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ABSTRACT

This study used structural modeling methodologies to analyze student outcomes at Prince George's Community College (PGCC) in Largo, Maryland. Path analysis and cluster analysis were used to analyze data on 2,643 first-time entrants to PGCC in fall 1990 over the course of 6 years. Path analysis revealed the centrality of student attitude factors (motivation, flexibility, academic gamesmanship) on student career success, as compared to the lesser impacts of social background, college preparedness, and other factors. It also highlighted the importance of the formative early semesters in setting student trajectories. Cluster analysis identified several varieties of success-prone students, as well as four varieties of low-achievement students. The results are discussed in light of Vincent Tinto's (1993) model of retention, which posits that success-prone college entrants will be those who, during their first year of study, learn how to become students, adopt academic and institutional identities, and integrate themselves into the college community. (MDM)

NEW APPROACHES TO THE ANALYSIS OF ACADEMIC OUTCOMES: MODELING STUDENT PERFORMANCE AT A COMMUNITY COLLEGE

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Dolores Vura
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2

ABSTRACT

Using two advanced structural modeling methodologies—path analysis and cluster analysis—parallel models of the academic process at Prince George's Community College were developed, supported by data tracking the Fall 1990 first-time entering credit student cohort over a period of six years. Path analysis revealed the centrality of student attitude factors (motivation, flexibility, academic gamesmanship) to study career success compared with the lesser impacts of social background, college preparedness, and various other process model components. It also highlighted the importance of the formative early semesters in setting student trajectories. Cluster analysis identified several varieties of success-prone students, as well as three different student sub-bodies, each highly problematic for distinctive reasons. The author concludes with remarks on the generalizability of the findings and a discussion of how the PGCC model relates to Tinto's theoretical model of retention.

INTRODUCTION

Since the Fall of 1990, the Office of Institutional Research and Analysis at Prince George's Community College has been tracking the academic careers of a cohort of first-time entrants (N=2,643). The Cohort data set was drawn from PGCC student record databases, augmented with material supplied by the Maryland Higher Education Commission's Transfer Student System to enable us to identify cohort members who ceased community college attendance due to transfer to a Maryland four-year public post-secondary institution. Attendance, study progress and related data were all organized on a term-by-term basis so that we might assess student academic status and level of achievement at any term point in the cohort's effective six-year life span, connect patterns of attendance with outcomes, and summarize any part of the process in terms of time to outcome. The use of this data tended to be limited to establishing academic outcomes benchmarks for college policy-making and reporting.

As the cohort approached maturity, however, it occurred to us that its fulsome data provided a prime opportunity to capture the big picture—how all of the socio-economic, educational and administrative components of the overall academic process at the college worked together to produce final academic outcomes. As a first step, Boughan and Clagett (1995)[1] developed a community college-oriented approach to measuring academic achievement and established its utility in an exploratory regression analysis of the predictors of Cohort 1990 four-year outcomes. But while regression has much to recommend it as a data-exploratory technique in the early stages of research, its simple, fixed linear-additive structure severely limits its usefulness in dealing with a phenomenon as complex as the academic process. To move to the next research step, we needed analytic techniques which would produce a more fully-realized causal understanding of the forces impinging on student academic progress at PGCC. We selected two appropriate methodologies, both unfortunately neglected by institutional researchers—path analysis and cluster analysis. [2]

Based on structural equation modeling, path analysis treats the relationships among the components of a complex system as series of multiple regressions overlapping in their independent and dependent variables, the interactions among which are set by the analyst. This allows analyst to structure and empirically validate variable linkages according to theory and causal logic, leading to a more realistic mapping of the network of forces at work. Furthermore, since each variable takes the independent position with respect to some other variables and the dependent position with respect to still others, the analyst is freed to assess each model component's important in the overall model according to its local effects; for example, although demographic factors like race and social class may not directly impact on a single criterion variable like academic achievement (regression case), it may be found to be a key influence on neighboring academic process components which do directly impact on academic achievement (e.g., level of college preparedness) and therefore to be an important indirect achievement level conditioner (path case).

In contrast, cluster analysis involves sorting cases into "clusters" which are maximally within-group homogeneous and without-group heterogeneous, according to the patterns found in an all-case distance matrix based on multiple dimension scores. When applied to our Cohort 1990 tracking data, its product is a typology of stable student career patterns defined by the main variety of treks actually made through the academic process. While path analysis models the academic process itself, cluster analysis, in effect, models the student body with respect to the workings of the academic process. The student typology provides a useful complement to the academic process path model, especially when types are assessed by collective achievement levels. By revealing the specific diversity of process behavior patterns linked to academic success or failure, cluster analysis can generate insights of immediate practical utility for college policy formulation.

In this paper we present the main findings of both a full path analysis and a complete cluster analyses of Cohort 1990 academic outcomes, extended to the sixth year of the cohort's life.

MODELING COMPONENTS

In all of the results to follow, the variable of prime focus was Academic Achievement. The achiever classifier was developed by the Office of Institutional Research and Analysis as a simple summary measure of positive academic outcome for college internal assessment reporting, and takes the dichotomous form 0=Non-Achiever/1=Achiever. Classified as Achievers are all members of a cohort who earned an academic award (associate degree, occupational certificate or occupational letter-of-recognition); successfully transferred to a four-year post-secondary institution; or who accumulated 30 or more credit hours in good academic standing (sophomore status).

Selection of the predictor variables was more difficult. Our earlier regression research, involving over 90 separate independent variables, quickly alerted us to the need for a radical data reduction program. Not only was this very large data set extremely awkward to manipulate and interpret, regression statistics implied a truly confounding level of multicollinearity. Reduction to a manageable list of predictors was mainly achieved by means of factor analysis,[3] which transformed the original vast array of variables into just 11 factor scales. These are summarized in Table 1 below, which provides the name used to identify each factor scale in all data displays, a capsule review of the original variables loading most highly on each and defining each's underlying sense, and a descriptive title.

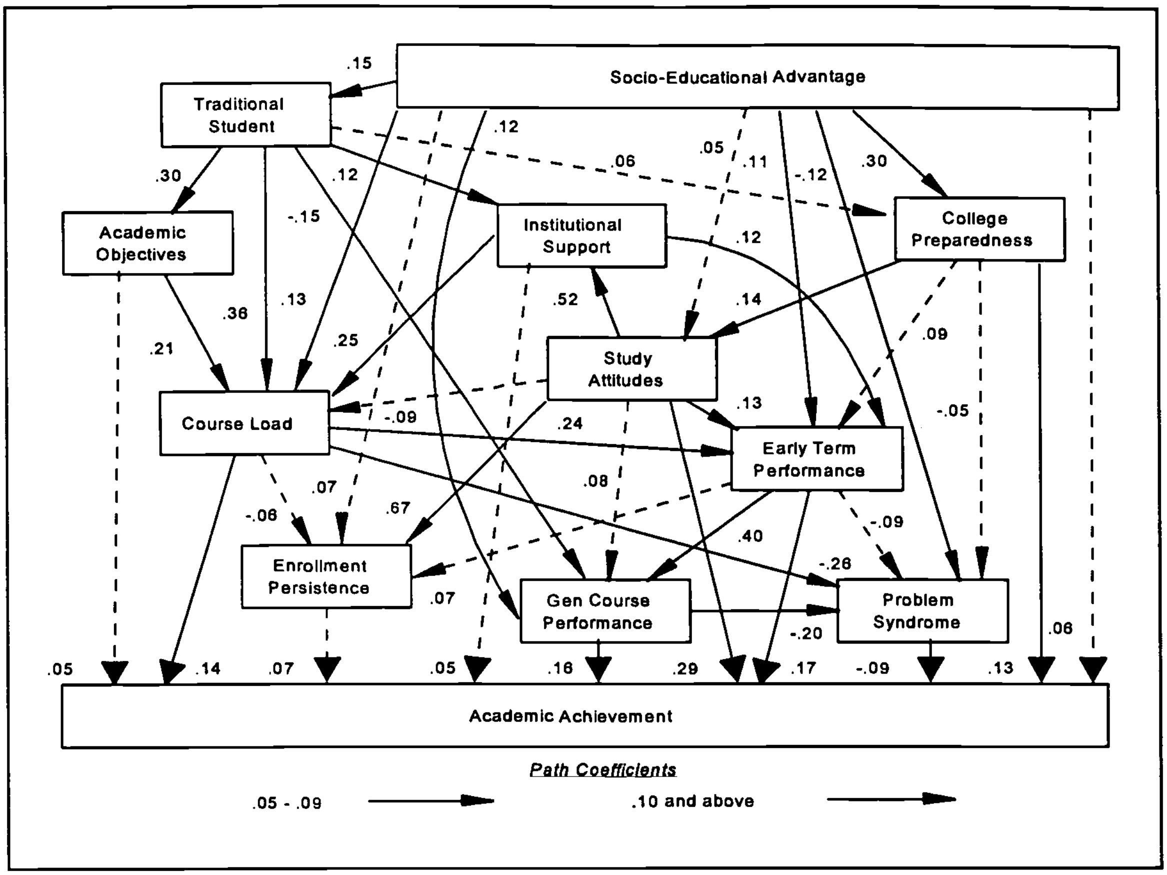
Table 1. Model Component Factor Scale Names and Descriptions
Traditional Student: Under 20 Years Old/Unmarried/ Entry Immediate from High School
Socio-Educationally Advantaged: White Racial Background/ High Income, High Job Status, College-Educated Home Neighborhood[a]/ Prestige County High School Graduate[b]
Regular Academic Objectives: Transfer Program/ Arts & Sciences Program/ Stated 4-Year Transfer Motive/ Stated PGCC Degree Goal/ No Stated Enrichment or Occupational Motive
Implied Good Study Attitudes: Combined Day-Evening or Campus-Extension Center Attendance/ Any Summer Term Attendance/ Any Study Major Shift/ No Stopping Out/ Enrolled in All 3 Earliest Major Terms
Institutional Financial & Academic Support: Pell Grants Received/ Any Minority Retention Program Participation/ Any Student Services Participation/ Any Job Planning or Study Technique Courses
College Preparedness and Remediation Progress: High Basic Skills Placement Test Scores/ Number of Required Remedial Programs (-)/ Completed Remedial Programs/ No Remedial Math Requirement
Early Term Performance: Enrolled in All 3 Earliest Major Terms/ Year-1 Good Academic Standing/ 10+ Credits Earned in Year-1/ Post-Fall-1 Enrollment/ Any Year-1 Credits / Year-1 GPA
Course Load: Mean Year-1 Course Hour Attempts/ Mean Major Term Course Hour Load/ Fall-1 Course Hour Load 15+
General Course Performance and Academic Status: Year-1 GPA/ Final GPA/ Earned-to-Attempted Hours Ratio/ Always in Good Standing/ Good Standing Terms-to-All Enrolled Terms Ratio
Enrollment Persistence and Continuity: Attendance Term Span/ Number of Major Terms Attended/ Any Post-Year-1 Enrollment/Any Post-Fall1 Enrollment/ 10+ Credits Earned/ No "Stopping Out"
Syndrome of Academic Problems: Number of Remedial Programs Required/ Any Year-1 Remedial Course-Taking/ Any Remedial Course Repeating/ Any Academic Restriction or Probation Terms/ No Credit Course-Taking/ No Credit Course Passing/ Remedial Math Incomplete
a. Derived from an analysis of student home Census Tracts (1990 Census Data) b. Based on a prestige ranking of area high schools by a panel of PGCC staff

As the table makes clear, for the most part our factor analysis of academic background and process variables rounded up the usual suspects, but the unexpected emergence of three factors deserves special comment:[4] First, variables measuring non-normative course scheduling (taking both day and evening classes, taking both main campus and extension center classes, and attending both major and summer terms), midstream change in program curriculum, and strict sequential semester enrollment (no "stopping-out") combined to define a separate factor (Study Attitude). We interpreted the resulting scale as a gauge of student commitment to academic success, because each of the defining variables, in its own way, seemed to imply extra effort, determination or attention to study goals. As we shall see, this turned out to be a key component of the overall causal matrix. Second, a group of attendance and performance variables specific to the three earliest major semesters, instead of factoring in with other attendance and performance variables, coalesced into a separate factor measuring initial study survival and success (Early Term Performance). This suggests that the first year of study has its own dynamic which may be critical to ultimate success or failure.

Lastly, the factor analysis detected a substantive interaction among certain developmental- and credit course-related variables (Problem Syndrome). It would seem that some combination of the number and types of remediation required, absence of remedial progress, and subsequent difficulties in entering credit courses and accumulating credit hours is a common enough pattern in the working out of the academic process at PGCC to constitute an independent phenomenon.

FINDINGS FROM PATH ANALYSIS

Our final path analytic model, developed after much trial and error, is graphically depicted in Figure 1 below, as a mapping of the causal network making up PGCC's academic process.[5] It shows the 11 predictor variables distributed in rough terms of temporal, logical and structural distance from the achievement classifier and from one another. Diagrammatically, the causal flow works downwards, with many lateral links in between. The existence and direction of causal paths linking variable pairs are indicated by means of arrows. Each is shown with its associated path coefficient (p), a probability weight measuring the impact of the first on the second variable, controlling for all causally preceding variables. The thick arrows indicate moderate to strong links



Squared Multiple Correlation Coefficients			
Traditional Student	.022	Early Term Performance	.176
College Preparedness	.100	General Course Performance	.252
Study Attitudes	.026	Enrollment Persistence	.498
Institutional Support	.291	Problem Syndrome	.219
Academic Objectives	.089	Academic Achievement	.466
Course Load	.327		

Goodness of Fit Statistics			
Chi-square	174.7	Goodness of Fit Index (GFI)	.988
Degrees of Freedom	21	Adjusted GFI	.956
Probability Level	.0000	Tucker-Lewis Index	.934
CMIN/DF (model)	8.3		
CMIN/DF (independence)	111.6		
Normed Fit Index (NFI)	.976		

Figure 1. The Academic Process at PGCC (First-Time Students 1990 - 1995)

($\underline{p} \geq .10$) while the dash-pattern arrows show marginal relationships (.05 - .09). Since path coefficients are discrete probability weights, absolute p-values for a sequence of paths can be summed, and their total ($\underline{P}_t$) can be used as a very rough and ready gauge of the causal importance of the entire "trail."

Our path model result in a wealth of insights concerning local areas of academic process function (e.g., the high positive impact of institutional support on study load: $\underline{p}$=.25), but space permits only an overview of the major features of the model:

- The total path model explained almost half of the achievement variance ($\underline{R}^2$=.47). This suggests that the model's ability to portray just how process vectors impact on this final key component was reasonably good. Technically, however, this coefficient of determination statistic only estimates the model's predictiveness at a single, albeit very important, node; it does not measure overall model performance or goodness-of-fit. For path analysis, this involves tests of numerous aspects of model operation, not all of which our model passed; in general, however, our model performed acceptably within key diagnostic parameters.[6]

- A central feature of the path diagram turned out to be the existence of two semi-independent "trails" (sequences of paths), of almost equal probability weight, leading to Achiever Classification. The first was the "Effort Trail" which linked the following in rough causal sequence: "traditional student" attributes (young, single, immediate from high school), transfer program orientation, level of institutional support, typical term study load, and attendance persistence ($\underline{P}_t$=1.56). The second was a broad "Performance Trail" of student socio-educational attributes (race, social class, quality of high school experience), college preparation level and remedial need, early term survival and progress, course performance, and academic problem syndromes ($\underline{P}_t$=1.58). These may be compared with the whole model path sum (7.06).

■ Another prominent feature of the path model was a busy junction of paths with Study Attitude at its center. Moderate-to-strong paths ran from it to Achiever Classification and to virtually all nodes along the Effort and Performance trails. The centrality of study motivation in student achievement, as represented by its strategic positioning in the model and its very high total probability weight (P_t=1.83), was perhaps the single most important finding of this study.[7]

■ Other key findings were the importance of Early Term Performance, a prime node of the Performance Trail, and the significant role Institutional Support was shown playing in conditioning both launch period outcomes and Course Load. These two findings have major implications for academic policy.

■ Finally, in this brief review, we should mention how the model depicted the specific way student background variables operated in the overall causal network conditioning student outcomes. Past research on the correlates of academic achievement often found student background factors like race and socio-economic status as having little impact on college success. The path analysis model, however, suggests that these low achievement correlations may have been a methodological artifact—the restriction of the analysis to direct effects. Situated at the "head" of the Performance Trail, the factor scale summarizing various forms of Socio-Educational Advantage showed strongly local predictive power (P_t=1.13 with all impacted variables), especially affecting level of college preparation; and the measure of Traditional Student attributes, beginning the Effort Trail, proved to have a good deal to do with program orientation, level of institutional support, and study load (P_t=.99).

FINDINGS FROM CLUSTER ANALYSIS

As already discussed, the last part of our research involved using cluster analysis to capture the actual study career patterns resulting from the academic process at PGCC. To assure that only student behavior would define career types, the background variables Socio-Educational Advantage and Traditional Student were dropped and data elements restricted to the nine pure academic process factor scales. To these data we applied the k-means form of cluster analysis, which calculates the mathematically optimum case sort for a specified number of group breaks, and examined cluster solutions 5 through 15. The 10-fold solution was found best in satisfying our two key evaluation criteria—high realism of emergent student career types and high articulation of types with achievement level. The student career types were easy to interpret through an examination of the pattern of each cluster's defining mean factor scores, and to tag with summary characterizations in the form of cluster "nicknames." Furthermore, the Eta^2 correlation[8] between student career type and achiever classification with the former as the predictor came in at a robust .381.

Table 2, below, embodies the model. The table displays the ten student career clusters, labeled by nickname, in percent Achiever order. The data columns display cluster means for the original 9 process variables used in the sort, indexed to the overall cohort averages to make cross-scale and cluster comparisons easier. Also shown are indexed cluster achievement tendencies by main classifier and achievement sub-types, plus indexed scores for the Traditional Student and Socio-Educationally Advantaged factors to identify the socio-educational backgrounds predominating within each career type. The cluster model is rich in detail,[9] but again, space limitation permits only a general review:

- High Achievement Clusters (60 % or more). Three student clusters registered high achievement levels. All had in common elevated group preparedness, academic goal, launch period success, course performance and study load scores, and low cumulative problem scores, but each distinguished itself in some salient fashion. The **Collegiate** cluster was special for its below-average Persistence and Attitude scores; it contained the highest concentration of full-time "traditional students" (the youngest and most straight-from-high-school group), most strongly favored transfer

Table 2. Student Career Clusters within Cohort 1990 (Achievement Eta^2=.381)

Factors	(Raw) COHORT	EXTRA EFFORT	SUPPORTED SCHOLARS	COLLEGI-ATES	TRUE GRIT	PRAGMA-TISTS	FULL-TIME STRUGGLE	PART-TIME STRUGGLE	VANISHERS	UNPRE-PARED	CASUALS
		Student Career Clusters (Index Values)									
Cluster %	100.0	9.8	6.6	14.3	9.9	4.4	5.6	10.6	7.0	15.5	16.2
Cluster (N)	(2,386)	(233)	(158)	(342)	(236)	(106)	(134)	(254)	(168)	(369)	(386)
Academic Objectives	50.0	110	113	126	109	63	100	58	115	98	92
Coll Preparedness	50.0	120	119	129	114	79	91	90	105	30	127
Early Performance	50.0	126	137	155	80	117	102	116	54	74	62
Study Attitude	50.0	174	132	87	154	83	109	106	68	68	63
Institutional Support	50.0	93	222	86	91	88	210	81	82	81	75
Course Load	50.0	127	144	150	84	105	117	49	138	107	66
Enrollment Persistence	50.0	162	117	92	159	99	107	125	64	73	50
General Performance	50.0	126	131	130	94	131	87	126	125	61	61
Problem Syndrome	50.0	58	71	67	137	57	170	120	61	140	97
Achievers	31.2	242	219	212	139	97	79	56	36	3	2
Transfers	13.4	202	208	325	89	63	44	21	36	2	4
Awards	8.6	340	253	122	172	121	43	55	14	0	0
Either	18.9	244	217	254	123	89	47	35	28	2	3
Sophomore Status	12.3	237	221	145	163	107	128	85	49	4	0
Continuing	9.8	118	52	54	264	67	132	177	55	66	29
Dropout	63.7	36	48	51	67	107	103	114	135	146	152
Socio-Ed Advantaged	*50.0*	126	90	121	94	108	64	102	106	75	102
Traditional Student	*50.0*	114	107	123	97	81	109	63	109	107	86

NOTE: In the Student Career columns, all figures are indexed group means (Index=100*(raw group mean/raw whole population mean)). In the Whole Cohort column, unitalicized figures are percentages of all cohort students in the variable criterion category; figures in italics (e.g. *50.0*) are transformed factor scale score means. In their original format, factor score whole population means are always 0, with scores below the mean indicated by negative numbers. This format does not permit indexing because indexing requires division by the population mean and mathematics forbids zero division. The transformation formula (Index=50+(20*cluster score mean)) resets the population factor mean to 50, with a constant multiplier (20) which has the effect of creating a factor score case range of between 0 and 100.

programs, especially in the Arts & Sciences, and had the highest transfer rate (especially early and without a degree). In contrast, **Extra Effort** students registered extreme Persistence and Attitude scores and exhibited strong degree-seeking behavior. While also inclined to be "traditional students," nevertheless many were a bit older, entered PGCC on a somewhat delayed basis, often took evening and extension center classes, and tended more to favor technical programs like computer programming and allied health. The Persistence and Attitude scores of the **Supported Scholars** fell somewhere between those of the first two. These were mostly strongly motivated African American "traditional students" from the middle socio-educational ranks, while Collegiates and Extra Effort students were mostly white and upper-middle class. Most notably, students with this academic career pattern were the likeliest of any to bolster their study success chances by participating in institutional support programs.

- High Medium Achievement Clusters (40-59%). At this level of achievement we found only one study career pattern—**True Grit**. Many in this essentially African American middle class cluster of older students, often part-timers taking evening classes, experienced significant problems with remedial programs and credit courses, but over two-fifths eventually became achievers through drive (second highest Attitude score) and pluck (second highest Persistence score).

- Average Achievement Clusters (20-39 %). Two unlike clusters occupied this niche. The somewhat more successful **Pragmatists**, like True Grit students, tended to be middle class adult learners, but were predominantly white, much older, more part-time (fourth lowest Load score), and more oriented to occupational courses and job-related goals (second lowest Academic Objectives score). Most arrived at PGCC poorly prepared, but nevertheless did well academically as a group (tied for highest General Performance score). Their only moderate group Persistence score and 30 percent achievement rate may be related to a prevalence of short-term occupational objectives for attendance. In contrast, **Full-Time Strugglers** were mostly young working class African American full-time students straight from lower prestige high schools. These entered PGCC somewhat unprepared, exhibited only moderate drive and persistence, and then typically bogged down in the remediation process (highest group Problem Syndrome score). Despite a strong tendency to avail themselves of support programs (second highest Support score), only around a quarter became Achievers by their last term.

- Low Achievement Clusters (Under 20%). Four disparate study career types were found in this category. **Part-Time Strugglers**, mostly African American, were fully-employed, delayed-entry, part-time students (lowest Traditional Student score) with clear job-related attendance objectives (lowest Academic Objectives score). Below average college preparation, low study loads and high "stop-out" tendencies prevented any more than one in five becoming Achievers, despite high Persistence scores (third best mean). **Vanishers**, on the other hand, were predominantly white, degree- and transfer-oriented full-time students with excellent initial course performance records. Nevertheless, most of them dropped out within a few terms (second lowest Persistence score)—as if study had been cut short by some personal emergency like ill-health or financial collapse. Hardly more than one in ten made it into the Achiever category. Much less mysterious were the **Unprepareds**, who arrived at PGCC with the greatest remediation needs of any cluster; most of the students in this working class African American group did not survive the first year of study (57 percent never earned a single credit hour), and less than 1 percent became Achievers. Lastly in this bottom achievement tier were the **Casuals**, mostly well-prepared, part-time students from middle and upper-middle class neighborhoods, many explicitly giving job and personal enrichment reasons for attending, who took very few courses and exerted little effort to get good grades in those they did take. Again, less than 1 percent became Achievers.

The cluster model taught three main lessons. First, our top performing students were *not* necessarily socially and educationally advantaged transfer-bound "traditional students" (the equivalent of the Collegiate cluster). Two other high success clusters emerged, one consisting mainly of evening students and the another of lower-middle class African Americans, both more oriented toward degree-seeking than transferring. Second, a goodly proportion of our cohort member actually fell outside the regular parameters of college study. Around 7 percent "vanished" in the midst of successful study careers, probably due to personal emergencies, and fully 16 percent proved to be "casual" course-takers, not serious about pursuing a degree or transfer. Third, another 16 percent (Unprepareds) proved so unready for college work that they were beyond the best efforts of our developmental teachers and counselors to help in any real way. And fourth, among clusters with high concentrations of the socio-educationally disadvantaged, adult learners, part-time and job-oriented students, those who accomplished the most academically had in their study career profiles high scores on either level of personal motivation or level of financial/academic support receipt or both. Sheer attendance persistence, often present, did not seem to be enough.

DISCUSSION AND CONCLUSION

To our knowledge, this paper represents the first-ever attempt at a systematic modeling of the whole academic process of a college or university by means of path and cluster analyses. And although very much a work-in-progress, our research even at this early stage managed to yield many important if tentative findings. Path analysis revealed the central importance of personal motivation and the launch period in conditioning achievement probabilities. It also identified student participation in institutional support services and a structured accumulation of academic difficulties as important contributing factors in determining study success. And cluster analysis highlighted the inherent diversity of motives, needs and academic experiences within the PGCC student body and the importance of taking student career differences seriously.

The question remains, however, as to how generalizable our finding were to the typical American higher educational institution, or even to the average community college. We believe that the most likely answer is that the particular model we have just presented provides a good starting point for the quest for a generic model of the community college academic process. Although Prince George's Community College does have some unique features (e.g., a predominantly middle class African American student body), according to Vincent Tinto's (1993) comprehensive review of the findings of recent national research on academic outcomes it comes sufficiently close to national community college norms with respect to student body demographics and behavior to serve as a rough exemplar of two-year schools. For example, PGCC students in the 1990 first-time entering cohort, like first-time students at two-year schools typically, were somewhat more likely to be female than male, much more likely to be under 25 years of age than to be adult learners, much less likely to be carrying a full course load than to be registered for 15 or more term credits, and somewhat more likely to be enrolled in an occupationally-oriented than a transfer-oriented degree program. Also, PGCC institutional outcome rates tend to fall within the normal range. For example, 49 percent of our cohort members continued on into their second year, compared with 54 percent of a national student sample surveyed in 1992 by the American College Testing Program , and within six years 16 percent of PGCC cohort members managed to transfer to a four-year school, compared with 21 percent of a 1980 national cohort surveyed by the High School and Beyond study.

Furthermore, several important features of the academic process model which Tinto derived from his national review seemed to emerge in our own model as a natural function of the data analysis. Tinto views the academic process as a social sub-system which attempts to assimilate new members during a critical period of adjustment. Success-prone college entrants will be those who during their first year of study learn how to become students, adopt academic and institutional identities and integrate themselves into college community. This seems to be reflected in the Early

Term Performance component of our model and its demonstrated impact on academic achievement at PGCC. Tinto also emphasizes the roles of personal commitment (motivation, drive) and involvement in learning (attention to study career, assimilation of educational values) for staying in school. These seem to be combined in our Study Attitude factor, which we found to be the single most potent predictor of academic achievement and the central correlate of most other key components in the PGCC model. Finally, Tinto posits social congruence, the degree of fit between a student's academic intentions and resources and his position within the larger social structure, as a major conditioner of enrollment persistence and academic achievement. Students who have clear educational goals jibing with their life and career circumstances tend to experience more study success, as do those who move to acquire the financial wherewithal for college study and who seek help in managing the competing demands of college study with family and job responsibilities. These seem find some parallel in the Academic Objectives and Institutional Support components of our model.

Such similarities between the Tinto model and the PGCC model suggest that a wider application of path and cluster analysis to readily available institutional data organized by student entry cohorts can go far in converting academic retention theory into empirically validated models.

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FOOTNOTES

1. See also Clagett (1995), and Boughan and Clagett (1996).

2. Just three instances of the employment of structured equation modeling turned up in our review of the recent institutional research literature and no instance of the use of cluster analysis. See Pike (1996), Eimers and Pike (1997), and Cubeta, Sheckley and Travers (1997). None of the SEM utilizations involved an attempt to model the total academic process at a college or university.

3. SPSS factor module: principle components extraction method, .1 minimum Eigenvalue extraction criterion, oblique rotation to conserve dimensional intercorrelation, regression-based case scores.

4. For a complete treatment of the original predictors and the derivation of the factor scales, see Boughan (1997).

5. For model development we used AMOS v. 3.6 software. The appropriate error estimates and path coefficient significance values were calculated but are not shown in Figure 1 to preserve clarity.

6. According to the most common measure, the Joreskog and Sorbom Goodness-of-Fit coefficient (GFI), our model performed at a very high level (.988 unadjusted, .956 adjusted for non-parsimony effects). Using another popular measure, the Tucker-Lewis Index which controls for sample size effects, also indicated an acceptable level of model fit (.934). The Chi-square test, however, showed a significant difference between the actual model and the saturation model ($p<.0001$), although even here the normed fit index, which compares actual and independence model chi-squares, suggested that our model greatly does move us quite far towards the saturation ideal (.976).

7. The central role played by personal attitude factors in academic performance was also the finding of another academic process path analysis, although method (survey research), and model elements (GPA as performance measure; multiple motivation variables) and base (four-year university students) differed significantly from ours. See Cubeta et al. (1997).

8. <u>Eta</u>^{2} is the appropriate statistic for gauging how much of the variance of a two-category variable can be explained by a typology; it is highly analogous to the R^2 statistic used in linear models like regression and causal path analysis.

9. See Boughan (1997) for a full report of the cluster model.

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