral study has proven invaluable to my professional journey. I wrote my doctoral dissertation on the role of policy analysis in legislative decision making. This topic was more than an academic interest to me as, prior to my doctoral study, I had worked as a legislative analyst, using what I learned in my public policy Master's program to craft rational recommendations to influence the California Legislature's fiscal policy decisions. I had observed how legislative decisions seemed to be made in spite of, not because of, supposedly rational arguments. At the same time I observed that there had been a huge growth in the policy analysis industry, with scores of new graduate programs and legions of policy analysts being hired at all levels of government. The typical policy program would advertise itself as

teaching students how to "solve policy problems." In my experience, policy problems were not really "solved" and the "solvers" – the legislators and other "clients" of the policy analysts who were producing the supposed solutions – were not consulting policy analysis before taking a position. Furthermore, academicians studying "research use" in the social and policy sciences had not found much ground for support for the profession. I resolved to investigate this "paradox of policy analysis," whereby it was not being used. However, our society continued to produce more of it.

To make a long story short, my answer, confirmed with statistical results as applied to the US Congress and honored with a disciplinary award, was that policy analysis is, in fact, used but not in the way that researchers sought to document or that policy schools advertised to recruits. It is used as a means to increase and shape understanding of issues and problems, not necessarily to solve them. It is used to frame issues in ways that can mobilize new populations to get involved, which can lead to different outcomes that otherwise would have occurred. It is used to justify some issues winning the competition for space on the policy agenda and getting attention that would otherwise be lacking.

Even though I was a working professional when I wrote my dissertation, I could never have imagined at the time how relevant my doctoral research would become in my professional career. Since the founding of IHELP in 2001, I have tried to put into practice what I have learned about making policy research useful. While I learn more and more with each passing year, the signal lesson of my dissertation has been borne out in my work on community college student success. By choosing to study topics that matter greatly, forging ahead despite controversy, setting high standards of research quality, producing accessible and actionable research products that reflect great care in defining and framing issues appropriately, and engaging actively with the policy community, we have amassed a body of useful policy research.

I looked up my presentation to the Academic Senate and every one of the items I put forth as a "policy change agenda" has been, or is being, substantively addressed by the community college system. Did this happen because IHELP produced a series of research reports that offered those recommendations? Certainly not. I do think that our work, over time and in concert with complementary work from inside and outside the state, helped California lawmakers and educators better understand the educational problems facing our state, the role of the community colleges in addressing them, the urgency of taking action at the policy level, and the kinds of actions that might be taken. I feel immensely fulfilled by this last decade as a policy professional that has allowed me to participate in a movement that should have a lasting legacy for California.

About the Author

NANCY SHULOCK is executive director of the Institute for Higher Education Leadership and Policy and professor of public policy and administration at Sacramento State. The Institute conducts applied policy research to help state policy makers and educators improve postsecondary readiness and success. She has authored numerous reports and articles on higher education policy and performance, finance policy, community college student success, career technical education, community college transfer and accountability.

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Staying Focused on the Agenda:

The Greatest Challenge in a Complex Environment

Brice W. Harris, Ed.D., Chancellor
California Community Colleges

As change accelerates at a seemingly unmanageable rate, organizational leaders frequently find themselves criticized for not being willing to implement enough change fast enough to satisfy critics. Although effective leaders are not overly worried by their critics, the actual ability to foster renewal and change in an organization can be inhibited by these forces that are always quick to want to "help."

In American higher education, specifically here in California's large and diverse system of 112 community colleges serving nearly 2.4 million students, there is no shortage of helpers. These generally well-meaning foundations, organizations, policy staff members and media representatives all have what they believe to be solutions to the problems of a chronically underfunded and overburdened set of colleges. Although in many instances they actually do have tremendous ideas that can and often do work, there are so many of them – pulling the system in so many directions – that remaining focused on an agenda is a daily battle. One system leader recently stated, "We are a system overburdened with helpers, if there were a thousand different directions in which to go – we would be expected to go in all thousand at once."

A Clear Agenda

Many individuals facing a new leadership challenge are confronted with the added task of charting a new agenda. In my case of assuming the role of Chancellor of the California Community College System in November, 2012, the agenda was clear on day one. The Board of Governors had spent the past two years charting a course for improving student success through their Student Success Task Force, and the system had sustained tremendous damage to open access by turning away more than 500,000 students during the past four years of budget cuts. Restoring open access to California community colleges and helping students succeed at higher rates are clearly the dual challenges facing not only the California community colleges, but in many ways American higher education in general.

Policy makers and experts from President Obama to the media have pointed out the dramatic decline in American competitiveness due to an increasing decline in the percentage of Americans with college degrees. Restoring the leadership of the United States in this area will require both increased numbers of students completing colleges and universities, and an enhanced percentage of citizens enrolling in higher education. Additionally, it will not be enough to simply see the overall student success numbers improve without also closing the terrible gaps in performance by race, ethnicity, gender and age. Student success cannot be for only part of the population. Everyone must have the same opportunity to succeed. To some extent we will – and should – be judged by how well we do in restoring access and improving success for our most educationally and economically disadvantaged students. If we enhance access and success by simply turning away our most challenged students then we have failed. For California to truly succeed everyone must participate and succeed regardless of their zip code, social economic status, race, ethnicity, age, gender, or level of previous educational preparation. American community colleges are historically the most integrative and welcoming public institutions in the country. California community colleges must reaffirm not refute that promise.

I feel strongly that over the next few years it is my responsibility to keep our system clearly focused on access and success. There will be many other issues we must face, but to allow our colleges to be drawn away from focusing the vast majority of our resources

and energy on restoring student access and ensuring increased student success for all students would result in failure.

Unique Environment

Leading the California Community Colleges as the system Chancellor requires a clear understanding of both a complex system of colleges and of the governance structure, which is more a "confederation" than a system. Unlike both the University of California and the California State University, which have a single Board leading all the campuses of each system, California's community colleges have a state-level Board of Governors as well as 72 locally elected boards that oversee the local colleges and districts. This system is actually highly effective and, I believe, the best way to ensure that local communities have colleges that meet their local needs. This unique structure may actually be the only way to deliver community college education that fulfills local needs in such a large and diverse state. However, leading with little line authority requires a more collaborative approach than one sees in the more centralized institutions. Although there have been numerous reports that have recommended a much more centralized system, I am convinced that any organizational efficiency achieved by that approach would be negated by the loss of local responsiveness to local educational needs.

Existing challenges

Assuming the leadership challenge of the California Community Colleges also requires an understanding of the current state of the system. After more than four years of significant budget reductions due to the prolonged fiscal challenges of the State of California, in November the State's voters approved temporary tax increases that will provide modest funding increases for the system over the next few years. Although this certainly heads the system in the right direction, the funding will mainly stop the terrible cutting that has been a necessity over the past four years and allow the colleges to begin modestly restoring access. The system has other significant needs including the resources necessary for the full implementation of the Student Success Task Force recommendations, which the Board of Governors approved in January of 2012; restoration of the operating budgets of the colleges whose expenses have continued to climb during the recession; and the restoration of valuable categorical programs for disadvantaged and disabled students that were cut more than 40 percent when the State began experiencing financial difficulties.

In addition to the financial challenges facing the system, a number of policy-related issues constantly being put into play have the potential to compliment or confuse the system agenda. Currently those include legislation to allow for differential tuition, unit limits for student enrollment, on-line education proposals, outcomes-based funding models and a recommended shift of adult education from K-12 to community colleges. The argument can be made that each of these has a direct impact on either student success or access. The challenge for our system of colleges is to respond to each of the various proposals in a manner that respects the intention of those pushing a given proposal while also ensuring that any resulting policy change actually furthers the agenda of student access and success.

To make matters even more complicated, of the more than 2,000 bills recently introduced prior to the deadline in the California legislature for the current session, more than 200 of them would impact community colleges. Each of these proposals has behind it individuals and groups genuinely trying to improve our system. Creating a problem as a result of this tremendous outpouring of assistance is not the intention of those attempting to help, but the sheer magnitude of different and often competing solutions presents a layer of challenges completely apart from the challenge of implementing any particular solution. Sometimes too much support can be as big a challenge as too little.

Staying Focused

Promoting an agenda and keeping any organization focused is difficult, but when that organization spans more than 100 autonomous units, in multiple media markets, across thousands of miles in the state of California, it seems even more daunting. These individual colleges have their own cultures, and what works in suburban San Diego may not work in downtown San Francisco or in rural Yuba County.

The California Community College system has been

called "unmanageable." I believe there is a great deal of truth to that statement if by "management" we mean control. In my view, no individual or team can, or should, control this vast system from a central office. However, the Chancellor's Office of the California Community Colleges, overseen by the Board of Governors, should determine the direction of the system based on state policy set by the Governor and Legislature. That direction should serve as the guideposts or navigational buoys within which the colleges fulfill their local and regional educational needs.

I believe it is my job, working under the direction of the Board of Governors, to articulate that direction and move the system accordingly. Although the Chancellor's Office will occasionally function in an oversight capacity as required by policy and law, more often our work will involve seeking resources for our colleges, creating regulation and policy that allow colleges to fulfill the state agenda, and constantly monitoring developments so that we do not lose sight of our two most important goals – restoring student access and increasing student success for all of California's diverse student population.

My Personal Leadership Challenge

Before assuming this office, I served for more than four decades in community colleges first as a faculty member, administrator and vice chancellor in the Kansas City, Missouri, community college system; then as President of Fresno City College; and, for the past sixteen years, as Chancellor of the Los Rios system here in Sacramento. With each of those progressively responsible positions came increasing complexity as the institutions grew in size and the jobs in scope. All the valuable leadership lessons I learned came from the people I worked for and with, as well as the good decisions and mistakes I made along the way. I believe in the concept of time-in-grade and feel as if my pathway to this position prepared me well for the challenges I am now facing.

As I considered applying for this opportunity, I spoke with six of the men and women who have held the job prior to me. I know and am friends with all of them. There was a great deal of consistency in what each of them said about being Chancellor of the California Community Colleges; so I took the post with my eyes wide open. Now only four months into this new role, there is a risk in stating with any certainty how this job will impact me or what will be the result of my tenure as Chancellor. However, I have formed these early personal conclusions about this post:

- As Chancellor, I will not have the luxury of focusing only on the system agenda, and yet I will try daily to do just that.
- Balancing the demands of being in the field and doing the work needed in Sacramento will be impossible, and so I will simply do the best I can.
- My dual roles of oversight and leadership will often be in conflict and result in individuals and groups that are less willing to pursue the agenda because they are unhappy with a decision I have made on a single issue, and so I will lead with the utmost in integrity and shoulder the words of my critics as well as my supporters.
- I simply will not have the human stamina to do everything that needs to be done, and so I will focus most of my energy on the agenda and not spend a lot of time worrying about the rest.
- I will, and should, be judged as Chancellor by how successful the system is in serving all Californians who want and need an education.
- This could well end up being the greatest opportunity of my professional life, and so I plan to enjoy every moment.

The California community college system represents one in every five community college students in the country, and one in ten in American public higher education. Succeeding in California at restoring access and improving success will give America a fighting chance to regain our global leadership. This leadership opportunity is important. After more than four decades in community college education, I am still energized by this work and excited by a new leadership challenge.

BRICE HARRIS is the Chancellor for the California Community Colleges. Prior to being selected as the leader of the largest system of higher education in the nation, Harris served 16 years as chancellor of the Los Rios Community College District in the Sacramento region, president of Fresno City College and a faculty member and vice chancellor in the Kansas City, Mo., community college system. Harris is also a recognized leader on national education issues and recently completed a term as a board member of the American Council on Education (ACE) in Washington, D.C.

The Journal of Transformative Leadership and Policy Studies - JTLPS

Call for Papers

Article Themes

Science, Technology, Engineering, and Math (STEM); Educational Leadership and Policy Studies

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Submission Guidelines

A comprehensive set of submission guidelines are available online to help you prepare your manuscript.

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Sponsored by the California State University's Chancellor's Office and the system's thirteen Education Doctorate programs, the Journal of Transformative Leadership and Policy Studies (JTLPS) publishes peer-reviewed studies for the educational leadership and policy community in California and beyond. The focus is to advance our understanding of solutions to the many problems faced by the nation's schools and colleges.

Themes

One particularly serious problem, in terms of student access and outcomes, lies in STEM Education. We know that competence in STEM disciplines is becoming increasingly important not only for students seeking full participation in our economy and our society, but for our collective well-being and productivity. We also know that students in the United States continue to lag behind students in several East Asian countries and European nations in math and science disciplines.

As the journal representing education leadership doctorates in one of the largest state university systems in the country, we want to provide an ongoing place for scholars, practitioners and policy-makers to communicate deeply with one another about cutting-edge education research, innovative education policies, and effective STEM-related strategies and initiatives. To that end, we put out the following CALL FOR SUBMISSIONS OF SCHOLARLY ARTICLES:

Call For Papers

With this call, JTLPS invites scholars to submit papers on a range of topics pertinent to STEM Education, Educational Leadership and Policy Studies in Education. We are interested in manuscripts on promising STEM Education and Educational Leadership Policy initiatives and projects that are in place in California, and in other states along with their results. We encourage articles that deal with the integration of technology and engineering within math and science as well as the leadership focused practices that are the driving force across disciplines. For example, approaches that incorporate literacy with STEM, such as STEAM, that combine the arts and STEM education. We also have a special interest in programs and topics that address the foundations for STEM success in the elementary grades.

In line with our Journal's mission, we seek submissions that address the preparation and development of P-20 educational leaders. We encourage papers that focus on strategies for increasing the number of students who pursue and succeed in STEM majors and courses. Finally, we invite articles on methods to increase the number and quality of elementary and secondary school teachers prepared in STEM disciplines, and beyond.

JTLPS aims to publish two issues per year, Fall and Spring. Manuscripts will be accepted on an ongoing basis.

For more information

www.csus.edu/coe/academics/edd/jtlps

Submission Guidelines

JTLPs primarily publishes peer-reviewed empirical studies of interest to the educational leadership and policy community that advance our shared understanding of possible solutions to the many inequities present in America's schools and colleges. Our offerings are meant to help focus our distributed, collective actions to transform schools and colleges from places with uneven opportunities to learn from to institutions that provide an abundance of opportunities for all learners. We believe that leadership and policy are twin levers in the struggle for social justice. We are particularly interested in research into leadership in STEM education and plan to publish 1-3 articles per issue on this topic as a regular part of the journal.

We invite submissions in the following genres:

- Empirical studies:
- concept papers grounded in empirical and scholarly literature;
- policy briefs; and
- reflective essays on professional experience.

General guidelines regarding format must be applied to all submissions. Particular guidelines for empirical studies and for policy briefs are applied as appropriate. Independent of the genre selected for publication submission, all submissions will follow a strict peer review process. At the same time, every effort will be made to match topics with the expertise area of respective reviewers.

General Guidelines

Please read the general guidelines thoroughly. Articles will be accepted in the following format:

1. The submission file is in Microsoft Word.

2. Use 12-point Times New Roman or similar font.

3. Margins should be 1.0 inches on the top, bottom, and sides.

4. Include a title page with each author's name and contact information. (Please indicate the institutions and/or grant numbers of any financial support you have received for your research. Also indicate whether the research reported in the paper was the result of a for-pay consulting relationship.) If your submissions is derived from a paper you have published elsewhere, please make that evident on your title page as well.

5. Include an abstract of 175 or fewer words. The abstract should reflect the content and findings of the article and emphasize new and important aspects of or observations related to the study. In general, it should include information on the background or context of the study as well as the purpose(s), methods, results, conclusions, and policy and/or leadership recommendations.

6. Using the APA Style Manual, 6th edition, fully reference all prior work on the same subject and compare your paper to that work. In addition to referencing the work of other scholars, you should be certain to cite your own work when applicable.

7. Figures and Tables
   - Please state the number of figures, tables, and illustrations accompanying your submission so that editorial staff and reviewers can verify their receipt.
   - Where possible, supply figures in a format that can be edited so that we can regularize and edit spelling, the font and size of labels and legends, and the content and presentation of captions.
   - Illustrations need to be of publishable quality as we do not have a dedicated graphics department.
   - If you are submitting a figure as an image file (e.g., PNG or JPG), do not include the caption as part of the figure; instead, provide the captions with the main text of your article.

Submission Guidelines

8. We recommend short, effective titles that contain necessary and relevant information required for accurate electronic retrieval of the work. The title should be comprehensible to readers outside your field. Avoid specialist abbreviations if possible.

9. We publish a picture on the journal home page with each article. We encourage authors to submit their own digital photographs.

10. The submission has not been previously published, nor is it before another journal for consideration.

11. Where available, URLs for the references are provided.

12. Upon acceptance of the manuscript, all revisions must be made in 'Track Change Mode' when resubmitted

Genre Guidelines

The genre guidelines are specific to the type of submission. Please review these detailed guidelines on the internet:

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Submissions are accepted on an ongoing basis.