INTRODUCTION TO THE PROBLEM SOLUTION EXPLORATION PAPERS

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About the Problem Solution Exploration Papers

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Background Papers

A large percentage of community college classes are developmental (or remedial or basic skills) and cover academic material that has been presented in K-12. These classes blur the boundaries between the K-12 and higher education. There are conversations –and occasionally heated discussions—in the field about whether developmental education should re-trace the high school curriculum and cover exactly what students "missed," or if in fact, community colleges should approach the material in different ways.

In choosing to create an accelerated statistics pathway, we are opting for the latter approach, one that not only focuses on the academic material, but also examines the transition from K-12 to college. Thus, when we started planning the statistics pathway, we recognized that we would have to cast a broad net to capture potentially useful work in both higher ed and K-12 education research to inform our development. In creating the statistics pathway, we needed to begin with, but also go beyond mathematical content and look at who the students are, how they learn and what affects both teaching and learning.

There is an existing and growing knowledge base about effective practices in developmental education, (see for example, Hunter Boylan, *What Works: Research-Based Best Practices in Developmental Education* and the RP Group's *Basic Skills as a Foundation for student Success in California Community College).* However, there are still large gaps in what we know and what we need to know.

We initially identified five topics that literature and experience told us would be essential in designing the statistics pathway and assigned investigations of these to educators and researchers who were examining these areas already. The topics broadly cover cognitive process and the social and technical environment of education, with a specific focus on community colleges. They are:

- Student mathematical learning
- Language learning
- Social support for students
- Human resources

- Technology value added

In general, these topics have not been extensively studied in community college settings. Our authors addressed this fact in different ways, by looking to the K-12 research, and in a few cases, by moving into exploratory field work.

Student Mathematical Learning

The relevance of student mathematical knowledge is self-evident to our work. What do we know about the patterns of mathematical understanding of students entering community colleges? There is an emerging literature about elementary school students' learning of basic mathematics that identifies common barriers and potential misunderstandings, but the research literature is silent on those same issues for young adults in higher education who are encountering mathematical content they have seen before and not mastered. Jim Stigler, a psychologist at UCLA who worked on the TIMMS Instructional Videos, reviewed the community college literature on developmental mathematics. Although there were literally hundreds of articles on community college students, they tended to describe student demographics or programs designed for students. He did not find material that directly described mathematical knowledge of community college students. In response, Stigler and colleagues conducted field research to answer three questions:

- What do students actually understand about mathematics concepts that underlie the topics they have been taught?
- What do they think it means to DO mathematics? (remember vs. understand/reason)
- Can we get students to reason about mathematics…or are they stuck with just remembering procedures?

They collected data from three sources:

- findings from the California Mathematics Diagnostic Testing Project administered as a placement test at Santa Barbara City College,
- surveys (with mathematical problems to be solved) administered to a convenience sample of more than 700 students in-developmental math classes, and

- in-depth interviews to gain more sense of student thinking and reasoning.

Triangulating across the sources of data, Stigler concludes that students view mathematics as a collection of procedures to be memorized. He notes that this is a direct result of the way that they have been taught mathematics. Stigler points out the limitation of this view of math: "…as they move into community college, many of the procedures are forgotten, or partly forgotten, and the fragile nature of their knowledge is revealed. Because the procedures were never connected with conceptual understanding of fundamental mathematics concepts, they have little to fall back on when the procedures fade."

Although the overall picture that Stigler paints is, in his own words, *disturbing,* in the interviews he also finds that " it is possible to coax the students into reasoning, first, by giving them permission to reason (instead of doing it the way they were taught), and second, by asking them questions that could be answered by reasoning…This gives us further cause to believe that developmental math students might respond well to a reason-focused mathematics class in which they are given opportunities to reason, and tools to support their reasoning."

Language Learning

A recognized strength of community colleges is that they serve students who are diverse in all dimensions: age, race and ethnicity, as well as language. Community colleges have historically served immigrants who are English language learners, but they are also now serving large numbers of students described as "generation 1.5," non-native English speakers who have completed substantial amounts of schooling in the United States. Such students may not identify themselves as English language learners. In examining the particular needs of the broad population of non-English-based students, Stanford education professor Guadalupe**Valdés** , in collaboration with Bernard Gifford, and other colleagues conducted an extensive literature review of research in higher education and K-12.

The literature points out that "community college systems generally do not collect data about the languages spoken by students, nor do they collect data about the country of birth of students or their parents (in other words, they do not track the number of language minority students nor the number of immigrant students)." **Valdés** and her colleagues note that this is a serious oversight

because “Generation 1.5 students have distinct academic needs, which may not be met by current community college structures.” To begin to address gaps in the literature, **Valdés** and a research team conducted exploratory field work, focusing on issues particular to language and mathematics instruction.

Valdés conducted her field work at three community colleges, chosen because “all three institutions enroll large numbers of non-English background students; however, the backgrounds and characteristics of the students are different at each one of these three institutions.” Interviews with students, faculty and administrators at the colleges all underscored the distinct challenges of language in general in mathematics courses, and the particular challenge of use of mathematical language. “Students have not learned how to use syntax as a guide to interpretation in arithmetic, and they are not likely to understand the significance of symbol order in algebraic notation. … They frequently misuse and misinterpret algebraic symbols and syntax even in simple tasks.”

Valdés found that ord problems present a particular challenge. “The vocabulary and syntactic difficulties students face in translating word problems into algebraic equations, for example, are compounded for the growing numbers of generation 1.5 students in community colleges who do not speak English as their native language. Researchers have described a small number of instructional practices designed to help students master the linguistic demands of mathematics, including using students’ primary languages for selected explanations and clarification, creating a classroom environment with positive sociomathematical norms, and teaching students specific strategies to connect everyday language with algebraic language, such as recognizing algebraic expressions with real world referents.”

The clearest conclusion is a not only a need for more research, but also a need for sensitivity to non-English based students in creation of instructional materials and in classroom instruction.

Student Support and Engagement

Another dimension of student life that we knew will be significant is how students learn to ‘do’ college. The transition to college entails a complex mix of cognitive and affective skills:

knowing about and using a range of college resources, identifying and engaging sources of support, and shaping an identity as college student and learner.

Often a collection of topics connected to the transition to college is packaged as an orientation or a student success course. The typical student success course is designed to address perceived student deficits and includes a cluster of study skills, time management, note taking, test taking, etc., as well as an orientation to campus resources like the library and tutoring center. Laura Hope, Interim Dean of Instructional Support at Chaffey College, reviewed the existing literature on student success courses. Hope found the formal research on these courses is thin. In general, colleges are so convinced of students' needs that they rarely study or evaluate the effects of student success courses. A recent large scale study in Florida by Community College Research Center (CCRC) showed positive outcomes for students who take student success courses (though somewhat less effect for developmental students than for non-developmental students). However, the studies with data to show effects did not necessarily include program descriptions.

While some commercial student success courses, for example *On Course*, include attention to the affective dimension of the transition, recent work in psychology on motivation and self-efficacy are not always part of thesecourses. A companion piece by Carlton Fong at the Charles A. Dana Center at UT Austin, provides a theoretical framework from social and educational psychology that could be applied to student support structures. These include Bandura's theory of self-efficacy as well as other theories of motivation. One of these theories is Dweck's malleability of intelligence, which declares that intelligence can be changed and increased. This contrasts with the widespread idea that intelligence is given, fixed and unchangeable. Fong looks at another relevant area of psychological theory is grit, resilience and self-discipline, which describes the capacity for an individual to persevere in the face of challenges and obstacles.

Fong's paper describes Academic Youth Development (AYD), a program designed for students making the transition from middle school into ninth grade, an experience which in some ways parallels the transition to college. AYD was designed to integrate advances in developmental and social psychology, in particular malleability of intelligence, with algebra readiness content. In pre-post surveys, students report increased confidence, higher motivation and persistence, and increased use of metacognitive learning strategies.

To build on and extend this work, the Dana Center at UT Austin organized a one-day meeting of psychologists and cognitive scientists working on anxiety, contextual learning, belongingness, and positive stereotype to discuss how theoretical work in these areas might be translated to the classroom.

Human Resources

Any discussion of improvement in K-12 schools today would have to include the human resource perspective, looking at who the teachers are and structures that could support improvement in their teaching. However, that focus is generally absent in higher education where the characteristic qualification is expertise in the disciplinary area and academic autonomy is the norm. Even though community colleges are regarded as 'teaching institutions,' there is more information about the demographics and academic background of the faculty than information about how they learn to teach.

Amy Gerstein, Executive Director of the John W. Gardner Center for Youth and Their Communities, reviewed the literature on community college faculty, including the literature on faculty professional development. When it came to questions of pedagogical preparation, she notes, "Faculty, however, arrive with little to no background in pedagogy and curriculum design." And the trend towards more Ph.D.-prepared faculty "will only exacerbate this gulf between the expert and the novice."

Gerstein summarizes the findings on common practices in professional development: "Murray (2002) found that the campus-wide activities tended to be diffuse and lack coherence. Without a set of intentional goals guiding the professional development work, the faculty in Murray's studies and in the Grubb and Associates (1999) study experienced isolation and pursued areas of their own interest. The flex days might feature an outside speaker or set of speakers intended to motivate faculty at the start of a school year. Planned by administrators, these days often garnered poor reviews (Murray, 2002; Kozeracki, 2005)." She writes that while faculty regularly attend department or division meetings, these are usually devoted to administrative concerns such as scheduling, and rarely focused on teaching and learning.

However, Gerstein had been the lead researcher on a study of professional development needs and experiences of faculty at the Foothill DeAnza District in California. The multi-year study was based on the assumption of a connection between professional development and improvement of instruction in ways that would improve student performance. One of the strongest findings was that "New faculty [less than five years] articulated their motivations to study how students learn and how to improve their teaching."

Technology

Cathy Casserly, former director of Open Educational Resources at the William and Flora Hewlett Foundation and now a Senior Partner with Carnegie, describes how technology and social media are currently being used by students and faculty inside and outside the community college institution. Technology has the potential to increasingly change the educational landscape. This work is in progress.

Background Papers and the Program Improvement Map

These five topics were chosen, not only as general background for the development of the statistics pathway, but also to inform development of a Program Improvement Map, an analytic tool for planning and evaluation of the statistics pathway. Taken together these topics will help inform the student characteristics we identify and measure, dimensions of instruction, organization of faculty development, as well as the ultimate student outcomes. And they will help set the research agenda to fill in the gaps in the research literature and the gaps between research and practice.

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