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ABSTRACT

This paper describes a study of native and transfer students conducted at an urban doctoral-granting university (Southern University, Louisiana) to determine the comparability of commonly numbered coursework between a two-year college and the university within the same state system of higher education. Using a cluster analytic model, the study examined stratified samples of graduating seniors composed of transfer students and those who had earned their entire credits (the so-called "natives") at Southern University. Differences were found between the groups in the gains the students demonstrated in student incoming abilities, general learned abilities, and differences in coursework patterns in which they enrolled. In general, community college students showed greater gains than did natives and took a more discrete set of courses from a more limited array of choices. Additionally, the cluster analysis did not find clearly discrete and logical sets of general education coursework. The results did not support the efficacy of a statewide core curriculum and common course numbering system, but did support the current use of a wide range of options in a distributional general education requirement. These findings suggest the need for greater academic advising in undergraduate course selection or greater prescription in the curriculum. Contains 20 references. (GLR)

ARE COMMON COURSE NUMBERING AND A CORE CURRICULUM VALID INDICATORS IN THE ARTICULATION OF GENERAL EDUCATION CREDITS AMONG TRANSFER STUDENTS?

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Are the credits a student earns at a community college truly equivalent to those earned in the lower division of a university? This simple question drives efforts to ease, increase and facilitate community college student progress, persistence, performance and degree attainment in baccalaureate programs (Giddings, 1985; Richardson & Doucette, 1980). Recent examination of the quality of undergraduate education, of the distribution of funding among public higher education, and of the success of minority students has brought a renewed interest in the process of articulation of credits between community and junior colleges to four-year college and university baccalaureate programs (Eaton, 1990).

Two common means for facilitating the transfer process within public higher education systems have been the common core curricula and common course number schemes (Kintzer & Wattenbarger, 1985). A core curriculum asks students at all system colleges and universities to take the same sequence of courses to complete their general education requirement for the baccalaureate degree. When a student completes the core at one institution, it is held applicable to degree requirements for all system institutions (Morgan & Teel, 1990). The underlying assumption is that the effect of the core pattern of courses at one institution in the system is comparable to all others in its effect on student learning. Similarly, a common course numbering system requires that comparably named courses bear the same department and course numbering scheme. The assumption is that Math 101 at the Community College is comparable in its effect on student learning to Math 101 at the State University.

What is the most effective pattern of undergraduate general education for a given group of students? "No curricular concept is as central to the endeavors of the American college as general education, and none is so exasperatingly beyond the reach of consensus and understanding" (Carnegie Foundation for the

Advancement of Teaching 1977, p. 164). The debate has continued concerning the structure and content of general education as discussed by numerous reports (Association of American Colleges 1988; National Institute of Education 1984; National Endowment for the Humanities, 1984; American Colleges Committee's Project on Redefining the Meaning and Purpose of Baccalaureate Degrees 1985). Yet, evidence has emerged that different students experience different subenvironments within colleges and universities, particularly in relation to their formal coursework (Pascarella, 1985; Ratcliff, 1989; Jones & Ratcliff, 1990).

At one end of the continuum, there are advocates for a core curriculum who believe that general education should consist of prescribed coursework required of all students (Boyer and Kaplan 1977; National Endowment for the Humanities 1989). They believe that one curriculum is appropriate and fits all students. Others support the distributive model which consists of "requirements designed to ensure that each student takes a minimum number of courses or credits in specified academic areas" (Levine 1978, 11). Students at many colleges meet distribution requirements by enrolling in courses selected from many offerings in differents subject fields. The advocates of the distributive requirements believe that different curricula are necessary for different students based upon student interest and/or student ability. Common course numbering and system wide core curriculum requirements are based on the assumption that the effects of commonly named and labeled courses are the same. This paper examines student transcripts and test scores of native and transfer students at an urban state university to determine the extent to which general education coursework with comparable course numbering produces common effects in the general learning abilities among these college students.

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Problem Investigation

Given the views of the advocates of common course numbering systems as articulation mechanisms, the fundamental question is whether the effect of coursework at a two-year college is comparable in its effect on general learned abilities to that of the identically numbered coursework at an urban doctoral granting university (hereafter called Southern University) within the same state system of higher education. We first established relationships between student coursework and common measures of general learned abilities, the Scholastic Aptitude Test and the General Test of the Graduate Record Examination. Secondly, we examined if these relationships were the same for native students (those who began their education at Southern University) and for transfer students.

Framework

A literature review indicated that no single curricular model and no single analytical process clearly identified the effect of coursework patterns on the general learned abilities of students. Therefore, a cluster analytic model was developed to determine the effect of coursework in colleges and universities (Ratcliff 1987). This model has proven valid and reliable within the context of a variety of higher education institutional types and student populations (Ratcliff 1988). The model uses a conceptual-empirical approach. Student decisions about courses and actual selections guided the empirical search for coursework patterns associated with gains in general learned abilities.

Sample

Two stratified samples of graduating seniors were drawn from a doctoral-granting university (referred to as Southern University). Since the sample size was small, they were combined together. Two subsamples were drawn from this combined sample. One subsample consisted of 76 students who had earned up to 90 quarter credits at a nearby public two-year college and subsequently transferred to Southern University. The second subsample consisted of 168 "Native" students who earned their credits exclusively from Southern University. These students graduated from Southern during the 1986-87 and 1987-88 academic years. Analysis indicated that the sample was proportional to the distribution of Scholastic Aptitude Test (SAT) scores, majors, and other socioeconomic characteristics of the population of graduating seniors at this institution.

Differences in Southern University Transfer and Native Subsamples

Characteristics

A brief description of the characteristics of the Southern University subsamples reveals some differences between the Transfer and Native groups. Gender is a factor related to academic performance. Approximately two-thirds (65.8%) of the Transfer group were female, while 56.5 percent of the Native group were female.

Ethnicity is also related to academic performance. Ninety-two percent of the Transfer group were white, while 35.1 percent of the Native students were white (see Table 1). However, 47.6 percent of the Native students did not indicate their ethicity. Gender and ethnicity differences may be contributors to the variation in performance among the two groups of students, but due to missing data, were not directly addressed in this paper.

Major field of study has been shown to be correlated to performance in the GRE examinations. The distribution of majors in the Transfer group approximated that of the Native group. Majors in Accounting, Journalism, Management, Marketing, and Psychology were frequently evident in both groups. These majors were dominant curricular groups at Southern and may have an effect on the variation in scores of general learning but did not vary significantly between the Transfer and Native students.

Both subsamples enrolled in Southern University coursework dispersed over a number of years. In the Transfer group, one student began his/her enrollment in 1958 while for the Native group two students began their enrollment in 1970. Nearly one-third (30.4 percent) of the native students and one-quarter (24.8 percent) of the trsnfer students began their enrollment prior to 1980. These students were probably enrolling in courses on a part-time basis.

Students in the Transfer and Native groups were clearly planning some form of post-baccalaureate study (see Table 2). Over one-half (56.6%) of the Transfer students and 66.1 percent of the Native students planned a master's degree. Approximately 16 percent of the Transfer and Native students planned a doctoral program. These students planned advanced study in greater proportion than most undergraduates and reflect the self-selected nature of the sample.

The educational attainment of parents has been shown to be positively correlated to student achievement in college. One-quarter of the fathers and 15.8 percent of the mothers of the Transfer group had attained a high schools diploma or its equivalent while over 14.3 percent of the fathers and 30.9 percent of the mothers of Native students had attained a high school diploma. Only 1.3 percent of the fathers and the mothers of Transfer students had attained at least a bachelcr's degree while 10.1 percent of the fathers and 9.5 percent of the mothers of Native students completed the bachelor's degree (see Table 3).

Nearly two-thirds (63.2%) of the Transfer students and 52.4 percent of the Native students had performed some community service during the past year, but for 42.1 percent of the Transfer students and 38.1 percent of the Native students this comprised less than five hours per week (see Table 4). Over one-third (38%) of the Transfer students and 50 percent of the Native students had earned some form of professional, community service, literary, artistic, or student government honor, or award.

Contrary to popular conceptions of community college and university students, the Native Southern University students were more likely to be from a a racial/ethnic minority and were slightly more likely to be part-time students. For this reason, extrapolation of these results to other community college or university populations should be viewed with caution.

TABLE 1
Distribution of Subsamples by Ethnicity

ETHNICITY	TRANSFER N	TRANSFER Percent	NATIVE N	NATIVE Percent
Not specified	1	1.32%	80	47.62%
Black	2	2.63%	3	1.79%
Chinese American	0	.00%	0	.00%
Japanese American	0	.00%	0	.00%
Other Asian American	1	1.32%	0	.00%
Native American	0	.00%	0	.00%
Chicano/Hispanic	2	2.63%	1	.60%
White	70	92.11%	59	35.12%
Foreign	0	.00%	0	.00%
TOTALS	76	100.00%	168	100.00%

TABLE 2
Degree Objectives of Subsamples

DEGREE OBJECTIVES	TRANSFER N	TRANSFER Percent	NATIVE N	NATIVE Percent
Unknown	9	11.84%	21	12.50%
Nondegree study	8	10.53%	5	2.98%
Masters degree	43	56.58%	111	66.07%
Intermediate degree (e.g. Specialist)	3	3.95%	3	1.79%
Doctorate (Ph.D., Ed.D.)	12	15.79%	28	16.67%
Postdoctoral study	1	1.32%	0	.00%
TOTALS	76	100.00%	168	100.00%

TABLE 3

Educational Attainment of Parents of Subsamples

HIGHEST LEVEL OF EDUCATION COMPLETED	TRANSFER				NATIVE			
	Father		Mother		Father		Mother	
	N	Percent	N	Percent	N	Percent	N	Percent
No response	6	7.89%	6	7.89%	12	7.14%	13	7.74%
Grade school or less	10	13.16%	14	18.42%	22	13.10%	12	7.14%
Some high school	15	19.74%	29	38.16%	21	12.50%	30	17.86%
High school diploma or equivalent	19	25.00%	12	15.79%	24	14.29%	52	30.95%
Business or trade school	9	11.84%	3	3.95%	25	14.88%	15	8.93%
Some college	7	9.21%	5	6.58%	18	10.71%	12	7.14%
Associate degree	6	7.89%	3	3.95%	10	5.95%	7	4.17%
Bachelor's degree	1	1.32%	1	1.32%	17	10.12%	16	9.52%
Some graduate or professional school	1	1.32%	2	2.63%	6	3.57%	1	.60%
Graduate or professional degree	2	2.63%	1	1.32%	13	7.74%	10	5.95%
TOTALS	76	100.00%	76	100.00%	168	100.00%	168	100.00%

TABLE 4

Community Service Activities of Subsamples

HOURS PER WEEK IN COMMUNITY SERVICE ACTIVITIES OVER THE PAST YEAR	TRANSFER		NATIVE	
	N	Percent	N	Percent
No response	6	7.89%	19	11.31%
0 hours	28	36.84%	61	36.31%
1 - 5 hours	32	42.11%	64	38.10%
6 - 10 hours	6	7.89%	16	9.52%
11 - 20 hours	1	1.32%	2	1.19%
More than 20	3	3.95%	6	3.57%
TOTALS	76	100.00%	168	100.00%

Overview of Methodology and Procedures

While incoming student ability of the sample was controlled by SAT scores, the exiting student achievement was measured by the Graduate Record Examination (GRE) scores. Specifically, the residual differences from the predicted and observed scores on the nine item-types within the General Test (of the GRE) served as the measures of exiting student achievement. In the Verbal section of the GRE, the four item-types were Analogies, Sentence Completion, Reading Comprehension, and Antonyms. In the Quantitative section of the GRE the item-types were Quantitative Comparison, Regular Mathematics, and Data Interpretation. In the Analytic section, the item-types were Analytical Reasoning and Logical Reasoning. These nine GRE item-type residual scores represented the gains students experienced in general learned abilities from the time they entered college to the time of GRE testing during their senior year.

Next the coursework patterns at Southern University were identified among the student transcripts. The unit of analysis was a single course. Each course examined had nine attributes represented by the nine residual item-type scores of students enrolling in the course. Courses with sufficient enrollment by the student sample were grouped according to the collective item-type scores of the students enrolling in the course. Therefore, each course had a mean residual score for each item-type. The effect of individual courses on test score residuals was determined by using cluster analysis. The cluster analysis techniques facilitated the construction of a classification scheme for unclassified data sets and it empirically examined the college curriculum using student decision-making behavior (represented on the student transcripts) as the primary source of information.

Reliability and Correlation of GRE Item-types

On average, the Transfer group answered 93 of 186 items correctly (see Table 5); the Native group gave correct responses to an average of 100 of the 186 items (see Table 6). Based on raw GRE scores alone, the Native students performed better than the Transfer students. This performance may be attributable to differences in incoming student ability or to the extent of gain in learning over the four years of undergraduate education.

TABLE 5
Distribution of GRE Scores for Students in the Transfer Group of Southern University

GRE Item-types	Number of Items	Minimum Right	Maximum Right	Score Range	Sample Mean	Standard Deviation
Analogy	18	0	16	16	9.79	2.6347
Sentence Completion	14	0	14	14	8.08	2.8084
Reading Comprehension	22	0	21	21	10.91	3.7173
Antonyms	22	0	20	20	10.34	4.3191
Quantitative Comparison	30	0	29	29	17.30	5.3342
Regular Mathematics	20	0	18	18	9.20	3.3784
Data Interpretation	10	0	9	9	4.68	2.2581
Analytical Reasoning	38	0	29	29	16.72	5.8506
Logical Reasoning	12	0	12	12	6.28	2.2838
GRE Verbal	76	0	66	66	39.12	11.3160
GRE Quantitative	60	0	53	53	31.18	9.3033
GRE Analytic	50	0	39	39	23.00	7.0730
GRE Verbal (converted)					452.00	94.6830
GRE Quantitative (converted)					458.40	103.9366
GRE Analytic (converted)					481.47	102.6104
Minimum	10	0	9	9	4.68	2.26
Maximum	38	0	29	29	17.30	5.85
Mean	21	0	19	19	10.44	3.74
Total	186				93.30	32.58

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TABLE 6
Distribution of GRE Scores for Students in the Native Group of Southern University

GRE Item-types	Number of Items	Minimum Right	Maximum Right	Score Range	Sample Mean	Standard Deviation
Analogy	18	3	16	13	10.26	2.5966
Sentence Completion	14	3	14	11	8.92	2.6860
Reading Comprehension	22	4	21	17	12.06	4.0516
Antonyms	22	0	22	22	10.92	4.1513
Quantitative Comparison	30	6	29	23	17.45	4.7974
Regular Mathematics	20	1	18	17	9.98	3.2665
Data Interpretation	10	1	10	9	5.14	2.0177
Analytical Reasoning	38	5	33	28	18.99	6.1508
Logical Reasoning	12	1	12	11	6.11	2.2678
GRE Verbal	76	19	70	51	42.15	10.9615
GRE Quantitative	60	13	53	40	32.56	8.6035
GRE Analytic	50	10	44	34	25.10	7.3929
GRE Verbal (converted)					474.58	102.4073
GRE Quantitative (converted)					475.83	108.9823
GRE Analytic (converted)					504.23	112.8801
Minimum	10	0	10	9	5.14	2.02
Maximum	38	6	33	28	18.99	6.15
Mean	21	3	20	17	11.19	3.67
Total	186				99.82	31.99

Transfer and Native Groups' Performance on the GRE Examination

Differences among scores for the subsamples appeared when the effect of the precollege learning (as measured by the SAT) was removed. When the theoretical scores (as predicted by corresponding SAT scores) were compared with the students' actual responses, the subgroups showed large proportions of change on most item-types. Table 7 presents the results of the regression analyses of individual GRE item-type scores on SAT subscores. For both the Transfer and Native groups, the greatest amount of variance in item-type residuals, including the greatest standard error and standard deviation, were found in Analytic Reasoning. In analysis of other student groups and institutions, the greatest amount of score variance was in Analytic Reasoning as well (Ratcliff, 1987, 1988; Jones & Ratcliff, 1990). The variance in the residuals holds implications for the ensuing cluster analysis in that GRE item-types with greater variance will play a more significant role in sorting courses into clusters. As was discovered in the previous analysis of another institution, those GRE item-types with smaller variance play less of a role in discriminating course clusters.

Table 7 compares the explained variance (r^2) for each GRE item-type, raw GRE sub-score and converted GRE sub-score. In all cases within the subsamples of the Southern University where errors estimates were less than .01, the SAT accounted for more variance in GRE sub-scores than in the GRE item-type scores.

As this table demonstrates, from 12.6 percent (Data Interpretation) to 38.45 percent (Reading Comprehension) of GRE item-type score variation among the Transfer group was explained by SAT scores; from 26.9 percent (Data Interpretation) to 52.1 percent (Quantitative Comparisons) of GRE item-type score variation among the Native group was explained by SAT scores.

Using the student residuals obtained from the regression analysis above, the mean residuals for each course enrolling 5 or more students were calculated for all the 9 GRE item-types. Such a procedure did not assume that the specific gains of the students enrolled in each course were directly caused by that course. Rather, the residuals of each student were attributed to all the courses in which they enrolled, and the mean residuals for each course served as a proxy measure of student gains. Once courses were clustered by these residuals, then hypotheses were generated and tested as to why students who enrolled in a given pattern of courses experienced significant gains on one or more of the outcomes criteria (i.e., the item-type residuals).

TABLE 7
Summary of Regression Analysis of GRE Item-types on SAT Subscores for the Transfer and Native Groups of Southern University

Dependent Variables: GRE Item-types on SAT Sub-scores	CODE	Transfer Group 76 Students F Value	Prob>F	Adjusted R-Squared	Native Group 168 Students F Value	Prob>F	Adjusted R-Squared
GRE Item-type scores							
Sentence Completion	SC	32.148	.0001	.2934	124.610	.0001	.4253
Analogies	ANA	35.046	.0001	.3122	93.910	.0001	.3575
Reading Comprehension	RD	47.848	.0001	.3845	97.122	.0001	.3653
Antonyms	ANT	28.616	.0001	.2691	143.335	.0001	.4601
Quantitative Comparisons	QC	42.137	.0001	.3542	182.350	.0001	.5206
Regular Math	RM	34.089	.0001	.3061	146.754	.0001	.4660
Data Interpretation	DI	11.847	.0010	.1264	62.317	.0001	.2686
Analytic Reasoning	ARE	28.346	.0001	.[illegible]672	99.616	.0001	.3713
Logical Reasoning	LR	18.551	.0001	.1896	74.640	.0001	.3060
Raw Sub-test Scores							
Verbal	GRE-V	62.267	.0001	.4496	266.909	.0001	.6142
Quantitative	GRE-Q	51.195	.0001	.4009	268.383	.0001	.6155
Analytical	GRE-A	37.490	.0001	.3273	143.057	.0001	.4596

Quantitative Cluster Analysis of Transfer and Native Southern University Subgroups

This section reports the use of the quantitative cluster analytic procedure to analyze the Transfer and Native groups of Southern University. The results for each subsample are compared to determine the extent to which students benefit from differ nt coursework patterns. Secondary validation (discriminant analyses) of the two subsamples suggested that the cluster analytic model was valid (secondary validity) and reliable means for determining coursework associated with the general learned abilities of undergraduates. The objects of these analyses are the courses which constitute the enrollment patterns of students in the subsamples.

There were 3,427 courses listed on the 76 transcripts of the students in the Transfer group, indicating that, on average, each of these students had enrolled in an average of 45.1 courses as part of the baccalaureate degree program. There were 1,088 unduplicated courses on the Transfer transcripts, 177 in which 5 or more students had enrolled. These 177 courses were the subject of subsequent quantitative cluster analysis.

There were 7,850 courses listed on the 168 transcripts of the students in the Native group, indicating that, on average, each of these students had enrolled in an average of 46.7 courses as part of the baccalaureate degree program. There were 1,244 unduplicated courses on the Native transcripts, 300 in which 5 or more students had enrolled. These 300 courses were the objects of further analysis.

Discussion of Subgroup Residual Scores

Residuals represent the GRE item-type variance not explained by the corresponding SAT score. Residuals may be positive or negative. If they are positive, they indicate that the student's actual score exceeded its value predicted by the SAT. If the residuals are negative, they indicate that the students performance on the GRE item-type was less than that predicted by the corresponding SAT score. Thus, residuals may express either positive or negative change of a student's general learned abilities relative to the sample group.

While the average of residuals means for the Southern University Transfer group was positive, there were negative residuals on Antonyms and Quantitative Comparisons; positive residuals were particularly pronounced on Reading Comprehension (see Table 8). The Southern University Native group showed a positive average of mean residuals (see Table 9). Negative residuals were found on the Antonyms, Regular Mathematics, and Quantitative Comparisons item-types; positive residuals were particularly pronounced on the Reading Comprehension and Analytic Reasoning item-types. In both groups, there were positive and negative residuals in comparable areas. Antonyms and Quantitative Comparisons were negative; Reading Comprehension was positive. Native students also showed negative residuals on Regular Mathematics and positive residuals on Analytic Reasoning.

While the residual means describe the direction of change in general learned abilities (positive or negative), the standard deviation of residuals give estimates of the variation in change. The greatest variation in residuals occurred among the Native subgroup. The greatest variation for both groups occurred in the Analytic Reasoning item-type. These data indicated differences in general learned abilities according to the entering SAT scores. Also, these data suggested that the effect of the undergraduate experience varied between the Transfer subgroup and the Native subgroup. Specifically, incoming ability as measured by the SAT accounted for less of the score variance among the Transfer group. Using residuals as proxies for gains in general learned abilities, the Transfer students showed greater gains than did Native students in all 9 areas measured by the GRE.

The Southern University students in the two groups did not register strong positive gains, once the effect of their precollege SAT scores were removed.

Nevertheless, some students gained and some students declined in general learned ability within both subgroups. These cluster analyses differentiated between courses taken by students who showed gains on the item-types and those who declined. While the sum of all residuals is zero, when residuals were aggregated by course, some courses had positive mean residuals while others had negative mean residuals for the students who enrolled in them. Courses with 5 or more students had slightly positive average mean course residuals. This indicated that the average Southern University student did select common coursework associated with gains in general learned abilities.

TABLE 8
Distribution of GRE Item-type Residuals Scores for 177 Transfer Group Courses

GRE Item-types	Number of Items	Max Value	Min Value	Score Range	Residual Means	Standard Deviation
Analogy	18	.92	-1.33	2.25	.1756	.4348
Sentence Completion	14	2.21	-1.90	4.11	.1906	.8098
Reading Comprehension	22	2.01	-1.04	3.05	.4236	.7890
Antonyms	22	1.36	-2.19	3.55	-.1104	.7912
Quantitative Comparison	30	1.76	-2.08	3.84	-.0403	.8312
Regular Mathematics	20	2.25	-1.94	4.19	.1733	.8965
Data interpretation	10	1.60	-1.32	2.92	.1305	.6524
Analytical Reasoning	38	3.67	-2.96	6.63	.0027	1.4563
Logical Reasoning	12	1.51	-1.11	2.62	.0439	.6034
GRE Item-types:						
Minimum	10	.92	-2.96	2.25	-.1104	.6034
Maximum	38	3.67	-1.04	6.63	.4236	1.4563
Mean	21	1.92	-1.82	3.68	.1017	.8537
Total	186				.8139	

TABLE 9
Distribution of GRE Item-type Residuals Scores for 300 Native Group Courses

GRE Item-types	Number of Items	Max Value	Min Value	Score Range	Residual Means	Standard Deviation
Analogy	18	4.07	-2.43	6.50	.0690	.8968
Sentence Completion	14	5.13	-2.79	7.92	.0559	.7768
Reading Comprehension	22	3.86	-6.61	10.47	.1521	1.3937
Antonyms	22	3.83	-5.38	9.21	.0549	1.1732
Quantitative Comparison	30	3.50	-5.71	9.21	.0170	1.1261
Regular Mathematics	20	2.57	-4.47	7.04	.0090	.9393
Data interpretation	10	1.86	-1.90	3.76	.0420	.5694
Analytical Reasoning	38	9.56	-10.31	19.87	.1414	2.2364
Logical Reasoning	12	1.81	-1.70	3.51	.0538	.5837
GRE Item-types:						
Minimum	10	1.81	-10.31	3.51	.0090	.5694
Maximum	38	9.56	-1.70	19.87	.1521	2.2364
Mean	21	4.02	-4.59	8.61	.0658	1.0998
Total	186				.5261	

Creating the Raw Data Matrix and the Resemblance Matrix for the Transfer and Native Groups

Using the mean residuals of the Southern University Transfer group and the 177 courses found on 5 or more of their student transcripts, a raw data matrix was created. The data matrix consisted of 177 columns and 9 rows (177 x 9). Using the mean residuals of the Native group and the 300 courses found on 5 or more of their student transcripts, a second separate raw data matrix was created. This data matrix consisted of 300 columns and 9 rows (300 x 9). The rows represented the criterion variables: the 9 GRE item-type residual scores. The columns represented those courses enrolling 5 or more students. Thus, each cell value of the matrix was a mean GRE item-type score gain for those sample group students enrolling in a specific course.

For the Transfer group, a resemblance matrix was created next to describe how closely each course resembled the other 176 courses according to the criterion variables: the student score residuals. Likewise, for the Native group a resemblance was created to describe how closely each course resembled the other 185 courses according to the criterion variables. To calculate the resemblance matrix, the correlation coefficient was selected as a similarity measure. Thus, this coefficient assessed a pattern similarity of any two courses explained in terms of the 9 GRE item-type residuals.

The resemblance matrix produced in this step consisted of 177 rows and 177 columns for the Transfer group and 300 columns and 300 rows for the Native group, in which each cell value theoretically ranged from -1.00 to 1.00. The calculation of the resemblance matrix was done using the SPSSx PROXIMITY program.

Selection of the Clustering Method for Transfer and Native Groups

The method selected for the quantitative analyses was the average linkage method (UPGMA). The original dendrograms of both groups' courses were produced by SPSS-X. The results of the cluster analysis of the Transfer group of Southern University is briefly described. Courses were classified into 13 coursework patterns according to the resultant hierarchical cluster structure. In fact, the choice to present the data in 13 clusters was arbitrary. Any number of clusters can be identified depending on the hierarchical cluster structure produced; this structure remains constant regardless of the number of clusters used to form coursework patterns. A procedure for selecting the optimum number of clusters and for validating the resulting patterns is described in greater detail in a subsequent section of this paper.

Using a 13-cluster solution to the quantitative cluster analysis, the largest number of courses were in Coursework Clusters #2 with 31 courses and Cluster #8 with 28 courses. The smallest clusters were the 12th, and 13th clusters with 2 courses each. Overall, the differentiation between clusters was attributable to the number of criterion variables used in the analysis and also to the choice of those variables. The cluster analyses and subsequent discriminant analyses for both groups suggested that student residual scores on GRE item-types were strong, reliable and robust measures in differentiating student general learned abilities.

Each hierarchical cluster structure was represented in a dendrogram. The dendrogram displayed the clusters being combined and the distances between the clusters at each successive step, suggesting that the 13-cluster solution examined is appropriate and interpretable. Cluster analyses using smaller and larger numbers of cluster groupings provided comparably high levels of correct classification, as determined by subsequent discriminant analyses. However, as the resemblance index increases (as the Euclidean distance between courses grows), more distant courses joined into larger and larger clusters. A 12-cluster solution, for example, might provide a high degree of aggregation which may result in a high degree of predictive validity but a low level of utility in differentiating coursework by item-type.

For the Transfer group, a careful examination of courses within each cluster indicated that some courses coming from the same department appear in the same cluster, such as the Psychology (PSY) in Cluster #8 (see Table 11). Similarly, there were apparent sequences of courses, such as the Math 211, 212, 215, 216 sequence in Cluster #5. Also, a set of courses coming from various related disciplines may form a homogeneous cluster on the basis of a set of given attributes or criteria.

For the Native group a 13-cluster solution was used for the quantitative cluster analysis. The largest number of courses were found in Coursework Clusters #1 with 53 courses and Cluster #6 with 50 courses. The smallest clusters were the 13th cluster with 3 courses and the 8th cluster with 4 courses.

For the Native group, some courses from the same department appeared in the same cluster, such as the English (ENG) courses in Cluster #1, the Computer Information Systems (CIS) in Cluster #2, and the Journalism (JOURN) courses in Cluster #7 (see Table 12). Similarly, there were apparent sequences of courses, such as the Anthropology 201, 202, and 203 sequence in Cluster #1. Also, a set of courses coming from various related disciplines may form a homogeneous cluster on the basis of a set of given attributes or criteria. The homogeneity of disciplines is particularly apparent in Cluster #1.

At this point in the analysis, it was difficult to describe which dimensions of student general learned ability were represented in each cluster. However, it seemed clear that one pattern of course enrollment contributed to student general learned ability in a way significantly different from the other coursework patterns. Supporting this finding was a more detailed examination of subset courses of each clusters. In many cases, those courses offered at the same level often were combined into pairs together. But, those pairs were agglomerated with other courses offered at the higher level again according to the hierarchical structure of clusters. This suggested that student gains in general learned abilities was more likely a result of a sequential enrollment pattern during the college years, not at a single stage of the sequence (such as the freshman year experience).

Table 10a
Coursework Patterns: 13-Cluster for the Transfer Group

Cluster #1 n = 16		Cluster #2 n = 31		Cluster #3 n = 17		Cluster #4 n = 4		Cluster #5 n = 14	
AC	201	AC	201	ACCT	201	ANTH	100	APVC	200
ART	178	AC	202	ACCT	202	ENGL	201	APVC	300
BA	309	AC	301	BIO	142	HIST	112 *	CIS	303
DM	231 *	AC	401	CHEM	112	MATH	12	FED	305 *
DM	310	AC	402	COMP	201			FED	310 *
EC	386	BA	201	ECON	201			IS	220
ENG	20	BA	498	ECON	202			MATH	211
ENG	202	BED	450	ENG	111			MATH	212
IS	201	CNST	10	LSM	436			MATH	215
MGT	430	DM	122	MATH	111			MATH	216
MGT	435	DM	312 *	MATH	121			MUS	102
MGT	470	DSC	122	MUSI	211			MUS	108
PHIL	201	DSC	310	PHED	159			MUS	110
RE	410	DSC	312	POLI	111			PHIL	211 *
RE	495	EC	10	PSY	20				
SCPH	10 *	EC	201	SOCI	105 *				
		EC	202	SPCH	121				
		EC	350	SPCH	150				
		ENG	112						
		FI	330						
		INS	350 *						
		IS	20						
		LGLS	300						
		MATH	11						
		MGT	350						
		MGT	401						
		MK	301						
		PED	10						
		PHIL	241						
		PROG	20						
		RE	301						

"*" indicates a course misclassified according to the discriminant analysis of course clusters.

Table 10b

Coursework Patterns: 13-Cluster for the Transfer Group

Cluster #6		Cluster #7		Cluster #8		Cluster #9		Cluster #10	
n = 3		n = 15		n = 28		n = 25		n = 10	
ART	20	ART	211	BIOL	111	BIO	141	BIO	142
SOC	201	BIO	101	BIOL	112	CHEM	111	EC	201
SPE	401 *	FILM	370	CHEM	117	ENG	112	EC	350
		GEOL	101	CIS	410 *	ENG	201	ENG	111
		JOUR	304	CIS	480	FR	101	HIST	113
		JOUR	308	DM	121	GEOL	102	LSM	436A
		JOUR	410	ENG	201	HIST	20	LSM	436C
		MATH	107	ENG	313	HIST	111	MATH	10
		PHIL	301	FED	496	HIST	111	MGT	450
		POLS	101 *	FI	431	HIST	112	POLS	101
		PSY	101	FREN	111	HIST	251		
		PSY	404	FREN	112	JOUR	450 *		
		SCI	110	HIST	113	MATH	102		
		SPAN	101	HIST	252	MH	310		
		SPAN	111	MATH	105	PHED	101		
				MATH	112 *	PHED	102		
				MK	430	PSY	10		
				PHED	125	PSY	356		
				PHED	170	PSY	358		
				PSY	101	SOC	202 *		
				PSY	202	SOC	308		
				PSY	203	SPAN	202		
				PSY	204	SPCH	10		
				PSY	301	TH	370		
				PSY	303	US	301		
				PSY	416				
				PSY	423				
				SOC	201 *				

"*" indicates a course misclassified according to the discriminant analysis of course clusters.

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Table 10c
Coursework Patterns: 13-Cluster for the Transfer Group

Cluster #11 n = 5			**Cluster #12** n = 2		**Cluster #13** n = 2	
ECON	201	*	FED	210	FI	415
EDUC	201		MUS	193	PSY	314 *
ENGL	111					
ENGL	112					
PSYC	201					
PSYC	258					

"*" indicates a course misclassified according to the discriminant analysis of course clusters.

Table 11a

Coursework Patterns: 13-Cluster for the Native Group

Cluster #1	n = 53	Cluster #1	Continued	Cluster #2	n = 49	Cluster #2	Continued	Cluster #3	n = 15
AC	201	POLS	315	AC	202	PHYS	239 *	AC	301
AC	409	POLS	404	AC	451 *	POLS	101	AC	401
ANTH	201	SOC	202	ANTH	102	PSY	423	AC	402
ANTH	202	SOC	311	ASTR	101	RE	301	AC	420
ANTH	203	SOC	317	ASTR	102	RTP	25	APPF	100 *
BL	301	SOC	400 *	BA	498	SOC	201	BED	456
CJ	341	SPAN	102	BED	450	SOC	316	BED	471
CM	105	SPAN	201	BIO	388 *	TH	304	CIS	303
DM	231	SPAN	202	BIO	389 *			JOUR	460 *
DRAM	370	SPAN	303	CIS	220			LGLS	405
DS	91	SPCH	150 *	CIS	305			MATH	220
EC	360	TH	370	CIS	400			MK	434
EC	386			CIS	410			MUS	320
ENG	202			CIS	434			RMI	350
ENG	208			CIS	450				
ENG	280			CIS	460				
ENG	316			CIS	472				
ENG	317			CIS	480				
ENG	370			DM	121				
EXC	401			DS	70				
FED	210			DS	80				
FR	201			DSC	104				
FR	202			DSC	201				
GEOL	101			EC	201				
HIST	111			EC	202				
HIST	112			EC	350				
IS	220			ENG	313				
IS	301 *			FI	330				
IS	302			FR	101				
IS	400			FR	102				
ITAL	101			GER	102				
JOUR	308			HPRD	101				
JOUR	309			INS	350				
LAT	101			LGLS	300				
MATH	102			MATH	211				
MUS	393			MATH	216				
PHIL	201 *			MATH	447				
PHIL	301			MATH	448				
PHYS	230			MK	301				
POLS	201			PHYS	237				
POLS	305 *			PHYS	238				

"*" indicates a course misclassified according to the discriminant analysis of course clusters.

Table 11b
Coursework Patterns: 13-Cluster for the Native Group

Cluster #4		Cluster #5		Cluster #6		Cluster #7		Cluster #8	
n = 9		n = 40		n = 50		n = 14		n = 3	
AC	450	AC	460 *	APTP	200	ART	350	BIO	141 *
BED	436 *	ANTH	100	APTP	300	CJ	371	BIO	142 *
CIS	210 *	APFL	200	APVC	200	HIST	113 *	PSY	416
DM	122 *	ART	101	APVC	300	HIST	476		
GER	201	ART	102	ART	466	JOUR	201		
GER	202	ART	103	BA	201	JOUR	302		
IS	410	ART	104	CJ	490 *	JOUR	304		
MGT	450	ART	105	DM	310	JOUR	306		
UL	301	ART	178	DSC	122 *	JOUR	410		
		ART	179 *	DSC	310	JOUR	421		
		BA	309	DSC	312	JOUR	454		
		BIO	111	ENG	111 *	JOUR	498		
		BIO	112	ENG	112 *	PSY	303		
		BIO	324	FED	305				
		BIO	325	GEOL	102 *				
		CHEM	102	HPRD	345				
		CHEM	111	IB	309				
		CHEM	113	LSM	436				
		CHEM	116	MATH	126 *				
		DS	81	MGT	430				
		DS	90 *	MGT	435 *				
		ENG	212 *	MGT	436				
		FILM	370	MGT	437 *				
		GEOG	103	MGT	439				
		GEOG	104	MGT	470				
		HRTA	310	MK	410 *				
		HRTA	330	MK	420				
		HRTA	350 *	MK	430				
		IS	201	MK	431				
		JOUR	101 *	MK	451 *				
		MK	433	MK	490				
		MUS	105	MUS	102	Cluster 6 con't.			
		MUS	193	MUS	103	MUS	245		
		PHYS	210	MUS	106	MUS	246		
		PSY	204 *	MUS	108	PHIL	241 *		
		RTP	25A	MUS	110	PSY	101		
		SPAN	101	MUS	126	PSY	203		
		TH	410 *	MUS	144	PSY	301 *		
				MUS	145	SPCH	101		
				MUS	161	SPE	401		
				MUS	191				
				MUS	244				

"*" indicates a course misclassified according to the discriminant analysis of course clusters.

Table 11c
Coursework Patterns: 13-Cluster for the Native Group

Cluster #9 n = 19		Cluster #10 n = 12		Cluster #11 n = 13		Cluster #12 n = 19		Cluster #13 n = 3	
BIO	325	CHEM	101	CJ	301	DM	312 *	MATH	104 *
BIO	384	DS	50 *	CJ	311	ENG	113 *	MGT	401 *
BIO	390	DS	71 *	CJ	321	ENG	211	SOC	308
CHEM	112	ENG	385	CJ	331	ENG	409		
CHEM	117 *	MATH	107 *	CJ	370	ENG	435		
CHEM	118	MATH	122	CJ	411	GEOG	350		
CHEM	240	MH	498	CJ	475	GER	101 *		
CHEM	241	PSY	105	CJ	494	MATH	105		
CHEM	242	PSY	202	DS	92	MATH	125		
CHEM	460	PSY	356	ENG	201 *	PHIL	302 *		
ENG	315 *	PSY	358	GEOG	101 *	PHYS	102 *		
MATH	212 *	PSY	404	US	301	POLS	414		
MATH	215			US	302	POLS	462		
MATH	335					PSY	201		
MATH	435					PSY	314 *		
MATH	451					RUS	101		
MATH	461					RUS	102		
MATH	462					RUS	201		
MGT	350 *					SPCH	445		

"*" indicates a course misclassified according to the discriminant analysis of course clusters.

Discriminant Analysis of Coursework Patterns for the Transfer and Native Groups

In examining the dendrograms of the Southern University Transfer and the Native groups, a logical question arises as to which number of clusters or pattern groupings provides the best explanation of the relationship between student item-type residuals and coursework patterns. Separate discriminant analyses of different numbers of cluster groupings were be performed in order to determine the number of groupings that optimizes the proportion of courses correctly classified for each group. Four different cluster solutions for the Transfer group and for the Native group provided comparably high levels of correct classification.

Transfer Group

8 cluster solution : 92.66% of courses correctly classified
9 cluster solution : 92.09% of courses correctly classified
11 cluster solution : 90.96% of courses correctly classified
13 cluster solution : 89.83% of courses correctly classified

Native Group

8 cluster solution : 81.67% of courses correctly classified
11 cluster solution : 83.00% of courses correctly classified
13 cluster solution : 81.33% of courses correctly classified
15 cluster solution : 80.33% of courses correctly classified

While these cluster solutions produced comparable classification results, the different grouping evidenced differing effectiveness in identifying relationships between mean item-type residuals and coursework patterns. The 13-cluster solution provides a great extent of information for the Tranfer and Native groups about the relationships between these residuals and coursework patterns. It was therefore used in this research.

As in the previous analyses, the discriminant analysis was conducted using the DISCRIMINANT program in SPSSx in the following manner. Discriminant functions were applied to the data using the course item-type attributes as independent variables and the cluster group membership as the dependent variables. The resulting percentage of correct predictions served as a secondary validation of the cluster solution (Romesburg 1984).

TABLE 12

Discriminant Analysis of the 13-cluster Solution for Transfer Group

Actual Cluster	No. of Cases	Predicted Group Membership Gr 1	Gr 2	Gr 3	Gr 4	Gr 5	Gr 6	Gr 7	Gr 8	Gr 9	Gr 10	Gr 11	Gr 12	Gr 13
Group 1	16	14	2	0	0	0	0	0	0	0	0	0	0	0
		87.5%	12.5%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%
Group 2	33	2	31	0	0	0	0	0	0	0	0	0	0	0
		6.1%	93.9%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%
Group 3	18	0	0	17	0	0	0	0	0	0	0	1	0	0
		.0%	.0%	94.4%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	5.6%	.0%	.0%
Group 4	4	0	1	0	3	0	0	0	0	0	0	0	0	0
		.0%	25.0%	.0%	75.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%
Group 5	14	0	0	0	0	11	0	0	0	1	1	1	0	0
		.0%	.0%	.0%	.0%	78.6%	.0%	.0%	.0%	7.1%	7.1%	7.1%	.0%	.0%
Group 6	5	0	0	0	0	0	4	0	0	0	1	0	0	0
		.0%	.0%	.0%	.0%	.0%	80.0%	.0%	.0%	.0%	20.0%	.0%	.0%	.0%
Group 7	15	0	0	0	0	0	0	14	0	1	0	0	0	0
		.0%	.0%	.0%	.0%	.0%	.0%	93.3%	.0%	6.7%	.0%	.0%	.0%	.0%
Group 8	28	0	1	0	0	1	0	0	25	0	0	0	1	0
		.0%	3.6%	.0%	.0%	3.6%	.0%	.0%	89.3%	.0%	.0%	.0%	3.6%	.0%
Group 9	25	0	0	0	0	0	0	1	0	23	1	0	0	0
		.0%	.0%	.0%	.0%	.0%	.0%	4.0%	.0%	92.0%	4.0%	.0%	.0%	.0%
Group 10	10	0	0	0	0	0	0	0	0	0	10	0	0	0
		.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	100.0%	.0%	.0%	.0%
Group 11	5	0	0	0	0	0	0	0	0	1	0	4	0	0
		.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	20.0%	.0%	80.0%	.0%	.0%
Group 12	2	0	0	0	0	0	0	0	0	0	0	0	2	0
		.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	100.0%	.0%
Group 13	2	0	0	1	0	0	0	0	0	0	0	0	0	1
		.0%	.0%	50.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	50.0%

Percent of "Grouped" Clusters correctly classified: 89.83%

TABLE 13

Discriminant analysis of the 13-cluster solution for the Native Group

Actual Cluster	No. of Cases	Predicted Group Membership												
		Gr 1	Gr 2	Gr 3	Gr 4	Gr 5	Gr 6	Gr 7	Gr 8	Gr 9	Gr 10	Gr 11	Gr 12	Gr 13
Group 1	53	43	3	0	0	0	0	0	0	0	0	0	1	0
		81.1%	5.7%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	1.3%	.0%
Group 2	49	0	45	1	1	0	0	1	0	3	0	0	0	0
		.0%	91.8%	2.0%	2.0%	.0%	.0%	2.0%	.0%	6.1%	.0%	.0%	.0%	.0%
Group 3	15	0	0	12	0	1	1	0	0	0	0	2	0	0
		.0%	.0%	80.0%	.0%	6.7%	6.7%	.0%	.0%	.0%	.0%	13.3%	.0%	.0%
Group 4	9	1	2	0	6	0	0	0	0	1	0	0	0	0
		11.1%	22.2%	.0%	66.7%	.0%	.0%	.0%	.0%	11.1%	.0%	.0%	.0%	.0%
Group 5	40	2	2	0	1	31	1	0	1	0	1	1	0	0
		5.0%	5.0%	.0%	2.5%	77.5%	2.5%	.0%	2.5%	.0%	2.5%	2.5%	.0%	.0%
Group 6	50	2	7	2	0	0	38	0	0	0	0	1	0	0
		4.0%	14.0%	4.0%	.0%	.0%	76.0%	.0%	.0%	.0%	.0%	2.0%	.0%	.0%
Group 7	14	0	1	0	0	0	0	13	0	0	0	0	0	0
		.0%	7.1%	.0%	.0%	.0%	.0%	92.9%	.0%	.0%	.0%	.0%	.0%	.0%
Group 8	4	2	0	0	0	0	0	0	2	0	0	0	0	0
		50.0%	.0%	.0%	.0%	.0%	.0%	.0%	50.0%	.0%	.0%	.0%	.0%	.0%
Group 9	19	0	3	0	0	1	0	0	0	15	0	0	0	0
		.0%	15.8%	.0%	.0%	5.3%	.0%	.0%	.0%	78.9%	.0%	.0%	.0%	.0%
Group 10	12	0	3	0	0	1	0	0	0	0	9	0	0	0
		.0%	25.0%	.0%	.0%	8.3%	.0%	.0%	.0%	.0%	75.0%	.0%	.0%	.0%
Group 11	13	0	2	0	0	0	0	0	0	0	0	11	0	0
		.0%	15.4%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	84.6%	.0%	.0%
Group 12	19	1	2	0	0	2	0	0	0	0	1	0	13	0
		5.3%	10.5%	.0%	.0%	10.5%	.0%	.0%	.0%	.0%	5.3%	.0%	68.4%	.0%
Group 13	3	0	2	0	0	0	0	0	0	0	0	0	0	1
		.0%	66.7%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	.0%	33.3%

Correlations and Discriminant Functions of Coursework Clusters

The discriminant analyses of the Southern University group provided secondary validation that 89.83 percent of the classification of courses was correctly predicted by cluster analysis for the transfer group while for the native group 81.33 percent of the classification was correctly predicted. The discriminant analyses was a secondary validation, since it was based on the same sample of transcripts and test scores.

Nine of ten courses most frequently taken by students in the Transfer group were correctly classified according to their mean residual GRE scores while in the native group eight courses were correctly classified. While the cluster analysis produced coursework patterns according to criteria of general student learning, additional steps were needed (1) to determine which courses were correctly classified and (2) to ascertain which item-type scores contributed to any given coursework pattern.

Using the BREAKDOWN procedure in the DISCRIMINANT program of SPSS-X (Norisus 1985) courses which were incorrectly classified or which may be classified within another coursework pattern are identified. To compute the contribution of each mean item-type residual score to the discriminant functions, the correlation coefficients between mean residual scores and discriminant functions were examined.

The relationships between GRE item-type residuals and discriminant functions are listed below for the Transfer group:

Function 1 was not strongly correlated with the item-types;

Function 2 was positively correlated to Quantitative Comparisons (*r*=.82), and was positively correlated to Analytic Reasoning (*r*=.52);

Function 3 was positively correlated to Logical Reasoning (*r*=.53), and was positively correlated to Antonyms (*r*=.51);

Function 4 was positively correlated to Antonyms (*r*=.62), and was positively correlated to Regular Mathematics (r=.67);

Function 5 was positively correlated to Sentence Completion (r=.57), and was positively correlated to Analogies (r=.58);

Function 6 was not strongly correlated with the item-types;

Function 7 was positively correlated to Analogies (r=.50);

Function 8 was positively correlated to Logical Reasoning (r=.53), and was positively correlated to Data Interpretation (r=.61);

Function 9 was not strongly correlated with the item-types.

The relationship between GRE item-type residuals and discriminant functions are listed below for the Native group:

Function 1 was negatively correlated with Antonyms (r=-.62), and was positively correlated with Analytic Reasoning (r=.61);

Function 2 was positively correlated with Reading Comprehension (r=.59);

Function 3 was positively correlated with Reading Comprehension (r=.64);

Function 4 was positively correlated with Analytic Reasoning (r=.57), and was positively correlated with Quantitative Comparisons (r=.50);

Function 5 was positively correlated with Quantitative Comparisons (r=.67);

Function 6 was positively correlated with Regular Mathematics (r=.65);

Function 7 was positively correlated with Logical Reasoning (r=.74), was positively correlated with Analogies (r=.61), and was positively correlated with Sentence Completion (r=.68);

Function 8 was positively correlated with Data Interpretation (r=.76);

Function 9 was negatively correlated with Sentence Completion (r=-.57).

Once the relationships between discriminant functions and mean item-type residuals have been established, then the relationships between the discriminant functions and the coursework clusters can also be determined.

By examining the average score of each cluster group for each discriminant function, the extent to which each discriminant function contributes to that group was calculated. Functions which had no correlation with specific item-type residuals were omitted.

Each discriminant function explains a certain proportion of the variation in residual scores. Discriminant functions with strong explanatory power, "good discriminant functions," have large between-cluster variability and low within-cluster variability (Romesburg 1984). The eigenvalues of Tables 16 and 17 present the ratio of between-group to within-group sums of squares of the residuals. Large eigenvalues are associated with the discriminant functions that most contribute to explaining variability in GRE item-type scores.

Wilk's Lambda is the ratio of the with-group sum of squares to the total sum of the squares. It represents the proportion of the total variance in the discriminant function values not explained by differences among cluster groups. Wilk's Lambda serves as a test of the null hypothesis that there is no difference in the mean residuals of a coursework cluster means and the mean residual scores of the coursework in the total sample.

Thus, the eigenvalues and canonical correlations indicate the extent to which each discriminant function contributes to our understanding of the variability in coursework mean residuals. Lambda tests the null of the differential coursework hypothesis for each discriminant function. Results of the analysis indicated a relationship did exist between coursework taken and performance on the GRE. Certain GRE item-type residual scores predominated.

Table 14
Canonical Discriminant Functions: Transfer Group

Function	Eigen- Value	Percent of Variance	Cumulative Percent	Canonical Correlation	Wilk's Lambda	Degrees Freedom	Signifi- cance
0					.0082	108	.0000
1	3.2761	39.22%	39.22%	.8753	.0350	88	.0000
2	2.0706	24.79%	64.01%	.8212	.1075	70	.0000
3	1.2720	15.23%	79.24%	.7482	.2442	54	.0000
4	.8144	9.75%	88.99%	.6700	.4430	40	.0000
5	.3872	4.64%	93.63%	.5283	.6145	28	.0000
6	.2735	3.27%	96.90%	.4634	.7826	18	.0018
7	.1503	1.80%	98.70%	.3615	.9002	10	.0671
8	.0723	.87%	99.57%	.2596	.9653	4	.2122
9	.0360	.43%	100.00%	.1863			

TABLE 15
Canonical Discriminant Functions: Native Group

Function	Eigen- value	Percent of Variance	Cumulative Percent	Canonical Correlation	Wilk's Lambda	Degrees Freedom	Signi- ficance
0					.0247	108	.0000
1	1.6618	30.83%	30.83%	.7901	.0657	88	.0000
2	1.3113	24.33%	55.16%	.7532	.1519	70	.0000
3	.8144	15.11%	70.27%	.6700	.2757	54	.0000
4	.7632	14.16%	84.43%	.6579	.4861	40	.0000
5	.5066	9.40%	93.83%	.5799	.7323	28	.0000
6	.1918	3.56%	97.39%	.4011	.8728	18	.0027
7	.0990	1.84%	99.22%	.3000	.9592	10	.2845
8	.0256	.47%	99.69%	.1579	.9837	4	.1351
9	.0166	.31%	99.99%	.1278			

Interpreting the Coursework Clusters for the 13-cluster Solution for the Transfer Group

Coursework clusters with positive or negative means greater than 1.0 were selected for further analysis.

Coursework Cluster #1 had high positive means on Functions 2 and 4, and a high negative mean on Function 3. Function 2 was positively correlated with Quantitative Comparisons (r=.82) and Analytic Reasoning (r=.52). Function 3 was positively correlated with Logical Reasoning (r=.53) and Antonyms (r=.51). Function 4 was positively correlated to Antonyms (r=.62) and Regular Mathematics (r=.67). Therefore, students who enrolled in the coursework pattern represented in Cluster #1 were more likely to improve in ability on Quantitative Comparisons, Analytic Reasoning, and Regular Mathematics but were likely to decline on Logical Reasoning item-types. The results for the item-type of Antonyms were inconclusive.

Cluster #2 had a high positive mean on Function 2. Students enrolling in this set of courses showed high gains in Quantitative Comparisons and Analytic Reasoning.

Cluster #3 had a high positive mean on Function 2 and a high negative mean on Function 1. Function 1 was not strongly correlated with the item-types. Therefore, students enrolling in this cluster tended to show positive gains in their ability to answer Quantitative Comparisons and Analytic Reasoning questions.

Cluster #4 had no high positive or negative means on Functions 1 through 4.

Cluster #5 evidenced a high positive group mean on Function 3 and a high negative group mean on Function 2. This evidence suggested that students enrolling in Cluster #5 courses showed declines in ability on Quantitative Comparisons and Analytic Reasoning but showed gains on Logical Reasoning and Antonyms item-types.

Cluster #6 consisted of three courses. One course was misclassified. Therefore, no further analysis was conducted with this cluster.

Cluster #7 had a high negative group mean on Function 2. Students enrolling in Cluster #7 showed declines on Quantitative Comparisons and Analytic Reasoning item-types.

Cluster #8, Cluster #9, and **Cluster #10** had no high positive or negative means on Functions 1 through 4.

Cluster #11 had a high negative group mean on Function 4. Students enrolling in Cluster #11 tended to decline in abilities relative to Regular Mathematics and Antonyms.

Cluster #12 consisted of two courses. One course was misclassifed. Therefore, no further analysis was conducted with this cluster.

Cluster #13 had no high positive or negative means on Functions 1 through 4. Therefore, no further analysis was conducted with this cluster.

Table 16 demonstrates that for the Transfer group, Functions 1 to 4 explain 88.99% of the variation in residuals. Lamdba values were significant at the .0001 level. Functions 1 to 4 were used in the further analysis of the coursework clusters for the Transfer groups. Given that Functions 1 through 4 were correlated with Quantitative Comparisons, Antonyms, Analytic Reasoning, and Reading Comprehension, it may be inferred that these GRE item-type residuals were predominant in explaining the coursework patterns of the Transfer group.

Interpreting the Coursework Clusters for the 13-cluster Solution for the Native Group

Coursework clusters with positive or negative means greater than 1.0 were selected for further analysis. **Coursework Cluster #1** had a high negative group mean on Function 1 and a high positive group mean on Function 2. Function 1 was positively correlated to Analytic Reasoning (r=.61) and was negatively correlated to Antonyms (r=-.62). Function 2 was positively correlated to Reading Comprehension (r=.59). Students enrolling in this coursework improved in Antonyms and Reading Comprehension but declined in their Analytic Reasoning abilities.

Cluster #2 had high positive group mean on Function 1. Function 1 was positively correlated to Analytic Reasoning (r=.61) and was negatively correlated to Antonyms (r=-.62). Students enrolling in this cluster gained in Analytic Reasoning but declined in Antonyms.

Cluster #3 evidenced a high positive group mean on Function 4 and high negative group mean on Functions 3. Function 4 was positively correlated to Analytic Reasoning (r=.57) and Quantitative Comparisons (r=.50). Function 3 was positively correlated to Reading Comprehension (r=.64). Students taking Cluster #3 coursework improved in Analytical Reasoning and Quantitative Comparisons but declined in Reading Comprehension.

Cluster #4 had high positive group means on Functions 2 and 5, and a high negative group mean on Functions 3. Function 5 was positively correlated to Quantitative Comparisons (r=.67). Students enrolling in this cluster showed gains in Quantitative Comparisons. The results for Reading Comprehension were inconclusive.

Cluster #5 had high negative group means on Functions 1 and 2. Students enrolled in this coursework gained in Antonyms but declined in Analytic Reasoning, and Reading Comprehension.

Cluster #6 encompassed high negative group means on Functions 2 and 3, and a high positive group mean on Function 1. Students signed up for this coursework pattern declined in Antonyms and Reading Comprehension but gained in Analytic Reasoning.

Cluster #7 had high positive group means on Functions 1 and 5. Students taking this coursework pattern gained in Analytic Reasoning and Quantitative Comparisons and declined in Antonyms.

Cluster #8 consisted of three courses. Two courses were misclassified. Therefore, no further analysis was conducted with this cluster.

Cluster #9 had high positive group means on Functions 1 and 4. Students enrolled in these courses improved in Reading Comprehension, Analytic Reasoning, and Quantitative Comparisons.

Cluster #10 had high negative group means on Functions 2 and 5, and a high positive group mean on Function 3. Students enrolling in these clusters showed declines in Quantitative Comparisons. The results for Reading Comprehension were inconclusive.

Cluster #11 encompassed high positive group means on Functions 4 and 5. Students registering in this coursework gained in Quantitative Comparisons and Analytic Reasoning.

Cluster #12 had a high positive group mean on Function 3. Students taking courses in this cluster improved in Reading Comprehension.

Cluster #13 consisted of three courses. Two courses were misclassified. Therefore, no further analysis was conducted with this cluster.

Table 17 indicates that for the Native group, Functions 1 to 5 explain 93.83% of the variation in residuals. Lambda values were again significant at the .0001 level. Functions 6 to 9 individually account for less than 5 percent of the variance. Thus, only Functions 1 to 5 were used in the analysis of the coursework clusters. Since these functions were correlated with Reading Comprehension, Quantitative Comparisons, Analytic Reasoning and Antonyms, it suggested that these GRE item-type residuals were predeominant in explaining the coursework patterns of the Southern University Native group.

It should be cautioned that the association was established at the cluster level. No direct causal link is intimated between student enrollment in any one given course and scores on the GRE. Furthermore, at this point, one cannot say why students who enrolled in these courses had higher residuals. The cluster serves to hypothesize relationships between coursework patterns and the general learned abilities measures by the item-types of the GRE. **One can say that students who enrolled in specific patterns of coursework tended to evidence stronger gains on specific GRE item-types, while others who enrolled in different coursework patterns did not tend to show such gains.** This evidence affirms the hypothesis that student gains in general learned abilities are associated, positively and negatively, with the coursework in which they enrolled. Further analysis is required to determine the nature of these associations.

Conclusion

The examination into the subsamples of the transfer and native students was the focus of this paper. The goal was to determine whether the assumption underlying common course numbering schemes in statewide public higher education held validity. In short, did taking coursework at the community college produce the same effect as taking comparably-numbered coursework at Southern University. The patterns of coursework for Natives and Transfers identified in this project were logical and salient to the extent that the group analyzed was homogeneous in its gains in general learned abilities. If all undergraduates were to benefit from a single of general education coursework requirement--regardless of insitution enrolled--the cluster analysis would produce such a core among all such coursework taken. This in fact did not occur. Logical sets of courses were found among the different groups of students, while the cluster resulting from the analysis of the total sample was less discrete and logical. The results did not support the efficacy of a statewide core curriculum and common course numbering system. Only forty percent of the courses enrolling 5 or more students were part of the general education requirements and associated with gains in the transfer student's learning. Seventeen percent of the courses enrolling 5 or more students were part of the general education requirements and associated with improvement in the Native student's learning. Such a finding argues against the establishment of a core curriculum as advocated by the National Endowment for the Humanities (1989). The results support the view of the advocates for distributive requirements in general education since there were differences in the gains these students demonstrated in student incoming abilities, general learned abilities, and differences in coursework patterns in which they enrolled. In general, community college students showed greater gains than did Natives, took a more discrete set of courses and from a more limited array of choices. Thus, our support the current use of a wide range of options in a distributional general education requirement. Instead, it suggests that discrete arrays of coursework be identified which are more appropriate and productive for different ability levels of students. This conclusion was manifest in the findings of the analysis of Transfer and Native students. Discrete sets of coursework were identified that were beneficial to these students. These results suggest the need for greater academic advising in undergraduate course selection or greater prescription in the curriculum. The cluster analytic model also can be used to identify coursework which has been beneficial to students of specific ability levels, interests and aptitudes (Jones & Ratcliff, 1990).

In the quantitative cluster analysis of Southern University Transfer and Native groups, the results were comparable. Roughly 8 or 9 of each 10 courses analyzed were accurately grouped according to differential effects in the general learned abilities of students. Taking different patterns of coursework does lead to different types and levels of development as measured by the 9 item-types of the GRE General Test.

The cluster analytic model employed in this study used the 9 GRE item-types as multiple measures of general learned abilities. The GRE item-types generally provided reliable measures of learning. Rarely did the GRE score predicted by the SAT exceed the actual highest score possible on the GRE. This study generally affirmed the use of GRE item-types as limited but discrete measures of general learning.

Student transcripts, generated from a student records database, proved to be a powerful, non-obtrusive indicator of the curriculum experienced by undergraduates. It is recommended that the research be continued longitudinally to establish trends in course patterns over multiple years of graduating seniors. Through such panel studies, the extent of variation in general learning and in course-taking behavior can be established. Such research is currently underway at the National Center for Postsecondary Teaching, Learning and Assessment at Penn State.

Nevertheless, clear sequences and combinations of coursework do emerge from this research. Quantitative abilities are not developed solely in lower division mathematics courses, but are enhanced through an array of select applied science, social science and business courses as well. General learning is not confined to one lower division; upper division causes contributed strongly to the development of specific learned abilities, particularly Analytic Reasoning.

Native students at Southern, like many universities and colleges, do not share much common formal learning experiences. From 15 to 20 percent of the coursework on one student's transcript was shared with 5 other students from the same sample. The lack of a common intellectual experience is only problematic to the extent it is held as an institutional value. Indeed, it is the mark of a great university to preserve and advance the full landscape of fields and disciplines of inquiry. Yet, we must advance beyond the days of Charles Elliot and Ezra Cornell. The vastness of curricular choice can be either an asset or a liability, depending on the extent to which it effectively advances student learning.

References

American Colleges Committee's Project on Redefining the Meaning and Purpose of Baccalaureate Degrees. 1985. Integrity in the college curriculum: A report to the academic community. Washington, DC: Association of American Colleges.

Association of American Colleges. 1988. A new vitality in general education. Washington, DC: Association of American Colleges.

Boyer, Ernest L., & Kaplan, Martin. 1977. Educating for survival. New Rochelle, NY: Change Magazine Press.

Carnegie Foundation for the Advancement of Teaching. 1977. Missions of the college curriculum. San Francisco, CA: Jossey-Bass.

Eaton, J. S. 1990. Three myths of transfer education. Community, Technical and Junior College Journal, 60, 18-20.

Giddings, W. G. 1985. A study of the performance, progress, and degree achievement of Iowa community college transfer students at Iowa's state universities. (Doctoral dissertation: Iowa State University, October 1985).

Jones, Elizabeth A., & Ratcliff, James L. 1990. Is a core curriculum best for everybody? The effect of different patterns of coursework on the general education of high and low ability students. Paper presented at the annual meeting of the American Educational Research Association, Boston, Massachusetts.

Jones, Elizabeth A., & Ratcliff, James L. 1990. Effective coursework patterns and faculty perceptions of the development of general learned abilities. Paper presented at the annual meeting of the Association for the Study of Higher Education, Portland, Oregon.

Levine, Arthur. 1978. Handbook on undergraduate curriculum. San Francisco, CA: Jossey-Bass.

Morgan, D. M., & Teel, J. W. 1990. Historical analysis: Georgia's core curriculum. Community, Technical and Junior College Journal, 60, 9-10.

National Endowment for the Humanities. 1984. To reclaim a legacy: A report on the humanities in higher education. Washington, DC: National Endowment for the Humanities.

----. 1989. 50 hours: A core curriculum for college students. Washington, DC: National Endowment for the Humanities.

National Institute of Education. 1984. Involvment in learning: Realizing the potential of American higher education. Washington, DC: Government Printing Office.

Norusis, Marija J. 1985. SPSS-X advanced statistics guide. New York, NY: McGraw-Hill.

Pascarella, E. T. 1985. College environmental influences on learning and cognitive development: A critical review and synthesis. In J. Smart (Ed.), Higher education: Handbook of theory and research, Volume I. New York, NY: Agathon Press, Inc.

Ratcliff, James L 1987. The effect of differential coursework patterns on general learned abilities of college students: Application of the model to an historical database of student transcripts. Task #3 Report for U.S. Department of Education, Office of Educational Research and Improvement, Contract No. OERI-R-86-0016. Ames, IA: Iowa State University.

----. 1988. "The development of a cluster analytic model for determining the associated effects of coursework patterns on student learning." A paper presented at the annual meeting of the American Education Research Association (AERA), New Orleans, Louisiana.

Ratcliff, James L., & Jones, Elizabeth A. 1990. General learning at a women's college. Paper presented at the annual meeting of the Association for the Study of Higher Education, Portland, Oregon.

Romesburg, H. Charles. 1984. Cluster analysis for researchers. Belmont, CA: Lifelong Learning Publications.

Richardson, R. C., & Doucette, D. S. 1980. Persistence, performance, and degree achievement of Arizona's community college transfers in Arizona's public universities. Tempe, AZ: Arizona State University. ERIC Document Reproduction Service, ED 197 785.