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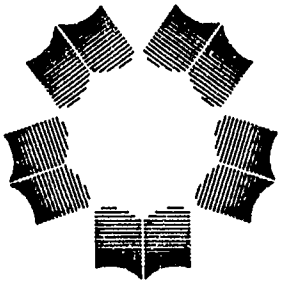
ABSTRACT

A study was conducted at Prince George's Community College in Maryland, to investigate the relatively low pass rates associated with General Chemistry 1 (CHM101), a lower-level science course that satisfies a general education requirement and serves as a prerequisite for Chemistry and Biology students. To identify correlates of student success, Spring 1996 CHM101 enrollees were surveyed during the first 2 weeks of the course concerning their work and life experience and educational preparation. Multiple regression analyses, combining survey results from 180 completed questionnaires, students' course grades, and social and academic characteristics derived from student records, yielded the following findings: (1) cumulative grade point average was the preeminent predictor of success in CHM101, followed by socio-educational "maturity," and developmental reading and math placement scores; (2) since the CHM101 population differed very little from the general credit student population, the very low completion rates could not be traced to any special characteristics; and (3) a large proportion of the enrollees simply found the uncompromising subject matter of CHM101 beyond their power to master. Future studies should assess the effect of personal motivation, quality of study habits, family pressures, receipt of counseling and tutoring, and levels of "science anxiety" on student success. (MPH)

Correlates of Chemistry 101 Course Performance

Preliminary Findings



PRINCE GEORGE'S
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Office of Institutional Research and Analysis

Research Brief RB97-8

August 1996

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CORRELATES OF CHEMISTRY 101 COURSE PERFORMANCE: PRELIMINARY FINDINGS

Research Brief RB97-8
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Introduction and Methodology

General Chemistry I (CHM101) is the entry-level course[1] in the physical sciences department's series of transfer offerings. It is a prerequisite for all students planning to take any further chemistry courses or BIO103, a course required by most four-year schools of Health Technologies students and others wishing to transfer into Allied Health and pre-medical baccalaureate programs. In addition, CHM101 is one of the lower-level science courses satisfying the college's general education science requirement, needed by all hoping for an associate degree from PGCC. Typically, major term enrollment exceeds 200 students.

Aware of the relatively low pass rates associated with CHM101 in the last few years, the physical sciences department has recently instituted major curriculum reforms and a series of course performance studies. One of the latter was a survey of CHM101 enrollees in the 1996 Spring semester. The survey, including questions on employment and previous science and math course-taking, was administered to all students enrolled in CHM101 who attended classes in the first two weeks of the term. With the help of the Office of Institutional Research and Analysis, student course grade was added to the dataset at the conclusion of the semester, along with a selection of social background and academic characteristics data derived from student records. The total number of usable interviews resulting was 180, a substantial proportion of all students enrolled in CHM101 that term.[2]

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[1]CHM101 is preceded in the department's catalogued offerings by *Basic Science Concepts* (CHM100), an introduction to scientific thinking and theory in place mainly for students needing CHM101 but not yet grounded enough in mathematics and the scientific method.

[2]Two sample members turned out to be course auditors, and faulty recording of student identification numbers used to match back student record data to the survey dataset marginally reduced the base further by five dropped respondents.

In this research brief, we will present our preliminary findings on the correlates of course performance and successof the CHM101 survey, based on this first in a planned series of surveys. The analysis will proceed first by means of cross-tabulations of various social background and academic status and performance variables against measures of CHM101 course performance. Then we will present the results of a multiple regression analysis of all student attribute variables upon CHM101 performance in order to clarify which predictors continue to show important impact upon course performance once independent variable interactions and spurious correlations have been eliminated.

CHM101 Course Performance

The full status and grading outcome for the sample is shown below:

Status/Grade	N	Sample %
A	12	7 %
B	30	17 %
C	25	14 %
D	32	18 %
F	31	17 %
Official W	36	20 %
Early W[3]	14	8 %
Sample	*180*	*100 %*

Although we do not have data yet on official course-by-course pass rates for the 1996 Spring semester, past reports find CHM101 pass rates near the bottom for all courses offered. For example, in Fall 1995, CHM101 registered the fourth lowest course completion percentage of enrollees that term (56 percent D or better).[4] The Spring 1996 CHM101 enrollees in our sample did only slightly better – 60 percent. The official pass rate formula discussed above is a generous measure which

[3]Withdrawal before the official third week cut-off data; these students do not appear in official college third week and end-of-semester enrollment reports.

[4]See *Course Pass Rates for Fall 1995* (EA96-5, March 1996), p. 4. The top completion rate among the12 lowest courses was 63 percent. PGCC's experience in this regard is probably not atypical. Such comparative data as exists from other U S. post-secondary institutions suggests that entry-level chemistry courses normally reflect lower pass rates than most other entry-level courses.

considers course completion to be any *D* or better outcome[5] and does not count early withdrawals in the enrollment base. In this study, however, we will employ two more stringent measures of student course performance. For our main measure we will use a version of pass rate which pegs course completion at *C* or better and includes early withdrawals in the enrollment base. The tighter completion grade interval provides a better sense of the critical proportion of all course-enrolled students earning *transferable* CHM101 credits and credits fulfilling the prerequisites for the many higher level science and Health Technologies courses with C or better standards for enrollment. And the broader enrollment base (including unofficial as well as official withdrawals) gives us a more realistic gauge of the extent of course drop-out. As a secondary measure of course performance, we will also utilize enrollee collective grade point average (standard letter grade to numerical equivalents, e.g., A=4, withdrawals discounted). This will give us a feel for sample grade performance beyond the mere frequency of meeting a minimum completion grade standard.

Using these two gauges, the CHM101 course performance of our sample turned out as follows: Of the 180 initial enrollees (early withdrawal included), 67 (37 percent) managed to complete the course with a grade of C or better. And of the 144 sample members who remained in the course to receive letter grades (all withdrawals excluded), the collective GPA was 1.69, a group D+. The GPA for students in the completion C or better group was 2.81, a collective B-.

Population Bias as a CHM101 Success Explanator

Basically, there are three main reasons why a course's pass rate may prove exceptionally high or low: (1) The course attracts a set of enrollees who deviate from general student norms in terms of demographic characteristics or academic attributes (for example, the best scholars or least academically prepared); (2) Enrollee characteristics are normative but the course itself deviates from the average offering in terms of intrinsic difficulty, quality of instruction, grading standards, etc.; (3) Both factors may be operating and interacting. In this section we will briefly explore the first possibility by comparing our sample's social and educational background characteristics and academic qualities with those of all 1996 Spring credit attenders.[6]

A review of the data on demographic and other background comparisons revealed little dramatically deviant in the CHM101 sample. In fact, sample attribute distributions turned out to be remarkably similar along side of those for all Spring

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[5]Or P (Passing) or TP (Toward Passing) for courses not awarding standard letter grades.

[6]For a detailed report of this data, see appendix Tables A and B.

1996 registered students. As we expected of a sample of enrollees in a hard science course, CHM101 students, compared with students generally, were more likely to be male (41 to 36 percent, respectively), to come to PGCC from another college or university (39 to 33 percent), to be associate degree-seekers (34 to 24 percent), to intend transferring to four-year institutions (68 to 58 percent), and to have been drawn disproportionately from those in transfer curriculum programs (61 to 42 percent), particularly in the Arts & Sciences/General Studies (52 to 40 percent), Engineering (7 to 2 percent), and those in Health Technologies (21 to 16 percent) areas.[7] These differences, however, can hardly be characterized as profound. Other minor divergences, less clear in their implications at this point, were the somewhat greater tendency of respondents to be international students (19 to 10 percent, respectively), to be white in racial background (31 to 26 percent), to have attended a Prince George's County secondary school (54 to 49 percent), to have enrolled straight from high school (46 to 38 percent) and to be younger (under 25 years old – 52 to 40 percent).

Academic record comparisons provided somewhat more dramatic contrasts: the CHM101 students in our sample were more prone than students on average to be attending the college full-time (42 to 20 percent, respectively), to have earned at least 15 credit hours while at PGCC (74 to 55 percent), to have merited a PGCC G.P.A. of 2.5 or better (69 to 58 percent), and to have been accorded good academic standing in every major term attended (66 to 55 percent). Additionally, they seemed no more likely to have placed into developmental reading than other students and a good deal less likely to have required developmental English (9 to 20 percent) and math (17 to 38 percent) courses. These appear to favor good rather than poor performance in CHM101.

Thus, we found population bias insufficient, by itself, to account for the strong negative skew in CHM101 success incidence. Furthermore, it could be argued that many of the attribute deviancies identified ought to have worked on behalf of course completion rather than against it. In the next section, we will begin to examine the second possibility – that certain aspects in the normal range of the background and behavior for PGCC students tend to interact on certain special, intrinsic qualities of the CHM101 course, with negative effect.

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[7]While not, strictly speaking, in *transfer* curricula, Health Technologies students frequently do transfer into Allied Health baccalaureate programs after getting their associate degrees.

Table 1. Spring 1996 CHM101 Course Outcomes by Student Social and Academic Characteristics

Student Categories	Category GPA[1]	Category Pass Rate[2]	Category GPA N	Category Rate N	Pass Rate *Eta*
WHOLE SAMPLE	1.69	37 %	130	180	--
Transfr to PGCC with Credits	2.11	43 %	9	14	
Transferred without Credits	1.91	51 %	46	55	
1st Time Anywhere Student	1.51	30 %	75	111	*.201*
Female	1.89	44 %	83	107	
Male	1.34	27 %	47	73	*.167*
U.S. White	1.85	45 %	41	55	
African American	1.43	32 %	56	75	
U.S. Other	1.40	19 %	10	16	
International Students	2.17	44 %	23	34	*.230*
Under 20 Years Old	1.31	19 %	16	27	
20-24	1.20	26 %	59	77	
25-29	2.26	55 %	23	31	
30-39	2.58	65 %	26	34	
40 and Over	*	27 %	6	11	*.364*
30+ Hr Job while Student	1.83	48 %	64	79	
Part-Time Employment	1.74	28 %	35	58	
Not Employed	1.36	30 %	28	39	*.201*
Immediate Entry from HS	1.14	21 %	59	82	
1-4 Year Delayed Entry	1.83	42 %	24	36	
5-9 Years	2.29	58 %	24	31	
10+ Years	2.33	57 %	18	23	*.337*
PG Secondary School Grad	1.31	21 %	76	97	
Other MD Secondary School	2.35	74 %	17	19	
Non-MD Secondary School	2.22	48 %	45	64	*.410*
Associate Degree Goal	1.64	40 %	50	62	
Certificate Attendance Goal	1.75	23 %	8	13	
Just Taking Courses	1.72	38 %	72	105	*.087*
Transfer Attendance Reason	1.46	34 %	91	123	
Career/Subject Pursuit[3]	2.22	47 %	23	30	
All Other Reasons[4]	2.25	41 %	16	27	*.171*
Transfer Curriculum Program	1.53	34 %	79	109	
Occupational Program[5]	1.79	37 %	39	57	
No Program Indicated	2.42	64 %	12	14	*.184*
Arts & Sciences Curr. Area	1.63	29 %	16	24	
General Studies	1.60	35 %	52	71	
Engineering	1.20	38 %	10	13	
Allied Health Fields	2.40	54 %	25	37	
Other Occupation Fields	.67	5 %	15	22	
No Program Indicated	2.42	69 %	12	13	*.342*

NOTES:
1. For students with grades F through A (0-4) only
2. Pass = Grades C through A; Non-Pass = D, F, W or pre-3rd Week withdrawal (Auditors excluded)
3. Conflates standard categories First Career Preparation (n = 5) and New Career or Subject Exploration (n = 26)
4. Includes standard categories Job Skill Upgrading (n = 7), Personal Enrichment (n = 1) and Other Reason (n = 19)
5. Conflates Occupational Associate Degree (n = 57) and Certificate (n = 2) categories

Student Background Attributes as CHM101 Success Correlates

Table 1 shows how selected social and educational background attributes of CHM101 enrollees correlated with course success. For any set of enrollee attribute subpopulations (e.g., female and male gender groups), it displays each subpopulation's collective course GPA, course completion rate (group percentage of students graded C or better) and a correlation statistic called the *Eta* coefficient which summarizes the degree of pass rate variation across groups.[8] Some caution should be exercised in interpreting individual attribute category GPAs and pass rates, especially in the case of groups with respondent populations below 20 members.

According to Table 1, the top student background correlate with CHM101 success was type of secondary educational experience (*Eta* = .410): enrollees who had graduated from a Prince George's county secondary school had a collective pass rate of only 21 percent, compared with pass rates of 74 and 48 percent, respectively, for products of other Maryland high schools or out-of-state secondary systems. The second most powerful predictor turned out to be student age (*Eta* = .364). Almost two-thirds (65 percent) of CHM101 enrollees aged 30-39 years ended up with a C or better grade in the course, and 55 percent of those in the 25-29 age bracket did so. Only about a quarter (26 percent) of the 20-24 year olds, however, completed CHM101, and fewer than one in five (19 percent) under the age of 20; the oldest group of adult learners in the course also tended to find CHM101 quite difficult (27 percent pass rate). Curriculum Choice (Eta = .342) was third best as a pass rate correlate. Collectively, respondents not pursuing a particular degree program seemed to find CHM101 the easiest to pass (69 percent), followed by students in Health Technologies programs (54 percent); least likely to pull a C or better were students in the Arts & Sciences program (29 percent) and those in any of the occupational degree programs other than Health Technologies (5 percent). Engineering students fell in the middle, 38 percent passing CHM101. The last in the top tier of predictors of course success was Recency of Secondary Education (Eta = .337), the more recent a student's high school diploma the *lower* that student's chance of a C or better in CHM101. For example, enrollees who entered college straight from high school had only a .21 probability of completing, compared with the .57 odds in favor of those out of high school 10 or more years before attending.

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[8]The *Eta* coefficient is the appropriate strength-of-association measure to use when comparing correlations between a dichotomous dependent variable (e.g., passing course/ not passing course) and a mix of nominal, dichomous and short scale ordinal independent variables. It has a range of 0 (no relationship) to 1 (perfect prediction). *Eta* can be thought of as the non-parametric analog of the better known parametric measure of correlation – Pearson's *r*. In fact, *Eta* and *r* are mathematically equivalent in the case of the correlation of two dichotomous variables.

Three variables made up the second tier of CHM101 pass rate correlates (Eta=.201-.230): PGCC Entry Status, Employment Status while a PGCC Student, and Racial Background. Almost half (49 percent) of the respondents who came to PGCC from some other college or university passed CHM101 while only three in ten (30 percent) of students for who PGCC was a first-time college experience did so. Similarly, nearly half (48 percent) of CHM101 students holding full-time jobs completed the course, compared with around 30 percent working part-time or claiming no employment. Finally, students who were U.S. citizens and white (45 percent pass rate) and international students (44 percent) tended to do somewhat better than African Americans (32 percent) and much better than U.S. Hispanics, Asians and Native Americans (19 percent) in CHM101.[9] Degree Program Type (Eta=.184), self-reported Reasons for Attendance (.171), Student Gender (.167) and self-reported Academic Goal (.087) proved only marginal zero-order predictors of CHM101 success.

When reviewing Table 1, we were struck by robust positive correlations of age, delayed entry to college, full-time employment and transfer student status, all in the first or second tier of predictors of CHM101 success. Taken together, these four variables suggested an underlying theme, perhaps loosely expressible as socio-educational "maturity." Students in the course success-facilitating categories of these variables (adult learners, the full-time employed, transfer students, those delaying college study), it could be argued, tended to represent a greater collective level of experience of the world and what it takes to meet its demands than their opposites. We wondered whether this hypothesized dimension of socio-educational "maturity" could be expressed in a summary measure. Through scalar analysis of the inter-correlations of dichotomous versions of the four variables (where placement in the "mature" category scored 1 and the residual category scored 0), we found that a simple, statistically reliable additive scale, with a range of 0 (all residual category placements) to 4 (all "mature" placements) could be constructed. We cross-tabulated scale score with CHM101 pass rate, with the following result:

Scale Score		Pass Rate	N	
Low "Maturity"	= 0	19 %	(48)	
	1	25 %	(36)	
	2	37 %	(41)	
	3	52 %	(27)	
High "Maturity"	= 4	71 %	(28)	Eta=.379

[9]Small representation in Spring 1996 CHM101's enrollment from these groups forced us to merge them into a single category (n=16).

Table 2. Spring 1996 CHM101 Course Outcomes by Student Academic Record

Student Categories	Category GPA[1]	Category Pass Rate[2]	Category GPA N	Category Rate N	Pass Rate *Eta*
WHOLE SAMPLE	1.69	37 %	130	180	--
Dev. Reading /Incomplete	.75	0 %	4	6	
Dev. Reading/Completed	.60	0 %	5	10	
Not Required	1.60	40 %	81	107	
No Test Taken	2.10	42 %	40	57	*.241*
Dev. English/Incomplete	.50	0 %	6	9	
Dev. English/Completed	1.20	29 %	5	7	
Not Required	1.63	37 %	72	97	
No Test Taken	2.00	43 %	47	67	*.192*
Dev. Math/Incomplete	1.43	30 %	7	10	
Dev. Math/Completed	1.69	25 %	13	20	
Not Required	1.63	38 %	87	119	
No Test Taken	2.00	45 %	23	31	*.114*
No Developmental Placements	1.78	41 %	102	140	
At Least 1 Program[3]	1.25	25 %	28	40	*.135*
Mean Credit Load 12+ Hour[4]	1.40	28 %	50	75	
Less than 12 Hours	1.88	44 %	80	105	*.161*
<15 Cum. Credits Earned[5]	1.56	33 %	34	46	
15 -29 Credits	1.55	33 %	44	64	
30+ Credits	1.90	45 %	52	69	*.123*
0-.99 Cum. G.P.A./Fall 1995	.00	0 %	9	11	
1.00 - 1.99	.36	0 %	14	18	
2.00 - 2.49	.84	11 %	19	28	
2.50 - 2.99	1.85	45 %	39	56	
3.00 - 3.49	2.13	49 %	31	45	
3.50 - 4.00	3.39	77 %	18	22	*.498*
No Terms in Good Standing[6]	1.15	24 %	13	17	
< .67 Major Terms	1.31	17 %	13	23	
.67 - .99 Major Terms	1.71	43 %	17	21	
Always in Good Standing	1.83	42 %	87	119	*.193*
Sequential Attendance Only	1.69	36 %	98	137	
Some Stopping Out	1.69	42 %	32	43	*.054*
Completed 1+ Chemistry Crs	2.00	50 %	23	28	
No Courses Completed[7]	1.63	35 %	107	152	*.113*
Completed 1+ Biology Crs	1.80	46 %	65	83	
No Courses Completed[7]	1.58	30 %	65	97	*.164*
Completed 1+ Math Courses	1.71	38 %	112	155	
No Courses Completed[7]	1.56	32 %	18	25	*.043*

NOTES:
1. For students with grades F through A (0-4) only
2. Pass = Grades C through A; Non-Pass = D, F , W or pre-3rd Week withdrawal (Auditors excluded)
3. Placement in any term and combination of placement test-taking
4. Average taken over major terms attended 5. Native credits earned only
6. Proportion of major terms attended in formal good academic standing
7. Self-reported course completion

Furthermore, the initially high correlation of non-P.G. County high school diploma with CHM101 pass rate (Eta=.410) dropped to marginality (.171) when student "maturity" was controlled for.[10] The non-P.G. high school correlation, therefore, was in large degree a spurious product of a high correlation of non-P.G. high school experience with socio-educational "maturity."

Student Academic Record Correlates of CHM101 Success

Table 2, above, is identical to Table 1 in format but this time the data on the academic correlates of CHM101 success are displayed. A glance at its Pass Rate *Eta* column quickly imparts the main story it has to tell: Far and away the strongest predictor of course completion among the academic record variables, and in fact among all independent variables, turned out to be simple general course performance. Grade Point Average while attending PGCC had an *Eta* correlation of .498 with a CHM101 grade of C or better. Hardly any (5 percent) of the 57 enrollees with a GPA less than a C+ equivalent in their course work outside CHM101 passed the chemistry course, while those with a 2.5+ GPA had an even shot at passing (50 percent) and nearly four out of five students with B+ or better general averages completed (77 percent). The importance of good scholarship also showed up in the much weaker correlation of consistent good academic standing with CHM101 completion (*Eta*=.193).

In remote second place as an academic correlate of CHM101 pass rate was placement into developmental Reading (*Eta*=.241). Around two in five CHM101 enrollees not required to take developmental reading courses or bypassing the placement test ended class with a passing grade, but *no* developmental reading student completed CHM101. The importance of language skills also showed up in the somewhat lower correlation of English Developmental Placement with course completion (.192). Unexpectedly, given that mathematics skills are arguably more intrinsically connected with success in learning a physical science than language skills, Developmental Math Placement turned out to be a weak predictor (.114). Also surprising were the low impacts of previously completed course work in mathematics, biology or even chemistry (all pass rate *Eta*s <.165).[11]

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[10]Mean pass rate-by-high school *Eta* for each level of the "maturity" scale

[11]These developmental correlations raise two methodological issues. First, it should be noted that only a small proportion of CHM101 students actually classified into either developmental reading or English; as a practical if not statistical matter, this greatly limits the numerical loss in terms of course completers due to remedial academic background. Second, completion of developmental math is a prerequisite for taking CHM101, and while half of the CHM101 students placed into developmental math at some earlier point completed their remediation, the other half did

The remaining academic variables were equally weak course completion predictors – mean major term credit hour load (Eta=.161), cumulative native credits earned (.123), and consistency of attendance (.054). The main finding, then, of Table 2 remains that of all standard academic record variables only grade point average made a substantial contribution toward explaining CHM101 success. This suggests that much of the difficulty students experience in completing entry level chemistry lies in the inherent difficulty of the class material – CHM101, as it stands today, is simply a tough course, requiring a level of study skill, application, science and math preparation and academic ability not found in goodly proportion among PGCC students needing it.

Finally, we looked into one more possible source of course success related to the academic process, but one not strictly having to do with *student* academic record – instructor grading variability. Six instructors participated in teaching CHM101 in the Spring of 1996 and data were available on the mean grade received by the students in the sections taught by each. We noticed a fair degree of grading variability, instructor to instructor, and wondered how much a student's final mark might be the product of luck in drawing a particular section taught by a particular instructor with a particular central grading tendency. To test for this we rank-ordered instructors by grading tendency from low (1) to high (6) and assigned each student a score on this scale a cording to which course section he or she attended. The result was an *Eta* correlation of .226 with CHM101 pass rate, suggesting that instructor grading variability may have been a contributing but not a major factor in student success.

A Multiple Regression of Course Success Correlates

Using Tables 1 and 2, we examined the one-on-one (zero-order) relationships between a series of background and academic factors and CHM101 course performance. One of the perennial problems confronting the researcher, however, is that in the real world all of the independent variables act simultaneously upon the dependent variable, leading to all sorts of interactions and spurious effects. One of the main statistical tools for disentangling this complex of interference effects is multiple regression.

Regression is designed to give more realistic estimates of the explanatory weights of individual causal factors by filtering out multiple variable effects, and to

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not complete developmental math but entered CHM101 on some sort of waiver. This introduces a complication which makes it difficult to interpret the developmental math-CHM101 pass rate correlation, for the waived requirement students may have had special characteristics not typical of developmental math students generally.

produce a summary predictive equation which includes only those variables making the strongest and truest independent contribution toward determining the variability of the dependent variable. The essential results of such a multiple regression, regressing all 23 of the independent background and academic variables already discussed upon CHM101 pass rate, can be found in Table 3 below.

The principle statistic present in Table 3 is Pearson's partial correlation coefficient, basically Pearson's *r* showing the strength of relationship between a particular independent variable and the dependent variable once the interference effects caused by all other independent variables correlated against the dependent variable have been filtered out.[12] The rows indicate which of the initial 23 variables the regression were identified as making any discernable contribution toward explaining CHM101 pass rate in terms of partial correlation. Using the cut-off point of .05, 14 of the original predictors survived this test. The variables labelled in italics were the independent variables singled out by the regression analysis for inclusion in the regression equation, which flags them as the main predictive factors in the overall causal network conditioning the behavior of the dependent variable.[13]

According to Table 3, these turned out to be just three: Cumulative Grade Point Average (partial r = +.430), Socio-educational "Maturity" (+.333) and Developmental Reading Placement (-.159). The overall predictive power of a regression equation is gauged by the Coefficient of Determination or R^2 , which can be interpreted as the proportion of the total variance of the dependent variable (its full range of empirical behaviors) pinned down in the formula. In this 3-term case, R^2 equalled .346. Had all 23 variables been forced into a regression equation predicting CHM101 pass rate, R^2 would only be increased to .410. Put another way, Table 3 suggests that it actually takes only three predictors to do 85 percent of the prophetic work on chemistry course completion that all 23 variables crow-barred together into a formula could do.

As we already mentioned, the most powerful of these equation-included predictors (+.430) turned out to be Cumulative Native Grade Point Average, no surprise since it proved to be the preeminent predictor of CHM101 pass rate in Table 2's display of zero-order academic record correlates.

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[12]Partial *r* varies from -1 (perfect negative relationship through 0 (no relationship) to +1 (perfect positive relationship). As already mentioned, Pearson's *r* bears a close mathematical kinship with *Eta*.

[13]The variable inclusion test is called the stepwise procedure, which systematically sifts through all independent/dependent variable relationships to produce an equation which best maximizes formula predictiveness which simultaneously minimizing variable term number.

Table 3. Chemistry 101 Pass Rate by Enrolled Student Characteristics: Selected Multiple Regression Results ($R^2 = .346$; N = 180)

Student Characteristics (Main Predictors)	Partial *r*
Cumulative Native Grade Point Average	+.430
Socio-Educational "Maturity"	+.333
Developmental Reading Requirement	−.159
*25-40 Years Old (1996)/Other Ages	+.190
*Transfer-In Student	+.131
Section Grading Variability (Low to High)	+.110
No Academic Program Chosen	+.107
Cumulative Native Credits Earned	+.103
Number of Major Terms Attended FY91-96	+.099
*Full-Time Employed while a Student	+.095
Developmental Math Requirement	−.093
Good Standing/Proportion of Major Terms	+.087
Claimed Previous Completed Bio. Course	+.070
Non-White/White Racial Background	−.065
Previous Chemistry Courses Completed	+.060
Previous Biology Courses Completed	+.055
Claimed Previous Completed Chem. Course	+.055
*Delayed Entry from High School	+.054

NOTE: Stepwise Linear Regression (PIN = .05; POUT = .10); *Italicized* labels indicate variables in the regression equation

* Result of separate regression breaking out the components of the summary scale "Maturity" variable

Table 3 also shows Cumulative Native Credit Hours Earned (+.103) and Number of Major Terms Attended (+.099) to be somewhat contributory to course completion at a level just below the threshold of equation inclusion. This reinforces our sense of the importance of scholarship and persistence as keys to CHM101 success. Also important at the sub-equation level was Absence of Degree Program (+.107) and Section Grading Variability (+.110). The first may relate to presence of a disproportion of "transient" students in CHM101 (transfer students from other local post-secondary schools "stopping in" just to take a single PGCC course more conveniently scheduled than or otherwise preferable compared to an equivalent course offered by their own institutions). The second suggests that, though not a key to a CHM101 student's fate in the course, section assignment cannot be discounted as negligible in outcome impact.[14]

[14]It is important not to rush to assume that Section Grading Variability simply amounts to a measure of variation in the grading styles of particular instructors. While this is undoubtedly a component of Section Variability, other factors may be active as well. For example, the three sections with the highest pass rate reports also happened to be evening classes and those with the

The second most powerful predictor in the regression equation was Socio-Educational "Maturity" (+.333) as measured by our composite four-variable scale. For sake of comparison, we also carried out an additional regression analysis keeping all the same except for substituting the scale's component variables in their original forms. These are the variables represented by labels preceded by an asterisk (*) in Table 3. The Partial r column suggests that even as single predictors of pass rate, three of the four keep their importance as predictors: Adult Learning Age showed the most independent impact on course completion (+.190, sufficient for equation inclusion in the second regression results), followed by Transfer-In Student (+.131) and Full-Time Employment (+.095).

The third most predictive of the equation variables was Developmental Reading Placement (-.159). a prime zero-order predictor in Table 2, accompanied this time, at the sub-equation level of importance, by Developmental Math Placement (-.093), of negligible position in Table 2.[15] This suggests that *technical* level of preparation (that measured by basic skills testing) has a real impact on chemistry course performance. One must, however, come to a proper understanding of what "real" means in this case. The terms of a conditionally constructed regression formula are "real" predictors always in the strict *statistical* sense that included variables have survived all tests of non-spuriousness and non-random prediction, but not necessarily in the *practical* sense that they govern the behavior of any sizable proportion of the whole population being studied. While it seems true that students placed into developmental reading tended to do very poorly in CHM101 (and once needed statistical controls are in place, we can judge this true for developmental math students also), there were just too few remedial students taking CHM101 for this to matter much in the pass rate big picture. Cumulative GPA and Socio-Educational "Maturity" are real predictors of CHM101 pass rate in both senses, remedial placement only in the one, less important sense.

Conclusions

Our study of Spring 1996 CHM101 student attributes and class performance found little evidence that the typically very low completion rate associated with the entry-level chemistry course traced to the special composition of the enrollment body compared with credit students generally. By and large, CHM101 differed little from the mass, and where there were modest deviancies from the norm, these seemed to represent a rough balance of factors which tended to favor success in chemistry

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highest proportion of Socio-Educationally "Mature" students. Also, the statistical weight of the Section Variability variable should not be exaggerated. It did not prove to be a prime indicator of pass rate (formula inclusion) but only one secondary indicator among many.

[15]This illustrates how multivariate statistical controlling can sometimes reveal hidden strengths of relationship as well as discover spuriousness in seemingly strong zero-order relationships. When the effects of all other causal variables are taken into account, Developmental Math Placement turns out to be a more robust indicator of CHM101 success than what was suggested by simple two-variable cross-tabulation.

study (e.g., more transfers from other colleges) and those which tended to discourage it (e.g., more students under 20 years old). Rather, cross-tabular and regression analyses suggested this answer to the question of low CHM101 pass rates: Given the ranges typical for this group of not atypical students in life experience, educational preparation and academic skill, a large proportion find the uncompromising subject matter of CHM101 simply beyond their power to master.

We must hasten to add, however, that there is a lot we don't know yet about the forces at work in producing CHM101 grade outcomes. This is evident in the fact that our summary regression equation carried an R^2, expressing the totality of its power to predict pass rate by means of the included variables, of only .346. In plain English, this means that we are able, by its means, to explain around 35 percent of the phenomenon of CHM101 course performance, a not inconsiderable amount. Even so, this leaves 65 percent unexplained! Obvious factors now missing from the equation, to name just a few, are level of personal motivation, quality of study habits, family pressures, receipt of counseling and tutoring, and presence or absence of "science anxiety" (analogous to but not identical to "math anxiety"). This research is ongoing and the physical sciences department plans to include questionnaire items in future surveys to test for the effects of these and other currently missing pieces to the puzzle of CHM101 success.

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A * P * P * E * N * D * I * X

Table A. Spring 1996 CHM101 and General Enrollment Compared: Student Social and Academic Characteristics (Column Percentages)

Student Categories	CHM101 Students	Spring 96 Students*
SAMPLE N (PERCENT BASE)	180	11,100
Transfer to PGCC with Credits	8 %	8 %
Transferred without Credits	31 %	25 %
1st Time Anywhere Student	62 %	67 %
Female	59 %	64 %
Male	41 %	36 %
U.S. White	31 %	26 %
African American	42 %	59 %
U.S. Other	9 %	5 %
International Students	19 %	10 %
Under 20 Years Old	15 %	11 %
20-24	43 %	32 %
25-29	17 %	17 %
30-39	19 %	23 %
40 and Over	6 %	18 %
Immediate Entry from HS	46 %	38 %
1-4 Year Delayed Entry	20 %	18 %
5-9 Years	17 %	14 %
10+ Years	13 %	26 %
No Diploma/Data	5 %	4 %
PG Secondary School Grad	54 %	49 %
Other MD Secondary School	11 %	14 %
Non-MD Secondary School	35 %	37 %
Associate Degree Goal	34 %	24 %
Certificate Attendance Goal	7 %	7 %
Just Taking Courses	58 %	60 %
No Answer	0 %	9 %
Transfer Attendance Reason	68 %	58 %
Career/Subject Pursuit[3]	17 %	24 %
All Other Reasons[4]	15 %	9 %
No Answer	0 %	9 %
Transfer Curriculum Program	61 %	42 %
Occupational Program[5]	32 %	48 %
No Program Indicated	8 %	10 %
Arts & Sciences Curr. Area	13 %	16 %
General Studies	39 %	24 %
Engineering	7 %	2 %
Allied Health Fields	21 %	16 %
Other Occupation Fields	12 %	32 %
No Program Indicated	7 %	10 %

NOTES: See Notes for Table 1

*End-of-Semester Credit Enrollment data

Table B. Spring 1996 CHM101 and General Enrollment Compared: Student Academic Record (Column Percentages)

Student Categories	CHM101 Students	Spring 96 Students*
SAMPLE N (PERCENTAGE BASE)	180	11,100
Dev. Reading /Incomplete	3 %	7 %
Dev. Reading/Completed	6 %	9 %
Not Required	59 %	59 %
No Test Taken	32 %	25 %
Dev. English /Incomplete	5 %	11 %
Dev. English/Complete	4 %	9 %
Not Required	54 %	48 %
No Test Taken	37 %	32 %
Dev. Math/Incomplete	6 %	29 %
Dev. Math/omplete	11 %	9 %
Not Required	66 %	33 %
No Test Taken	17 %	29 %
No Developmental Placements	78 %	55 %
At Least 1 Program[3]	22 %	45 %
Mean Credit Load 12 + Hour[4]	42 %	20 %
Less than 12 Hours	58 %	80 %
<15 Cum. Credits Earned[5]	26 %	46 %
15 -29 Credits	36 %	24 %
30 + Credits	38 %	31 %
0-.99 Cum. G.P.A./Fall 1995	6 %	11 %
1.00 - 1.99	10 %	13 %
2.00 - 2.49	16 %	18 %
2.50 - 2.99	31 %	19 %
3.00 - 3.49	26 %	21 %
3.50 - 4.00	12 %	18 %
No Terms in Good Standing[6]	9 %	17 %
< .67 Major Terms	13 %	16 %
.67 - .99 Major Terms	12 %	13 %
Always in Good Standing	66 %	55 %

NOTES: See Notes for Table 2

*End-of-Semester Credit Enrollment data