Improving Mathematics Learning in Community Colleges: Building a Professional Community of Teachers

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Community colleges: serving a diverse population

Community colleges are the open doors to those who would not otherwise be able to attend college. Community colleges are first and second—and sometimes third and fourth—chance institutions for those who were not successful in K-12 schools, those who did not want to or could not afford to move away from home, those who did not attend college after high school, immigrants to the country, and those seeking new careers when work conditions change.

More than 11 million students attend community college nationally and 7.7 million students are enrolled in credit programs(AACC, 2014). Forty-five percent of all undergraduates are enrolled in community colleges; this includes fifty-nine percent of Native American students, fifty-six percent of Latino students, forty-eight percent of African American students, and forty-four percent of Asian/Pacific Island students. In addition, forty-two percent of entering freshmen start at community colleges (AACC, 2014).

Recognizing that community colleges serve a diverse student population, various organizations, including the National Research Council (NRC, 2012) the National Governors' Association (NGA, 2011) and the National Science Foundation (NSF, 2006) have all issued reports on the importance of community colleges in the overall national effort to produce more STEM-skilled workers. Researchers (Hagedorn & Purnamasari, 2012; Malcom, 2010; Starobin, Laana, & Burger, 2010) have explored the ways community colleges could increase the diversity of the STEM workforce. These reports recognize the widespread need and the important contributions community colleges could make to workforce development.

Community colleges have a broad inclusive mission, however, as various reports recently acknowledged, community colleges have been more successful at access than success (see for example Community Colleges: Special Supplement to The Condition of Education 2008. Statistical Analysis Report, National Center for Educational Statistics). In defining success, attention has shifted from measuring the numbers of courses completed with a passing grade to looking at overall numbers of degrees, certificates, and transfers. The need is great. Bailey and CCRC colleagues (2006) in "*Is Student-Right-to-Know All You Should Know? An Analysis of Community College Graduation Rates*" found the rate of degree or certificate completion between 10 and 30 percent. Overall, less than one quarter of first time full time students earned a postsecondary credential at their starting institutions after three years, while an additional 16 percent transferred out. The completion agenda began as a federal economic manpower mandate; the banner of completion has been taken up by state and national policymakers, and by initiatives such as Completion by Design and Achieving the Dream.

Mathematics in community college: requirement, barrier, and opportunity

> *More than in many other subject areas, students approach math with high anxiety, which interferes with their learning. Many delay taking a math class until they are too far along in their studies, while others are eager to get the math requirement over with, and end up taking classes beyond their capabilities.* -- (Rosin, 2012a)

Research by the Community College Research Center (Jenkins et al., 2009) underscored what many in the field have observed and experienced: mathematics has been a major obstacle for students succeeding, persisting, and completing community college programs. Mathematics courses are required for the full range of academic majors and access to careers. Math is the direct gateway to STEM majors; medical fields, such as nursing, require math and general education for transfer for any baccalaureate degree also includes mathematics requirements.

Community college departments teach mathematics courses from basic arithmetic through college level courses that cover the first two years of preparatory content for STEM majors. The aggregate data on student performance in community college math courses makes a compelling case for investment to improve student success (although we later note some of the exceptional colleges where results are better). In California, for example, in Fall 2010, across the 112 community colleges in the system, only 55% of students enrolled in credit-bearing math courses for an AA degree or transferable earned passing grades. And pass rates in these math courses varied by student ethnicity; African Americans passed only 41% of the time and Hispanic students had a 49% success rate (Rosin, 2012b). These success rates "have essentially remained unchanged since fall 1992, the earliest term for which the California Community Colleges publish comparable data" (Rosin, 2012b, pg. 3).

The lack of student success is acute in developmental math, where the majority of community college students start. An average of 60% of community college students enroll in developmental mathematics (and that number probably underestimates the need, as many students who are referred to developmental mathematics do not enroll in the courses). Jenkins et al. (2009) in a multi-state study of Achieving the Dream colleges found only 20% of those who enroll in developmental math went on to pass the relevant entry-level or "gatekeeper" college course. The numbers in California were even lower; between 10% and 15% completed the developmental math sequence (Grubb & Gabriner, 2013).

To improve student success and completion in community colleges, it is imperative to improve mathematics instruction.

Pedagogical inertia

Overall, pedagogical approaches and content in mathematics have tended to be consistent over time while the context is changing: the population of students who attend college is changing, the distribution of jobs and careers is changing, and the math needed for work and citizenship is changing.

Although community colleges are described as teaching intensive institutions, teaching practices of community college faculty have reflected traditional higher educations methods, with lecture and demonstration as the mainstays of the classroom. A major reason for this instructional approach is that the requirement for teaching in higher education—community colleges and four-year colleges and universities—focuses on mastery of the subject are rather than mastery of teaching and learning.

An advanced degree is considered sufficient preparation for teaching. The underlying assumption is that someone who knows the content knows how to teach it. In four-year institutions this means a doctorate, at community colleges, the minimum is typically a masters degree. (Levin et al., 2006; Townsend & Twombly, 2007). Close to three-quarters of community college faculty (71%) have an earned masters degree[1] and, 13% have a doctorate (AACC, 2014). The number of faculty with Ph.D.'s teaching at community colleges has been increasing, however, that is unlikely to improve quality of teaching.

Typically math teachers, who understand mathematics and were successful in their math classes, most often teach the way they were taught. This traditional approach underestimates the complexity of teaching and learning. This is particularly the case when teachers are teaching community college students with different socio-economic, educational, and mathematical backgrounds, in other words, when mathematicians are teaching students who have different learning needs.

The mismatch of pedagogy and learning needs is evident across the entire sequence of community college math courses, however, the impacts are particularly severe in developmental math courses. Developmental students generally have intense needs as learners. Remedial math education was originally created to refresh the knowledge of students who had been away from school for some time. Now, more commonly, students in developmental math may not have passed their high school classes or they may have gotten through with a superficial level of understanding. As a result of their experiences, developmental students are likely to hold beliefs about themselves, learning, and mathematics that are obstacles to success in math classes. Stigler and colleagues (2010) interviewing and observing developmental students doing math, found that students had well established procedures for problem solving, but those routines were rooted in "faulty notions of when and

[1] Career Technical Education faculty may have work experience in place of academic degrees.

how procedures should be applied." For the most part, community college mathematics instructors have not had educational experiences to prepare them to meet the learning needs of developmental students.

On the other hand, we know that there are many community college math teachers who have been innovative, creative, and responsive in the classroom, including faculty who teach with traditional lecture pedagogy who have worked hard to improve their teaching and student learning. These approaches could be covered by what Huberman (1993, as cited in Talbert & McLaughlin, 2002) described as the artisan model of teachers—those who accumulate a requisite knowledge base and skill repertoire but essentially work alone, learn alone, and derive important professional satisfaction from interactions with pupils rather than with peers.

Teaching in community colleges: autonomy or isolation?

> *What you would expect, I would think, is communities of teachers, who are developing their skills as teachers, and that there would be lots of institutional attention for that very goal… but instead what you find in the community college is…teachers who are phenomenally isolated. They have their classes, they have class autonomy… Because there's this irony: it's a teaching institution, but there's almost nothing for the teacher…So I've felt really isolated. …* - Grubb & associates, 1999, *Honored But Invisible*, p 50)

Although the culture of higher education is characterized by individual autonomy and responsibility for instructional decisions, there is actually great similarity across classrooms and institutions. Faculty describe teaching responsibilities in terms of bureaucratic norms and make decisions based on known routines, which may come from departmental expectations, or from their own experiences as math students. Community college teachers typically list their professional tasks within a bureaucratic organizational framework (Levitt, 1988). Teachers present learning topics in syllabi following a recommended schedule; they assign and manage homework; they design and grade summative assessments; they prepare final grades. On top of classroom responsibilities, (full-time) faculty members attend to other committee work as part of shared governance practices (Levin et al., 2006).

However, it is also possible to describe the conditions of work, as the faculty member in *Honored but Invisible* (Grubb et al., 1999) did above, in terms of isolation. Teachers may—or may not—be part of ongoing professional conversations about teaching and learning, depending on where they happen to teach and whether they choose to actively seek out resources and interactions. Professionally isolated in their classrooms, faculty may not perceive the broader professional or political context for their struggles or successes and they may not be aware of resources that are available to them. Without professional support and resources, without ongoing forums for professional learning, individual faculty continue the familiar and

maintain the status quo. This isolation also constrains the scale up of successful improvements in instruction.

The practice of instruction has been shaped by pedagogical norms, faculty isolation, and cultural expectations. There is overwhelming evidence that the current system is not effectively serving either student needs or, at this point, the needs of the broader society that supports education. In the face of policy mandates for greater effectiveness and productivity, a trend of education redesign, and growing public interest in community colleges, improvement cannot rest on individual motivation, nor can change be accomplished one person at a time. Change at scale requires broader vision, systemic perspectives, and a sustainable infrastructure.

A Theory of Change: Supporting a Professional Community of Teachers

> *Three dimensions of scale:*
>
> *Individual – unit of instruction*
> *Organizational – across units within an institution*
> *System– across institutions within a system*
>
> *To produce large effects at scale, improvement has to be managed at all three levels simultaneously* ---Elmore, 2006

Drawing on research, theory, and practice, we propose a practical theory of change to improve community college math teaching and learning. The widespread nature of the problem means that work has to be designed at scale; as Elmore (2006) suggests, this requires working at the individual level, the departmental level and the broader system level.

Our work plan centers on engaging math teachers in opportunities to expand their pedagogical repertoire, enlarge their network of professional relationships, and extend their professional identity. This model requires recognizing the complexity of teaching and learning, investing in teachers, and providing settings rich in professional learning opportunities in the department and beyond.

This is not a theory focused solely on addressing the particular or immediate problems of student success in courses or overall completion. This is a strategic proposal for building the ongoing capacity, resilience, and flexibility for community colleges to deal with inevitable future changes in policy, economy, technology, and job growth.

Professional Teaching and Collective Autonomy

> *This (individualistic) view of teaching is, among other things, profoundly unprofessional, even anti-professional … it effectively precludes any possibility of improvement of instruction at scale… and makes it impossible to treat human skill and knowledge as the main instrument of improvement.*
> --Elmore, 2008, p. 50

One ways to counter the isolation is to foster collaboration locally, making it possible for teachers to work together, visit each others' classrooms, and develop a sense of collective responsibility for student learning. When teachers work together, guided by evidence about learning from research and their classrooms, they are able to provide students with a more coherent experience across a sequence of math classes.

Research in K-12 schools has demonstrated the effectiveness of investing in professional learning and supporting professional communities of teachers (See Appendix 1). In Huberman's (1993) view of artisanal teaching, the individual was the agent of instruction and improvement; he feared that bureaucratic mandates for school wide collaboration would undermine rather than support teachers' artisanship and individual effectiveness. Talbert and McLaughlin (2002) challenged this view of the solitary individualistic artisan teacher. In contrast to Huberman's predictions about the effects of collaboration, Talbert and McLaughlin (2002) found in practice that teachers who collaborate are more likely to hold high expectations for students and colleagues, to innovate and to have strong commitments to the teaching profession. In contexts with weak communities they observed isolation and demoralized teachers. Although Talbert and McLaughlin studied high schools, what they observed was similar to conditions that have been observed in community colleges.

Talbert (2010) also offers the practical caution that collaboration cannot be mandated from the top-down. When it is, the likely teacher response will be anxiety, compliance with ritual enactment, or resistance in many forms, including outright attack on the ideas and 'waiting it out.' Talbert (2010, p 568) notes that "system change entails dynamic tensions between bureaucratic and professional perspectives and strategies," essentially, it entails working bottom up, top down, and from the middle out.

In thinking more globally, Gamble (2010) takes on the question of teaching as a profession and the perceptions of autonomy. Community college faculty value their individual autonomy (Levin et al., 2006) and have taken it as a measure of professional standing. Much of the defense of individual autonomy may, in fact, be resistance to real or imagined bureaucratic imposition of prescribed routines.

Gamble (2010) reconsiders the professional base of teaching. Professions have been defined by expertise based on a specialized knowledge base. Math professors have seen knowledge of math content as their specialized knowledge, but professional teaching merges the knowledge of math with an understanding of learning science and the principles of addressing individual learning needs in the classroom (Ball et al., 2008; Shulman, 1987).

The knowledge base in cognitive science is expanding and describes the ways learning is active, not passive, which has deep implications for schooling at all levels. In 2000 the National Research Council's Committee on Developments in the Science of learning produced *How People Learn: Brain, Mind, Experience and School.* The following year, NRC (2001) published *Adding It Up: Helping Children Learn Mathematics*, which applied learning principles to mathematics. *Adding It Up* defined mathematical proficiency as comprising five independent but intertwined strands: strategic competence, conceptual understanding, procedural fluency, adaptive reasoning, and productive disposition**.** The Common Core State Standards further develop the understanding that the acquisition of mathematical proficiency requires the intentional formation of mathematical thinking (Devlin, 2014). The Standards for Mathematical Practice inform the implementation of the content standards from Kindergarten until College Ready mathematics. The leaning strands as well as the Standards for Practice articulate the challenges of learning and teaching mathematics beyond procedural competency.

Gamble (2010) notes that when a profession has the power and responsibility to determine specifications for professional preparation, certification, and conditions of work, members of the profession may redefine autonomy in collective terms. Professional autonomy may come to mean implementation of agreed on evidence-based standards of teaching and learning and teachers would be accountable to the professional community and the broader society the profession serves.

A professional approach to teaching mathematics would be a crafted, negotiated, and continually improving practice. In spite of some fears and hesitance, a professional approach to teaching would *not* mean that teachers move in unison through a dictated curriculum or are forced to follow a scripted pedagogy. Nor would it mean that students endure standardized content and exams without attention to their individual differences in background and learning. In a professional community rooted in learning science and reflection on practice, teachers would receive and give support to shape pedagogies responsive to their students' needs. As teachers work together, guided by evidence about learning—from research and their classrooms—they would able to provide a more coherent experience for students as they move through a sequence of math classes.

> *Teaching is such a complex craft that one lifetime is not enough to master it; but by rigorously focusing on practice, teachers can continue to improve throughout their career.* Dylan Wiliam (2010)

Innovations in community college mathematics

Recent innovations in community college math demonstrate the impact of a broader pedagogical approach and more organized professional learning. For example, in developmental math, in response to the growing recognition of the overwhelming ineffectiveness of the traditional developmental math sequence, there are a number of redesigned developmental models. Virginia, North Carolina and Arkansas statewide reconstructed developmental math courses into sequenced modules, which in many places are being taught in computer labs. Accelerated models of the Charles A. Dana Center (Cullinane & Treisman, 2010), the Carnegie Foundation for the Advancement of Teaching and the California Acceleration Project[i], all shorten time (and content) in developmental courses and are designed to lead directly to college level statistics or quantitative reasoning courses. These accelerated models all pay attention to applying principles of learning science and include student support within the course. In addition, they all incorporate professional development for teachers. Initial student results from the Carnegie Statway (Carnegie Foundation for the Advancement of Teaching, 2013) and California Acceleration project (Hayward & Willett, 2014) have been positive.

Redesign is not stopping at developmental math. In North Carolina the *Curriculum Improvement Project*, for example, has created two new college level math courses, revised 14 existing courses and removed 30 courses from the Combined Course Library. These developments require faculty to make a pedagogical shift from "instructor" to learning facilitator and to develop/adapt resources to contextualize the math instruction with examples of quantitative information encountered in everyday life and work. The waves of math redesign will continue. Faculty across states and colleges will continue to encounter challenges in content and audience that that require different ways of teaching.

Building professional communities of teachers

> *The research on teacher learning shows that teacher learning communities provide the most effective process for teacher change, while research shows that a focus on assessment 'for' learning is the most powerful, and yet most neglected, aspect of teacher practice. By fusing these together, educators have the real possibility of providing effective teacher learning at scale and a reasonable cost.* –Dylan Wiliam (2006)

The current routines of teaching are unlikely to shift when faculty work in isolation. When teachers can close the door and determine their own teaching approach, there are few levers or opportunities to move from familiar pedagogy. Even the constant demands of a teaching schedule can discourage it. Faculty need tangible support and opportunities to engage in changing practice from familiar tasks and to shift their perceived role from dispensers of content to creators and facilitators of learning opportunities.

To create rich classroom experiences for students, teachers need the same kinds of supported, engaged, collaborative learning experiences that students need. Teachers need to experience learning collaboratively because it exemplifies the principles of learning science in practice and because they need to experience learning in this way to bring it to students in their classrooms.

Talbert and McLaughlin (2002) observed that the craft of improving teaching thrived in professional communities that supported teacher growth and also provided the opportunity to mentor new members into the profession.

The growth of professional teaching cannot take place in isolation, teachers need:

- a resource rich environment,
- the opportunity to engage with new ideas and resources,
- the means to establish professional relationships
- time for ongoing professional conversations
- opportunities to engage with other teachers in practice
- structures for support and reflection while trying different pedagogical approaches in the classroom and a safe environment to reflect on their experiences
- a place to make practice visible and share questions and problems with colleagues.

The theoretical work of Lave and Wenger (1991)on communities of practice, and research by Horn (2005), Wiliam (2007) and Talbert and McLaughlin (2002) demonstrate the ways that professional responsibility can shift through intentional work in a community of practice. Communities of practice share the tasks of problem solving, requests for information, identification of assets, discussions of common issues, and documentation of experiences (Wenger & Trayner, n.d.).

As teachers' professional identity shifts from one that centers on conveying and assessing static knowledge to one that centers on creating rich environments and engaging students in conceptual learning, faculty may become more willing to engage with new pedagogical approaches in the classroom. Their sense of professional creativity may shift from rebuilding the curriculum to applying learning principles in ways that fit the needs of their students.

Gaining new pedagogical skills and shifting professional identity are mutually supportive experiences. As teachers are willing to try new pedagogical approaches in the classroom, they see their students differently and understand learning differently. As they understand student learning in more depth, the sense of professional identity—what it means to be a teacher—and their professional responsibility—commitments to students and their profession—deepen.

Our plan is to support faculty learning and growth, through two complementary levels of professional communities:

- within departments, where it can shape and support the daily work of teaching, and
- as extended regional or state networks that would provide a broad professional community to support departmental growth as well as including individual faculty who do not have access to institutional resources (for example instructors at small rural colleges and adjunct faculty).

Reconstructing academic departments as professional communities of teachers

> *…reforming departments requires both an instructional vision as well as organizational, political, and personal skills—and 'how often do these skill sets come together*?' Grubb and Gabriner (2013 p 87)

Community college departments tend to reflect the practices of departments at four-year institutions. Overall, academic departments are designed for governance and bureaucratic functions (Levin et al., 2006) and are typically viewed as the vehicle for administrative communication. Departments are important because through hiring, through content and curricular decisions, and through faculty interactions, they shape the work values and culture.

Academic departments would be the logical home for collaboration and collective professional community; however, in practice, they rarely serve those purposes. Grubb's 1999 study noted that departments did not tend to be collegial; he found tremendous variation in how instructors use departments as a place for professional conversation and engagement: "without a collegial culture, departments are not much more than places where instructors get their mail and assignments" (p 51). Kezar (2005) observed the lack of a consistent understanding of what it means for a college or a department to be a learning organization and Stigler et al. (2010) found that community college math departments do not have routines that bring research on learning into professional conversation.

In a subsequent study more than a decade after *Honored But Invisible*, Grubb and Gabriner (2013) did not find much change in the status of departments. The cases of collaboration and initiatives that have been successful in community colleges tended to be 'pockets of innovation,' frequently based on the effort of an individual or small group of faculty and often grant supported for a defined period of time. Across the thirteen colleges Grubb and Gabriner, (2013) examined, the research team found only three or four departments (among mathematics, English and English as a Second Language departments) that stood out because they had developed their own approach to teaching. The departments that had a common

teaching approach had garnered resources, often from external grants, to provide professional development for full and part-time faculty.

There are occasional cases of collaborative departments in practice. For example, at Glendale Community College, all developmental math courses use common final exams that are jointly constructed and scored (Bond, 2009). Often the roots of such departmental collaboration stretch back over a decade and the origins of the collaborative practices are hazy; current explanations can come down to 'this is our culture,' or 'this is how we do things here.' So it can be hard to generalize from these examples.

In looking for instances of growth in departmental teaching culture, Rethinking Pre-college Math (RPM)[ii] in Washington provides examples of departments in the process of becoming professional communities. RPM focused on fostering collective responsibility and improving teaching to increase student engagement and conceptual understanding (Moore et al., 2013). From the beginning, departments were defined as the unit of change; applications to participate in RPM were required to be submitted as departmental initiatives.

A goal of RPM was to change departmental norms of collaboration, communication and decision-making to take collective responsibility for student-learning needs (Davis et al., 2013) . RPM colleges all conducted local redesigns of their developmental sequences; most decreased the number of courses, which often meant cutting out some content. In the process of coming to agreement on curriculum, most of the campus RPM teams encountered resistance among colleagues in their departments. Those opposing the redesign did not want to relinquish their autonomy and they were skeptical of innovations. Resistors defended the status quo as necessary to preserve the rigor of the mathematics. They viewed reforms as lowering standards to accommodate students who lacked the intelligence or effort to succeed. In retrospect, this response is not surprising. Similar contentious conversations take place in many departments with almost any proposed innovation; they reveal common tensions across colleges.

Activities that RPM (Moore et al., 2013) used to increase collaboration in the department included:

- Examining patterns of student performance in data
- Proposing focused experimental versions of a course and tracking effects
- Setting up regular times for faculty to meet and talk
- Sharing examples of student work that are real problems and puzzles
- Establishing relationships with other departments and offices on campus

Although change was not consistent across participating RPM departments, several departments made notable progress. There were shifts toward collaborative culture with shared materials and reciprocal classroom visits among faculty. One college set up a time, affectionately known as 'math and munch,' an idea and name picked

up by other colleges, on Friday afternoons for faculty to get together and talk. This established a time for people to meet and share satisfactions as well as problems. Over time, faculty were able to bring examples of student work, including things they were struggling with in class. When the environment felt safe enough, teachers could say when they were struggling without fear of being demeaned (Asera, 2013). Developing trust and relationships is an early requisite stage in growth of departmental teaching culture.

Building on initial trust and communication, RPM campus teams actively invited and included the circle of faculty who are interested but hesitant. As part of the developmental process, *Inside Out,* (Bickerstaff, 2014) from the CCRC Scaling Innovation Project describes three orientations towards instructional reform: Ready to Act; Ambivalent; and Reluctant to Change. RPM campus teams actively invited and included the circle of faculty who were interested but hesitant, perhaps because they didn't know how to use new pedagogies. RPM ran long enough to see active participation by some people who were initially ambivalent or reluctant.

One more outcome that contributed to professional and departmental growth was that some of the participating faculty took on leadership roles in the project, in their department, and on campus (Asera, 2013).

The three-year timeframe for RPM was too short for department cultures to both change and mature. The evaluation reports (Asera, 2013; Davis et al., 2013) illustrate the early stages of departmental change, including the sense of struggle that is part of intentionally trying to shift departmental culture. From the experience of RPM, we should not expect the process of departmental change to be linear, smooth, or rapid. However, from the research literature and observations of departmental collaboration we conclude that academic departments can be enabled to develop as professional communities of teachers that support the growth of professional skills, knowledge, and identity.

Cases from the field: A teaching- and learning-centered community college

Valencia College[iii] is another powerful example of an institution where context, leadership and opportunity combined to enable scalable and sustainable change (Aspen Institute, 2013). Valencia is a nationally recognized and award winning college; it was the inaugural winner of both the Achieving the Dream Leah Meyer Austin Award and the Aspen Prize. Valencia demonstrates what is possible when the college defines itself as a professional community of teachers.

Valencia is known both for student support and faculty development. Valencia as a college is an educational community dedicated to professional learning in order to support student learning. The Valencia Office for Faculty Development is "a comprehensive program for Valencia's learning leaders." Valencia faculty development is organized around a set of essential educator competencies that

exemplify professional teaching. These include competencies such as learning-centered teaching strategies, assessment, outcomes-based practice, inclusion and diversity, and the scholarship of teaching and learning. All faculty—full- and part-time—are invited and welcome to take part in the wide offering of face-to-face and online courses that faculty can choose to address their particular teaching needs.

New hires for full-time positions go through a three-year induction; they are supported in creation of a portfolio that demonstrates their competence in the educator outcomes by conducting action research in their own classrooms. In addition, resources for faculty induction and support include a mentor, annual retreats focused on practice, monthly meetings for teachers teaching the same course, and summer onboarding workshops for new teachers. As one math teacher sums up the experience of teaching at Valencia, "*Talking about learning, teaching, and student success is just part of our culture."*(J. Phelps, personal communication, March 24, 2014)

This institutional culture and coherence came about as a collaboration of executive leadership and faculty leadership. Through a series of grants, a group of fifteen or twenty faculty had been working on student learning outcomes and assessment. In 2000, when Sandy Shugart was hired to be the president of Valencia, he brought the faculty leaders with the focus on learning from the margins of the institution to the center. Valencia College believes, acts on, hires for, and organizes the budget around teaching as the central responsibility of the college and sees teaching as a professional skill that can be continually improved. Valencia College invests in faculty and it pays off in student learning across the institution.

An extended regional or state professional community for teachers

Higher education has not had a consistent infrastructure to support professional learning at the individual or institutional level. Professional organizations do some professional development, but they are voluntary service organizations with limited resources. State system offices or coordinating boards may organize some professional development, but their main responsibilities are governance and they rarely have the capacity for widespread professional development efforts. Some community colleges have centers for teaching and learning, but they are not common.

Improvement initiatives and externally-supported projects frequently create collaborative settings for participants, but they are typically grant-funded and tend to be time limited. However, several projects have paid attention to documentation and learning from the process. Across more than half a dozen projects with similar community-building design —Rethinking Precollegiate Mathematics (RPM) California Community College Success Network (3CSN), Strengthening Pre-collegiate Education in Community Colleges (SPECC), Faculty Inquiry Network (FIN), and North Carolina Curricular Improvement Project (CIP)— leaders have deployed common strategies and observed common benefits*:*

i) Seeing the bigger picture
Both individuals and departments benefit from seeing their work in a broader context. Alone in a classroom a teacher doesn't know what colleagues are doing; as doors—physical or virtual—open, as teachers talk with colleagues and people visit each others' classrooms, they begin to see a bigger picture of teaching and student learning. Similarly, departments and colleges gain perspective by learning how peer departments and colleges work.

ii) Learning from experience—their own and others
These projects have been intentional about creating opportunities for participants to reflect on their own experiences and to share and learn from the experiences of others. Project-wide events can provide time and place for reflection and planning, which can be difficult to carve out of the busy schedule of campus life.

In an extended network faculty participants can hear stories from and about other campuses. They can hear how other colleges work, something they rarely know about; people can gain strategies from hearing how others approach a widespread problem. This broader perspective can help people understand the particulars of their own institutions, both its local strengths and areas that could be improved. Wenger, Trayner and deLaat (2011) note that shared narratives can be grounded in common experience and everyday life or they can be aspirational in defining what the collective is aiming to achieve and what is possible over time.

iii) Connections and interactions
Because a community of practice casts a wide net, there will a range of participants, such that people can find those with both similar and different points of view and come to value both. Individuals can grow and be mentored into leadership roles for their colleges and for the network. Professional connections can be nurtured and maintained over time and serve as a professional network across the state.

Some sub-groups of teachers benefit in particular ways from connecting to a network, for example, faculty at remote rural colleges may not have immediate colleagues to work with directly. In addition, a network can provide a base for adjunct faculty who may not feel connected to the institutions where they work. A network can take pressure off isolated innovators who bring ideas to their campuses and can attribute them to a stronger base of practice and authority.

An extended regional or state network that brings together faculty members and departmental teams can provide support for individual professional learning and departmental growth. An extended network can:

- model professional learning so that teachers experience learning in the way that they are encouraged to bring into the classroom
- provide a forum for faculty teams to share, reflect on, and strategize their departmental experiences
- mentor faculty leadership

- seed and focus professional conversations surrounding contexts that shape instruction including
    - Policy-- local (institutional and district), legislative mandates (state, system,) and nationalorganizations (voluntary professional standards)
    - Research--from math education and learning sciences
    - Practice-- emerging work from the field

The conditions of society, of education, and of teaching will continue to change. A professional community will provide flexible, adaptable support for ongoing professional teaching.

Afterword – where do we go from here?

The research survey and environmental scan above was commissioned by academic leaders involved in networks for math faculty collaborations and professional development in three state community college systems (CA, NC, WA). The results have been very valuable to us in shaping plans to move forward on improving student success by strengthening the professional context in which our math faculty engage in teaching. In this brief epilogue, we illustrate how these ideas might be realized in practice, via example plans from one of our participating networks. This is only one snapshot, in a particular context and a particular point in time (August 2014). The plans will evolve as we continue to learn more, from each other and the wider research community).

Our first desired direction is to move forward on the development of a more professional teaching culture of continuing improvement in collective teaching practice. One aspect of our work plan is to focus on supporting departments who commit to an ongoing year-over-year improvement in student math success. We are more concerned with the intent of departments to "surpass themselves" in math teaching – by continuing to improve student math success by X% or Y students per year, however they choose to define success – than with the actual values for X and Y that they may choose (which will depend greatly on local contextual factors).

To support the departmental goals for continuing improvement and to prepare other departments for continuing to advance teaching practice, our second desired direction envisions a faculty development program for leadership in advancing departmental teaching practices. This role is not an administrative function, and in some cases may be an informal rather than formal role within the department. The program to enable such leadership must include building faculty capability in using evidence-based practices to advance their own personal teaching, as well as developing capability and commitment to advancing collective teaching practice at the department and regional levels (and beyond). Our model of effective change relies on a capable and committed faculty cohort serving as catalysts, coaches and connectors.

A final desired direction is to expand and enhance our regional networks of faculty inquiry and innovation teams, to accelerate the development, dissemination and scale-up of innovative teaching practices and resources (including program structure, curriculum and course content, and teaching resources and pedagogical practices). In addition to encouraging faculty knowledge exchange and resource sharing, we have specific program elements in our evolving network plan to ensure that innovation projects engage faculty beyond the 'first generation' team that develops and pilots new approaches.

We expect that one key element for interdepartmental collaboration will be faculty inquiry and innovation project teams, with faculty members contributing in two complementary roles:

- a *develop & pilot* role in which team members do more of the 'heavy lifting' through leadership in researching, developing and piloting new teaching practices and resources (the 'inquiry' part);
- an *adapt & enhance* role in which team members engage throughout with the *develop & pilot* faculty as design consultants and 'friendly critics' (with a more modest time commitment) in this initial phase – and then become leaders in scaling up the approach by adapting and enhancing the practices and resources to meet the needs of their particular contexts (the 'innovation' part).

One suggested target is for each participating department to eventually have faculty taking on roles in both categories across projects, and over time to have individual faculty taking on both roles for different projects. These changes in practice are intended to help us scale up professionalism within the teaching culture of our math departments. In particular, we want to encourage members of interdepartmental faculty teams to engage their departmental colleagues with the insights, progress and challenges from innovations *while they are still emerging*.

We want these new practices and resources to be perceived as coming from "our" community, and hence belonging to an internal 'us' and not an external 'them'. This *emotional ownership* of innovations is a key factor in faculty adoption and adaptation of innovative practices [Pawlowski 2012], and one of the key approaches we hope to employ in addressing 'not-invented-here' as an obstacle to scaling up innovations in teaching.

Appendix 1
Looking beyond higher education—research on collaboration in K-12 schools

> *The teacher is the most important influence on student achievement. Students who get the best teachers learn at twice the rate of students taught by average teachers. Greater improvement in teacher quality can be obtained, at a lower cost, by investing in teacher learning.* (Wiliam, 2006)

Higher education is not the only system facing a redefinition from individual focus to the collective. Throughout the 1950s, 60s, 70s, 80s and 90s K-12 teachers were described in a similar way: when the door was closed, teachers were generally left to their own decisions. Over the last ten to twenty years, however, changes in policy and practice have opened doors and conversations.

Although it is not necessarily the practice everywhere, it is no longer an anomaly for K-12 teachers to work together in different configurations – across a grade, vertically connecting grades, across transition points, and school wide.

The research literature shows the effectiveness of collective approaches for professional learning, professional teaching, and ultimately for student learning. Garet, et al. (2001) found that professional development that is coherent with the daily environment of schools enhances practice.

Judith Warren Little's 2006 review, *Professional Community and Professional Development in the Learning Centered School* contrasts ongoing, site-based, intensive professional development with the more frequent experience of episodic and disconnected workshops that have done so much to give professional development a negative reputation. In defining the elements of a professional community, Little identifies shared values and purpose, collective focus on responsibility for student learning, coordinated efforts to improve student learning, and a range of practices that support teacher learning, including observation, problem solving, and advice giving. In conclusion Little underscores the connection between teacher learning and student learning, "schools that exhibit a high level of success with students, sometimes against considerable odds, tend to supply consistent portraits of work environments conducive to teacher learning."

One notable difference between professional development in K-12 and in higher education is the focus on content area. Math instructors in higher education know the math content, but typically have not had pedagogical preparation. Teachers in K-12 have been formally prepared to teach, however, particularly elementary and middle school teachers with a multiple subjects certification may not have a strong background in mathematics. The focus of professional development can be on learning the mathematics content. Both Cohen and Hill (2000) and Hill and Ball (2004) found that emphasis on content and hands-on experience working together on math problems led to changes in teaching practice. When the professional development was consistent with the curricular materials and aligned with assessments, this led to positive student results.

Practice can be the motivator and the medium of professional learning. When professional development is rooted in practice and focused on the goals and problems of teaching and learning, professional learning directly affects practice and student learning.

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