PACE

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Effective Basic Skills Instruction:

The Case for Contextualized Developmental Math

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Policy Brief 11-1

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Entering the second decade of the 21st century, California faces unprecedented demographic, economic, political, and social changes. As the state emerges from another recession, jobs that remain and those opening require workers with higher-order skills most often acquired in postsecondary education. Increasing numbers of adults look to community colleges to learn those skills and to find a way out of a cycle of low paying, unstable jobs. Even workers with years of experience see community colleges as a mechanism to keep their jobs by increasing their skill levels and their appeal to employers.

Many if not most of those looking to community colleges are under-prepared for college-level work. To succeed, these students will need remediation in one or more areas. Estimates of incoming college students under-prepared for college-level work in all institutions are often around 30-40 percent, but estimates for community colleges run as high as 90 percent. Under-prepared students include new college students; returning students, both employed and unemployed; and first time college students entering after years of employment. Many of these students may not have even completed high school.

Executive Summary

As the state emerges from another recession, jobs that remain and those opening require workers with higher-order skills most often acquired in postsecondary education. Increasing numbers of adults look to community colleges to learn those skills and to find a way out of a cycle of low paying, unstable jobs. Even workers with years of experience see community colleges as a mechanism to keep their jobs by increasing their skill levels and their appeal to employers.

Recent research on students entering California community colleges found that less than one in ten students who enter at the basic arithmetic or pre-algebra math level successfully complete college-level math. Students entering at the next higher level of math (elementary algebra) are only slightly more likely to succeed in college-level math. Yet, college-level math skills are required for success in nearly all college programs including most occupationally-focused certificate programs. Overall, fewer than 20 percent of remedial math students who do not complete a college-level math course earn a certificate, degree, or transfer to a four-year university within six years.

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Executive Summary (Cont.)

Beginning in 2006, California community colleges, through changes in regulations designed to strengthen the core curriculum for the associate degree, began to eliminate many occupationally-focused and "contextualized" math courses such as "Business Math" and "Technical Math for Airframe Mechanics." These integrated courses often focus on the mathematics required in specific occupations, starting with basic arithmetic or pre-algebra and progressing into intermediate algebra topics, and have significantly higher success rates than traditional math courses. Unfortunately, the pressure for traditional academic courses has eliminated many of these contextualized courses, as they no longer meet the requirements for the associate degree. But the low success rates that are common in remedial math courses in the academic model mean that few students will be able to acquire the occupational skills necessary to complete an advanced occupational course, certificate, or degree.

In this policy brief, Charles Wiseley documents both the scarcity and the effectiveness of contextualized developmental math in the 110 public California Community Colleges (CCC) during the 2006-2007 academic year.

Recent research on students entering California community colleges found that less than one in ten students (9 percent) who enter at the basic arithmetic or pre-algebra math level successfully complete college-level math (Bahr, 2007). Students entering at the next higher level of math (elementary algebra) are only slightly more likely to succeed in college-level math (23 percent). Yet, college-level math skills are required for success in nearly all college programs including most occupationally-focused certificate programs. Overall, fewer than 20 percent of remedial math students who do not complete a college-level math course earn a certificate, degree, or transfer to a four-year university within six years.

A number of potentially effective instructional methods for remediating gaps in foundational skills have been documented over the past few decades (Bailey & Morest, 2006; Boylan & Saxon, 1999; Grubb & Associates, 1999). These include integrated academic and occupational curriculum (with contextualization of basic skills); learning communities using various configurations of cohorts, block scheduling, and team teaching; and paired foundational academic and content courses. There is little research, however, providing evidence of the effectiveness of these innovative approaches.

Thomas Bailey points out that, while for-profit colleges often have tied their academic courses to occupational curricula, community colleges have often followed a traditional academic model (Bailey & Morest, 2006). California community colleges are no exception. Beginning in 2006, California community colleges, through changes in regulations designed to strengthen the core curriculum for the associate degree, began to eliminate many occupationally-focused and "contextualized" math courses such as "Business Math" and "Technical Math for Airframe Mechanics." These integrated courses often focus on the mathematics required in specific occupations, starting with basic arithmetic or pre-algebra and progressing into intermediate algebra topics. Unfortunately, the pressure for traditional academic courses has eliminated many of these contextualized courses, as they no longer meet the requirements for the associate degree. But the low success rates that are common in remedial math courses in the academic model mean that few students will be able to acquire the occupational skills necessary to complete an advanced occupational course, certificate, or degree.

Methodology

This study documents both the scarcity and the effectiveness of contextualized developmental math in the 110 public California Community Colleges (CCC) during the 2006-2007 academic year. To identify contextual courses and examine their effectiveness, a mixed method design using both qualitative and quantitative research was required. With no indicator of contextualization in the course records in the CCC Chancellor's Office MIS database, contextualized courses were identified through an elaborate multi-step process.

Identifying Courses and Students

The study began with an e-mail survey in the fall of 2006 to identify contextualized basic skills courses offered in the CCC. As

TABLE 1. Vocationally contextualized credit basic skills courses, reported by area of contextualization in colleges responding to the survey.

	Colleges	Credit Courses	Courses Selected 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.

shown in Table 1, 39 responses to the surveys came from 35 colleges (34 semester colleges and one quarter system college). To maintain consistency in the comparison, only colleges on the semester system were included in the data analysis. Only ten of the colleges reported contextualized developmental offerings.

Of the ten colleges reporting contextual courses, nine colleges reported contextual math for thirteen credit courses. After reviewing curricula, ten of the thirteen courses were selected for this study, each of which began at the pre-algebra level. Once a course was identified as contextualized through examination of curricular materials, it was flagged as contextual in the CCC MIS data.

As Table 1 clearly shows, a large majority (25 of 35) of the responding colleges reported no contextualized credit basic skills courses. More importantly, only two colleges offered a course with more than one section, and sections averaged less than 25 students. Large colleges reported that enrolling a sufficient number of students in a basic skills math course contextualized for a specific program area was a challenge. More importantly, contextual basic skills courses were most often found in a single program area at these colleges. Only two of the 35 responding colleges offered a contextual math course in more than one program area.

Math was more likely to be contextualized with occupational content than reading or writing. Only three credit courses offered at two colleges were reported with linked occupational and academic content in reading or writing, and only one could provide course materials. A number of noncredit reading and writing courses were reported in the survey but were not included in the study due to comparability problems with credit courses. Even with all of the credit and noncredit contextualized courses that were reported, however, little contextualization was offered in the fall of 2006 relative to the thousands of courses offered in basic skills areas found at the 35 responding colleges.

With so little reading and writing available for analysis, math was selected as the single focus of the study. Developmental math courses at the pre-algebra level in the standard academic model were also identified for comparison purposes at the responding colleges. Those courses were identified using course classifications provided by colleges in the Chancellor's office database. With both the contextual and academic developmental math courses identified, all other courses attempted by the students in those developmental courses were also identified for the same and the subsequent semester. The final sample of 17,152 students were identified as being in one of two groups: students who had enrolled in contextual pre-algebra level math courses and students in conventional pre-algebra courses. The two groups included 392 students in contextual math and 16,760 in standard pre-algebra courses.

The demographics of the two groups were similar. Students enrolled in contextual math courses were slightly older than students in standard courses, with the median ages for the two groups at 23 and 20 respectively. Hispanics dominated both groups, but white students represented 38.5 percent of the contextual group and only 31.5 percent of the standard math group. Over 71 percent of the students in the contextual group were male, while students in the standard math course were predominantly female (61 percent). These differences in demographics may be attributable to the higher rates of CTE program participation by

students in the contextual group, since many contextualized math courses are linked to CTE courses. Over 79 percent of the students in the contextual group were enrolled in a CTE course above the introductory level, while only 17 percent of the standard math group were enrolled in such a course.

The outcomes examined in this study included not only whether students passed the basic skills course, but also whether students enrolled in and passed college-level and transferable coursework during the same or subsequent semesters. The study examined the effectiveness of contextualized basic-skills math instruction for each of the five major ethnic groups included in the study, as well as for all students.

A number of variables describing student characteristics were used as controls, including age, gender, race and ethnicity, vocational status, and two proxies for socioeconomic status (SES): a) the receipt of a Board of Governors Fee Waiver, for students living below 150 percent of the poverty guidelines;[1] and b) the amount of any cash grant the student received, where larger grants signify larger financial need.

Findings

Effectiveness of Contextualized Basic Skills Math: Initial Semester

Students in the contextual group passed their developmental math course at much higher rates (86 percent vs. 59 percent) than students in the control group, as shown in Table 2. The contextual group also attempted and passed degree-applicable courses at much higher rates.

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	337	86.0%	9,930	59.3%
Degree-applicable (includes contextual course)				
Attempted	390	99.5%	14,137	84.4%
Passed	361	92.6%	10,636	75.2%
Degree-applicable (contextual course not included)				
Attempted	264	67.4%	14,137	84.4%
Passed	245	92.8%	10,636	75.2%
Transfer coursework				
Attempted	228	58.2%	13,274	79.2%
Passed	210	92.1%	9,669	72.8%

Notes: 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. Students who attempt a transfer course may also have attempted a degree-applicable course.

In fall 2006, the first semester of the study, most of the contextual math courses in this study were degree-applicable. Because of this, over 99 percent of the students in the contextual math courses had attempted a degree-applicable course at that time, while just over 84 percent of students enrolled in the standard math courses attempted a degree-applicable course while in their basic skills course. More importantly, however, 93 percent of the students in the contextual course passed their degree-applicable course, while only 75 percent of students in the standard math course passed an additional degree-applicable course. When we look at degree-applicable courses other than the contextualized math course, we observe similar differences in pass rates. Nearly 93 percent of students in the contextual group passed a degree-applicable course other than their contextualized math course, while only 75 percent of standard math group students passed a degree-applicable course while enrolled in the basic skills math course.

The proportion of students attempting transferable courses was lower for students in integrated courses (58 percent vs. 79 percent). This could be expected since these students are likely to be in Career Technical Education (CTE) programs and many advanced occupational courses are not transferable. However, 92 percent of the contextual group of students who did attempt a

course transferable to the California State University or University of California systems passed the course. In contrast, only 72.8 percent of the standard math group passed transferable courses that they attempted.

Table 2 displays student outcomes without controlling for variables that may affect outcomes. When controls are introduced in a logistic regression analysis,[2] the results are even more dramatic.

As shown in Table 3, students were over four times (4.27) as likely to pass the contextual math course as students in the standard math course when controlling for the covariates, compared to 45 percent 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 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 make clear that the positive effects of contextualized courses persist, even after controlling for other explanatory variables.

Gender, ethnicity, and SES had significant effects on whether students would pass the basic skills math, degree-applicable, and transferable courses even when controlling for the other covariates, as shown in Table 4. For example, females had a 23 percent greater likelihood (1.23) of successfully

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	Odds Ratio (OR)	95% Confidence Interval (CI)
Passed Basic Skills Math	4.27	3.18 - 5.74
Degree-applicable		
Attempted	15.24	3.71 - 62.55
Passed	3.84	2.60 - 5.66
Transfer Coursework		
Attempted	0.20	0.16 - 0.26
Passed	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. The "Attempted" estimates are based on the total cohort (*N* = 17,152). The "Passed" estimates are calculated based on the number attempted for the category: Attempted degree-applicable *N* = 14,527; Attempted transfer *N* = 13,502.

TABLE 4. Likelihood of passing basic skills math, degree-applicable, and transferable courses comparing the contextual and the standard basic skills groups in the initial term, controlling for demographics, vocational status, and SES.

	Basic Skills Math (N = 17,152)		Degree-applicable (N = 14,527)		Transferable (N = 13,509)	
Parameter	OR	95% CI	OR	95% CI	OR	95% CI
Contextual vs. Standard[a]	4.27	3.18 - 5.74	3.84	2.60 - 5.66	4.00	2.48 - 6.44
Age	1.03	1.00 - 1.05	0.97	0.94 - 1.00	1.00	0.97 - 1.03
Age-squared	1.00	0.99 - 1.00	1.00	1.00 - 1.00	1.00	1.00 - 1.00
Female vs. Male	1.23	1.15 - 1.31	1.09	1.01 - 1.18	1.08	1.00 - 1.17
Ethnicity (vs. White)						
Asian	1.14	1.01 - 1.29	0.91	0.78 - 1.05	0.88	0.76 - 1.02
Black	0.45	0.41 - 0.50	0.56	0.49 - 0.63	0.56	0.49 - 0.63
Hispanic	0.69	0.64 - 0.74	0.76	0.70 - 0.84	0.76	0.69 - 0.83
Other	0.61	0.51 - 0.74	0.91	0.72 - 1.15	0.97	0.77 - 1.23
Vocational						
No vs. Yes	1.06	0.98 - 1.15	0.87	0.78 - 0.96	0.94	0.85 - 1.03
SES						
No Fee Waiver	1.37	1.27 - 1.48	1.26	1.15 - 1.38	1.25	1.14 - 1.37
Grant Amount	1.22	1.17 - 1.27	1.30	1.22 - 1.38	1.25	1.18 - 1.33

Note: *OR* = odds ratio; *CI* = confidence interval.
[a] Contextual Basic Skills Math vs. Standard Pre-Algebra.

completing a basic skills math course than males, but only a small advantage in passing degree-applicable (9 percent) and transferable (8 percent) courses. Students in lower SES groups were less likely to pass their courses. Students who did not receive a fee waiver were 37 percent more likely to pass the math course, 26 percent more likely to pass a degree-applicable course and 25 percent more likely to pass a transferable course than those who received a fee waiver.

The analysis also indicates that the effects of SES can be ameliorated up to a certain point. With increases of grant amounts up to $3,203, there was an increased likelihood of passing a basic skills math course, compared with students who did not receive a grant. As grant amounts increased beyond $3,203, however, the likelihood of passing the math course decreased, suggesting that the beneficial effects of a higher grant are outweighed by the negative effects of very low income.

Vocational status alone (i.e., enrolling in a vocational course above the introductory level) while controlling for other covariates, did not provide any significant advantage or disadvantage in passing basic skills math, degree-applicable or transferable courses. The increased motivation of occupational students to pass the math required for their occupational choice was not sufficient to increase the likelihood of passing any of the courses when controlling for all the other variables.

White students were more than twice as likely as black students and 46 percent more likely than Hispanic students to pass the math course with the other covariates controlled.

Table 5 displays the effects of contextual math within ethnic groups. Black students in contextual courses were more than twice as likely to pass the basic skills math course as black students in the standard math course. Likewise, Hispanic students and students in the "Other" category were 27 percent and 33 percent more likely to pass a contextual math course than the standard math course. There was no significant difference in the likelihood for white students of passing the contextual math course and the standard math course.

Students in the contextualized math course were nearly four times more likely than their counterparts to pass a degree-applicable course in the same semester, as shown in Tables 3 and 4. In addition, the likelihood of success in degree-applicable courses increased for students in each ethnic group, except Asians, when they took a contextual basic skills math course rather than a standard basic skills course. The effects were particularly large for black and Hispanic students taking a contextualized math course. Black students were nearly 2.4 times as likely and Hispanic students 1.6 times as likely to pass a degree-applicable course if they were simultaneously enrolled in the

TABLE 5. 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	t - statistic	Odds Ratio
Basic Skills Math			
Asian	-0.124***	-12.102***	0.88
Black	0.968***	18.935***	2.63
Hispanic	0.238***	18.139***	1.27
Other	0.286***	6.562***	1.33
White	-0.068	-1.168	0.94
Degree-applicable			
Asian	-0.036**	-3.209**	0.96
Black	0.861***	13.242***	2.36
Hispanic	0.471***	24.101***	1.60
Other	0.205***	13.642***	1.23
White	0.205**	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.

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

contextual math course rather than in the standard basic skills math course. In contrast, the likelihood of passing a degree-applicable course was only 23 percent greater for students in the other and white categories if they were also enrolled in a contextual math course.

Effectiveness of Contextualized Basic Skills Math: Progress in Subsequent Semesters

Progress toward program completion requires that students re-enroll and pass courses in subsequent terms. The study therefore examined pass rates in the subsequent term to determine whether student engagement persisted beyond the initial terms in which they took the basic skills math course. Table 6 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 the contextual and standard basic skills math courses in the initial term enrolled in credit courses in the subsequent term at similar rates (81.9 percent and 85.1 percent respectively). A slightly higher proportion of the students in the contextual group (89.1 percent) passed degree-applicable courses than students in the standard group (82.2 percent). Students in the contextual group enrolled in transferable courses at much lower rates than students in the standard group, but students in the contextual group were more likely to complete those courses.

When controlling for demographics, vocational status, and SES, as shown in Table 7, students who passed math

TABLE 6. 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	337	100.0%	9,930	100.0%
Attempted Credit	276	81.9%	8,448	85.1%
Degree-applicable				
Attempted	276	100.0%	8,212	97.2%
Passed	246	89.1%	6,749	82.2%
Transferable				
Attempted	165	59.8%	7,344	86.9%
Passed	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 degree-applicable or transferable course or both course types. The percent "Attempted" is calculated based on the number for the "Attempted Credit" category. The percent "Passed" is calculated based on the number of attempted for the category.

TABLE 7. 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**	χ^2
Attempted Credit	0.86	0.63 - 1.17	0.914
Degree-applicable			
Passed	1.67	1.12 - 2.50	6.317*
Transferable			
Attempted	0.21	0.16 - 0.28	104.711***
Passed	2.28	1.32 - 3.92	8.790**

Note: Students in the "Attempted Credit" category returned in the subsequent semester and enrolled in credit courses. All of the students in the contextual group attempted a degree-applicable course.

* $p < .05$; ** $p < .01$; *** $p < .001$.

in the contextual group were nearly 1.7 times 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 more than twice as likely as students in the standard math group to pass a transferable course in the subsequent term.

For those students returning in the semester after passing their basic skills math course, only black students and students receiving a fee waiver were

significantly less likely to pass a degree-applicable course when controlling for the contextualization of the math course and all other variables. With the other variables controlled, black students were only three-fourths (0.75) as likely to pass the course as white students, and students not receiving a fee waiver were 25 percent more likely to pass (1.25) than students receiving the fee waiver. Similarly, black students were only 73 percent as likely and BOG fee waiver recipients only 79 percent as likely to pass a transferable course when controlling for all other variables.

In summary, math courses with rich occupational content provided an environment where students stayed and passed subsequent 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. Contextual basic skills math participants were also more likely to attempt and pass degree-applicable, as well as 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.

Discussion

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 have supported efforts to increase contextualized instruction. Despite these efforts, very little contextualized basic skills instruction was found in the colleges. 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 that focuses on integrating CTE content and basic skills instruction.

A number of state policies create disincentives to integrate academic and CTE content. Recent Title 5 policy changes[3] designed to increase the skills of associate degree recipients inadvertently reduced the likelihood of integrated math course offerings. The changes required that as of Fall 2009 the AA/AS degree math requirement be increased from elementary algebra to intermediate algebra or higher. Additionally, only intermediate algebra level math courses that had at least a prerequisite of elementary algebra, or the equivalent, could meet the new mathematics requirement. The new regulations focused on the prerequisite required for the AA/AS degree math course rather than the learning outcomes of the course.

While some of the contextual courses in this study have learning outcomes similar to those in intermediate algebra, they often have relaxed requirements for entry that allow enrollments of students with mixed skill levels. Regardless of the effectiveness or learning outcomes of the courses, the courses could no longer meet the new math degree requirement because they did not have an elementary algebra prerequisite. Without the ability to meet the requirement, students were, and continue to be, counseled away from the contextualized courses, effectively reducing the number of contextualized offerings. Policies about degree applicability should be determined by learning outcomes, rather than by incoming student skill levels that ignore the accelerated yet deep learning produced by the integrated engaging active learning pedagogies of contextual instruction.

Policies on course transferability also inhibit contextualization. An academic math course such as "Introduction to Contemporary Math," which has intermediate algebra as a prerequisite and is designed for the liberal arts major, is transferable to the California State University (CSU) system, but a math course that covers math topics supporting job skills such as "Mathematics for Wastewater Management" is not transferable because the main focus of the course is considered job skills, even though the course includes some more advanced math topics. When CCCs identify a course as advanced occupational, because it includes specific job skills, they put at risk the transferability of the course. Current transfer practice also does not allow a transferable community college course to have an applied course as a prerequisite. Current CSU IGETC policy states that transferable courses meeting the "mathematical concepts

and quantitative reasoning" area criteria (IGETC 2A) "must have an explicit prerequisite of Intermediate Algebra." Community college faculty, then, are concerned about allowing applied prerequisites for transferable courses. Given evidence of the ability of students in contextual courses to transfer skills from one content area to another, policy should be implemented that allows contextual and applied courses as prerequisites, providing better incentives to offer contextual courses.

Given the current crisis in basic skills and its negative impact on college completion, increasing the availability of contextual math and English courses would make the most efficient use of the resources for basic skills while also enhancing courses that meet degree requirements. Rather than eliminating funds for instructional improvement, or the Basic Skills Initiative, policymakers and college decision-makers might target resources in the Basic Skills Initiative to strengthen basic skills through the expansion of contextualized instruction.

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Endnotes

1 The poverty guidelines are based upon those set by the US Department of Health and Human Services.

2 In studies where the outcomes are dichotomous, such as "passed a course" or "did not pass," a logistic regression is particularly useful. Most important, a logistic regression produces a statistic known as the "odds ratio," which allows us to estimate how much more or less likely students in one group are to pass a course, compared to students in another group.

3 CCR, Title 5, Div. 6, Chapter 6, Article 6, § 55063.

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