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A SERU Project and Consortium Research Paper*

Recognizing and then Using Disciplinary Patterns of the Undergraduate Experience: Getting Past Institutional Standards

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ABSTRACT

The assertion that there are a limited set of generalizable good educational practices (Chickering & Gamson, 1987) with a common model of preferred active student engagement in learning (Kuh, 2001) is appealing to those responsible for simply stated institutional outcomes and to the faculty who teach in fields that espouse the same practices and outcomes (Braxton, 1998). After all, if they are wrong and educational experience and good educational practices differ in important, substantive, and replicable ways by area of academic major, then assessment, accountability, administration, and admissions become more complicated and less amenable to central "oversight" and uniform standards. This paper reports that there are indeed important differences in student experience and engagement by academic discipline, that disciplinary patterns of student experience cluster, and that academic performance by students in these clusters is differentially predicted by standard admissions measures and student engagement factors. Recognizing the differences and identifying the predictors will lead to better admission practices.

In 2001, the University of California embarked on an effort to increase by an order of magnitude the resolution with which it could perceive the undergraduate experience through survey activities by asking all students at all campuses to answer both a series of common questions and a randomly assigned supplemental module. Its efforts continued and evolved and in 2008, over 60,000 students completed the Student Experience in the Research University's (SERU's) University of California Undergraduate Experience Survey (SERU/UCUES), a 40% response rate.

* The SERU Project and Consortium is a collaborative of 15 major research universities based at the Center for Studies in Higher Education at UC Berkeley and including the administration of the SERU survey of undergraduates. A version of this paper was presented at the conference "Beyond the SAT: Rethinking Admissions" at Wake Forest University, April 15 and 16, 2009.

These data were confidential, requiring a student login, and therefore, the results can be linked with all other institutional records. Given a common core set of items, four or five randomly assigned modules, and the ability to link to admissions, registration, and financial aid files, this creates endless opportunities for policy studies and academic research. One highly successful application of these data has been comparative academic program review, where comparisons across campuses can be made at the level of the academic major. For example, responses by political science majors at Berkeley can be compared to those of political science majors at UCLA and San Diego or to any combination of campuses.

The results differ from intra-campus major to college or major to campus comparisons in ways that lead to different conclusions and interventions. To have so many options for inquiry supported by a regularly administered comprehensive questionnaire that is supplemented by institutional operating system records can be somewhat overwhelming. Especially when applied to a practical matter like deciding which applicants to admit, one challenge is to reduce complexity without blurring necessary detail.

So, what detail is necessary to consider when creating and applying admissions policies?

This paper argues that cumulative academic performance is a preferred outcome over general skills acquisition and that there is, in fact, no such thing as general educational skills acquisition. Stated simply, “general” education experience is not uniform across disciplines and, therefore, the extent to which performance can be predicted by common admissions measures varies widely.

More importantly, general education outcomes are not of much interest to higher education constituencies, with the notable exception of some administrators and many governmental bureaucrats. Students, parents, faculty, and employers are primarily concerned with outcomes in academic disciplines, and faculty additionally desire to teach appropriately engaged students.

The Myth of a General Education

There are several bodies of evidence to support the assertion that general educational outcomes can accurately be measured only within the context of academic disciplines. While there are skills developed in college that cross disciplinary areas, all are expressed within the epistemology of the discipline.

These bodies of evidence have been amassed by researchers using a variety of methods, but one trend is clear: Researchers who have used methods capable of testing for disciplinary differences in general skill acquisition have found them. If general educational outcomes reflect disciplinary differences, then it is logical to assume that the variables that predict performance will also differ by discipline.

Relevant Literature

Among the bodies of evidence that general skills outcomes reflect disciplinary differences, eight will be briefly summarized.

Donald

Janet Gail Donald has led a series of studies into epistemological differences in disciplines and how they are conveyed to students: What is valued? How is knowledge advanced? How is knowledge transmitted? These are questions answered differently in different academic fields. Her methodology has been anthropological — relying on interviews, observation, and exemplars. It began when she dropped the assumption that all teaching and learning is uniform across disciplines and decided in 1976 to understand those processes in other disciplines. Her 2002 book, *Learning to Think: Disciplinary Perspectives*, is a persuasive accounting of her work.

Beyer

Catherine Beyer and colleagues at the University of Washington employed a variety of quantitative and qualitative methodologies in completing a four-year longitudinal study of undergraduate students' personal, social, and intellectual development. As reported in Beyer, Gillmore, and Fisher's *Inside the Undergraduate Experience* (2007), they concluded that all academic learning is mediated by the discipline, even in courses labeled "general education." Moreover, the disciplinary mediation begins in lower-division coursework. "We have learned, and we argue here, that there is no such thing as an undergraduate education; instead, we have many undergraduate educations filtered through the lenses of particular disciplines …" (p. 23).

Smart

With several colleagues over a number of years, John Smart has convincingly demonstrated that disciplines, faculty, and students' behaviors and attitudes can be described by John Holland types and that students do best in compatible disciplinary fields in the same way that employees are most successful in compatible work environments. Holland types are realistic, investigative, artistic, social, enterprising, and conventional. Moreover, commonalities among types by discipline are reflected in academic organization structures. An excellent summary of the work is Smart, Feldman, and Ethington (2000), *Academic Disciplines: Holland's Theory and the Study of College Students and Faculty*.

Biglan

Similar to the atheoretical, empirically based classification strategy used in this paper, Biglan derived a three-dimensional solution using multidimensional scaling of faculty ratings of subject matter area similarities. The dimensions of hard/soft, pure/applied, and life/nonlife responses have proven to be remarkably useful to higher education researchers because they have been shown to distinguish everything from faculty attitudes and behaviors to class size. His 1973 *Journal of Applied Psychology* papers are a good starting point.

Nelson-Laird, Kuh, Pike, and others

Whether viewed from the perspective of student learning behaviors (2005) or faculty teaching behaviors (2006), cross-institutional studies from the National Survey of Student Engagement (NSSE) and Faculty Survey of Student Engagement (FSSE) show reliable and consistent disciplinary differences in information processing that tend to favor social sciences and humanities over sciences and engineering. In their 2002 publication, Gary Pike et al. described how disciplinary differences affected institutional scores and thereby comparisons or rankings

based on those scores. Put simply, institutional measures and relative institutional scores may reflect little more than program composition.

Chatman

The idea that there can be more variance within campus by discipline than by discipline between campuses was pursued by Chatman in 2006. Using the eight-campus census survey, University of California Undergraduate Experience Survey (UCUES), Chatman used factor scores to cluster programs based on similarities. The outcome was a sorting that tended to replicate academic structures — at least suggesting construct validity. In addition, the pattern of factor scores by cluster tended to replicate the results of NSSE researchers described earlier with humanities and social sciences students scoring higher on typical measures of engagement and sciences and engineering students scoring lower.

The UCUES principal component factor solutions did find quantitative and research engagement factors where the disciplinary patterns were reversed. Chatman's paper showed how AAU institutions would fare in rankings based solely on mix of programs. Interestingly, traditional engagement scores placed perennially top-ranked Harvard and Yale at the top of ranked lists based on nothing more than program composition.

Brint, Cantwell, and Hanneman

In their *Research in Higher Education* article "The Two Cultures of Undergraduate Engagement" (2008), Steve Brint, Allison Cantwell, and Bob Hanneman described two cultures based on student responses to a subset of 15 items measuring student engagement from the 2006 University of California Undergraduate Experience Survey (UCUES). The humanities/social sciences culture was identified by differences in interaction, participation, and interest in ideas. The natural sciences/engineering culture valued improvement of quantitative skills, collaborative study, and career orientation.

Academic majors could be sorted into one of the two cultures and among cultural differences were post-graduate degree plans, social class and gender, and academic aptitude. Given that there were two distinct cultures of academic engagement, the authors asserted that models of good practices in education and student engagement in learning that assumed a common, "normative" view applicable to all students in all majors would not likely be embraced by both cultures.

Arum and Roska

The four-year longitudinal study of Collegiate Learning Assessment (CLA) involving over 2,300 students attending 24 institutions supported disciplinary differences. Arum and Roska (2008) reported that general education outcomes as measured by the CLA were affected by academic major. "Our analyses confirm the relevance of college major. Students majoring in science and math as well as those majoring in social sciences and humanities exhibit higher growth in cognitive skills, as measured by the CLA, than students majoring in business. Students majoring in engineering, agriculture and computer science also experience more cognitive growth, although of smaller magnitude" (p. 11).

As is consistent with the work of the other authors, they noted that there were fields more conducive to the acquisition of cognitive skills as measured by the CLA: critical thinking, analytical reasoning, and written communication. Braxton and others have labeled those academic areas affinity disciplines.

Methodology

There were two analytical steps used in this study. First, previously determined student factor score patterns (Chatman, 2008) were subjected to cluster analysis to determine naturally occurring similar response profiles for academic majors. Resulting academic clusters became the highest level of defensible aggregation for predictive validity studies.

Second, the relative strength of various predictive measures was determined using SAS GLMSELECT where the dependent variable was cumulative grade point average of upper-division majors — a traditional predictive validity design with less traditional predictors and performed at the level of disciplinary clusters.

Factor Structure

The factor structure of the first University of California System survey of all undergraduates, SERU/UCUES 2006, was determined by a research team using principal components analysis with varimax rotation followed by promax rotation within principal components. The process and results were described in Chatman, 2007.

The intercampus UCUES Institutional Research Work Group made several changes to the 2006 core segment of the questionnaire for 2008 based on feedback from students and the results of various research projects conducted in 2006 and 2007. Student use of time, campus climate and diversity, and academic experience components were increased or moved from randomly assigned modules to the common core.

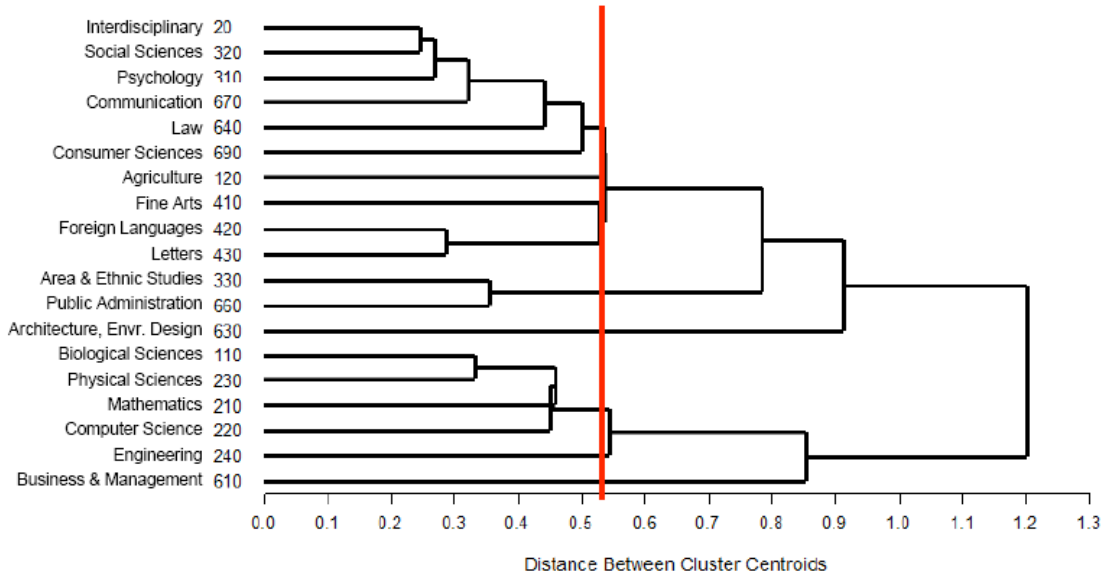
A new factor analysis was therefore in order and the results were described elsewhere (Chatman, 2008). The 2008 solution replicated the 2006 methodology and the results were exactly the same for four factors and very nearly for a fifth. There were three new principal components: Factors 3, 6, and 7. The 2008 solution was comprised of eight factors:

- Factor 1: Satisfaction with Educational Experience
- Factor 2: Current Skills Self-Assessment (Nonquantitative)
- Factor 3: Engagement with Studies
- Factor 4: Gains in Self-Assessment of Skills (Nonquantitative)
- Factor 5: Development of Scholarship
- Factor 6: Campus Climate for Diversity
- Factor 7: Academic Disengagement
- Factor 8: Quantitative Professions

Cluster Analysis

Student scores on these eight factors and academic time (time studying and in class) were computed and subjected to cluster analysis for academic major using an agglomerative method. The analysis was performed at the level comparable to a two-digit CIP Code. The resulting dendogram is shown as Figure 1. The vertical line marks a useful and reasonable level of centroid separation that sorts disciplinary areas into nine clusters. (The numbers following disciplinary area labels are University of California area codes.)

Figure 1: Empirically Derived Academic Discipline Clusters



The empirically derived academic structure for a hypothetical university formed from the eight-campus University of California composite had nine divisions:

1. Social Sciences — Interdisciplinary Studies, Social Sciences, Psychology, Communication, Law and Consumer Sciences
2. Agriculture — Agriculture
3. Fine Arts — Fine Arts
4. Humanities — Foreign Languages and Letters
5. Public Administration — Area and Ethnic Studies and Public Administration
6. Architecture and Environmental Design — Architecture and Environmental Design
7. Science and Math — Biological Sciences, Physical Sciences, Mathematics, Computer Science
8. Engineering — Engineering
9. Business and Management — Business and Management

A similarly organized real university would not be exceptional. In fact, except for the placement of Public Administration (Area and Ethnic Studies and Public Administration), it would be fairly typical. Recall again that the analysis began with student scores and found disciplinary clusters. It did not begin with disciplinary clusters and then look for confirmation. The analysis made no

assumptions about student experience within academic disciplines. The resulting academic clusters were used subsequently as a reasonable level of aggregation for undergraduate academic outcomes—all subsequent analyses were performed at the level of these clusters. The next analytical step was to determine the variables that were useful predictors of academic performance within the clusters.

Factors Associated with Academic Performance

Seven of the SERU/UCUES 2008 factors were considered in the prediction of cumulative grade point average in addition to important demographic variables and standard admissions measures collected by the university. Given that the California Constitution prohibits consideration of sex, race, or ethnicity in public university admissions, the demographic variables included were first-generation college (parents without bachelor degree), English as a first language (not other language or combination of other language and English), family income (above or below $65,000), and the Academic Performance Index score (API) quintile rank for high school attended. The standard measures included were high school grade point average and SAT Reading/SAT1 Verbal and SAT Math/SAT1 Math and SAT Writing/SAT2 Writing[1]. The factors and the items that comprise these factors are shown in Appendix 1.

Analysis

To avoid known problems of stepwise regression bias (Flom & Cassell, 2007), SAS Procedure GLMSELECT was used. The forward choice fit statistic specified was the Schwarz Bayesian Information Criterion (Schwarz, 1978) that balances increased prediction from the addition of new variables with a penalty term for number of parameters. In addition, students were limited to upper-division declared majors who matriculated as freshmen, and the declared majors had to fit the clusters identified in the first step.

Table 1: Descriptive Statistics for Variables Used in Analysis (N=15,171)

	Mean	Standard Deviation
Academic Performance		
Cumulative GPA (4.0 maximum)	3.21	0.44
Principal Component Factors		
Engagement Factor*	5.2	2.0
Disengagement Factor*	5.1	1.8
Quantitative Factor*	5.0	2.0
Academic Time Factor*	4.9	1.9
High School Measures		
HS Grade Point Average (Unweighted)	3.61	0.31
SAT Math/SAT1 Math	634	88
SAT Reading/SAT1 Verbal	600	91
SAT Writing/SAT2 Writing	608	94
Academic Performance Index Quintile	4.3	1.7
HS Honors Classes	15	7.1

* Standardized to a mean of 5 and standard deviation of 2

The group with complete data records was described in Table 1. The average University of California freshman matriculants reaching the upper division were well prepared for college. For the upper-division freshman matriculants in this study, mean unweighted high school GPA was 3.61, and SAT scores were 634 (SAT Math/SAT1 Math), 600 (SAT Reading/SAT1 Verbal) and 608 (SAT Writing/SAT2 Writing). They had also taken 15 high school honors classes on average. Across the University of California, six-year graduation rates were about 80%.

Results

Stepwise optimal solution produced variable series with two important characteristics for this paper. First, the variables selected were intuitively appealing and consistent with prior research (Table 2). For example, the first SAT score entered was Writing (SAT Writing/SAT2 Writing) for Social Sciences, Fine Arts, and Business Management; Reading (SAT Reading/SAT1 Verbal) for Agriculture, Language and Foreign Language; and Math (SAT Math/SAT1 Math) for Mathematics and Science and Engineering. It is also interesting that SAT Math/SAT1 Math was not included for Social Sciences, Fine Arts, Letters and Foreign Language.

These results confirm notions about skills important to or developed by instruction in academic areas and offer construct validity. The second important characteristic for this paper was that questionnaire-based factors frequently entered into the predictive series, especially Engagement, Disengagement, and Quantitative Professions for Mathematics and Science, Engineering, and Business Management. Self-ratings of skill gains were occasionally added, but not uniformly.

Table 2: Relative Predictive Strength by Academic Discipline Area

	Social Sciences	Agriculture	Fine Arts	Letters & Foreign Language	Mathematics & Science	Engineering	Business Management
	Predicting Cumulative Grade Point Average of Upper-Division Students Matriculating as Freshmen						
1st	SAT Writing/SAT2 Writing	HS GPA	SAT Writing/SAT2 Writing	1st Language	HS GPA	HS GPA	SAT Writing/SAT2 Writing
2nd	HS GPA	SAT Reading/SAT1 Verbal	HS GPA	***Engagement***	SAT Math/SAT1 Math	SAT Math/SAT1 Math	HS GPA
3rd	***Engagement***	***Disengagement***	***Engagement***	***Disengagement***	***Engagement***	***Engagement***	***Engagement***
4th	***Disengagement***	SAT Math/SAT1 Math	***Disengagement***	HS GPA	SAT Reading/SAT1 Verbal	***Disengagement***	SAT Math/SAT1 Math
5th	SAT Reading/SAT1 Verbal		1st Generation	SAT Reading/SAT1 Verbal	***Disengagement***	SAT Writing/SAT2 Writing	***Disengagement***
6th	HS API		HS API	SAT Writing/SAT2 Writing	***Skill Gains (NonQuant)***	***Skill Current (NonQuant)***	***Quant Professions***
7th	***Skill Gains (NonQuant)***				***Skill Current (NonQuant)***	***Quant Professions***	HS API
8th	***Skill Current (NonQuant)***				***Academic Time***	***Dev. of Scholarship***	
9th	1st Generation				***Quant Professions***		
10th	1st Language				SAT Writing/SAT2 Writing		
11th					HS API		
12th					***Dev. of Scholarship***		
R^2	0.36	0.34	0.35	0.47	0.39	0.31	0.36
N	6,643	418	606	866	3,954	1,623	669

To illustrate the extent to which disciplinary variation was important in describing the relationships, correlations among four factor scores, three SAT scores, high school GPA, and cumulative GPA were presented as Table 4. Engagement was typically correlated about 0.20 with cumulative GPA but not in Agriculture. Disengagement was always negatively correlated

[1] If an upper-division student in spring 2008 had submitted SAT scores after the addition of SAT Writing, then SAT Critical Reading was treated as SAT1 Verbal and SAT2 Writing as SAT Writing.

with GPA but less strongly in Mathematics and Science and Engineering where curricular practices differed from those in Social Sciences, Humanities, and Agriculture.

The strongest simple correlations for the Quantitative Professions factor were negative correlations for Letters and Foreign Languages, and Fine Arts. It is also important to note that the principal component factors were no more than weakly correlated with SAT scores and were nearly always more strongly correlated with GPA than with SAT scores. The correlations by discipline between Engagement or Disengagement and SAT were about 0.10 or less and frequently less than 0.05.

The correlations between Quantitative Professions and SAT scores were surprisingly negative. And last, considering the two most frequently used admissions measures, both high school GPA and SAT scores were consistently moderately to strongly correlated with cumulative GPA. High school GPA was not always the most highly correlated.

For the seven disciplinary areas shown in Table 4, there were three ties, three times that an SAT score was more highly correlated, and once when high school GPA was more highly correlated. The SAT score that was most highly correlated was more closely aligned with the content of the discipline:

o Social Sciences	SAT Reading/SAT1 Verbal
o Agriculture	SAT Writing/SAT2 Writing
o Fine Arts	SAT Writing/SAT2 Writing
o Letters and Foreign Languages	SAT Writing/SAT2 Writing.
o Mathematics and Sciences	SAT Math/SAT1 math and SAT Writing/SAT2 Writing
o Engineering	SAT Math/SAT1 Math
o Business and Management	All Three Scores

Viewed collectively, the results clearly supported the inclusion of Writing (SAT Writing/SAT2 Writing) as an SAT component.

The factor scores from SERU/UCUES 2008 were contemporaneous with cumulative grade point average and were therefore not necessarily causal. Did engaged students succeed at higher rates or does academic success encourage student engagement? The answer was not available from this study but should become addressable with subsequent questionnaire administrations, including the extension of this line of questioning to incoming freshmen.

An indirect indicator was available. If Engagement within academic discipline was strongly correlated with admissions test scores, then there would be support for the idea that good students were more engaged and got better grades. The GLMSELECT results for Engagement as a dependent variable were also in Table 2.

From these lists it was apparent that admissions test scores were infrequently associated with Engagement and that demographic variables dominated. More importantly, variance explained (R^2) for the models never exceeded 3%. Predicting student engagement with reasonable accuracy will require something more.

Table 3: Correlations Between Select Factor Scores, Admissions Scores and Cumulative GPA

	GPA	Engagement	Disengagement	Quantitative Professions	Academic Time	HS GPA	SAT Reading/ SAT1 Verbal	SAT Math/ SAT1 Math	SAT Writing/ SAT2 Writing
Social Sciences									
GPA	1.00	0.18	-0.19	-0.05	0.09	0.40	0.43	0.31	0.43
Engagement	0.18	1.00	-0.06	0.13	0.27	-0.02	0.00	-0.08	0.01
Disengagement	-0.19	-0.06	1.00	-0.05	-0.16	*-0.09*	0.03	0.10	0.03
Quantitative Professions	-0.05	0.13	-0.05	1.00	*0.13*	*-0.04*	*-0.14*	*0.00*	-0.12
Academic Time	0.09	*0.27*	*-0.16*	*0.13*	*1.00*	*0.07*	*-0.05*	*-0.01*	-0.05
HS GPA	0.40	*-0.02*	*-0.09*	*-0.04*	0.07	1.00	0.26	0.26	0.29
SAT Reading/ SAT1 Verbal	0.43	*0.00*	0.03	-0.14	*-0.05*	*0.26*	1.00	0.59	*0.79*
SAT Math/ SAT1 Math	0.31	-0.08	0.10	0.00	-0.01	0.26	0.59	*1.00*	0.61
SAT Writing/ SAT2 Writing	0.43	0.01	0.03	-0.12	-0.05	0.29	0.79	*0.61*	*1.00*
Agriculture									
GPA	1.00	0.03	-0.21	-0.02	0.13	0.41	0.41	0.33	0.40
Engagement	0.03	1.00	0.03	0.10	0.18	-0.02	0.06	-0.11	0.11
Disengagement	-0.21	0.03	1.00	-0.01	-0.17	-0.07	0.04	0.03	-0.03
Quantitative Professions	-0.02	0.10	-0.01	1.00	0.02	-0.13	-0.20	-0.07	-0.22
Academic Time	0.13	0.18	-0.17	0.02	1.00	0.11	-0.07	-0.07	-0.04
HS GPA	0.41	-0.02	-0.07	-0.13	0.11	1.00	0.19	0.21	0.21
SAT Reading/ SAT1 Verbal	0.41	0.06	0.04	-0.20	-0.07	0.19	1.00	0.49	0.80
SAT Math/ SAT1 Math	0.33	-0.11	0.03	-0.07	-0.07	0.21	0.49	1.00	0.46
SAT Writing/ SAT2 Writing	0.40	0.11	-0.03	-0.22	-0.04	0.21	0.80	0.46	1.00
Fine Arts									
GPA	1.00	0.17	-0.26	-0.11	0.14	0.36	0.40	0.28	0.41
Engagement	0.17	1.00	0.05	0.10	0.27	-0.08	0.00	-0.08	-0.02
Disengagement	-0.26	0.05	1.00	0.02	-0.07	*-0.19*	-0.01	0.07	-0.01
Quantitative Professions	-0.11	0.10	0.02	1.00	*0.04*	*-0.10*	*-0.16*	*-0.02*	-0.08
Academic Time	0.14	*0.27*	*-0.07*	*0.04*	*1.00*	*0.04*	*-0.04*	*-0.03*	-0.02
HS GPA	0.36	*-0.08*	*-0.19*	*-0.10*	0.04	1.00	0.23	0.19	0.23
SAT Reading/ SAT1 Verbal	0.40	*0.00*	-0.01	-0.16	*-0.04*	*0.23*	1.00	0.54	*0.77*
SAT Math/ SAT1 Math	0.28	-0.08	0.07	-0.02	-0.03	0.19	0.54	*1.00*	0.51
SAT Writing/ SAT2 Writing	0.41	-0.02	-0.01	-0.08	-0.02	0.23	0.77	*0.51*	*1.00*
Letters and Foreign Languages									
GPA	1.00	0.18	-0.28	-0.19	0.10	0.47	0.47	0.34	0.54
Engagement	0.18	1.00	-0.06	0.18	0.18	0.01	0.02	-0.05	0.06
Disengagement	-0.28	-0.06	1.00	0.02	-0.21	*-0.18*	0.05	0.08	-0.02
Quantitative Professions	-0.19	0.18	0.02	1.00	*0.14*	*-0.14*	*-0.24*	*-0.20*	-0.25
Academic Time	0.10	*0.18*	*-0.21*	*0.14*	*1.00*	*0.09*	*-0.08*	*-0.03*	-0.05
HS GPA	0.47	*0.01*	*-0.18*	*-0.14*	0.09	1.00	0.27	0.31	0.33
SAT Reading/ SAT1 Verbal	0.47	*0.02*	0.05	-0.24	*-0.08*	*0.27*	1.00	0.60	*0.81*
SAT Math/ SAT1 Math	0.34	-0.05	0.08	-0.20	-0.03	0.31	0.60	*1.00*	0.60
SAT Writing/ SAT2 Writing	0.54	0.06	-0.02	-0.25	-0.05	0.33	0.81	*0.60*	*1.00*
Mathematics and Science									
GPA	1.00	0.21	-0.14	-0.01	0.09	0.44	0.36	0.37	0.37
Engagement	0.21	1.00	0.02	0.14	0.22	0.02	0.02	-0.03	0.03
Disengagement	-0.14	0.02	1.00	0.01	-0.13	*-0.11*	0.07	0.12	0.05
Quantitative Professions	-0.01	0.14	0.01	1.00	*0.06*	*-0.08*	*-0.18*	*-0.11*	-0.16
Academic Time	0.09	*0.22*	*-0.13*	*0.06*	*1.00*	*0.04*	*-0.08*	*-0.10*	-0.06
HS GPA	0.44	*0.02*	*-0.11*	*-0.08*	0.04	1.00	0.18	0.19	0.23
SAT Reading/ SAT1 Verbal	0.36	*0.02*	0.07	-0.18	*-0.08*	*0.18*	1.00	0.52	*0.78*
SAT Math/ SAT1 Math	0.37	-0.03	0.12	-0.11	-0.10	0.19	0.52	*1.00*	0.56
SAT Writing/ SAT2 Writing	0.37	0.03	0.05	-0.16	-0.06	0.23	0.78	*0.56*	*1.00*
Engineering									
GPA	1.00	0.19	-0.15	0.03	0.11	0.37	0.27	0.37	0.32
Engagement	0.19	1.00	0.08	0.23	0.26	0.00	-0.02	-0.02	-0.02
Disengagement	-0.15	0.08	1.00	0.03	-0.15	*-0.13*	0.06	0.08	0.04
Quantitative Professions	0.03	0.23	0.03	1.00	*0.11*	*-0.03*	*-0.12*	*-0.14*	-0.12
Academic Time	0.11	*0.26*	*-0.15*	*0.11*	*1.00*	*0.03*	*-0.05*	*-0.04*	-0.05
HS GPA	0.37	*0.00*	*-0.13*	*-0.03*	0.03	1.00	0.21	0.20	0.25
SAT Reading/ SAT1 Verbal	0.27	*-0.02*	0.06	-0.12	*-0.05*	*0.21*	1.00	0.47	*0.78*
SAT Math/ SAT1 Math	0.37	-0.02	0.08	-0.14	-0.04	0.20	0.47	*1.00*	0.55
SAT Writing/ SAT2 Writing	0.32	-0.02	0.04	-0.12	-0.05	0.25	0.78	*0.55*	*1.00*
Business and Management									
GPA	1.00	0.11	-0.15	0.06	0.08	0.38	0.41	0.40	0.44
Engagement	0.11	1.00	0.02	0.16	0.27	-0.07	-0.09	-0.14	-0.13
Disengagement	-0.15	0.02	1.00	-0.02	-0.08	*-0.07*	0.03	0.13	0.03
Quantitative Professions	0.06	0.16	-0.02	1.00	*0.09*	*-0.07*	*-0.12*	*-0.12*	-0.13
Academic Time	0.08	*0.27*	*-0.08*	*0.09*	*1.00*	*-0.04*	*-0.16*	*-0.10*	-0.12
HS GPA	0.38	*-0.07*	*-0.07*	*-0.07*	-0.04	1.00	0.27	0.28	0.34
SAT Reading/ SAT1 Verbal	0.41	*-0.09*	0.03	-0.12	*-0.16*	*0.27*	1.00	0.60	*0.82*
SAT Math/ SAT1 Math	0.40	-0.14	0.13	-0.12	-0.10	0.28	0.60	*1.00*	0.64
SAT Writing/ SAT2 Writing	0.44	-0.13	0.03	-0.13	-0.12	0.34	0.82	*0.64*	*1.00*

Discussion

It is in our nature to see that for which we look. If we use sample-based surveys we see institutional patterns with perhaps a few demographic distinctions that can be supported by the sample size. If our admissions studies focus on that critical first year, then we see important associations between high school requirements, performance in high school, and on admission tests. If we redirect our focus on upper-division performance by academic major and if we include all students in our campus surveys, we realize that we haven't been seeing very much at all. That is unfortunate because quality of academic programs should be our educational focus. It is the quality of our academic programs that most concerns our faculty, parents, students, and employers.

This research takes a step in the direction of supporting admissions within a framework that recognizes the disciplinary differences in student experience by answering three questions.

- Should we view admissions policies as predicting general education outcomes or disciplinary specific outcomes?
- Can we aggregate our 100+ programs per campus to produce a manageable and accurate number of clusters?
- Can we identify the factors associated with performance by students in those clusters?

While recognizing that admission policies perform many important institutional functions, this study was concerned with the academic predictive validity of admissions practices generally and more specifically with the nature of the dependent variable. Based on several bodies of research and the results of SERU/UCUES census undergraduate surveys, the paper argues that general education is a misleading term and that admission standards designed to predict success in general education will therefore be misled. Instead, this paper asserts that admission policies should be designed to predict outcomes in the academic disciplines. Unfortunately, many institutions offer well over 100 academic programs and many students are unclear about their major at the time of application.

Cluster analysis of factor scores from a comprehensive undergraduate census survey was used to identify nine broader disciplinary areas: Social Sciences, Agriculture, Fine Arts, Humanities, Public Administration, Architecture and Environmental Design, Science and Mathematics, Engineering, and Business and Management. These disciplinary areas evidence varying levels of relative importance of factors including Engagement, Disengagement, Development of Scholarship, Quantitative Professions, and Non-quantitative Skills and Gains. The academic clusters are asserted as a minimum level of distinction that should be recognized in admissions.

A stepwise regression technique (SAS GLMSELECT) was employed to identify the relative importance of a variety of admissions, demographic, and survey-based educational experience factors. The results were telling. Traditional predictors were important in predicting cumulative grade point average of upper-division majors but the measures reflected disciplinary content,

and the traditional measures were joined by factor scores from the SERU/UCUES questionnaire, especially student Engagement and Disengagement.

- High school grade point average was an important early predictor for all disciplinary areas. That is reasonable given the required broad and rigorous high school curriculum for University of California admissions (History/Social Science – 2 years required; English – 4 years required; Mathematics – 3 years required, 4 years recommended; Laboratory Science – 2 years required, 3 years recommended; Language Other than English – 2 years required, 3 years recommended; Visual and Performing Arts – 1 year required; and one additional College-Preparatory Elective).

- The SAT scores were also reasonably identified as predictors and usually in expected orders. For Social Sciences, SAT Writing/SAT2 Writing and SAT Reading/SAT1 Verbal were important with Writing appearing first. In Agriculture, SAT Reading/SAT1 Verbal was the first test score to appear and was joined by SAT Math/SAT1 Math. Fine Arts saw only SAT Writing/SAT2 Writing and it appeared first. Test scores were not especially important for Letters and Foreign Language but SAT Reading/SAT1 Verbal was added and Math was not. Mathematics and Science saw the broadest range and longest list of predictors with SAT Math/SAT1 Math appearing before SAT Reading/SAT1 Verbal and SAT Writing/SAT2 Writing was well down the series. Engineering was best predicted by SAT Math/SAT1 Math and then SAT Writing/SAT2 Writing. Business Management saw SAT Writing/SAT2 Writing appearing before SAT Math/SAT1 Math.

- In all disciplinary areas, questionnaire-based factor scores appeared as predictors. In all but one case, Engagement was the first questionnaire-based factor to appear and was joined by Disengagement. The Quantitative Professions factor was a predictor in Mathematics and Science, Engineering, and Business Management. Current Skills and Skill Gains (nonquatitative) were predictors for Social Sciences, Mathematics and Science, and Current Skills was a predictor for Engineering. Development of Scholarship was last to appear as a significant predictor for Mathematics and Science, and Engineering. Demographic variables were inconsistent predictors and typically appeared late in the listings with one notable exception. In Letters and Foreign Language, first language was the first predictor and there was a GPA advantage for native English speakers.

Whether questionnaire-based factor scores should be considered predictors or outcomes is an interesting question that warrants further research. Many of the factors are probably both predictors and outcomes, especially Engagement. From this study, it cannot be determined whether students earn higher grades by engagement activities, become increasingly engaged because they have been academically successful, or that academic success is due in part to rewarded past engagement.

When Engagement was treated as a dependent measure, demographic variables were more common predictors than SAT scores or HS grade point average and no combination of variables predicted more than 3% of Engagement variance. Engagement as an upper-division

student was not highly correlated with academic performance in high school. This suggests that Engagement brings something more to the admissions process than is offered by the SAT or high school grade point average. It certainly warrants further study, and we will soon have helpful information. In the fall of 2008, incoming freshmen at the Berkeley campus answered the Engagement factor items about their high school experience and longitudinal study of this group will help to identify causal directions

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Appendix 1: Principal Components and Items

Factor 2: Current Skills Self-Assessment (Nonquantitative)

2. Please rate your level of proficiency in the following areas when you started at this campus and now.

Current ability level

- Analytical and critical thinking skills
- Ability to be clear and effective when writing
- Ability to read and comprehend academic material
- Understanding of a specific field of study
- Ability to speak clearly and effectively in English
- Understanding international perspectives (economic, political, social, cultural etc.)
- Leadership skills
- Computer skills
- Internet skills
- Library research skills
- Other research skills
- Ability to prepare and make a presentation
- Interpersonal (social) skills

3. Similarly, please rate your abilities now and when you first began at this university on the following dimensions.

Current ability level

- Ability to appreciate, tolerate and understand racial and ethnic diversity
- Ability to appreciate the fine arts (e.g., painting, music, drama, dance)
- Ability to appreciate cultural and global diversity
- Understanding the importance of personal social responsibility
- Self awareness and understanding

Factor 3: Engagement with Studies

5. How frequently during this academic year have you done each of the following?

- Sought academic help from instructor or tutor when needed
- Worked on class projects or studied as a group with other classmates outside of class
- Helped a classmate better understand the course material when studying together

6. How frequently have you engaged in these activities so far this academic year?

- Taken a small research-oriented seminar with faculty
- Communicated with a faculty member by email or in person
- Talked with the instructor outside of class about issues and concepts derived from a course
- Interacted with faculty during lecture class sessions
- Worked with a faculty member on an activity other than coursework (e.g., student organization, campus committee, cultural activity)

7. During this academic year, how often have you done each of the following?

- Contributed to a class discussion
- Brought up ideas or concepts from different courses during class discussions
- Asked an insightful question in class
- Found a course so interesting that you did more work than was required
- Chosen challenging courses, when possible, even though you might lower your GPA by doing so
- Made a class presentation
- Had a class in which the professor knew or learned your name

12. Indicate the following research and creative activities that you are currently doing or have completed as a UC student.

- At least one student research course (e.g., course 99)
- At least one independent study course (e.g., 199)
- Assist faculty in research with course credit
- Assist faculty in research for pay without course credit
- Assist faculty in research as a volunteer without course credit
- Work on creative projects under the direction of faculty with course credit
- Work on creative projects under the direction of faculty for pay without course credit
- Work on creative projects under the direction of faculty as a volunteer without course credit

20. How many professors do you know well enough to ask for a letter of recommendation in support of an application for a job or for graduate or professional school?

Appendix 1: Principal Components and Items (Continued)

Factor 4: Gains in Self-Assessment of Skills (Nonquantitative) – Computed change between initial and current skill levels for items comprising Factor 2

Factor 5: Development of Scholarship

5. How frequently during this academic year have you done each of the following?
    - Raised your standard for acceptable effort due to the high standards of a faculty member
    - Extensively revised a paper at least once before submitting it to be graded

16. Thinking back over your coursework this academic year, how often were you REQUIRED to do the following?
    - Recognize or recall specific facts, terms and concepts
    - Explain methods, ideas, or concepts and use them to solve problems
    - Break down material into component parts or arguments into assumptions to see the basis for different outcomes and conclusions
    - Judge the value of information, ideas, actions and conclusions based on the soundness of sources, methods and reasoning
    - Create or generate new ideas, products or ways of understanding

17. Thinking back on this academic year, how often have you done each of the following?
    - Used facts and examples to support your viewpoint
    - Incorporated ideas or concepts from different courses when completing assignments
    - Examined how others gathered and interpreted data and assessed the soundness of their conclusions
    - Reconsidered your own position on a topic after assessing the arguments of others

Factor 7: Academic Disengagement

5. How frequently during this academic year have you done each of the following?
    - Turned in a course assignment late
    - Gone to class without completing assigned reading
    - Gone to class unprepared
    - Skipped class

15. Were the following factors very important to you in deciding on your major?
    - Easy requirements
    - Allows time for other activities

21. You told us earlier how much time you spend studying and working in a week. How many hours do you spend on each of these other activities in a typical 7 day week?
    - Attending movies, concerts, sports, or other entertainment events
    - Participating in physical exercise, recreational sports, or physically active hobbies
    - Participating in student clubs or organizations
    - Pursuing a recreational or creative interest (arts/crafts, reading, music, hobbies, etc.)
    - Socializing with friends
    - Partying
    - Using the computer for non-academic purposes (games, shopping, email/instant messaging, etc.)
    - Watching TV

Factor 8: Quantitative Professions

2. Please rate your level of proficiency in the following areas when you started at this campus and now.

Current ability level
    - Quantitative (mathematical and statistical) skills

Change between self-reported current skill level and skill level at entry
    - Quantitative (mathematical and statistical) skills

15. Were the following factors very important to you in deciding on your major?
    - Leads to a high paying job
    - Prepares me for a fulfilling career
    - Prestige

Factor TB: Academic Time

1. During your TYPICAL 7-day (168 hour) week during the academic term, how many hours do you spend doing the following?
    - Attending classes, discussion sections or labs
    - Studying and other academic activities outside of class