

Navigating the Turbulent Waters of School Reform
Guided by Complexity Theory

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Abstract

The goal of this research study was to develop, implement, and evaluate a school reform design experiment at a continuation high school with low-income, low-performing underrepresented minority students. The complexity sciences served as a theoretical framework for this design experiment. Treating an innovative college prep program as a nested complex adaptive system within a larger complex adaptive system, the school, we used features of complex adaptive systems (equilibrium, emergence, self-organization, and feedback loops) as a framework to design a strategy for school reform. The goal was to create an environment for change by pulling the school far from equilibrium using a strategy we call “purposeful perturbations” to disrupt the stable state of the school in a purposeful way. Over the four years of the study, several tipping points were reached, and we developed agent-based simulation models that capture important dynamic properties of the reform at these points. The study draws upon complexity theory in multiple ways that have supported improved education for low-achieving students.

Introduction

While not all high school graduates go to college, for those students who do attend college, adequate academic preparation for college-level coursework and support for developing learning strategies facilitates a successful transition to a college.

Yet many high school graduates, in particular racial/ethnic minority students and students from low-income families, have neither the academic skills nor learning strategies necessary for college success (Hurtado, Inkelas, Briggs, & Rhee, 1997). The lack of college readiness by underrepresented racial/ethnic minority student and students from low-income families has implications for college enrollment (Jones, Yonezawa, Ballesteros, & Mehan, 2002), and the likelihood of success for those who do go on to college.

According to an ACT report on college readiness (2010), “Students who are not ready for postsecondary education are less likely to enroll in college, more likely to need remedial coursework during their first year of college, less likely to succeed in their college courses, and less likely to earn a college degree” (p. 5). This is especially problematic for underrepresented racial/ethnic minority student and students from low-income families. Not only do gaps exist in college enrollment rates across racial/ethnic groups and annual family income ranges, but gaps in college degree completion rates also exist across these groups and range of family incomes.

These gaps in college success rates are also due in large part to a lack of preparation

for college-level coursework during high school. Students who graduate from high school unprepared for first-year college coursework often need substantial remediation. For example, of students who take remedial reading, more than half take four or more remedial reading courses and more than two-thirds also take remedial mathematics; of students who take remedial mathematics, more than 70 percent take two or more remedial mathematics courses (Adelman, 2004; Carey, 2004). Nationally, about one-third of high school graduates who enroll in college take remedial coursework. Underrepresented racial/ethnic minority students are almost twice as likely to take one or more remedial courses in college as Asian and White students (Parsad & Lewis, 2003).

School reform efforts aimed at raising student achievement levels have been studied using a variety of theoretical frameworks (Elmore & Burney, 1999; Fullan, 1999; Hubbard, Mehan, & Stein, 2006; Stringfield & Datnow, 2000).

In our research, complexity theory provided a lens for describing and explaining the reform process as it played out in the real-life context of a school with a majority of low-income, low-performing underrepresented students. Complexity theory was also used as a framework for developing a strategy for creating conditions for educational change that started, rather than ended, with students and a strategy for navigating the often turbulent and unpredictable waters of school reform efforts.

Literature Review

In this research, three branches of complexity theory (mathematical chaos theory, the theory of dissipative structures and the theory of complex adaptive systems) provided both a strategy for change and a theoretical lens for describing the changes that occurred in a continuation high school for low-income, low-performing underrepresented minority students

Chaos Theory

Chaos theory (Gleick, 1988; Stewart, 1989) represents an extension of system dynamics (Forrester, 1958, 1961). To the three possible states in system dynamics, chaos theory adds a fourth state, a strange attractor, which lies between the borders of the stability of point and cyclical attractors and the instability of high-dimensional chaos.

The strange attractor, called mathematical chaos, exhibits a pattern of movement that is paradoxical. The pattern is one of regular irregularity or stable instability. Stacey (2007) notes that: "Chaos does not mean total confusion, but patterns where stability and instability no longer mean what they do in their separate states" (p. 190). When a system is in a strange attractor state, it has a high degree of sensitivity to initial conditions. Small differences in input, an error or fluctuation, can and often do result in a large difference in output. This is known as the "butterfly" effect. A butterfly flapping its wings in Brazil causes a tornado in Texas. This feature of strange attractors makes long-term predictions impossible.

Theory of Dissipative Structures

In their laboratory experiments on open systems at equilibrium (Nicolis & Prigogine

1989; Prigogine & Stengers, 1984), found that when you perturb nonlinear physical and chemical systems far from equilibrium, they display intrinsically unpredictable behavior. When such a system is perturbed far from equilibrium, small changes, or fluctuations in the environment can cause the instability necessary to break an existing pattern of behavior and replace it with a different pattern of behavior. The process is one of destruction of existing patterns in order to make way for the creation of new patterns. When the system reaches a critical point, or bifurcation point, it spontaneously self-organizes. New structures emerge that cannot be predicted from previous states. These emergent states are called dissipative structures because it takes energy to sustain a system in that new state.

A key feature of dissipative systems is the addition of a third attractor to those of stable equilibrium and explosive instability, a state of stable instability that is far from equilibrium. So a dissipative structure is not just a result, it is a process that uses disorder to change.

While both chaos theory systems and dissipative systems are deterministic, such that neither system can evolve, there is an important difference between the two. A chaotic system cannot move on its own accord from one attractor to another whereas a dissipative system can. Dissipative systems produce behavior patterns that are regularly irregular, intrinsically uncertain, and emerge without a blueprint through a process of self-organization.

Because these theories are deterministic, the relationships between agents do not change. This makes it problematic to apply them to human relationships since humans are capable of change and can evolve. However, these theories do have value as metaphors for

understanding complex systems such as organizations.

Complex Adaptive Systems

Complex adaptive systems (Gell-Mann, 1994; Holland, 1998; Kauffman, 1995; Langton, 1996) represent a departure from traditional system models. According to Stacey (2007), complex adaptive systems (CAS) are made up of a large number of agents where each individual agent behaves according to a set of rules. These rules require individual agents, through their interaction with other agents; to adjust their actions to that of the other agents, forming what Stacey calls “population-wide patterns”. In this sense, CAS differ from most other system models, which view systems at a macro level, in that CAS view systems at a micro level, through the local interactions of their agents.

While it may be difficult to characterize individuals in organizations such as schools as following one set of rules, they do share certain common features that qualify them as CAS.

Equilibrium: CAS have the capacity for transformational change. However, for new structures and patterns of behavior to be created, CAS must be far from equilibrium, otherwise changes will be temporary (Mischen & Jackson, 2008).

Like dissipative structures that need disorder for change (Prigogine & Stengers, 1984), for CAS that are in a stable state, equilibrium needs to be disrupted in order to create conditions for change. Introducing perturbations into a system that push a stable system far from equilibrium may result in the emergence of a new system through interactions of its internal elements (Morrison, 2002).

Capra (1997) describes how systems can change when they are “pushed” far from equilibrium towards what Brown and Eisenhardt (1998) call the “edge of chaos”. When CAS are pushed far from equilibrium they can encounter bifurcation points, what Capra calls forks in the road, leading to self-organization, the emergence of new forms, or dissipation, where systems revert to a variation of their initial stable state. At bifurcation points systems have the possibility to develop in several different ways, and the new form cannot be predicted.

Self-Organization and Emergence: A key feature of all CAS is that they are self-organizing systems. Self-organizing systems exhibit a nonlinear interconnectedness of system components resulting in feedback loops. According to Stacey (2007), these feedback loops “take the form of agents interacting locally according to their own principles, in the absence of an overall blueprint for the system they form” (p. 196). These self-organizing local interactions produce emergent population-wide patterns of behavior. Emergence describes the patterns of interaction through the behavior of interconnected elements that both adapt to and construct their environment.

Emergence is the partner of self-organization (Morrison, 2002). Since change emerges over time interdependently, it is not possible to determine outcomes in advance with any certainty. In CAS such as organizations, individuals are interdependent -- none of them can simply choose what will happen to all of them. According to Stacey (2007), “what happens to all of them will emerge in the interplay of their intentions and no one can be in control of this interplay” (p. 239). Strategy for change in some sense emerges in the interplay

of individual intentions.

Feedback Loops: Since change in CAS occurs through local interactions, feedback loops exist between interacting elements of a system (Marion, 1999). Mason (2009) states that: A central concern of complexity theory is on the relationships among the elements or agents that constitute a particular and sufficiently complex environment or system (p. 118).

CAS's reliance on feedback loops means that agents need to be connected, creating social networks. Daly (2010) defines a social network as: "a group of actors who are connected to one another through a set of different relations or ties" (p. 4). In organizations, individuals within a social network are interdependent since they share the same social network. Because of the connections between individuals, social network analysis provides a tool for studying the structure of the relationships between individuals in organizations. Cilliers (2001) and Stacey (2001) argue that one way to understand CAS is to study the patterns of interactions within a network.

In organizations, where individuals can change or evolve, social networks can change or evolve. The actions of individuals not only move along feedback loops, they can also change these loops. In organization science, studies of how social networks change provide insights for scholars who view organizations as CAS (Anderson, 1999) and may be used to develop effective strategies for change (Daly, 2010).

The Role of the Practitioner

In CAS there is no master controller or prescribed blueprint for change (Stacey, 2007). Instead, local interactions between agents, operating according to their own rules, result in a process of self-organization, giving rise to emergent, often unpredictable, new structures and new patterns of behavior. The less than predictable nature of complex systems means that practitioners have less control over outcomes. In this sense, research is more an opportunistic form of activity than a planned form of activity. Radford (2007) states that “In this context the practitioner is less like the bulldozer driver carving a way through the landscape to a pre-conceived objective, more like a combination of a canoeist shooting the rapids and creative artist exploring possibilities and waiting for inspiration” (p. 275).

Research Approach

Although complexity theory has its origins in the natural sciences (Kauffman, 1995; Mitchell, 2009), over the last few decades it has been also increasingly used in the social sciences (Allen, 2001; Brown & Eisenhardt, 1998; Wheatley, 1999). Recently, complexity theory has been applied to school reform efforts (Levin & Datnow, 2012a, 2012b; Maroulis et al., 2010; Mason, 2009; O’Day, 2002; Sui, 2008).

Studies that examine school reform efforts through the lens of complexity theory tend to rely on computer simulations. For example, Maroulis et al. (2010) used computer simulation methods to examine the inter-organizational dynamics that gave rise to

organizational change across a large urban district. Stacey (2007) argues that complexity scientists use computers to simulate the behavior of CAS because “it is not possible to experiment with living systems in real-life situations” (p. 196).

While complexity theory has been used to describe and explain school reform efforts, to date, no studies have looked at how complexity theory could be used as a theoretical framework for designing and implementing a strategy for school reform.

Methodology

A design research experiment was conducted to create conditions for transformational change to occur at a continuation high school with low-income, low-performing underrepresented minority students, to produce data that would enable us to draw warranted conclusions about school reform and what contributes to it (White, 2011).

Cobb, Confrey, diSessa, Lehrer, and Schauble (2003) state that “design experiments are conducted to develop theories, not merely to empirically tune ‘what works’” (p. 9). According to Mehan (2008), who refers to this as design research, this approach is useful in educational settings because it focus on improving practice while at the same time building theory. Mehan argues that design research attempts to go beyond writing a description of “what’s going on here” (p. 84).

Design experiments have a number of characteristics (Cobb et al., 2003; Collins, 1999; Schoenfeld, 2006). First, design experiments are set in the messy situations that characterize real-life contexts. Design experiments therefore constitute a means of addressing the complexity found in educational settings. Second, unlike the design of quantitative-analytical experiments where one variable is changed while all other variables are held constant, in design experiments there are many variables that matter. Third, design experiments must be flexible, that is, they must be open to design revision. Design modifications are made based on what emerges. “The result is an iterative process featuring cycles of invention and revision” (Cobb et al., 2003, p. 10). Fourth, design experiments are

primarily concerned with developing theory in local contexts.

Research Setting

The setting selected for this study was Gonzago High School (GHS), a pseudonym. GHS, a continuation high school, opened its doors in 1921. Continuation education is a high school diploma program designed to meet the needs of students 16 through 18 years of age who have not graduated from high school, are not exempt from compulsory school attendance, and are deemed at-risk of not completing their education, according to California Education Code, 48400-48438 (California Department of Education, 2013).

Located on the campus of St. Diaz City College (SDCC), in a large urban city in Southern California, GHS operates in the St. Diaz Unified School District (SDUSD) on a traditional school year (10 month) calendar. GHS serves as both a dropout prevention and dropout recovery school. Students, referred to GHS through SDUSD district counselors, are typically 16-17 years old, are seriously credit deficient often having 10 or fewer credits, and are unable to catch up to their graduating class.

On average, GHS serves approximately 450 students, 350 in its continuation education program and 100 students in its independent study program. These numbers tend to vary month by month. Virtually all students who enroll at GHS are referred because they are at risk of dropping out of school. For the 2006-007 school year fifteen percent of GHS's students were pregnant and/or parenting.

GHS has a predominately low-income, minority student population. For the 2006-2007 school year, the student population was 76% Hispanic and 14% African American. Approximately 29.1 percent of GHS's student (112 students) were designated English Learners (ELs). Of the school's ELs, over 90 percent spoke Spanish at home. Student eligibility for free or reduced-price meals, based on household size and income, is one measure of low income among a school's families. For the 2006-2007 school year, 69.7 percent of GHS students (268 students) were eligible to participate in the free and reduced-price lunch program and thus were identified for support from the Title 1 program.

Data and Data Analysis

Research methods in this study consisted of two principal activities: review and analysis of school documents and records, and review and analysis of individual, audio-recorded interviews (White, 2011). A technique called Artifact Elicited Response, designed to provide a new dimension for conducting audio-recorded interviews, was used to provide a detailed picture and a description of respondents' social networks within the school's learning community.

Analysis of data from documents and records and audio-recorded interviews served two purposes. Our analysis of research materials was informed by our orienting research questions:

If an innovative program, with the primary goal of academically preparing low-performing students for rigorous college coursework, is implemented at a continuation high school,

1. What structures and patterns of behavior around academic preparation for college emerged as the program evolves?
2. In what ways did these emerging structures and patterns of behavior impact the organizational structure of the school's learning community?

Data analysis also served to allow design modifications to be made based on what emerged as a result of a particular purposeful perturbation. In this sense, the experimental design of the research was an iterative process. Design modifications were made based on what emerged as a result of each purposeful perturbation. Since outcomes from perturbations were emergent, design modification was also a responsive process.

Research Design: Complexity Theory as a Framework for School Reform

In our research, the theory of CAS, with features of equilibrium, emergence, self-organization and feedback loops provided both a strategy for school reform and a theoretical lens for analyzing the change process as it evolved.

One feature of CAS, equilibrium, requires that in order for change to occur, a system must be in a state far from equilibrium. The equilibrium of systems in stable states must be disrupted if one wishes to create conditions where real transformational change can occur. While disrupting the equilibrium of a complex adaptive system does not need to be by design, change can occur in response to external factors, the efforts to push GHS far from equilibrium

were by design - what we call “purposeful perturbations”.

Specifically, an innovative college program, Academic Commitment Creates Empowered Successful Students (ACCESS), created to academically prepare GHS students for college, was treated as a “nested” CAS with a larger CAS, GHS (see Figure 1). In the process of implementing this program, purposeful perturbations were introduced that disrupted the school’s stable state and had a major influence on the changes that occurred at GHS from February of 2007 through March of 2011 (White, 2011).

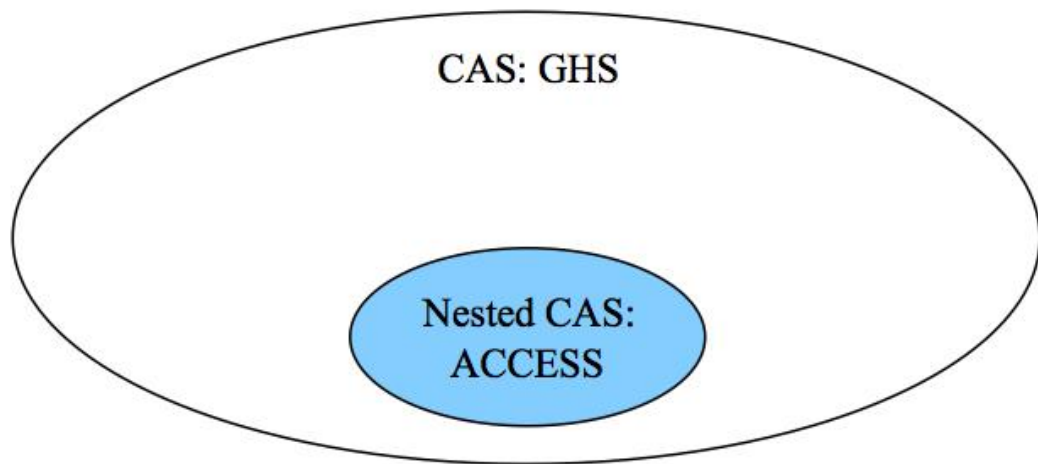


Figure 1: The ACCESS Program as a Nested Complex Adaptive System (CAS)

Results and Analysis

GHS’S Initial Stable State

Effective school reform efforts result in transformational change. By transformational

change, we mean a shift in the school's organizational structure and culture resulting from a change in the underlying strategies and processes that were used in the past. In CAS such as schools, transformational change ultimately involves the creation of "new contexts" that challenge the existing organizational structure by creating conditions where the stable state of the system no longer works. In order to create a "context" in which appropriate forms of change could occur, it was necessary to understand the existing context, the stable organizational state that existed at GHS in 2007.

GHS moved to a new facility located on the campus of St. Diaz City College (SDCC) in September of 1998. As early as the 2000-2001 school year, GHS's espoused goals were to increase student retention rates, increase graduation rates, provide GHS students with a college experience and increase the number of GHS graduates who went on to enroll in college courses.

Through the cooperation of SDUSD and the St. Diaz Community College District (SDCCD), GHS developed three programs with SDCC, the Joint Diploma Program (JDP), City Middle College (CMC) and the Tech Prep Development Program (TPDP) to help achieve these goals.

The JDP, a partnership between the St. Diaz Community College District Continuing Education Centers (SDCE) and SDUSD's Adult Education Office of Extended Learning Opportunities, was designed specifically to offer older students (ages 17-19) who were severely credit deficient an alternative diploma. Students at alternative schools such as GHS could earn an option 2 high school diploma through the JDP. The option 2 diploma required

high school students to earn 24-credits rather than the 44-credits required for high school graduation in the SDUSD and more generally, across the state of California.

In 1994, SDCC and GHS entered into a partnership that provided GHS students with the option to enroll in specific courses at SDCC in order to fulfill the JDP option 2 requirement of successfully completing one college course. Moving to the campus of SDCC facilitated GHS students' ability to meeting the requirement of the JDP of completing a college course.

City Middle College (CMC), a partnership program between GHS and SDCC, was a job skills program developed under the auspices of SDCE and GHS that opened in February of 2000. According to the initial CMC grant proposal (1999),

The overall project goal has been to enhance college and career options for high potential, low achievement students who are older, and more at risk of not completing high school diploma requirements than the usual middle college student." "It is understood that the 75 students participating in the CMC Bridge Project will be more difficult to serve than the traditional middle college student. (p. 3)

The CMC grant application also stated that the intended target student population were GHS students already enrolled in the JDP and seventeen and a half to nineteen years of age, who were severely credit deficient, seriously at risk of dropping out of school, not completing their high school diploma and entering the workplace without the skills required for securing quality employment. These were the same criteria as for the JDP.

SDCC was awarded a grant for a Tech Prep Development Program (TPDP) in 2003. The TPDP's main goal was to improve the outcomes of severely at-risk youth in the St.

Diaz community. At the high school level, the primary goals of the TPDP were to improve the academic performance and school retention of students attending GHS. Post-high school goals included increasing college entrance levels and associate degree completion and improved employment prospects for the low-income, at risk students enrolled at GHS.

While the TPDP program was short-lived, by 2006, both the JDP and CMC were instrumental in helping GHS meet its goals. There was a decrease in the number of students dropping out of GHS, a higher percentage of GHS students were earning a high school diploma, more than half of all GHS students were enrolling in at least one college course, and many GHS graduates were enrolling in classes at SDCC post high school.

Although there had been a steady increase in the number of GHS students earning a high school diploma, that increase coincided with an increase in the percentage of 24-credit, option 2 diplomas awarded GHS graduates. By the 2006-2007 school year, seventy-six percent of all diplomas earned by GHS graduates were option 2. GHS was well on its way to achieving its espoused goal of “becoming an all joint diploma school” (CMC Grant, 1999, p. 2).

To fulfill the JDP requirement to successfully complete a college course, virtually all GHS students were enrolling in non-degree track courses at SDCC instead of degree-track courses. Degree-track courses are transfer-level academic courses that are necessary to earn a baccalaureate degree in an academic discipline at a four-year college or university. Despite the fact that most GHS students took at least one college course, no GHS graduates had earned a Certificate of Achievement, Certificate of Completion or an Associate Degree that

led to a vocational career, much less transferred to a four-year college or university.

For the first eight and one-half years that GHS was on the campus of SDCC, academic preparation for college was neither one of GHS's goals nor one of its accomplishments. So while each of the individual goals were laudable, the way in which the cluster of goals was accomplished left GHS graduates without the ability to continue their education in higher education.

Perturbation One: Providing Disconfirming Evidence by Raising the Level of Student Academic Performance

From September of 1998 through the 2005-2006 school year, there was an existing state of dynamic equilibrium at GHS with regard to academic performance that manifested itself in low academic expectations of students by the GHS staff, low-levels of academic performance by GHS students, and low self-expectations of academic performance by the students. While individual student performance levels varied, there was an upper level of academic performance beyond which students did not go. Virtually no GHS graduates had the skills necessary for success in rigorous college coursework.

To address this problem, an innovative college prep program, Academic Commitment Creates Empowered Successful Students (ACCESS), was introduced at GHS in February of 2007 to arm GHS students with the skills and knowledge that might help them academically prepare for college (White, 2011). The mission of ACCESS has been to prepare students for post-secondary education through rigorous college-preparatory coursework with a primary

focus on improving reading, writing, and math skills, and to support a school culture that fosters school team spirit, and students' emotional health.

Many of GHS's teachers, counselors, and administrators did not think GHS students were capable of higher education. So this program caused trouble because it confronted the existing everyday practices and belief systems of the individuals, and groups of individuals, that defined the organizational structure of GHS. Despite the support of GHS's principal, ACCESS experienced resistance from the beginning. According to SP, the GHS English language learner support teacher:

When the ACCESS program began, it was greeted with open skepticism and hostility from much of the staff. The common attitude was that "these kids" were generally incapable academically, were not going to college, did not come from families that would support them going to college, and were unwilling to expend the extra time and energy to improve academically.
(10/10)

While the primary goal of ACCESS was to raise the academic performance of a small group of students to a level necessary for success in rigorous college courses, a secondary goal was to create the kind of disconfirming evidence that would challenge the belief systems of GHS staff members that put GHS students on a fast track to a high school diploma without adequately preparing them for post-secondary education.

Beginning in 2007, ACCESS students took college assessment tests in math and English at the end of the school year. Assessment test data served two purposes. First, test results provided feedback about how well ACCESS was academically preparing students for

college. Second, test results provided hard data that challenged the beliefs of GHS staff.

The Success of ACCESS Math: Over the five-year period from 2006 through 2011, ACCESS math had achieved more success in academically preparing GHS students for college than ACCESS English. While both ACCESS math and English started with eight students and one class for each subject, by May of 2010, ACCESS math offered more classes, enrolled more students and had more students testing at the transfer level than English on college assessment tests. There are a number of factors that contributed to the success of ACCESS math students.

First, ACCESS elementary algebra and intermediate algebra math courses were articulated with SDCC elementary algebra and intermediate algebra math courses. Textbooks, adopted by SDCC in these subjects were used as the textbooks for ACCESS math. This was done in an attempt to strengthen the view in the eyes of GHS students who were enrolled in ACCESS math, that these were indeed college prep classes and that successfully completing these courses would increase their chances of testing out of these courses on the college math assessment test.

Second, by the 2007-2008 school year the majority of GHS ACCESS students were enrolled in ACCESS math for the entire year. The majority of returning students who completed the first year of ACCESS math continued in ACCESS math during the following school year. For those returning students, ACCESS could provide them with two years of college prep math.

Third, we viewed the relationship between academic expectations and student academic performance as a matter of reciprocal causality. Teachers' academic expectations influence levels of student academic performance. Conversely, levels of student academic performance influence teachers' academic expectations. We represent these not as cause-effect relationships, but as a feedback loop (as shown in Figure 2).

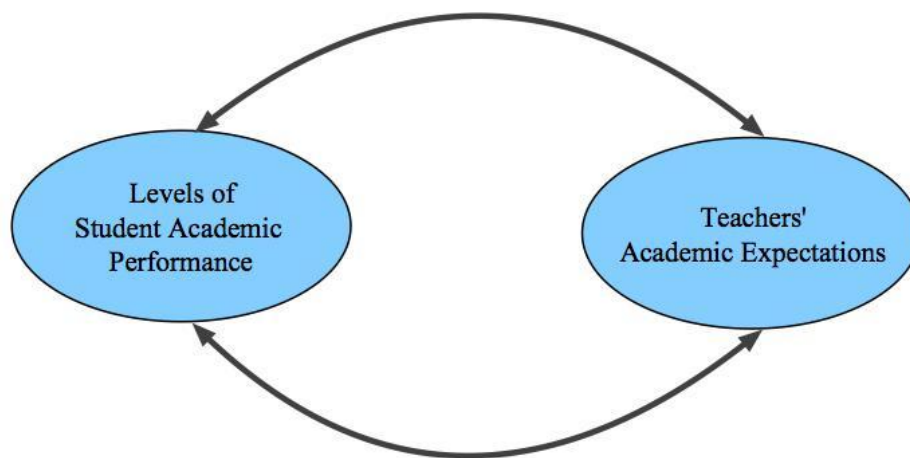


Figure 2: Teacher-Student Reciprocal Causality Feedback Loop

In the first year of ACCESS math, our academic expectations for ACCESS students were to successfully complete the ACCESS elementary algebra course and test into intermediate algebra on the college math assessment test. When the majority of first year ACCESS math students successfully completed elementary algebra and tested into intermediate algebra, the first author raised his academic expectations. In the second year of ACCESS math, his goal was to get some students through both elementary and intermediate algebra ACCESS courses and test into transfer-level math on the college math assessment

test. This “raising the bar” of academic expectations and the increasing level of academic performance in math resulted in 24 ACCESS students taking the college math assessment test in May of 2010, with 13 students testing into transfer-level math and 11 students testing into intermediate (see Figure 3).

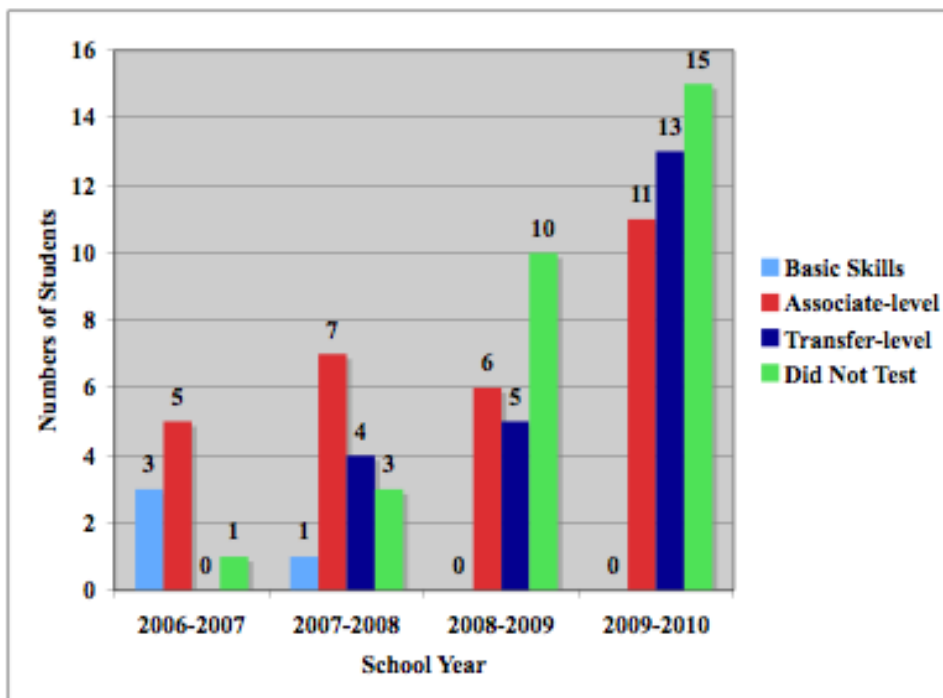


Figure 3: ACCESS College Assessment Test Results for Math

A multi-mediator model of the first perturbation and the tipping point it led to

To better understand the ways in which the improvement in student scores on assessment tests impacted the expectations both of the students themselves and of the staff at GHS, we constructed several multi-agent computer simulation models. The models were constructed within NetLogo, a free multi-platform agent-based model building environment constructed by

Wilensky (1999) and his colleagues at Northwestern University.

In this multi-mediator modeling framework (Levin & Datnow, 2012a, 2012b), the concepts in the domain being modeled are represented by labeled circles, each of which has an activity level that is partially determined by impact from other concepts within the model and partially determined by outside context. The activity level of each concept (orange circle) is indicated visually both by its size and the intensity of its color.

There are two ways in which a concept's activity level can be impacted by other concepts within a given model. A concept's activity level can be positively impacted by another concept within the model (indicated by a green arrow from that other concept).



The higher the activity level of that other concept, the higher the activity level will be of the positively impacted concept.

An concept's activity level can be negatively impacted by another concept within the model (indicated by a red line with a bar at the end from that other concept).



The higher the activity level of that other concept, the lower the activity level will be of the negatively impacted concept.

This framework not only allows for positive and negative actions by one concept on

another, but it also allows for interaction between two concepts (mutual actions), and for mediation among three or more concepts, as represented by a network of positive and negative directed connections among a set of concepts.

In addition, a concept can be impacted by context (everything outside the domain that is being modeled), and part of the model is specified by the levels of activity of each concept that is supported by its context.

All of these impacts occur in parallel, and so activity levels flow throughout a given model, based on the connections among the concepts and the impact from context. This multi-mediator framework has been used to represent learning at several levels of scale, including organizational learning (reform) at the district level (Levin & Datnow, 2012a, 2012b) and individual learning (Halter & Levin, 2013). In this paper, we will represent learning at the school level, the changes that flowed from the ACCESS reform.

Figure 4 captures some aspects of Perturbation One. It focuses on the role that improving student scores on community college placement examinations played in changing teacher expectations of student academic capabilities.

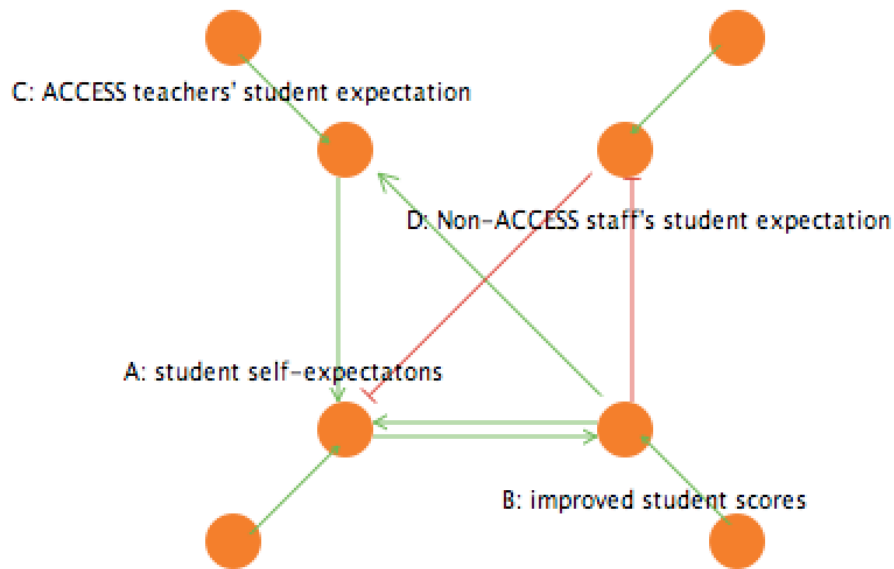


Figure 4: A multi-mediator model of the change in teacher expectations of low student academic performance, available online at <http://eds.ucsd.edu/netlogo5/ACCESS-student-scores.html>

There are four concepts in this model: the student self-expectations, student scores, non-ACCESS staff's expectations about the students, and the ACCESS teachers' expectations of students.

Initially student self-expectations and academic performance (as measured by student scores) are low, as impacted by the negative expectations of the non-ACCESS teachers and other staff at the school. As the ACCESS teachers' expectations of the student increase, initially there is no change, but eventually a tipping point is reached where the student expectations and scores increase, changing the expectations of the non-ACCESS staff members.

A Second Purposeful Perturbation: The Creation of New GHS-SDCC Social Network Connections and the Consequences of Competing Networks

Raising levels of student academic performance did provide disconfirming evidence that challenged the academic expectations at GHS. However, initial efforts to disrupt the equilibrium of GHS, even in a purposeful way, was not sufficient to promote the kind of changes that were desired. That is, raising students' levels of academic performance did not result in changes in the patterns of behavior that determined the type of diploma GHS earned, and which college courses they enrolled in. The vast majority of GHS graduates were still earning a 24-credit, option-2 diploma rather than the 44-credit diploma required by the St. Diaz Unified School District (SDUSD) at comprehensive high schools. Furthermore, GHS students were still being advised to enroll exclusively in non degree-track courses at St. Diaz City College (SDCC) by their high school counselors.

By the second year of ACCESS a few ACCESS students had raised their level of academic performance to qualify for enrollment in rigorous, degree-track college courses as evidenced by math and English scores on college assessment tests taken at the end the regular school year (White, 2011). For GHS students who would be graduating in June of 2008, this meant that they had qualified to enroll in transfer-level college courses. However, for those continuing GHS students who had tested into transfer-level math and English, this was problematic. By testing into transfer-level math and English on college assessment tests, continuing students may have met requirements to enroll in transfer-level courses at SDCC but

they were not being counseled to enroll in these kinds of college courses. The problem was further compounded by the fact that those students' level of academic performance in math and English went beyond the level of courses offered at GHS.

To understand why ACCESS students, or for that matter, GHS students in general, were not enrolling in degree-track courses at SDCC, we needed to understand the existing social networks between GHS and SDCC and the relevant standard operating procedures that determined the stable patterns of behavior for enrolling students in college courses at SDCC. If we were going to develop an effective strategy for changing these stable patterns of behavior, we needed to understand what was going on and why.

Artifact Elicited Response Technique – Creating a Picture of GHS's Existing Social

Networks: The primary source of data we used to construct a picture of the social networks that existed within GHS and between GHS and SDCC came from interviews the first author conducted in 2009 with the GHS teachers, GHS counselors, and the GHS principal (White, 2011). During those audio-recorded interviews we wanted respondents to provide a detailed picture and description of their social networks at GHS and with SDCC. To accomplish this, we used an approach developed by the first author called "Artifact Elicited Response Technique" (White, 2011). Like Tobin's (1989) use of a video elicited response technique, the use of an artifact-elicited response technique was designed to provide a new dimension to conducting audio-recorded interviews.

The technique, as used during interviews, was to ask respondents to construct an

artifact, in the form of a drawing, depicting their social networks within the school. Each respondent was provided with a magnetic white board and a set of magnetic squares with; either a job title of a key GHS or SDCC staff member, a GHS department, or a GHS-SDCC program written on each square. Respondents were also provided with instructions to guide them in the construction of their social networks. Each respondent was given as much time as they needed to complete their drawing. The drawing was then used as a prompt to generate questions from me, and responses from the interviewee. Figure 5 shows a photograph of the artifact constructed by CF, a GHS ACCESS science teacher.

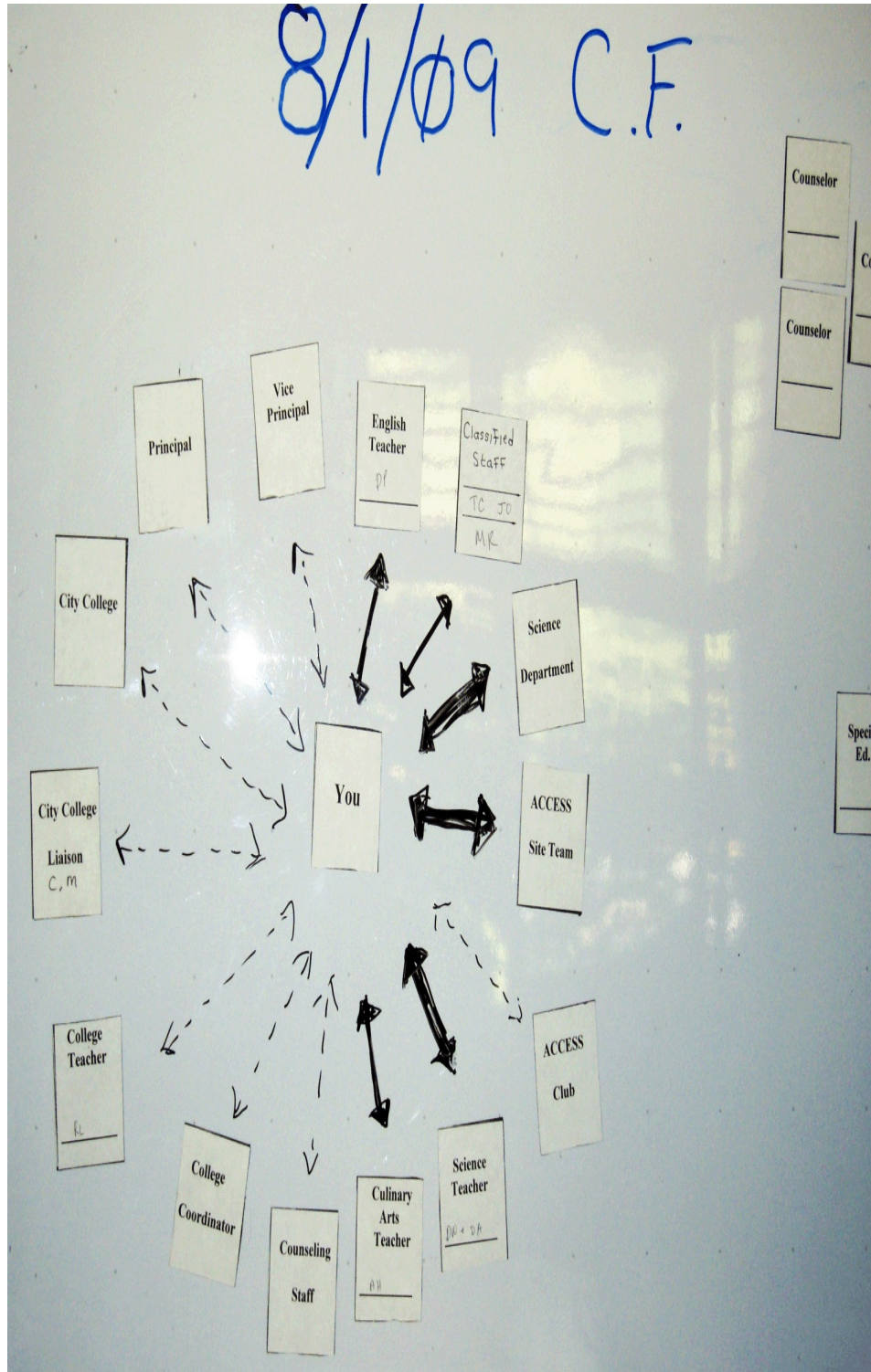


Figure 5: White Board Representations of CF's Social Network

The first author used the Visual Understanding Environment (VUE, 2010) software to construct social network diagrams based on each respondents white board social network drawing.

VUE is a concept and content mapping application developed by the Academic Technology group at Tufts University. Figure 6 shows the social network diagram that the first author constructed using VUE based on CF's white board drawing in figure 5. A thicker solid line represented a strong connection, a thinner, solid line represented a medium connection and a broken line represented a weak connection. No line represented the absence of a connection. Connections were represented by either one-way arrows or two-way arrows depending on how connections were represented on a respondent's drawing.

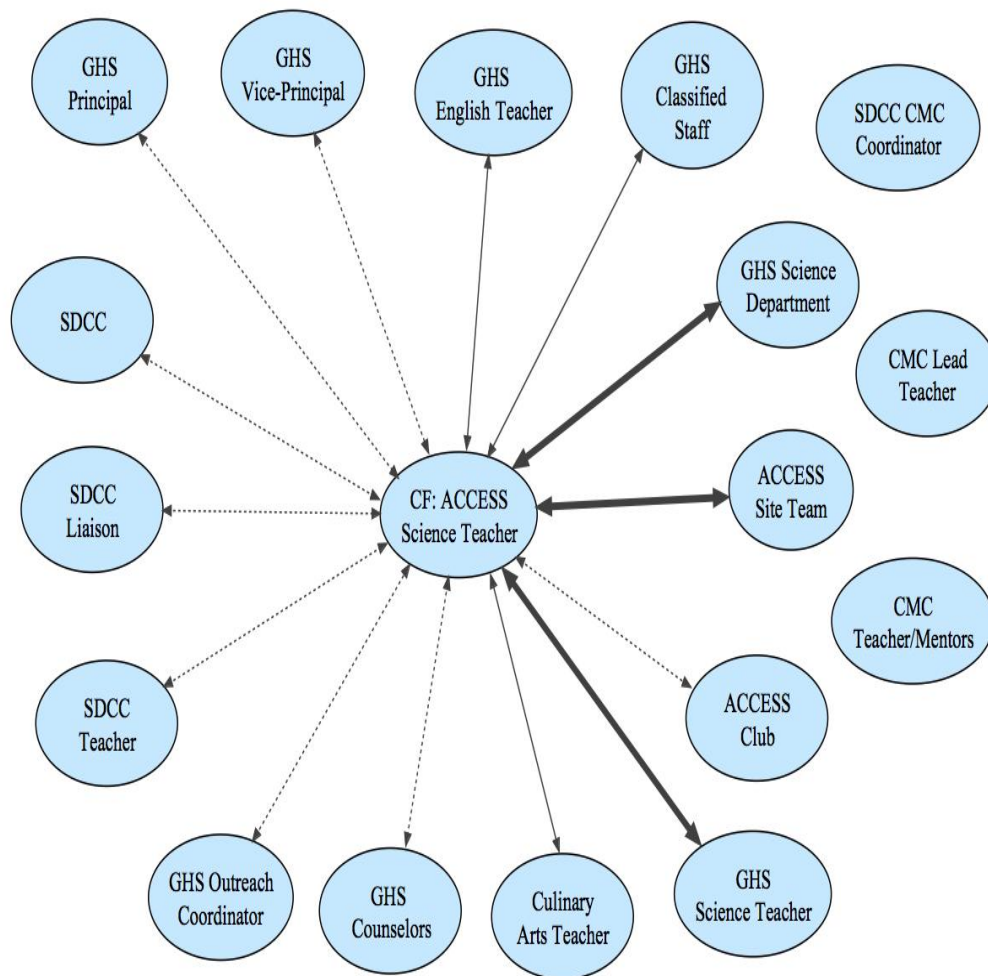


Figure 6: Diagram of CF's Social Networks

Using the diagrams for individual respondents, the first author constructed “composite” social network diagrams, one for the three ACCESS teachers that we had interviewed, one for the four non-ACCESS teachers we interviewed and one for the three GHS counselors that we had interviewed.

In order to create composites we used a number scale from zero to three to designate

the strength of a connection. A zero meant no connection and a three meant a strong connection. Then, based on the diagrams we had constructed for each respondent, we assigned numerical values to each respondent's connections. We arrived at an average strength of a specific connection by summing the numerical values for a particular connection within each group then dividing by the number of individuals in that group. Figure 7 shows the composite social network for ACCESS teachers.

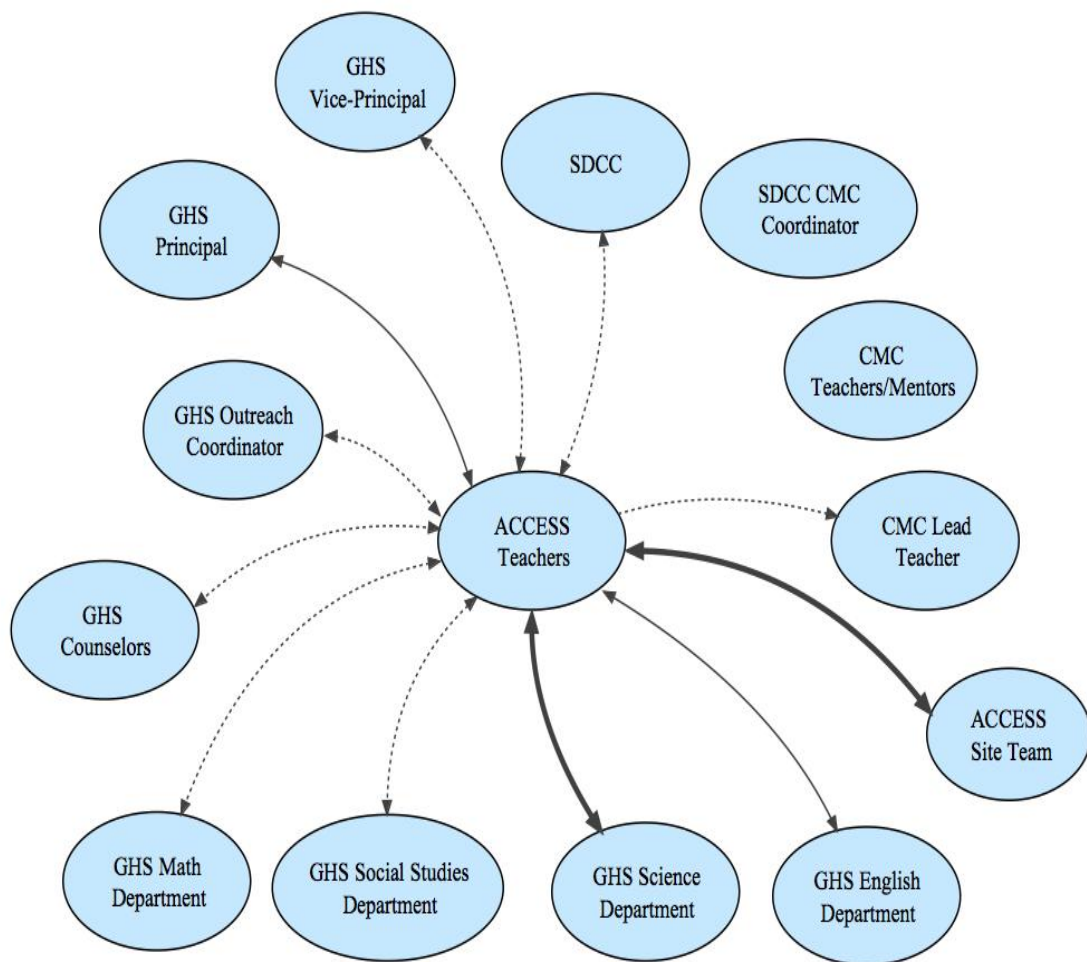


Figure 7: Composite of Social Networks for ACCESS Teachers

Based on social network diagrams constructed from audio-recorded interviews and from GHS documents detailing standard operation procedures for enrolling GHS students in SDCC courses, the first author constructed a social network diagram for enrolling GHS students in SDCC courses (Figure 8).

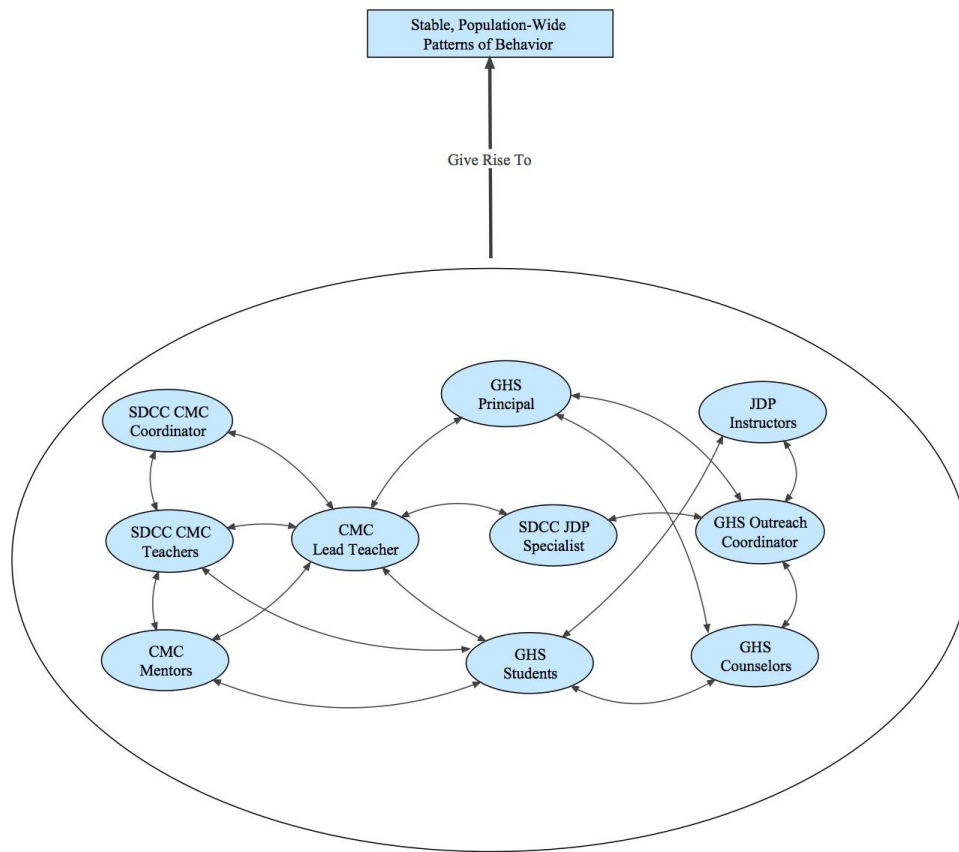


Figure 8: GHS-SDCC social network.

The social network diagram illustrated in figure 8 shows:

- There were two programs for enrolling GHS students in SDCC course, the JDP and CMC.
- GHS students were connected to non degree-track JDP courses at SDCC such as personal growth and business math through their counselors and the GHS outreach coordinator, and to CMC through their counselors and the CMC lead teacher. GHS students were also connected to CMC and JDP instructors through the classes they were taking at SDCC.
- Other than the GHS teachers who were also teaching at SDCC, GHS teachers had no direct connection to anyone at SDCC and were not part of the social network for determining which college classes that GHS students enrolled in at SDCC.

The social network in figure 8 is informative not only for what it shows, but for what is not there.

- There were no social network connections between GHS and the various academic departments at SDCC. The existing social network did not include connections that would allow GHS students to enroll in degree-track college classes.
- The ACCESS site team was not part of the social network for enrolling GHS students in SDCC courses.

Creating a New GHS-SDCC Social Network: In order to enroll students in the degree-track courses that had been targeted by the ACCESS site team, it was necessary to create a new social network (Figure 9).

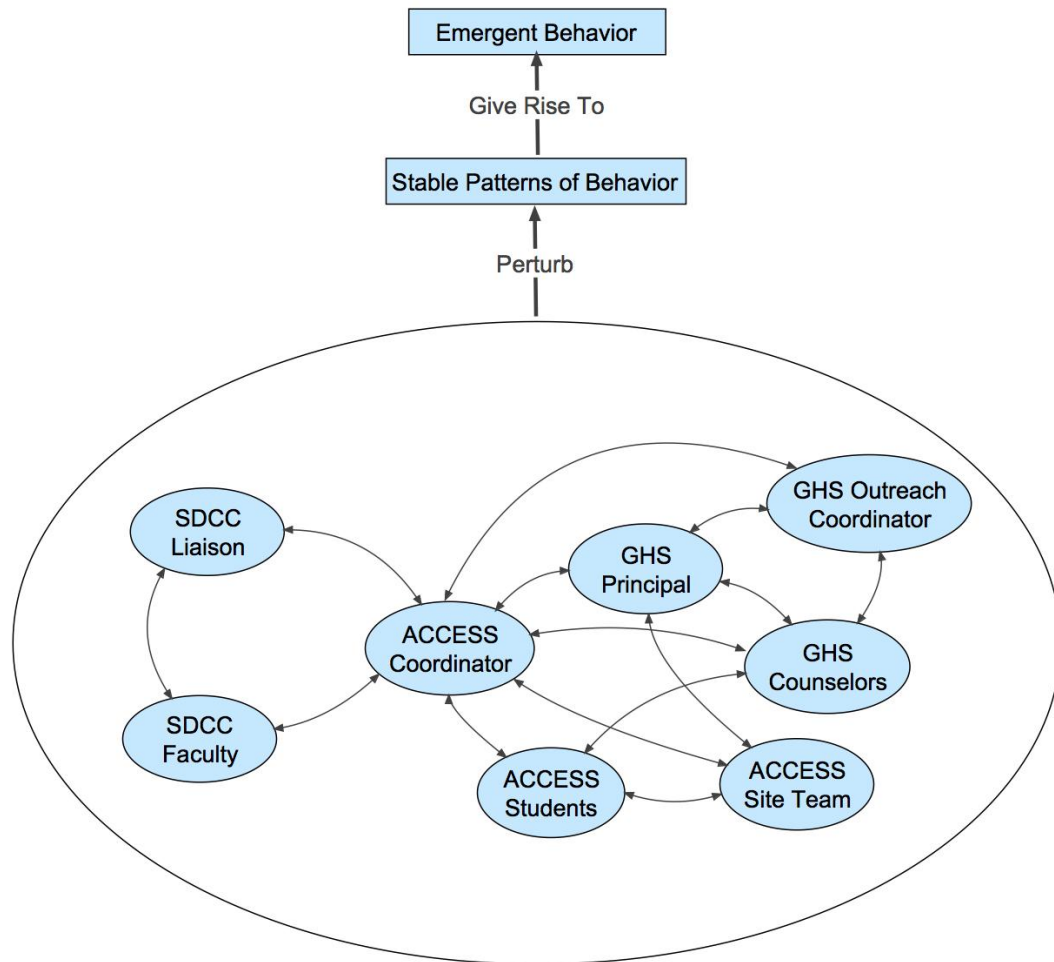


Figure 9: A new social network for enrolling ACCESS students in SDCC degree-track courses.

As the ACCESS coordinator, the first author developed a social network with various academic departments at SDCC and acted as a “bridge” for enrolling GHS students in degree-track courses at SDCC. Once an ACCESS student was guaranteed admission to a degree-track course at SDCC and had the approval of their high school guidance counselor, enrolling the ACCESS student in that course followed the same standard operating

procedures as those for enrolling GHS students in JDP courses (shown in Figure 8).

However, the new social network did not replace the existing social network. GHS counselors were still recommending which SDCC courses their students should take and prior to the existence of the new social network, a GHS student would chose to enroll in a specific SDCC course based solely on the recommendations of their high school counselor. What had changed was that ACCESS teachers were recommending specific SDCC courses to their ACCESS students and the first author was coordinating efforts to get students enrolled in those courses.

Competing Social Networks: GHS counselors continued to recommend JDP courses and CMC to their students where ACCESS teachers were recommending selected degree-track courses. One example where this happened was with SJ, an African-American student, who had been an ACCESS student for two years. Based on the advice of her ACCESS teachers, she completed one semester of transfer-level courses at City College in science, math, and English during her senior year in high school. In an interview, SJ credits the ACCESS teachers, not her counselor, with providing her with support for college preparation.

DW: How much counseling did he [SJ's counselor] do for your college prep here?

In other words, the courses you took, sort of advising on what you should take and things like that?

SJ: He wasn't much involved in that at all. I kind of had my own little plan of what I wanted to do, wanted to get done, based on what I really wanted to do but I

wanted to get all my General Ed done and he wanted me to take like Personal Growth or something. I mean, it was an OK class but I just wanted to focus on my General Ed so I could go forward.

DW: You said earlier that you got some sort of direction from some of the ACCESS Teachers?

SJ: Yes.

DW: Did most of that academic discussion come in that area [with the ACCESS teachers] rather than your counselor?

SJ: Yeah it did. They [ACCESS teachers] helped me focus where I really wanted to focus my energy and studying and the classes I wanted to take more than he did. (9/09)

SJ's responses illustrated a common problem. ACCESS teacher and GHS counselors frequently recommended different college courses for the same student. This environment of competing social networks created perturbations that impacted the existing patterns of behavior for enrolling GHS students in classes at SDCC. ACCESS students were receiving conflicting advice about which college courses they should take and in the process, emerging tensions between ACCESS teachers and GHS counselors escalated. As one counselor said, "The problem is my students now have two counselors."

This environment of escalating tension was evident in an interview the first author conducted with BG, GHS's head guidance counselor in June of 2009. BG felt that ACCESS

teachers were counseling students without a counseling credential and we were jeopardizing our jobs, and the school.

BG: And if the ACCESS team, of which there's no one with a counseling credential, is advising students, I think it's against Ed code. I've mentioned this to the principal. That I question what would happen if a family they came in and came back and said: You told my student that? Where did you get the idea that you had the right to advise my students? I've been in schools where they [teachers] were not allowed to have meetings with students unless there was a counselor there. That they couldn't have an ACCESS or an AVID meeting discussing college careers without someone there who really had a credential and the knowledge. (6/09)

Despite the first author's efforts act as a bridge between GHS and SDFCC, BG felt that the counselors were not aware of what was going on.

BG: But there is not very much communication. The counselors don't know which students are going to be taking which college courses. And when I share this information with other people, they're stunned. (6/09)

The role of the school Principal

From the beginning, the Principal of GHS adopted a hands-off approach, letting the teachers involved in ACCESS develop the program. When ACCESS teachers met with resistance

from other staff members, primarily the Counseling Department and the Vice-Principal, the Principal's main role was to act as a buffer from criticism directed at ACCESS and the teachers involved with ACCESS, and to clear away attempts to block the development of ACCESS. So while, within GHS, change was being initiated bottom-up by teachers, the GHS Principal protected ACCESS from above, and provided the program with the opportunity to grow (White, 2011).

A Third Purposeful Perturbation: Increasing the Number of GHS Students Enrolled in ACCESS

During the five-year period from when college prep. courses were first offered at GHS through the March of 2011, there was a steady increase in the number of students enrolled in college prep. classes (Figure 10). From a total of 15 students enrolled in AVID classes in the spring of 2007, the college prep. program grew to a peak enrollment of 74 students enrolled in ACCESS classes during the 2010-2011 school year, or about 20 percent of GHS's student population.

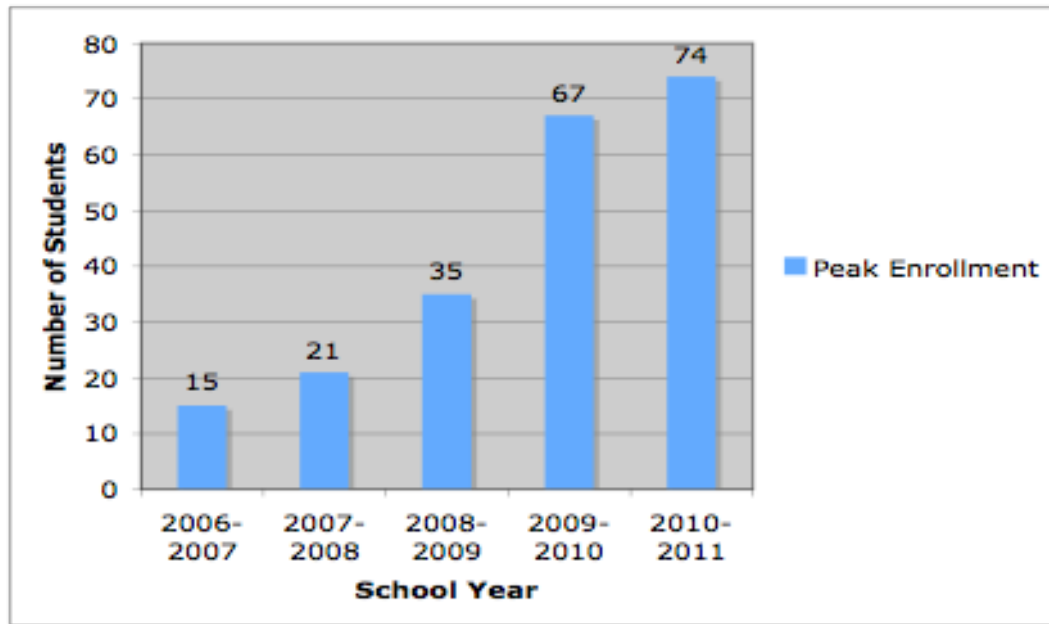


Figure 10: ACCESS Enrollment 2006-2011

One reason enrollment numbers had increased is that more college prep. courses were added to GHS’s course options (shown in Table 1). In the spring of 2007 GHS offered only two ACCESS Classes college prep. classes, one in English and one in math. By the 2010-2011 school year there were eight ACCESS classes in four subject matter disciplines.

Table 1: GHS ACCESS Classes 2006-2011

2006-2007	2007-2008	2008-2009	2009-2010	2010-2011
1 English	1 English	1 English	1 English	2 English
1 Elem. Algebra	1 Elem. Algebra	1 Elem. Algebra	1 Elem. Algebra	1 Elem. Algebra
		1 Marine Sci.	1 Inter. Algebra	1 Inter. Algebra

			1 Biology	1 Precalculus
				1 Biology
				1 Marine Sci.
				1 History

Adding additional ACCESS course offerings not only provided the opportunity for more students to participate in ACCESS, it also increased the number of teachers who were teaching ACCESS classes. The number increased from two ACCESS teachers in 2007, to seven ACCESS teachers by the 2010-2011 school year, or 25 percent of GHS’s teaching staff.

There were other reasons for enrollment growth. GHS students knew about ACCESS and understood that it was about preparing for college. According to DA, who teaches an ACCESS biology class:

DA: And then there’s the kids, the other population, the rest of the kids know about it and that whole social dynamic, like, “Oh you’re in ACCESS, so you must be wanting to go to college.”

Students were enrolling in ACCESS classes because it would help them do better in school. MS, a history teacher at GHS who did not teach an ACCESS class, explained the increase in enrollment as follows:

MS: Students wanted to join ACCESS because they knew it could help them excel in school.

A Tipping Point and The Expansion to School-Wide Change

As a result of the creation of ACCESS and the strategy to use ACCESS to disrupt the equilibrium of GHS by introducing purposeful perturbations created tensions within the school, primarily between ACCESS teachers and GHS counselors, that increased over time. By the summer of 2009, those tensions had reached a critical point.

On June 18th 2009, the GHS counseling staff was having a meeting at GHS in an open area adjacent to the counseling offices. The counselors were sitting around a large round table and the first author could hear them discussing ACCESS. He had some materials to give the counselors, so he walked over to their table and asked if he could give them an updated list of students that the ACCESS site team was recommending for the ACCESS program for the next school year.

At that point, BG, the head counselor, told him, "We just want you to know that we are discussing whether we are going to vote to file a grievance with the district against you and your fellow ACCESS teachers." The first author asked him why. He said, "Because you are counseling students, you don't have a credential, and we are considering filing a grievance with the district against the ACCESS teachers." BG added that the counselors were meeting with the principal in two hours to discuss their decision. The first author asked if he wanted him at the meeting with the principal and he said, "I really don't care whether you are there or not."

The first author sat down at the table and the counselors began to tell him why they

were considering filing a grievance. They felt that the ACCESS teachers had stepped in and that we were contradicting them, that we did not have counseling credentials, and that we were putting the school at risk. They said that they could not tolerate that anymore. The first author told them that he was no longer willing to put up with the existing situation either. He added that if they could not come to some kind of agreement, he was not going to be part of the ACCESS program anymore. He then asked them if they had any suggestions.

AV, one of the counselors, said: “ACCESS is becoming the largest program in the school. We think that what the ACCESS teachers are doing is great for our students but we have their best interests at heart too.” At that point BG suggested that what we needed to do was set up a time when the counselors and the ACCESS team could meet on a regular basis to try and work things out. The first author told them he thought that this was a good idea. BG said that the counselors would like to come up with a list of suggestions before they met with the school principal. The first author told them that he would return when they met with the principal and left the meeting. The last thing that he said was: “Just tell us what you want”.

The Creation of a New ACCESS Site Team

About one hour later, the counselors and the first author met with the principal and the discussion was very positive. The GHS counselors presented the following list of suggestions at that meeting:

- Set up a day and time for ACCESS teachers and counselors to meet. The following GHS staff members would attend the meetings: The GHS principal, at least one GHS

counselor, the GHS outreach coordinator and the ACCESS teachers.

- All students would be informed of the number of credits required for both the 44-credit diploma and the 24-credit, option 2 diploma.
- Procedures should be formalized for entrance into the ACCESS program and exiting the ACCESS program.
- The GHS counseling staff will provide ACCESS teachers with important deadlines.

It was agreed upon that our first meeting would be in September of 2009. The first item on our agenda would be to discuss the list of suggestions submitted by the counseling staff at that June meeting.

At that June 18th meeting, that the first author happened to attend, a tipping point was reached. Over a period of about ninety minutes, the atmosphere of the meeting changed from the counselors considering filing a grievance against the ACCESS teachers to “we need to work together”. Furthermore, by agreeing to work together, we had a self-organizing moment. And, we believe it to be an elegant example of self-organization. What happened at that meeting was unpredicted, emerging from local interactions. You cannot get more local than a group of people sitting around a table discussing their differences.

As we stated in earlier chapter, in order for change to occur in complex adaptive systems (CAS) that are in a stable equilibrium state, it is necessary to push the systems far from equilibrium. Change occurs at critical points, bifurcation points in the language of complexity science. You can think of a pile of sand. If you keep adding sand to the pile, it will

build up. But at some critical point, it will collapse. Change occurs at the point where the pile of sand is just about to collapse and change happens through a process of self-organization or self-reorganization. Self-organization means that change emerges through a process of local interactions, that is, in interactions between individuals or groups of individuals that are locally connected rather than by some sort of top-down strategy or blueprint for change.

As ACCESS evolved, it pushed GHS further and further away from equilibrium. Over time, tensions between ACCESS teachers and GHS counselors reached a critical point. At that critical point, self-organization occurred through local interactions between the GHS counseling staff, the ACCESS coordinator, and the GHS principal.

During the 2009-2010 school year the weekly ACCESS site team meetings began on September 22, 2009 and went through May 2010. The principal, ACCESS teachers and GHS outreach coordinator attended these meetings on a regular basis. The head counselor usually represented the counseling staff at those meetings. While these meetings were initially concerned with the ACCESS Program, over time they evolved into a discussion of a need for school-wide change.

A multi-mediator model of the tension between ACCESS and the status quo

We constructed a second model using the same multi-mediator framework as the model described previously for the shift in expectations about student capabilities for academic work. In this second model, the focus is on the interaction between the status quo at GHS (the CMC/JDP programs) and the innovation (ACCESS), as impacted by the

improvement in student academic performance (an element of the first model) and the role of the principal in protecting ACCESS. This second model is shown in Figure 11.

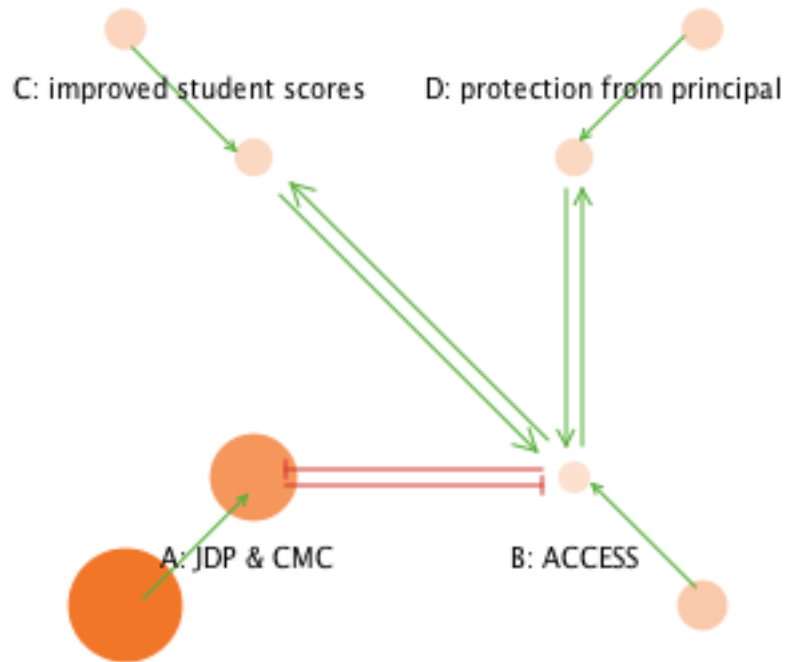


Figure 11: A multi-mediator model of the ACCESS reform tipping point, available online at <http://eds.ucsd.edu/netlogo5/access-tipping-point.html>.

This model shows the joint role that the improvement of student scores on college placement exams and protection of the reform by the principal played in the non-linear change from domination of the status quo (labeled “JDP & CMC”) and the new reform (“ACCESS”). Once the tipping point is reached, the changed state of the model persists even when the context returns to its previous state. This kind of “persistent change” is a key element of successful reform, and of learning more generally.

The College Planning Group: The Transition to a Co-Constructing Social Network for School-wide Change

While the development of ACCESS and meetings of the ACCESS site team had resulted in changes to ACCESS, JP, the GHS principal, and the first author believed that for change to be truly systemic, any changes in patterns of behavior needed to be institutionalized. In addition, that change needed to go beyond ACCESS. As a result, the College Planning Group (CPG) was created in October of 2010.

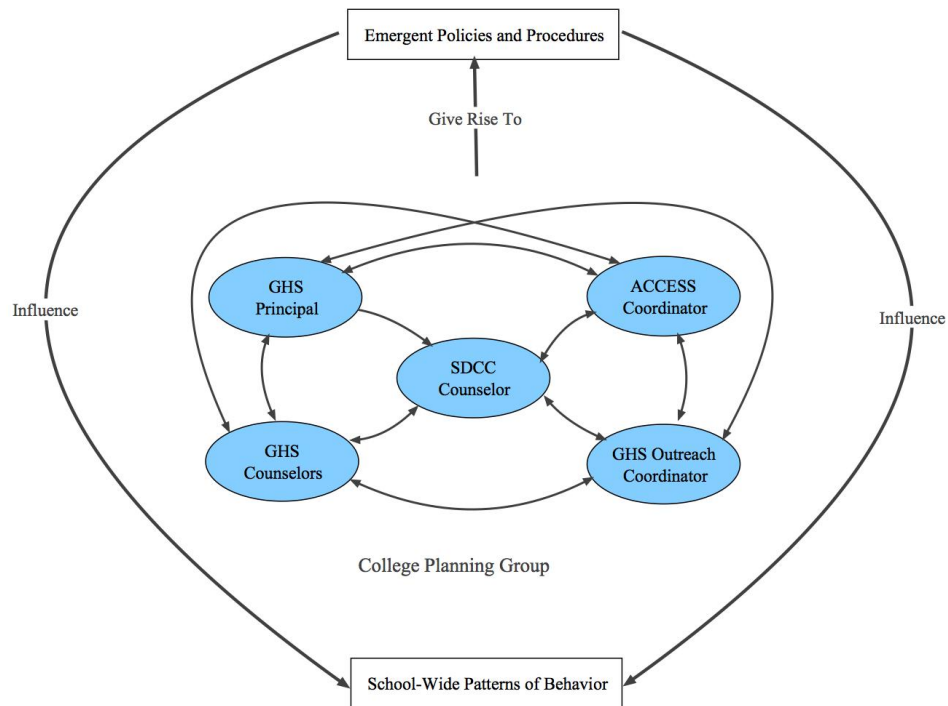


Figure 12: College Planning Group Social Network

Figure 12 is a representation of the social network for the CPG and its intended

impact on GHS. While the ACCESS site team continued to be concerned primarily with policies and procedures for ACCESS, the CPG was created to develop policies and procedures for the whole school, including ACCESS. The objectives of the CPG were:

- To identify and develop GHS's processes and procedures of academic and social/emotional development and support for college prep and college coursework.
- To add to GHS's master calendar the "who, what, when and where" of the identified processes, procedures and events relate to GHS's college prep and college coursework.
- To develop an assembled college-going set of procedures for the GHS staff.

Impact of the reform beyond the school

Since 1996, when the JDP program was first introduced, it had been the practice of high school counselors throughout the St. Diaz Unified School District (SDUSD) to inform many of their students who were transferring to GHS that they were recommending them for the 24-credit, option 2 diploma program. The option 2 diploma was designed for older students (seventeen and a half to eighteen years old) who were severely credit deficient. However, in many cases, the students sent to GHS did not meet the requirements for option 2.

Given the changes that had taken place at GHS, this practice became problematic. As evidenced by the type of diploma students earned for the 2009-2010 school year compared

with the type of diploma students had earned in previous years (shown in Figure 3), GHS was moving toward a 44-credit school. For the 2010-2011 school year many of the students sent to GHS who were expecting to pursue the option 2 diploma were being told by their GHS counselor that they would need to pursue the 44-credit diploma. This resulted in negative reactions by many of those students who were resistant and surprised that they would have to pursue the regular 44-credit diploma.

Because guidance counselors from other SDUSD high schools were recommending the 24-credit option 2 diploma to students who did not meet the criteria for that diploma, at the request of the GHS principal, an email was sent to all SDUSD counselors by the GHS district counselor on January 10, 2011 informing them that GHS had shifted its academic expectations (shown in Figure 13). Students referred to GHS were expected to pursue a 44-credit diploma. The changes that had occurred at GHS, due in large part to the impact of ACCESS, were beginning to have an impact on other schools in the district. The impact had moved beyond GHS.

We need your help... Many of you are properly informing your students of the benefits of an Option 2 (Joint) diploma and we thank you for your assistance. *However, please be aware of a shift of expectations... students referred to GHS are expected to pursue the regular 44-credit diploma and meet the same Board requirements of a-g coursework as all other district students.*

We still offer the Option 2 but here's the concern... We have many students who do not qualify for the Option 2 and yet they have been encouraged to attend GHS in order to pursue this diploma. Once the student has enrolled at GHS, they are then resistant and surprised that they must pursue the regular 44-credit diploma.

We understand that you may use the Option 2 as a way to provide hope to your students who are credit deficient. We would expect that you would continue to inform your students of options; however, please ensure that your students understand they must meet the following criteria to pursue the Option 2:

1. 17 years old
 2. ALREADY passed both CAHSEE tests
- Recommended by GHS site counselor and parent after considering:
1. Extreme credit deficiency
 2. Ability to successfully pass college class
 3. Military requirements for students pursuing this career
 4. Best interest of student.

Figure 13: E-Mail Sent to All SDUSD Counselors By GHS’s District Counselor

The Evolution of GHS’s Organizational Structure

Figure 14 is a representation of the changes that occurred at GHS from February of 2007 through March of 2011.

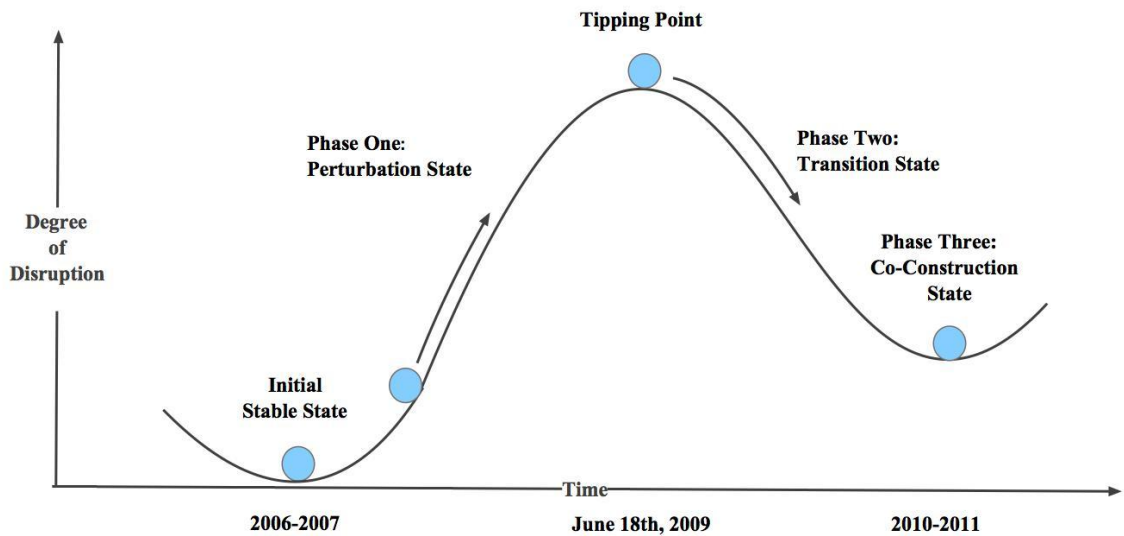


Figure 14: The Evolution of GHS’s Organizational Structure

Initial Stable State: When ACCESS was first introduced in February of 2007, there was an existing state of dynamic equilibrium at GHS. Virtually all GHS Students' academic performance was below levels necessary for rigorous college coursework. Since GHS staff beliefs about what GHS students were academically capable of, reinforced by low levels of student performance, did not include preparation for college, GHS students were put on a fast track to a diploma without preparing them for post-high school education, in particular for college. Indeed, these beliefs were reflected in the institutionalized, standard operating procedures and existing social networks within GHS and between GHS and St. Diaz City College (SDCC), a pseudonym, that resulted in GHS students enrolling in non-degree-track classes at SDCC, and most GHS graduates earning a 24-credit, option 2 diploma rather than the district adopted 44-credit diploma.

Phase One: A state of perturbation: From February of 2007, when ACCESS was first started at GHS, through June of 2009, ACCESS introduced perturbations, pulling GHS further and further away from equilibrium. First, ACCESS students' academic performance was raised to a level necessary for success in rigorous college coursework, as evidenced by ACCESS students' scores on college math and English assessment tests. This provided hard, disconfirming evidence that challenged the low academic expectations of GHS staff. Second, a social network was created between the ACCESS site team and SDCC for enrolling ACCESS students in degree-track classes at SDCC. Third, with the addition of more ACCESS course offerings, more teachers teaching ACCESS classes and more students

enrolling in ACCESS, more staff and student were participating in the program.

By June of 2009, the majority of ACCESS students were choosing to pursue a 44-credit diploma and many were enrolling in degree-track college courses at SDCC. This conflicted with the practice of enrolling students in non-degree track courses at SDCC and students pursuing a 24-credit, option 2 diploma. These perturbations were accompanied by increasing tensions, primarily between ACCESS teachers and GHS counselors.

Tipping Point: Tensions reached a critical level and a tipping point was reached on June 18th of 2009 during an impromptu meeting that the first author had with the GHS counseling staff. What started out as a threat by GHS counselors to file a grievance with the district against ACCESS teachers, evolved into a discussion of how counselors and ACCESS teachers could work together. By the end of the meeting, it was agreed that ACCESS teachers and GHS counselors would meet weekly beginning in September of 2009. The purpose of the meetings would be to work together for the continuing development of ACCESS. This agreement emerged through a process of self-organization, through local interactions in the absence of any blueprint for change.

Phase two: Transition state: During the 2009-2010 school year a newly created ACCESS site team met weekly to address the continuing development of ACCESS, but gradually began to consider the need for school-wide change with regard to college preparation and

college-going procedures.

Phase Three: Co-construction state: A new social network, the college planning group (CPG), was created in September of 2010, with the mission of institutionalizing college preparation and college enrollment procedures for the entire school, including ACCESS. Unlike the initial stable state that GHS was in prior to ACCESS, the co-construction state was not an equilibrium state, but a dynamic period of co-constructed change.

The tipping point meeting was only the beginning of a self-organization process that played out over the next two school years. During that time the self-organization process evolved from addressing change within ACCESS, what we call the transition phase, to a co-construction phase where the emphasis was on school-wide change. The social change that occurred at GHS that began bottom-up, initiated by teachers, evolved into a distributed leadership approach that was guided by the GHS principal.

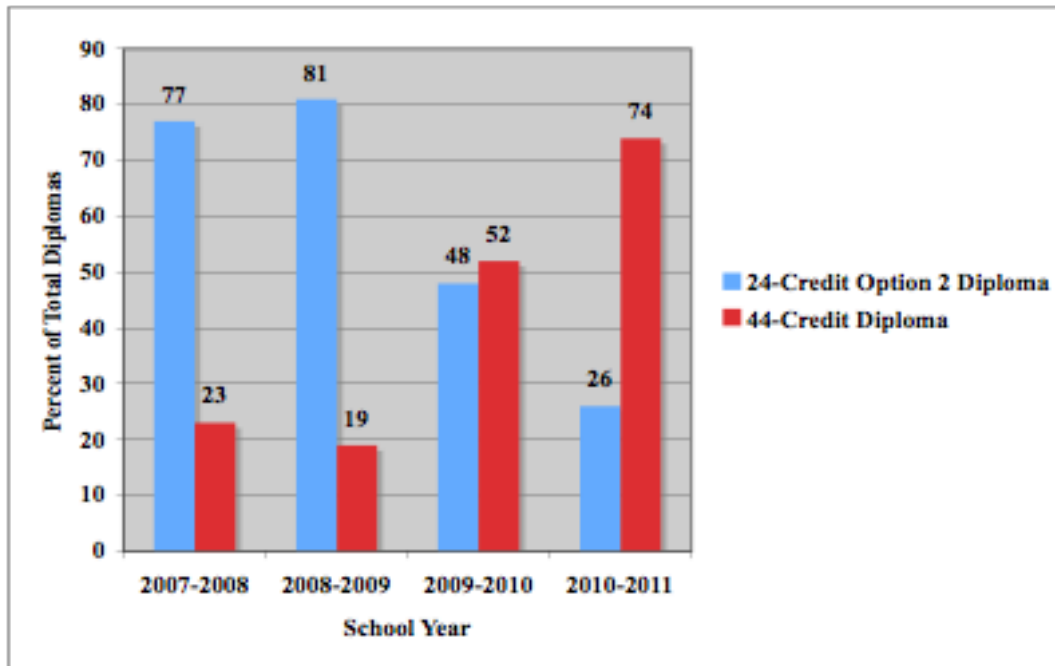


Figure 15: Option 2 Diploma versus 44-credit Diploma for GHS Graduating Seniors

While there were many changes that emerged at GHS, one of the more dramatic changes that occurred, beginning with the 2009-2010 school year, was a major shift in the type of diploma that GHS students were earning (Figure 15). While four out of every five GHS graduates earned the 24-credit, option 2 diploma in the 2008-2009 school year, by the 2010-2011 school year, three out of every four GHS graduates earned the 44-credit diploma.

The Transition from One Attractor Pattern to Another

Morgan (2006) argues that the fundamental role of managers is to create new

contexts that can challenge the established state of an organization, what he calls the “dominant attractor” pattern. He says that one way to change context is to create and develop a prototype of a new system that can break the hold of the dominant attractor, and asks the question: “How is the transition from one attractor pattern to another achieved?” (Morgan, 2006, p. 258). At GHS, ACCESS was used to create such a prototype, a new attractor pattern that challenged the dominant attractor (see Figure 16).

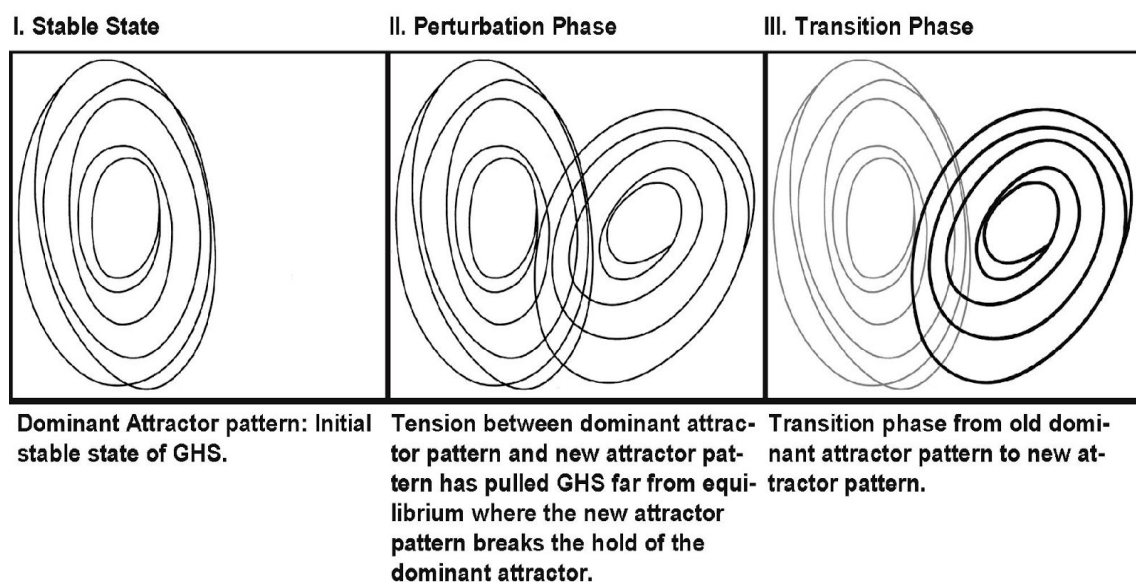


Figure 16: GHS’s Shift From Its Dominant Attractor To a New Attractor Pattern

The dominant attractor pattern, representing GHS’s stable state, put GHS students on a fast track to a diploma without preparing them for post-high school education, in particular for college. ACCESS created a new context in the form of a new attractor pattern with the mission of preparing GHS students for college. The new attractor pattern introduced perturbations at GHS. This resulted in GHS being caught between two attractors, creating

tensions and pulling GHS away from equilibrium until a tipping point was reached where the new attractor broke the hold of the dominant attractor. Beginning with the transition phase, the new attractor pattern gradually became the dominant attractor pattern and while the old attractor pattern still existed, its influence was weakening.

A multi-mediator model of both tipping points

As we noted earlier, there is a common concept in each of the two multi-mediator models we presented previously. This means that we can combine the two models, to create a more complete model of the ACCESS reform process. This model is shown in Figure 17.

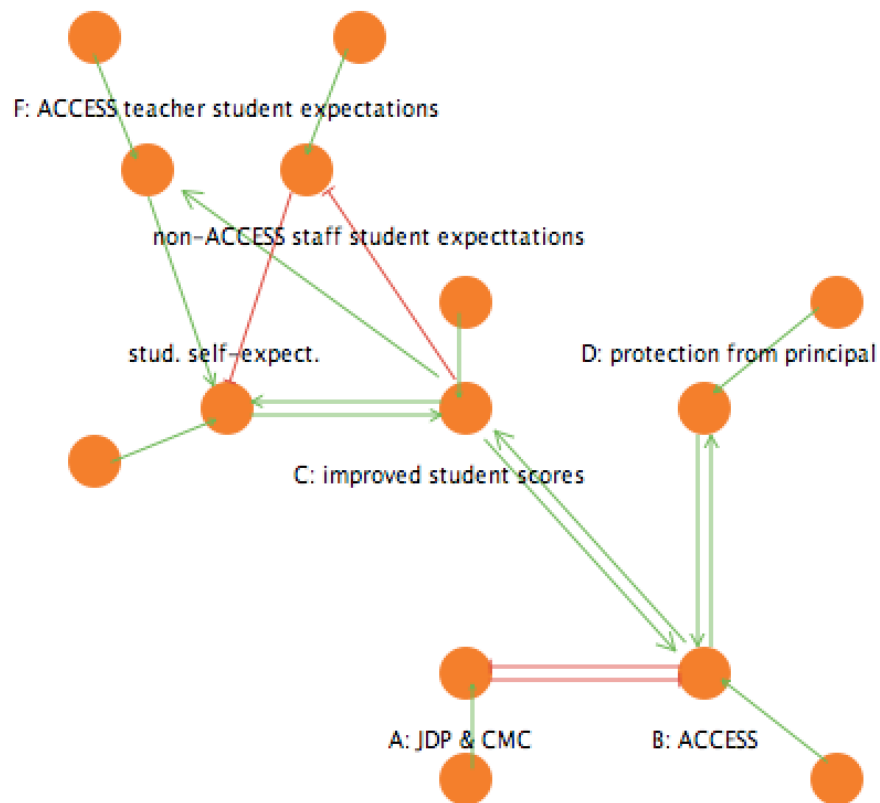


Figure 17: A combined multi-mediator model of the ACCESS reform, available online at

<http://eds.ucsd.edu/netlogo5/access-tipping-point-expanded.html>.

The model contains two tipping points, which can either cascade into one overall change or can exhibit two separate non-linear changes over time, depending on the sequence of changes in context.

Conclusion

This study provides an in-depth look at school reform efforts at a continuation high school with low-performing, low-income underrepresented minority students. The study draws upon complexity theory in multiple ways that have supported improved education for low-achieving students. Complexity theory has been used previously and has been used in this study as a lens for understanding school reform models. This study also uses complexity theory as a guide for developing strategy for creating change in a real-life context. In addition, this study has used agent-based modeling as a tool for exploring the interactions that were critical in leading to the tipping points at which the educational reform central to this study moved from an isolated niche within the school to becoming school-wide.

We are currently interviewing former students who participated in the ACCESS reform to see what impact it has had on them several years later. We want to discover the ways in which ACCESS best provides under-performing underrepresented students with the academic and college-going skills necessary for success in college, we want to know how these students experience the transition from high school to community college and from community college to a four-year institution, and we want to better understand the factors that support or constrain performance in college coursework and impact persistence in pursuing a college degree to completion. If our research can address these issues, it might be able to help others to navigate the turbulent waters of school reform, guided by complexity theory.

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