Chemistry 400 Placement Assessment California Chemistry Diagnostic Exam (CCDE) Validation, 2017-2018 Study

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Introduction

The California Community College Chancellor's Office (CCCCO) governs matriculation and course placement assessment in California community colleges (CCC) through Title 5 and a set of standards published in the 1990 report (CCCCO 2001). The report requires local colleges to ensure they meet the standards for matriculation and course placement assessment. For test instruments developed by a second party external to the CCC, test publishers are responsible for evaluating the instruments' reliability, validity, and bias while local colleges adopting the instruments are charged with evaluating the uses of the instruments. Specifically, at a minimum, the college is responsible for evaluating the predictive validity of a placement system or set of instruments, the cut scores used for placement, differential impact on various demographic groups, and accommodations for individuals who cannot take tests under standard conditions.

At Sacramento City College (SCC), the course Chemistry 400: General Chemistry I (CHEM 400) requires students to demonstrate prerequisite skill level of CHEM 300 and MATH 120/124 (intermediate algebra). Students meet the prerequisites for the course either by successfully completing the prerequisite courses or through the assessment placement process. The assessment placement process was implemented in Fall 2009 and combines the externally published American Chemical Society (ACS) California Chemistry Diagnostic Exam (CCDE), ACCUPLACER College Level Math (CLM) component, and other "multiple measures" predictive of student success. The College had submitted the CHEM 400 placement assessment—California Chemistry Diagnostic Exam validation study to the CCCCO and received full approval status in 2012. This validation study is conducted to update evidence for renewal of the use of the CCDE test instrument.

The chemistry exam was developed by California university faculty, is widely used for chemistry placement across the University of California (UC), California State University (CSU),

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and CCC systems, and fulfills prerequisite skills that are required by the UC and CSU systems for transfer articulation. SCC chemistry faculty chose an initial cut-score of 20, which is close to the exam's nationally-normed 1997 mean of 20.45 and is at the 51st percentile, nationally (ACS, 1997). We take established approaches to conducting validation research to meet standards and explore whether the system is adequately and accurately placing students in CHEM 400. All methods follow or are based on research designs in "Assessment Validation Project Local Research Options" (1991). Research Designs 10, 11, 12, 14, and 15 address eventual outcomes for students placed by the process.

Content review

The Chemistry Department assembled a panel of four faculty members to conduct the content review for the Chemistry 400 Placement Assessment with the CCDE as one of the multiple measures. Research Design 14 was applied in the content review to answer the question: How relevant are the CCDE test items to the prerequisite skills necessary for success in the CHEM 400 course? Each member of the faculty panel evaluated the relevance of the test items to the CHEM 400 prerequisite skills on a 1-5 scale, with 1 being "not relevant" and 5 being "critical." About 95% of the questions on the assessment test were rated with a "3 – moderately important" or higher ("important" or "critical"), providing evidence that the content of the CCDE test is valid for using as an assessment instrument for CHEM 400 placement. In other words, most of the items on the test are found to be relevant to the prerequisite skills necessary for success in the CHEM 400 course.[2] Appendix A includes details of the content review.

Consequential validation

As the placement instrument has been implemented since 2009 and was approved in 2012, it is necessary to collect evidence to validate its effectiveness. Research Design 15 was employed to obtain students' and faculty's perceptions on students' level of preparedness for the CHEM 400 course. Student and faculty surveys were administered approximately mid-semester in Spring 2017 for all three CHEM 400 sessions. Of the 137 students surveyed in the three sessions, 45 students took the assessment placement test. Table 1 summarizes the survey results. The range for students' levels of preparedness is from 1 to 3, with 1 being underprepared, 2 adequately prepared, and 3 over-prepared. Table *1* suggests that, on average, students are less confident about their preparation levels than are faculty (preparedness mean = 1.778 and 1.956 respectively). However, by levels of preparedness, 73 percent of the students thought that they were adequately prepared while only 56 percent of the students were rated as being adequately prepared by faculty. Note that such a

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[2] A note on test bias: A review for test bias is deemed unnecessary and thus not conducted for the following reasons. The CCDE is on the list of instruments approved for statewide use in California. The test has remained unchanged and is being administered to students in its original form. The Chemistry Department has not altered the copyrighted materials purchased from the American Chemical Society in any way. Although the test administration and cut-scores are locally-managed, the test instrument was not locally-developed.

difference in the "adequately prepared" percentages comes from the higher number of students being rated as "over-prepared" by faculty.

Table 1. Overall Survey Results

Mean estimation	N = 45			
Range is 1=under-prepared to 3=over-prepared				
Item:	**Mean**	**Std. Err.**	**[95% Conf. Interval]**	
How well-prepared are you?	1.778	0.070	1.636	1.919
How well-prepared is this student?	1.956	0.100	1.753	2.158
Level of work in the class	1.822	0.058	1.706	1.938

Item 2 and Faculty Rating				
How well-prepared is this student for the work in this class?	**Student Perception**		**Faculty Rating**	
	Number	**Percent**	**Number**	**Percent**
Under-prepared	11	24.444	11	24.444
Adequately-prepared	33	73.333	25	55.556
Over-prepared	1	2.222	9	20.000
Total	**45**	**100**	**45**	**100**

Item 3		
	Student Perception	
Describe the level of work in this class:	**Number**	**Percent**
Too hard	8	17.778
Just right	37	82.222
Too easy	-	-
Total	**45**	**100**

The 75% threshold for "adequately prepared" set in Research Design 15 is not met. When there are different course levels into which students can assess through an assessment test instrument, it would be inappropriate to combine responses for "adequately prepared" and "over-prepared" to define "appropriate placement". However, in the case of CHEM 400, it would be appropriate to do so as CHEM 400 is the only and the highest course that students can assess into through the CCDE exam. The 75% threshold is met for this course when "adequately prepared" and "over-prepared" levels are combined. Indeed, over 82 percent of the students think that the level of work in the class was "just right" for them.

Predictive validity

This validation study employed a dataset compiled from two main sources. Chemistry 400 student demographics and official course grades from Fall 2014 to Spring 2017 are retrieved from the end-of-semester profile and transcript data-files in the Los Rios Community College District (LRCCD) *PeopleSoft* database. Assessment placement data (CCDE scores) are provided by the SCC Assessment Center. Also included in the dataset is Math assessment levels, retrieved from the SCC Assessment Center. Math assessment levels are the Math level that a student had assessed into prior to enrollment into CHEM 400.[3]

There were a total number of 1,429 students who enrolled in CHEM 400 between Fall 2014 and Spring 2017. About one third of the students (475) took the CCDE assessment to meet the CHEM prerequisite requirement and thus are included in the sample for analysis. Note that not all of the 475 students who took the CCDE passed the test. There were 43 students (9%) who scored lower than the cut-score of 20 but enrolled in CHEM 400 by successfully completing the CHEM prerequisite course. These students are included in the CCDE student sample and thus the CCDE mean scores might have been underestimated. In the analysis, raw CCDE scores were used. Course official grades (letter grades) were converted into numeric grades ranging from 4 for A to 1 for D and 0 for F, I, and W (Note that in the CCDE sample there is no I grades). A dummy variable is created for Course Success, of which 1 = Success and 0 = No Success.[4] A dummy variable is also created for passing the CCDE exam, with 1 = "CCDE score equal 20 or above" and 0 = "CCDE score lower than 20".

For the criterion measures, the following measures are used. Table 2 presents summary statistics for the overall CHEM 400 and the CCDE tested samples.

(1) Success: Course official grades are coded into a new dummy variable for Success, in which 1 = Success (Grades A, B, and C), and 0 = Nonsuccess (Grades D, F, W, and I)[5]

(2) NumGrade: Course official grades are converted into numeric grades ranging from "4" for A to "0" for F.
2a. Grades W are assigned a value of "0" (treated as F grades)
2b. Grades W are removed from the sample

(3) Withdrawal: Course official grades are coded into a new dummy variable for Withdrawal, in which grade W = 1 and A-F = 0.

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[3] Math assessment level is a categorical variable—We coded students' math assessment levels from 1 to 4, of which 1 is the lowest and 4 is the highest. Of the CHEM 400 students who had taken the CCDE test, 338 students met the Math prerequisite by taking the Math assessment test (71.158%) while the rest did so after successful completion of intermediate algebra courses.

[4] To be counted as "Success" in the course, students have to have achieved a grade of A, B, or C. Those with D, F, or W are counted as "No success".

[5] Success is defined according to the RP Group's operational definition (2011). Accordingly, success rate is calculated with the numerator being total enrollment with a grade of A, B, C, P and the denominator being total enrollment with a grade of A, B, C, D, F, NP, I and W.

Table 2. Summary Statistics for Overall CHEM 400 and the CCDE Tested Samples

	All CHEM 400		CCDE taken	
	N	**%**	**N**	**%**
Enrollment	1,429	100	475	33.240
Success	915	64.031	337	70.947
Withdrawal	245	17.145	58	12.211
NumGrade	**Mean**	**SD**	**Mean**	**SD**
W included	2.015	1.475	2.326	1.435
W excluded	2.432	1.270	2.640	1.220
CCDE score			**Mean**	**SD**
W included	n/a	n/a	25.821	5.718
W excluded	n/a	n/a	25.950	5.888

Relationship of test scores to student performance

Table 3 summarizes the correlation coefficients between CCDE test scores and the three criterion measures above, i.e. Success, NumGrades, and Withdrawal.

Table 3. Correlation Coefficients between CCDE Test Scores and the Three Criterion Measures

Measure	N	Pearson Correlation	Sig. (2-tailed)
(1) Success	475	.249	.000
(2) NumGrade			
2a. W included	475	.347	.000
2b. W excluded	417	.403	.000
(3) Withdrawal	475	-.61	.181

For the first measure, the correlation between CCDE scores and course success is positive at .249 and is highly significantly ($p < .001$). For the second measure, CCDE scores and course grades are also positively correlated with high level of significance ($p < .001$). With W grades included in the sample, the correlation between CCDE scores and course grades almost meet the .350 target suggested in Research Design 10 ($r = .347$, $p < .001$). When W grades are excluded from the sample, the correlation is stronger and also highly significant ($r = .403$, $p < .001$). These results offers positive evidence establishing minimal predictive validity.

The results from the second measure also suggests that the W grades are not adding to the predictive power as the correlation coefficient is lower when W grades are included. Indeed, when examining the third measure, the correlation between CCDE scores and W grades is not statistically significant ($p > 0.05$). Although the inverse correlation ($r = -.61$) indicates some of the withdrawals might have included poor performing students, the correlation is not significant and thus the results from the second measure stand—the W grades appear to not adding predictive power. Therefore, the W grades are dropped in the regression analysis below.

We used linear regression to examine how much CCDE scores would be expected to contribute to predicting students' course grade. Figure 1 below illustrates the relationship between CCDE scores (x-axis) and course numeric grades (y-axis). Note that the scatter plot shows some students having CCDE scores below 20 as the sample included students who did not pass the CCDE exam (scoring lower than the cut-score of 20) but satisfied the CHEM course prerequisite by completing CHEM 300. The red regression trend line is fitted with a 95% confidence interval (area between dashed lines). As evident from trend line, there is a highly significant, positive relationship between CCDE scores and course numeric grades ($p < .001$). With each additional correct item scored on the CCDE, students would be expected to earn about .08 point higher in their course grade. CCDE scores would be expected to explain over 16% of the variation in course numeric grades (R squared = 0.162).[6] The 95% confidence interval indicates the predictive power of CCDE scores is strongest approximately between 20 and 30 correct items.[7]

Figure 1. Relationship between CCDE Scores and NumGrades

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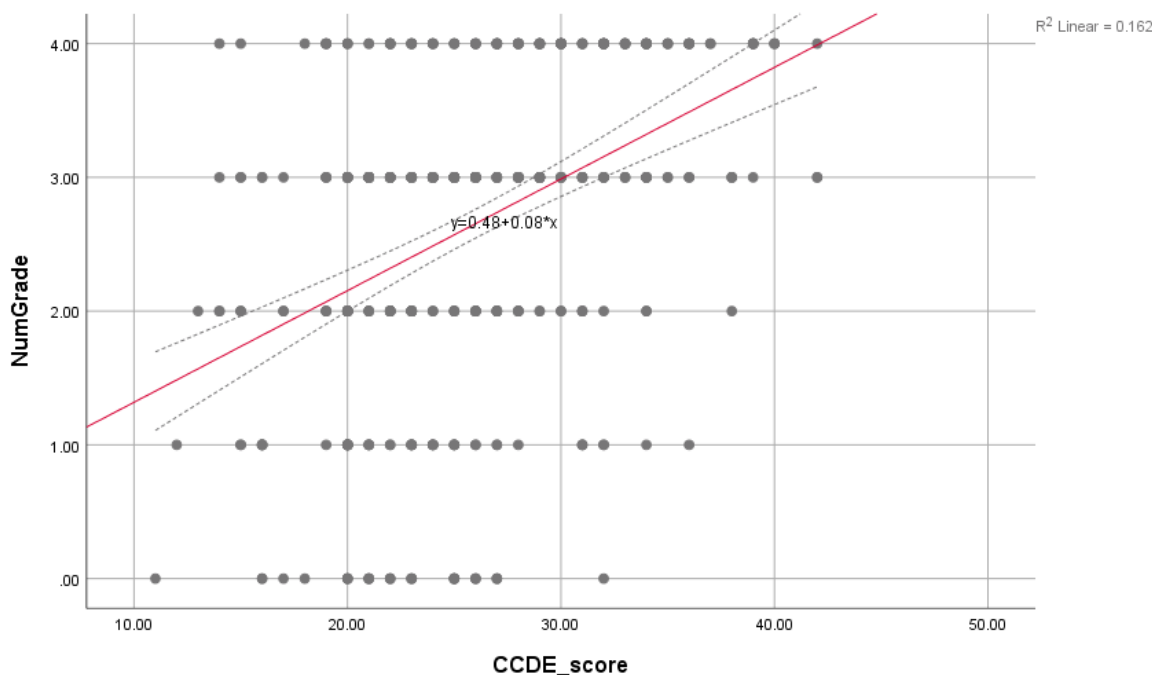
[6] In a separate analysis, we ran the same linear regression with the W grades included, which yielded comparable results (coefficient estimate = 0.087, $p < .001$) However, the R squared value is smaller (.012). This reinforces the previous analysis that the W grades are not adding to the predictive power and thus it would be appropriate to exclude them from the analysis.

[7] When we added Math level to the model, R squared improved by .071 (R squared = .233). We also ran a separate model using Math level as the predictor. With an additional higher Math level, students' numeric grades are expected to increase by .955 point (R squared = .167).

Distribution of grades and success

Table 4 shows CCDE mean scores by official course grade. Analysis of Variance (ANOVA) test result suggests that at least one CCDE mean score at a course grade level is significantly different than other levels' (F = 22.730, p = .000). Independent-samples t-test also indicates that CCDE mean score of the successful group is significantly higher than that of unsuccessful group (26.730 and 23.600 relatively, t = -6.101, p = .000).

Table 4. CCDE Mean Scores by Official Course Grade

Success	Row Labels	Count of EMPLID	Average CCDE_score by Grade	Average CCDE score by Success
Yes	A	120	29.292	26.730
	B	142	26.155	
	C	75	23.720	
No	D	49	22.878	23.600
	F	31	22.355	
	W	58	24.879	
Grand Total		**475**	**25.821**	

We went further to examine success rates by semester, from Fall 2014 to Summer 2017. Table 5 presents success rates by semester of the three groups—(1) all students in the sample, (2) non-CCDE-tested students, and (3) CCDE-tested students. The last two columns show the significance levels of the two t-tests employed: t-test 1 examines whether success rates of CCDE-tested students are significantly different than all students', and t-test 2 examines whether success rates of CCDE-tested students are significantly different than non-CCDE-tested students'. The last row shows the significance levels of the one-way ANOVA tests examining the variation of success rates by semesters in each of the three samples.

The two t-test results show success rates of CCDE-tested students are significantly higher than that of all students' and non-CCDE-tested students' in 7 out of 10 semesters while being significantly lower in Spring 2016 and Summer 2016. However, as evident from the ANOVA results, the variation in success rates by semester of CCDE-tested students is not statistically significant—the differences observed might have been by chance. In the overall sample and the non-CCDE-tested student sample, success rates vary significantly by semester. Although the results suggest that CCDE-tested students seem to be more likely to success, it is not an indictment of meeting the prerequisites by means other than the CCDE—the likelihood for success and the variation in success rates by semesters in the overall sample and non-CCDE-tested student sample might have inherently been influenced by the greater variation in how these students met the prerequisites.

Table 5. Success Rates by Semester

Term	(1) ALL students	(2) Non-CCDE students	(3) CCDE students	t-test 1 sig.(2-tailed)	t-test 2 sig.(2-tailed)
Fall 2014	55.556	50.327	73.333	.000	.000
Spring 2015	59.627	54.630	69.811	.000	.000
Summer 2015	71.264	68.519	75.758	.000	.000
Fall 2015	60.515	54.305	71.951	.000	.000
Spring 2016	68.421	70.085	64.815	.000	.000
Summer 2016	77.108	80.435	72.973	.000	.000
Fall 2016	67.078	63.975	73.171	.000	.000
Spring 2017	63.636	60.684	70.833	.000	.000
Summer 2017	64.773	63.830	65.854	.000	.000
Total	**64.031**	**60.587**	**70.947**	**.000**	**.000**
ANOVA Sig. (2-tailed)	**.013**	**.001**	**.970**		

Placement rule validation

The predictive validity above provided empirical evidence for the predictive power of the CCDE test, with a statistically significant correlation between the CCDE test scores and official course grades. This section continue to examine the accuracy of the placement rule using the cut score of 20 on the CCDE test. The cut score of 20 was set at the nationally-normed CCDE score mean of 1997, which was previously validated and approved in the 2009-2011 study on Chemistry 400 Placement Assessment Validation by the College. This placement rule validation follows the methods used in the 2009-2011 validation (Danenberg, 2012), adapting Options for Colleges with Assessment Systems in Use from Research Design 11 (page 11.6) in examining the effects of higher cut scores and by examining a subset of 45 CHEM 400 students who had previously not passed the CCDE placement but later successfully completed CHEM 300 (or equivalent) prior to enrolling in CHEM 400.

Table 6 presents the mean course grades and success rates of students at the three lowest CCDE passing scores. A majority of students at each of the lowest CCDE passing scores completed CHEM 400 successfully. Although the number of students in each of the score samples are relatively small, examining the mean course grades and success rates at each of these scores suggests that raising the cut score would result in the exclusion of a substantial proportion of students who could otherwise succeed in CHEM 400. It is evident that students who score at least 20 on the CCDE are more likely to succeed than not.

Table 6. Descriptive Statistics for Students with Lowest Passing Scores on CCDE

CCDE Score	Number of students	Mean NumGrade	% Successful
20	40	1.600	52.500%
21	30	1.867	60.000%
22	33	2.091	69.697%

We went further to examine a subset of students who had scored below the CCDE cut score and, as a result, had enrolled and successfully completed CHEM 300 (or equivalent) to satisfy CHEM 400's prerequisite requirement prior to enrolling in the course. There are a total number of 43 students in this subset. Although some of these students were successful in CHEM 400 (26 students, 60.5%), it should be noted that these students successfully completed CHEM 300 or equivalent prior to CHEM 400. Therefore, they are not representative of all students who scored below the cut score and it is not an indication for recommending a lower cut score. Rather, it appears to indicate that CHEM 300 might be an appropriate placement/"intervention" for those who scored below 20 on the CCDE.[8]

We also estimated the mean course grades and success rates had cut scores been raised to 21, 22, and 23 (Table 7). The predicted values for a passing score of 21 are not significantly different from the overall mean course grade of 2.326 and the overall course success of 70.947% ($p > .05$) while the predicted values for passing scores of 22 and 23 are significantly different. Mean course grade would only improve by about .163 – .204 point and success rates would improve by about 4.191 – 4.737%.

Table 7. Simulated Outcomes with Raised Cut Score

New cut score	Number of students	Mean NumGrade	Success rate
21	392	2.441	73.980
22	362	2.489	75.138
23	329	2.530	75.684

However, note that the likelihood for success of students who scored 20 already exceed the likelihood for nonsuccess, as shown in Table 6. While it might be good to see improvement on students' mean course grades and success rates with higher cut scores, raising the cut score would result in excluding a substantial proportion of students who score 20 on the CCDE and who have a higher likelihood for success than not. Based on Research Design 11, we calculated the placement classification table to examine the relationships between admission status (based on raised cut scores) and actual student course success. As evidenced in Table 8, raising the cut score to 21, 22, and 23 would decrease the net gain in correct placement by 2.316%, 3.579%, and 6.316% respectively.

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[8] Note that appeal and challenge processes are in place for students who believe CHEM 400 is the appropriate level for them despite not meeting the CCDE cut score.

Table 8. Percentage of Students by CHEM 400 Success and Placement Rule
with Raised Cut Scores

| Course Outcome | Placement Recommendation by Raised Cut Scores | | | | | |
| | Cut score of 21 | | Cut score of 22 | | Cut score of 23 | |
	Not eligible	Eligible	Not eligible	Eligible	Not eligible	Eligible
Successful	9.895%	61.053%	13.684%	57.263%	18.526%	52.421%
Not Successful	7.579%	21.474%	10.105%	18.947%	12.211%	16.842%
Correct Prediction	*68.632%*		*67.368%*		*64.632%*	
Base Rate of Success	*70.947%*		*70.947%*		*70.947%*	
Net Gain in Correct Placement	*-2.316%*		*-3.579%*		*-6.316%*	
Selection Ratio	*82.526%*		*76.211%*		*69.263%*	

The results from these analyses offer empirical evidence supporting the appropriateness of the current cut score/placement rule. The likelihood for success in CHEM 400 of students with the lowest CCDE passing score is higher than the likelihood for nonsuccess. On the one hand, raising the cut score would exclude a substantial proportion of students who would otherwise be able to successfully complete the course while not overwhelmingly improving mean course grades or boosting course success rates. Furthermore, raising the cut score would not only decrease the correct placement rate (i.e. correct prediction) but also decrease the net gain in correct placement. On the other hand, examining students who had scored lower than the current CCDE cut score and subsequently enrolled in CHEM 300 to fulfill CHEM 400 prerequisite indicates that CHEM 300 appears to be appropriate placement/intervention for these students.

Disproportionate impact on special populations

It is the College's responsibility to monitor the placement assessment process for disproportionate impact on student subpopulations and to develop and implement plans to address any disproportionate impact found (Minimum Standard II.2.a). This section of the validation study employs Research Design 12 to answer the question: Do CHEM 400 placements differ significantly for students of specific gender, age, or race/ethnic groups?

Table 9 to Table 12 present CHEM 400 placement proportionality by students' race/ethnicity, gender, and age among the overall samples and among students whose CCDE scores are in the lowest eligible range (20-22). The last column in each table indicates whether there is a proportionate or disproportionate placement of students. The tables show frequency and percentage by the demographic characteristics of interest of (1) all students who took the CCDE from Fall 2014 to Spring 2017, and (2) students who passed the CCDE and completed CHEM 400 in the same period. The last column of each table shows the differences in proportionality of the two student samples—negative numbers indicate the demographic groups' under-representation and positive numbers indicate over-representation in CHEM 400 eligibility. Being farther from zero indicates higher disproportionate placement. T-tests were applied to examine whether these

differences are statistically significant at p < .05. Statistical significance found is shown in **_bold italic_** in the tables.

In the overall samples, the differences in proportionality by Race/Ethnicity and by Age Group between all students tested and students assessed into CHEM 400 are within a less than +/- 2 percent range (Table 9 and Table 10). In terms of gender, the differences range between -.253 and 3.072 (Table 10). However, none of these differences is statistically significant (p > .05).

Table 9. CHEM 400 Placement Proportionality by Race/Ethnicity

	(1) All students tested		(2) Students assessed into CHEM 400		Over/Under-represented
Race/Ethnicity	**Frequency**	**Percent**	**Frequency**	**Percent**	**Difference**
African American	23	3.358	10	2.315	-1.043
Asian	232	33.869	152	35.185	1.316
Filipino	26	3.796	14	3.241	-0.555
Hispanic/Latino	138	20.146	88	20.370	0.224
Multi-Race	42	6.131	27	6.250	0.119
Native American	1	0.146	1	0.231	0.085
Other Non-White	5	0.730	4	0.926	0.196
Pacific Islander	5	0.730	3	0.694	-0.036
Unknown	12	1.752	7	1.620	-0.132
White	201	29.343	126	29.167	-0.176
Total	**685**	**100**	**432**	**100**	

Table 10. CHEM 400 Placement Proportionality by Gender and Age Group

	All students tested		Students assessed into CHEM 400		Over/Under-represented
Gender	**Frequency**	**Percent**	**Frequency**	**Percent**	**Difference**
Female	319	46.569	189	43.750	-2.819
Male	350	51.095	234	54.167	3.072
Unknown	16	2.336	9	2.083	-0.253
Total	685	100	432	100	
Age Group	**Frequency**	**Percent**	**Frequency**	**Percent**	**Difference**
Under 18	13	1.898	8	1.852	-0.046
18-20	335	48.905	220	50.926	2.021
21-24	208	30.365	144	33.333	2.968
25-29	72	10.511	37	8.565	-1.946
30-39	43	6.277	20	4.630	-1.647
40+	14	2.044	3	0.694	-1.350
Total	**685**	**100**	**432**	**100**	

Among students who received the lowest eligible scores on the CCDE (20-22) (Table 11 and Table 12), the differences in proportionality between those who assessed into CHEM 400 and all students who took the test seem larger than in the overall samples, ranging from -4.163 to

6.781% by race/ethnicity, about -/+3% by gender, and from about -2% to 9% by age group. Note that when examining the lowest eligible score sample, the goal is to identify any special populations that are over-represented (i.e. the difference in proportionality being positive and statistically significant). Under-representation (i.e. the difference being negative and statistically significant) is not of concern. No special population was found to be significantly over-represented in the lowest eligible score range. Although Filipino, Other Non-White students, and students in the 21-25 age group are significantly under-represented in the lowest eligible score sample, it is not necessarily an indicator of disproportionate impacts.

Table 11. CHEM 400 Placement Proportionality in lowest CCDE scores by Race/Ethnicity

	All eligible students with lowest scores (20-22)		CHEM 400 enrolled students with lowest scores (20-22)		Over/Under-represented
Race/Ethnicity	Frequency	Percent	Frequency	Percent	Difference
African American	7	5.303	6	5.825	0.522
Asian	50	37.879	46	44.660	6.781
Filipino	6	4.545	3	2.913	*-1.632*
Hispanic/Latino	30	22.727	19	18.447	-4.280
Multi-Race	7	5.303	7	6.796	1.493
Native American	3	2.273	0	0	-2.273
Other Non-White	7	5.303	2	1.942	*-3.361*
Pacific Islander	0	0	0	0	-
Unknown	3	2.273	4	3.883	1.610
White	26	19.697	16	15.534	-4.163
Total	**132**	**100.0**	**103**	**100**	

Note: Bold italics indicate statistical significance at p < .05

Table 12. CHEM 400 Placement Proportionality in lowest CCDE scores by Gender and Age Group

	All eligible students with lowest scores (20-22)		CHEM 400 enrolled students with lowest scores (20-22)		Over/Under-represented
Gender	Frequency	Percent	Frequency	Percent	Difference
Female	65	49.242	54	52.427	3.185
Male	64	48.485	46	44.660	-3.825
Unknown	3	2.273	3	2.913	0.64
Total	132	100.0	103	100	
Age Group	**Frequency**	**Percent**	**Frequency**	**Percent**	**Difference**
Under 18	2	1.515	2	1.942	0.427
18-20	59	44.697	44	42.718	-1.979
21-24	46	34.848	45	43.689	8.841
25-29	13	9.848	5	4.854	*-4.994*
30-39	9	6.818	5	4.854	-1.964
40+	3	2.273	2	1.942	-0.331
Total	**132**	**100.0**	**103**	**100**	

Note: Bold italics indicate statistical significance at p < .05

The analysis shows no evidence that the assessment process or the CCDE is causing any disproportionate impacts on certain populations. However, it should be noted that, compared to SCC overall student population of which about 10% are African American and 32% Hispanic/Latino, African American and Hispanic/Latino students seem to be under-represented in CHEM 400 (about 6% and 18% respectively). It is suggested that the Chemistry Department create and implement steps to mitigate possible impacts, such as working with student supports/services programs to proactively reach out to underrepresented enrollment populations. The Department is also encouraged to continue to provide additional instructional support for student groups being disproportionate in the lowest score range. Last but not least, the College will continue to conduct future validation studies in order to closely monitor the placement assessment process.

Discussion and conclusion

The content review indicates that the contents of the items on CCDE are relevant to the prerequisite skills required for success in CHEM 400. The results in the validation study also provides evidence that the CHEM 400 placement assessment using the CCDE as one of the multiple measures meet the minimum standards for predictive validity. There is empirical evidence that CCDE score is a relatively good predictor of CHEM 400 course outcomes. The consequential validation study and placement rule validation do not support raising the cut-score of the 1997 nationally normed mean of 20 although the nationally normed mean has increased to 23 in 2006.[9]

There is no evidence that the placement process is causing disproportionate impacts on special student populations. However, when compared with the college overall student populations, it appears that African American students and Hispanic/Latino students are underrepresented in CHEM 400 placement. It is suggested that the Chemistry Department create and implement steps to mitigate possible impacts, such as providing additional instructional supports and working with student supports/services programs to proactively reach out to underrepresented enrollment populations. The College will continue to conduct future validation studies in order to closely monitor the placement assessment process.

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[9] The 2006 nationally normed mean is 23, compared to the 1997's mean of 20. http://uwm.edu/acs-exams/wp-content/uploads/sites/351/2016/10/2006-California-Diagnostic-Exam.pdf

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APPENDIX A

March 13, 2018
Content Validity Study for the SCC Chemistry Placement Test

Design 14: what follows is either a paraphrase or copy of the contents of Design 14
Faculty: Bill Miller, Binh Dao, Joel Hwang, Ling Huang

I. Suggested Prerequisite Skills (as taken from Chemistry 400 Curriculum):
The following CHEM 300 prerequisite skills are needed in order to be successful in the course:
- acquire basic science study skills in learning chemistry concepts.
- demonstrate basic understanding of matter, energy, atomic theory and structure, chemical composition, chemical reactions, chemical bonding, stoichiometry, intermolecular forces, and solutions.
- perform basic chemical laboratory procedures using common laboratory equipment and to analyze the data collected.
- apply knowledge of quantitative chemical methods to chemical calculations, including application of the mole concept to stoichiometry and the use of dimensional analysis.
- name selected elements, ions, common ionic compounds, and binary covalent compounds, given their chemical formulae, and develop chemical formulas from chemical names.
- solve basic chemical word problems.

II. Review of each item. Each faculty member must review each item on the assessment instrument and record his/her judgements "regarding the relevance of the question to the prerequisite skills necessary for success in the course". A template is below:

For each of the questions on the placement exam, answer the following question: "How important is the academic knowledge or skill measured by this item for successful acquisition of the skills taught in this course?
       5 – critical
       4 – important
       3 – moderately important
       2 – of slight importance
       1 – not relevant"

The ratings below are the average of all four faculty members ratings.

Question	Rating	Question	Rating	Question	Rating
1	5	16	5	31	3.5
2	5	17	5	32	3.5
3	5	18	5	33	3.25
4	4.75	19	5	34	4.75

Question	Rating	Question	Rating	Question	Rating
5	4.75	20	4.25	35	5
6	2.25	21	5	36	4.25
7	4.25	22	4.5	37	4.5
8	4.75	23	4.5	38	2.5
9	5	24	5	39	4.75
10	4.75	25	4.5	40	4.25
11	4.25	26	5	41	4.75
12	5	27	5	42	4.5
13	5	28	4.75	43	4.75
14	4.75	29	3.25	44	4.25
15	5	30	5		

III. Analysis of Review. Upon completion of the review of the assessment instrument, the reviewing faculty meet to evaluate the following:

1. "what mean rating of the judges is required to consider the item as relevant to the course"? A suggested average rating is ≥3.

2. "what percent of the test questions must be judged as content appropriate for the assessment instrument to be considered as having acceptable content validity"?
A suggested percent is 80%; however, this percent will vary from college to college.
"At the conclusion of the review process, it is useful to discuss their ratings and revise them if appropriate."

IV. Conclusions. It was found that 95% of the questions on the assessment test were rated with a "3 – moderately important" or higher. Therefore, the content of the assessment test was found to be valid.