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Effectiveness of Contextual Basic Skills Math in California Community Colleges (CCC): A Working Paper

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Effectiveness of Contextual Basic Skills Math in CCCs

California and the nation have and will continue to experience unprecedented demographic, economic, political, and societal changes. Political, economic, and societal shifts are occurring at ever increasing rates. With these shifts, the nation is experiencing rapid changes in labor markets. Demands are increasing for workers with higher order information skills who can reason through complex processes in jobs that most often require some postsecondary education.

While some may have been able to have a long well paying career in the 1950s with quite low level skills, working in jobs that completed steps of larger processes with little complex decision making, most of those jobs that required high school or less education have disappeared. Some estimate that as high as 60-80% of jobs today require some postsecondary education (McCabe, 2000). Many, if not most, of those looking for higher skilled employment that will pay family sustaining wages look to the community colleges to learn those skills.

In the second half of the twentieth century, concerns over both equality and the continual increases in the complexity of work since World War II prompted dramatic increases in access to higher education (Boswell & Wilson, 2004; McCabe & Day, 1998). During the 1960's, the U.S. spent more on constructing institutions of higher education than it had in the previous history of the nation. Policies were put in place at federal, state, and institutional levels that promoted ideas of universal access and equal opportunity in education (Mumper, 2003). As access was broadened to include students from lower income families, the need for remedial education that would make up for substandard primary and secondary schools began to grow, institutions developed and expanded remedial programs to meet that need (McCabe & Day, 1998; Mumper, 2003).

As access was broadened, the student population became increasingly "diverse in every way: more students of color, more English language learners, more first-generation college students, more adult students, and more students from low-income families" (Boswell & Wilson, 2004, p. 8). California has been the model of increased access and diversity – by fall of 1993, with the lowest cost fees in the nation, California Community Colleges (CCC) became a minority majority system with less than 50% of its students being White (Data Mart, 2009). And, with that increased access and economic need for higher education, greater numbers of adults than ever before come under-prepared for college-level work.

It is important to understand, however, that developmental education is not new. In 1750, educators at Yale university recognized the need to develop student skills in areas that were below average in reading, writing, and arithmetic to prepare them for college-level work. Even in the homogeneous group of students attending universities at the end of the 19th century, more than 40% of first time students participated in pre-collegiate programs and in the beginning of the 20th century, it is reported that "over half of the students enrolled in Harvard, Princeton,

Yale, and Columbia did not meet entrance requirements and were placed in remedial courses" (Merisotis & Phipps, 2000, p. 69).

By the end of the 20th century, nearly 30% of entering freshmen and 40% of community college entering students were under-prepared for college-level work. At the same time, policies across the nation began redirecting the under-prepared into community colleges. By 2006, some California community colleges reported as high as 90% of entering students were under-prepared for college-level work. Even more disparaging, however, are the extremely high attrition rates in remedial courses and particularly those in developmental mathematics. Research over the past four years using the CCC database has consistently found that only about 10% of those entering at the pre-algebra level or below ever successfully complete a college-level math course (Bahr, 2007, 2008, 2010). A number of Bahr's studies, however, have provided evidence that students who successfully remediate succeed in college-level courses at rates similar to students who did not require remediation.

In the developmental education and adult learning literature, there are a number of descriptions of what many agree are effective practices but only a few studies documenting that effectiveness. Contextual teaching and learning is one of those practices that have been identified as engaging to students and some emerging research concludes is effective. The recent CCC Basic Skills literature review (CSS, 2005) cites the need for research documenting effectiveness of contextualized instruction. Bahr's work intentionally excludes cross-curricular or contextual basic skills courses because of the difficulty in identifying the courses directly from the CCC system database. Much of the other existing research that does focus on contextual teaching and learning (e.g., Bettinger & Long, 2004; Bloom & Sommo, 2005; Shore, Shore, & Boggs, 2004; etc.) either lacks the specificity required to be replicable or addresses populations or practices that do not inform community colleges generally.

The Study

In each authorization of the Carl D. Perkins Vocational Education Act since 1990, Congress has required the integration of academic and occupational content in vocational programs. Although most colleges across the nation met this integration requirement by requiring general education courses in their vocational associate degrees (National Assessment of Vocational Education [NAVE], 1994), the 1994 NAVE report suggested that cross-curricular courses, that integrated academics within content level courses, were a "longstanding feature of postsecondary institutions" (p. 99). With the work of Grubb and Krouskouskas (1992), Badway and Grubb (1997), and Grubb and Associates (1999) on the types and potential effectiveness of integrated courses, questions of whether these integrated cross-curricular types of courses that were engaging to students had continued or expanded into the basic skills area became relevant.

The problem that this research was concerned with then, given the increasingly vocational nature of students coming to the community colleges (i.e., concerned with how their learning relates to their interests and occupations), was: does occupational contextualization of basic skills mathematics, the linking of occupational content and basic math skill building; a) increase persistence and retention, b) more effectively move students into mainstream credit college-level study than standard basic skills math, c) provide students sufficient skills to succeed in subsequent courses. The final research questions that arose from these concerns focused on both the extent of implementation of contextualization as a basic skills solution and whether they were effective in terms of student retention, persistence, and progress. Additionally, the research question of "were contextualized forms of instruction more or less effective for students in specific population groups?" was critical given the populations we see in community colleges.

With the increasing demand for higher education, along with increasing numbers of students under-prepared for college level work, questions of social justice, equity, and access began to refocus on the question of "access to what". In an effort to better understand how colleges in California were addressing the need for developmental education, and a recognition of that increasing need, California began funding the Basic Skills Initiative in 2006. Over $30 million has been allocated to expanding "effective" developmental education each year through 2008. At the same time, in an effort to standardize educational requirements in community colleges in California, the CCC Board of Governors adopted new regulations increasing the academic rigor requirements for English and math courses in Associate degrees. This Title 5 change had a number of unintended consequences described later.

Methodology

The research uses a mixed method design of both quantitative and qualitative techniques. The study was implemented in two phases: in the first phase, colleges and faculty teaching contextualized courses at the basic skills level were identified through a survey and the second phase used course identifications from the first phase to pull data from the California Community Colleges Chancellor's Office Management Information System (MIS) database.

Surveys were first sent in the fall of 2007 to three administrators at each college by e-mail. Each e-mail included an introductory text that requested the survey be forwarded to the most appropriate person on campus who could identify whether contextualized courses were used or not. Surveys were sent to non-respondents in the following spring and fall semesters. Respondents either indicated that no contextual courses were being offered or, if contextual courses were being offered, respondents included contact information for further follow-up.

Follow-up with the identified contacts included both e-mail and telephone conversations. Courses that appeared appropriate for the study were then identified and course materials were

requested for review. Course materials included course outlines, syllabi, assignments, and assessments. Course materials were used to verify both the contextual design of the course and the level of basic skills math included in the course.

As shown in Table 1, 35 colleges responded to the survey. Twenty-five colleges reported no contextual credit courses and 26 reported no contextual credit math courses. Only one college reported contextualized credit basic skills reading and two colleges reported credit contextualized basic skills writing courses. With nine colleges reporting 13 contextualized credit basic skills math courses and 10 of those courses met a Pre-Algebra level contextualized basic skills review criteria, contextualized math became the focus of the study.

Table 1.

Vocationally contextualized credit basic skills courses reported by area of contextualization in colleges responding to the survey.

	Colleges	Credit Courses	Courses after Curriculum review
Total Responses (N=39)	35		
No credit contextual courses reported	25		
No credit contextual Math courses	26		
Credit contextual courses	10	16	11
Math	9	13	10
Reading	1	1	0
Writing	2	2	1
Learning communities	0	0	0

Note. Noncredit and non-vocational courses are not reported in this table.

Once the courses were identified, the data for those courses and their comparable non-contextualized Pre-Algebra courses could be extracted from the MIS database for each of the responding colleges. The first part of the analysis was to examine the makeup of the three groups: a) students in the contextual math group (N=392), b) students in standard basic skills math at colleges offering contextual math (N=3,657), c) students in standard basic skills math at colleges not offering contextual math (N=13,103).

Students in the contextual group were slightly older than students in the two non-contextual groups. While the median age was only three years older in the contextual group (23 vs. 20), nearly half of the two non-contextual groups (47% and 49% respectively) were under 20 years old while only 20% of the contextual group were. The contextual group was also male dominated while both non-contextual groups were female dominated (29%, 61%, 63%

respectively). This might be expected due to the occupational nature of the contextual courses included in this study. Finally, the contextual group had slightly higher percentages of Asian (+2%) and White (+ 4%) students and slightly lower percentages of Black (-3%) and considerably lower numbers of Hispanic (-9%) students.

Although there were slight differences in age, gender, and ethnicity among the three groups, there was little or no difference in the outcomes between the two standard basic skills math groups. There were significant differences, however, between the contextual group and the standard groups on all outcomes. Because the differences in outcomes were so similar between the two standard groups and so different between the contextual group and the two standard groups, the two standard groups were collapsed for further analysis.

The Sample and Statistics

As was clear from the previous discussion, the sample was very unbalanced with a large standard basic skills math group and a relatively small contextual math group. Additionally, other characteristics of the samples such as unequal variance between groups and the need to use the binary dependent variables drove the selection of the statistic. Logistic regression was selected for a number of reasons including its ability to handle dichotomous dependent variables, unequal variances and unbalanced sample sizes.

The first dependent or outcome variable used in the study was whether or not the student passed the basic skills course. Additional dependent variables were whether students attempted or passed college-level and transfer-level courses in both the same semester as the basic skills course and the subsequent semester. While there is significant interest in whether students in the contextual courses were able to attempt degree-applicable courses in that same semester, attempting courses is not sufficient to determine the success of an instructional method generally. Passing the courses students attempt is the key outcome of interest in this study.

The logistic regression also allowed us to control for variables that have been shown to have differential impact on course completion in mathematics. The control variables that were included were age, gender, ethnicity (four groups), vocational status, and two proxies for socioeconomic status (BOGW and Grant Amount).

The Findings

As demonstrated in the survey results and the numbers of students in each of the groups, it should be clear that contextual courses with integrated basic skills math and occupational content were scarce in the 35 colleges that responded to the survey. Most importantly, courses were found only in one or two areas on the campus and were often offered in only one section of the course. Although a few colleges offered multiple sections, the majority offered single sections with an average of 24 students in each section. Many of the courses were eliminated due to low enrollments in subsequent semesters as students were being counseled into the basic

skills math sequence that lead to math meeting the associate degree requirements and the subsequent transferable course prerequisites.

Table 2 displays the rates of attempting and passing courses during the semester in which the students attempted the basic skills math courses. Without controlling for any demographics and student characteristics, students in the contextual group were much more likely to pass the basic skills math course than students in the standard basic skills math group (nearly 27 percentage points higher or 45% more likely). The students in the contextual group also attempted degree applicable courses at higher rates (99.5% vs. 84.4% - 15 percentage points higher). Although one of the advantages of contextual math courses is that students often enroll in degree applicable courses while in the math course, this data shows that the students in the contextual course are much more likely to pass a college level course than their non-contextual counterparts (92.6% vs. 75.2%). Of course, this is one of the direct benefits of contextual

Table 2.

Rates of passing basic skills math courses and attempting and passing degree-applicable and transferable courses in the initial term for the two sample groups.

	Contextual Pre-Algebra		Standard Pre-Algebra	
Course type	Number	Percent	Number	Percent
Total (N=17,152)	392	100.0%	16,760	100.0%
Basic Skills Math				
Passed [a]	337	86.0%	9,930	59.3%
Degree-applicable				
Attempted [b]	390	99.5%	14,137	84.4%
Passed [a]	361	92.6%	10,636	75.2%
Transfer coursework				
Attempted [b]	228	58.2%	13,274	79.2%
Passed [a]	210	92.1%	9,669	72.8%

Note. Chi-squared tests of independence indicate significant differences ($p < 0.001$) for the likelihood of success between the contextual group and the standard basic skills group.
[a] The percent "Passed" is calculated based on the number attempted for the category.
[b] Students who attempt a transfer course may also have attempted a degree-applicable course.

courses that prepare students for other occupational content courses. Similarly, students in the contextual group were much more likely to pass a transfer course when they attempted it than were their counterparts in the standard group (92.1% vs. 72.8%).

More dramatic results can be seen when controlling for demographics, vocational status, and SES. As shown in Table 3, students were over four times (4.27) as likely, or 327% more likely, to pass the contextual math course as students in the standard math course when controlling for the covariates, compared to 45% more likely in the uncontrolled results shown in Table 2. Students in the contextual group were fifteen times (15.24) as likely to attempt and

Table 3.

Net likelihood of attempting and passing courses comparing the contextual and the standard basic skills groups in the initial term, controlling for demographics, vocational status, and SES (controls not shown).

Outcome/DV	*Odds Ratio*	95% *CI*	
Passed Basic Skills Math	4.27	3.18	5.74
Degree-Applicable			
Attempted[a]	15.24	3.71	62.55
Passed[b]	3.84	2.60	5.66
Transfer Coursework			
Attempted[a]	0.20	0.16	0.26
Passed[b]	4.00	2.48	6.44

Notes. All comparisons on the dependent variable (DV) are based on Contextual vs. Standard where the Standard group is the comparison category.
[a] The "Attempted" estimates are based on the total cohort N = 17,152.
[b] The "Passed" estimates are calculated based on the number attempted for the category: Attempted degree-applicable N = 14,527; Attempted transfer N = 13,502.
All beta coefficients used to calculate the odds ratio were significant ($p < 0.001$).

nearly four times (3.84) as likely to pass a degree-applicable course than their standard math group counterparts. While students in the contextual group were only one-fifth as likely (0.20) as their counterparts to attempt a transfer level course, they were four times (4.00) as likely to pass it. These results clarify that the positive effects of contextualized courses persist, even after controlling for other explanatory variables. Although the control variables are not shown here, females were 23% more likely to pass the basic skills course, even when controlling for participation in the contextual basic skills math course and other covariates. Similarly, students not receiving BOG fee waiver (incomes above 150% of poverty) were 37% more likely to pass the basic skills course and just over 25% more likely to pass degree-applicable and transferable courses in the same semester, even when controlling for participation in the contextual basic

skills math course along with other variables. Ethnic groups also differed significantly even when controlling for participation in the contextual basic skills math course and all other variables in the model.

Concerns over the possible differential effects of contextualized instruction on students in different ethnic groups led to an analysis to determine whether contextual math instruction was more or less effective for the race/ethnic groups in the study. While controlling for other demographic characteristics, vocational status, and SES, contextual instruction is clearly more effective for students in the Black, Hispanic, and Other categories as shown in Table 4. Black students were 263% as likely to pass the contextual basic skills math course as Black students in the standard basic skills math course. Likewise, Hispanic students and students in the "Other"

Table 4.

Net effects of contextualization on passing basic skills math for each of five ethnic groups controlling for age, gender, vocational status, and SES (controls not shown).

Ethnicity	Coefficient Difference	*SE*	*df*	*t*	*Odds Ratio*
Basic Skills Math					
Asian	-0.124***	0.010	6,921	-12.102***	0.88
Black	0.968***	0.051	7,682	18.935***	2.63
Hispanic	0.238***	0.013	12,405	18.139***	1.27
Other	0.286***	0.044	5,846	6.562***	1.33
White	-0.068	0.058	5,437	-1.168	0.94
Degree-Applicable					
Asian	-0.036**	0.011	5,934	-3.209**	0.96
Black	0.861***	0.065	6,620	13.242***	2.36
Hispanic	0.471***	0.020	10,464	24.101***	1.60
Other	0.205***	0.015	5,052	13.642***	1.23
White	0.205**	0.074	4,716	2.770**	1.23

Note. Coefficient differences are the "coefficient for contextual minus the coefficient for non-contextual" within each ethnic group. Original coefficients are calculated using the White non-contextual reference group. Asian includes Asians, Filipinos, and students from Pacific Island nations. Other includes Native American and Other Non-white.
Pseudo-R^2_{max} = 0.0428; The *Pseudo-*R^2_{max} is the *Pseudo-*R^2 adjusted to have a maximum of one.
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

category were 27% and 33%, respectively, more likely to pass a contextual math course than the standard math course. However, there was no significant difference in the likelihood for white students of passing the contextual math course and the standard math course.

While students in the contextualized math course were nearly four times as likely (384%) as their counterparts to pass a degree-applicable course in the same semester (as previously shown in Table 3), the likelihood of success in degree-applicable courses also increased for each ethnic group except Asians when students took a contextual basic skills math course rather than a standard basic skills course. The effects were particularly high for Black and Hispanic students taking a contextualized math course. Black students were nearly 2.4 times as likely (236%) and Hispanic students 1.6 times as likely (160%) to pass a degree-applicable course if they were simultaneously enrolled in the contextual math course rather than the standard math course. In contrast, the likelihood of passing a degree-applicable course was only 23% greater for students in the Other and White categories if they were also enrolled in the contextual math course. These results suggest that providing contextualized basic skills courses generally benefits Black, Latino, and "Other" students more than students in the White and Asian groups. And, those that benefit the most are precisely the groups whose prior educational experiences left them the most under-prepared and whose success needs to be improved the most if they are to succeed in college-level courses (Bahr, 2010).

Progress in subsequent semesters.

Progress toward longer term goals of completing programs throughout a career ladder requires that students not only re-enroll but pass courses in subsequent terms. By examining pass rates in the subsequent term, continued success might signal that student engagement persisted beyond the initial basic skills math course term where students were empowered by their successes. Table 5 shows the rates of attempting and passing courses in the subsequent semester for the students passing the basic skills math course without any control variables.

Students who passed either contextual or standard basic skills math courses in the initial term enrolled in credit courses in the subsequent term at approximately the same rates (81.9% and 85.1% respectively). Students in the contextual group passed degree-applicable courses at slightly higher rates (89.1%) when compared to the 82.2% passing in the standard group. Students in both groups enrolled in degree-applicable courses in the subsequent semester at similar high rates.

Students in the contextual group enrolled in transferable courses at much lower rates, probably due to the often vocational nature of their programs. However, students in the contextual group were 8.5% and 14% more likely to complete degree-applicable and transferable courses respectively.

Table 5.

Rates of attempting and passing courses in the subsequent term for those who passed the basic skills math course in the initial term.

	Contextual		Standard	
Course type	Number	Percent	Number	Percent
Total Returning	337	100.0%	9,930	100.0%
Attempted Credit	276	81.9%	8,448	85.1%
Degree-applicable				
Attempted[a]	276	100.0%	8,212	97.2%
Passed[b]	246	89.1%	6,749	82.2%
Transferable				
Attempted[a]	165	59.8%	7,344	86.9%
Passed[b]	150	90.9%	5,866	79.9%

Note. Students in the "Attempted Credit" category are those who returned the following semester and enrolled in a credit course. Students may enroll in either a credit non-degree-applicable, degree-applicable or transferable course or any combination of course types.

[a] The percent "Attempted" is calculated based on the number for the "Attempted Credit" category. [b] The percent "Passed" is calculated based on the number of attempted for the category.

Controlling for demographics, vocational status, and SES, as shown in Table 6, students who passed math in the contextual group were nearly 1.7 times (167%) as likely to pass a degree-applicable course in their subsequent semester as were students in the standard math course group. Additionally, students in the contextual group were nearly 2.28 times (228%) as likely as the standard math group to pass a transferable course in the subsequent term.

In summary, math courses with rich occupational content provided an environment where students stayed and passed those courses in much higher percentages than those taking standard math courses. Controlling for demographics, vocational status, and SES, students in contextual basic skills math courses were more likely to pass those courses than students in standard basic skills math courses. They were also more likely to attempt and pass degree-applicable, as well as pass transferable, coursework in the same semester as their basic skills math course. Students passing contextual math courses were also more likely than students passing standard basic skills math to pass degree-applicable and transferable courses in the subsequent semester.

Table 6.

Net likelihood of attempting and passing courses in the subsequent term for students who passed the basic skills math course in the initial term controlling for demographics, vocational status, and SES (controls not shown).

Outcome	*OR*	*95% CI*
Attempted Credit	0.86	0.63, 1.17
Degree Applicable		
Attempted[a]	undefined[c]	
Passed[b]	1.67*	1.12, 2.50
Transferable		
Attempted[a]	0.21***	0.16, 0.28
Passed[b]	2.28**	1.32, 3.92

Note. Students in the "Attempted Credit" category returned in the subsequent semester and enrolled in credit courses.
[a] The percent "Attempted" is based on the number for the "Attempted Credit" category. [b] The percent "Passed" is calculated based on the number attempted for the category. [c] Because all of the students in the contextual group attempted a degree applicable course, the cell for "did not attempt" contained no observations and the function was undefined.
* $p < .05$; ** $p < .01$; *** $p < .001$.

Discussion

Bahr (2008) points out that only 13.4% of students entering at the pre-algebra level ever successfully remediate and attempt college-level math. However, students in contextual math courses are much more likely to pass the basic skills math courses and other courses they take in the same semester. More importantly, they enrolled in and passed subsequent courses at higher rates than students in regular basic skills courses, so they were presumably able to learn and apply those skills to other contexts in subsequent courses. Furthermore, while Bahr (2010) points out that Black and Hispanic students begin remedial math in the colleges with much higher math deficits than Whites or Asians, contextualizing basic skills math significantly increased the likelihood of passing basic skills math for Black and Hispanic students and increased the likelihood that they would pass college-level courses in the same semester. With Black and Hispanic student enrollments constituting over 55% of basic skills enrollments in the fall of 2008, increasing opportunities through contextualized basic skills courses for these students is critical.

Given the positive evidence about contextual math in this study, institutional efforts to increase contextual basic skills courses should be supported both politically and financially. Several initiatives in California and the nation have supported efforts to increase contextualized

instruction since 1990. Despite these efforts, very little contextualized basic skills instruction was found in the colleges in 2006-7. Furthermore, most faculty have never experienced any form of integrated CTE, cooperative, or problem-based learning during their educational or teaching careers, and there is currently little professional development available focusing on integrating CTE content and basic skills instruction.

Continued funding for professional development in innovative approaches to teaching and learning as well as institutional support in community colleges are necessary for the development of contextual math courses.

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