MODELING STUDENT FLOWS THROUGH THE UNIVERSITY'S PIPELINES

Denise York Young and Lawrence J. Redlinger
University of Texas at Dallas

ABSTRACT

A cohort of first-time, full-time, degree-seeking freshmen was used to develop a model for tracking the flow of students through the university's degree pathways. Students were tracked over 6 years to determine retention and graduation rates by major, outflows to other majors, and performance in gateway courses. Students matriculating as electrical engineering majors had more diversity in the major in which a degree was ultimately obtained than students who started in other majors. Data for students not retained were examined to determine their academic standing at departure. Methodological issues encountered during this cohort study were documented and examined.

INTRODUCTION

Successful retention and graduation of students are important to both the institution and to the state. State universities in Texas are required to report freshman-to-sophomore retention and 6-year graduation rates as Annual Performance Measures to the Legislative Budget Board. Although much research has been conducted on these topics, the dynamics at a micro-level associated with these outcomes are not always understood well. Students enter a university and choose a major, even though their major may be "undeclared." The academic experience can be thought of as series of inflows and outflows. Students move from one major (outflow) to another major (inflow). They may also transfer (outflow) to another institution (inflow). An understanding of these flows is important so an institution can best determine where to expend resources to most efficiently obtain desirable results.

BRIEF REVIEW OF RELEVANT LITERATURE

Student retention has been a much-studied topic. Alexander Astin at UCLA and Vincent Tinto at Syracuse University have been some of the major contributors to research on student retention. Astin (1975, 1993), using large national data sets, identified involvement (academic involvement, involvement with faculty, involvement with student peers) as a key factor in retention. Tinto's (1987) model of institutional departure is based on academic and social integration. The greater the amount of integration, the greater the probability of retention. Recent work by Berger and Milem (1999) used Astin's Theory of Involvement as a helper theory to more explicitly specify Tinto's description of departure. These findings show that students who successfully integrate into the academic and social subsystems are more likely to persist at the institution, and are students whose values, norms, and established patterns of behavior are congruent with those already dominant on campus.

Broadly speaking, student retention efforts fall into two categories, academic and social, paralleling Tinto's model. Efforts to assist under-prepared students through remedial and tutorial programs are the primary methods used in academic retention. However, not all academic retention programs concentrate on under-prepared students. Nagda et al (1998) studied the impact of undergraduate student-faculty research partnerships on student retention. The primary finding was that such a program increased retention rates for some groups of students, particularly African-American students and for sophomores. Providing financial aid and personal support are examples of social student retention efforts.

McLaughlin, Brozovosky, and McLaughlin (1998) suggested that institutional researchers can play a vital role in identifying student retention as a strategic issue by analyzing data at the college and departmental levels, examining "killer" courses, and attaching money to the loss of students.

STUDY OF UTD FALL 1992 FRESHMAN COHORT

The focus of this study is on the relationship of retention and graduation to student flow through the academic pipeline. The Fall 1992 cohort of first-time, full-time, degree-seeking freshmen at the University of Texas at Dallas (UTD) was used to develop a model for tracking the flow of students through the university's degree pathways. Students were tracked over 6 years (through Summer 1998) to determine retention and graduation rates by major, outflows to other majors, and performance in first-year courses. This cohort was selected because it was the most recent

fall cohort for which the entire 6 years of data were available. Although results should be interpreted with caution due to the small size of the cohort, the size provided an advantage in the development of the modeling process because some of the student flows were more easily explored with smaller numbers of observations. It is our intent to repeat this study with the Fall 1993 cohort, which contains approximately 400 students. The tracking time of 6 years was selected because of the use of 6-year graduation rates by the Legislative Budget Board in the Annual Performance Measures and by the U.S. Department of Education in the IPEDS Graduation Rate Survey.

Cohort Characteristics
The cohort consisted of 91 students. The retention rate at UTD from Fall 1992 to Fall 1993 was 70% (64/91). The 6-year graduation rate from UTD was 47% (43/91). During the 6 years, 12% (11/91) "stopped-out" for at least one fall or one spring semester and then returned to UTD. The distributions of gender and ethnicity are contained in Table 1. Table 2 contains the frequency distribution of the major at time of matriculation in Fall 1992.

Table1
Distributions of Gender and Ethnicity

Male	58	64%
Female	33	36%
Total	91	100%
White-Non-Hispanic	61	67%
Asian Or Pacific Islander	17	19%
Hispanic	8	9%
Black-Non-Hispanic	5	5%
Total	**91**	**100%**

Table 2
Major at Matriculation

Electrical Engineering	23	25%
Biology	16	18%
Undeclared	16	18%
Computer Science	12	13%
Business Administration	8	9%
Chemistry	4	4%
Geosciences	2	2%
Literature	2	2%
Math	2	2%
Physics	2	2%
Psychology	2	2%
Arts & Humanities	1	1%
History	1	1%
Total	**91**	**100%**

Flow of Students and Persistence
Due to limited number of students in the cohort, data on student flow (Figures 1 through 6) will be presented on only the three most frequently selected majors at the time of matriculation (electrical engineering, biology, and undeclared).

The flow of students in electrical engineering is shown in Figure 1. Of the 23 who matriculated in electrical engineering, 14 (61%) graduated from UTD in 6 years and 9 (38%) did not graduate from UTD in 6 years. There is considerable variation in the majors in which degrees were awarded for students who matriculated in electrical engineering. Seven majors are represented by these 14 students.

The flow of students in biology is shown in Figure 2. Of the 16 who matriculated in biology, 8 (50%) graduated from UTD in 6 years and 8 (50%) did not graduate from UTD in 6 years. In contrast to electrical engineering, students who matriculated in biology were awarded degrees in only two other fields (chemistry and psychology).

The flow of students who matriculated as undeclared majors is shown in Figure 3. Of the 16 who matriculated as undeclared majors, only 4 (25%) graduated from UTD in 6 years and 12 (75%) did not graduate from UTD in 6 years. Tinto's theory of academic and social integration can help explain the low 6-year graduation rate for undeclared majors. Undeclared majors may also be undecided about attending college and obtaining a degree, which could contribute to a lower level of academic involvement and integration. In addition, undeclared majors may not fully integrate socially because of the lack of identity with a department. In a study on students who choose and leave science in highly selective institutions, students with undecided initial interests had the lowest retention rate compared to those who declared initial interest in a specific field (Strenta, Ellliott, Adair, Matier, & Scott, 1994).
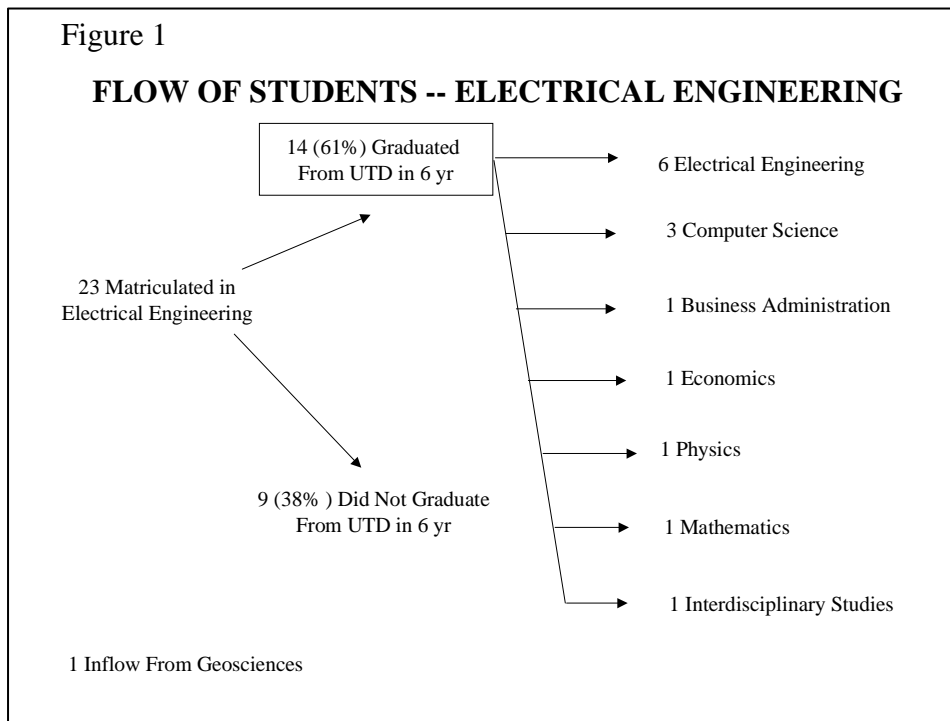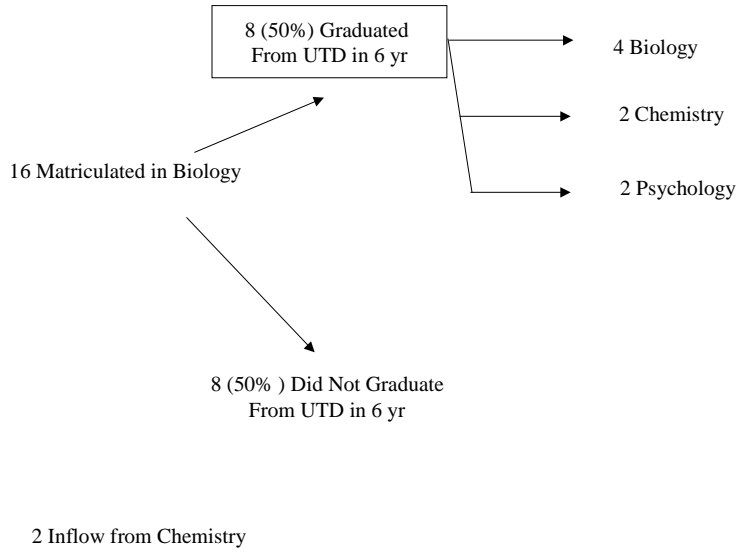
Figure 1

FLOW OF STUDENTS -- ELECTRICAL ENGINEERING

Figure 2

FLOW OF STUDENTS -- BIOLOGY

8 (50%) Graduated
From UTD in 6 yr

4 Biology

2 Chemistry

2 Psychology

16 Matriculated in Biology

8 (50%) Did Not Graduate
From UTD in 6 yr

2 Inflow from Chemistry

Figure 3

FLOW OF STUDENTS -- UNDECLARED

4 (25%) Graduated
From UTD in 6 yr

2 Business Administration

1 Chemistry

1 Computer Science

16 Matriculated as
Undeclared

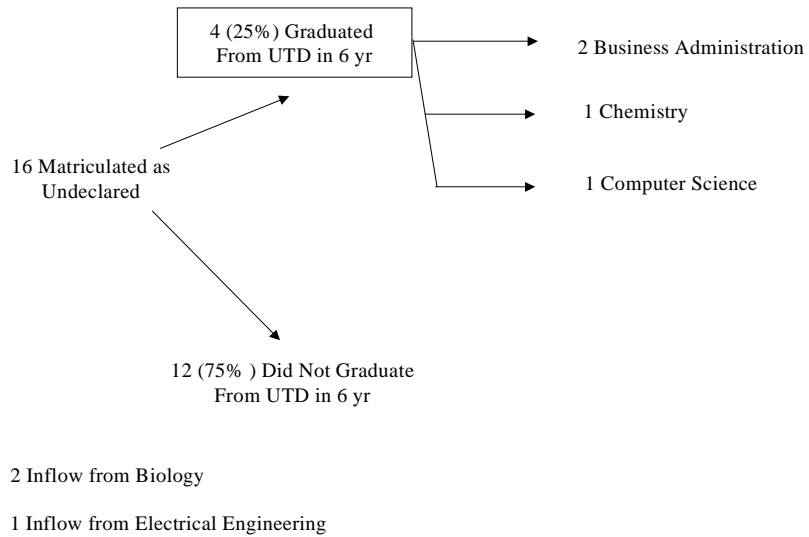12 (75%) Did Not Graduate
From UTD in 6 yr

2 Inflow from Biology

1 Inflow from Electrical Engineering

Figures 4 through 6 show the length of persistence and academic standing for students who matriculated as electrical engineering, biology, and undeclared majors but did not graduate from UTD within 6 years. For students matriculating in electrical engineering, academic probation occurred within the first two semesters. In contrast, academic probation tended to occur in later semesters for students who matriculated as biology majors. For all three of these majors, half of those who did not graduate within 6 years persisted no more than 2 semesters.
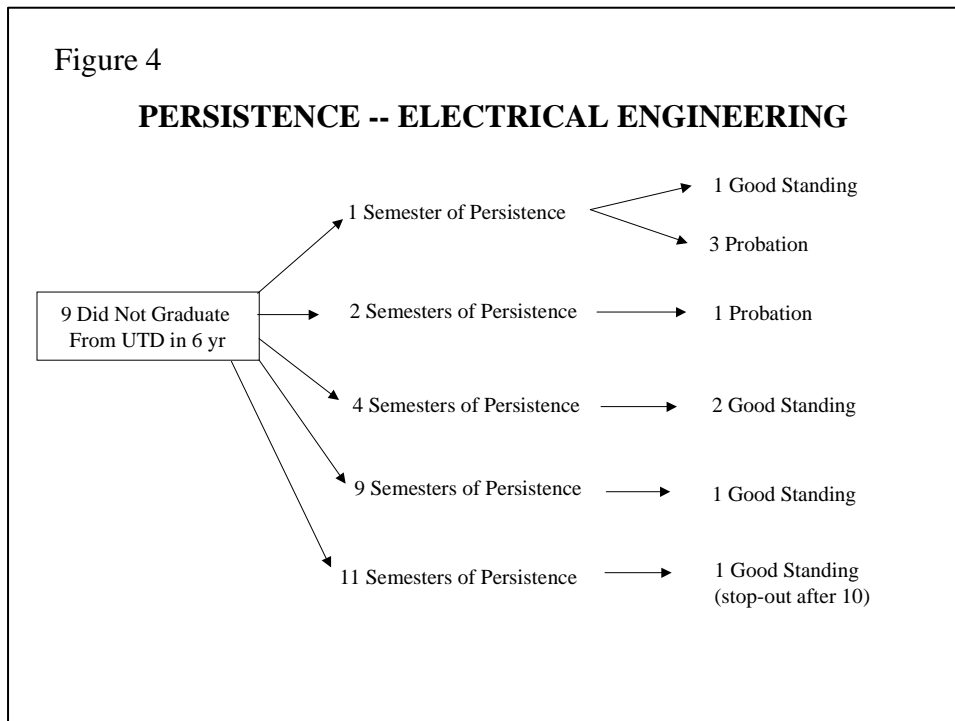
Figure 4

PERSISTENCE -- ELECTRICAL ENGINEERING

1 Semester of Persistence	1 Good Standing
	3 Probation
9 Did Not Graduate From UTD in 6 yr → 2 Semesters of Persistence	1 Probation
4 Semesters of Persistence	2 Good Standing
9 Semesters of Persistence	1 Good Standing
11 Semesters of Persistence	1 Good Standing (stop-out after 10)

Figure 5

PERSISTENCE -- BIOLOGY

8 Did Not Graduate From UTD in 6 yr

1 Semester of Persistence
  → 1 Good Standing
  → 1 Probation

2 Semesters of Persistence → 2 Good Standing

3 Semesters of Persistence
  → 1 Good Standing (stop-out after 2)
  → 1 Probation

5 Semesters of Persistence → 1 Probation (stop-out after 4)

7 Semesters of Persistence → 1 Good Standing (stop-out after 6)

Figure 6

PERSISTENCE -- UNDECLARED

12 Did Not Graduate From UTD in 6 yr

1 Semester of Persistence
  → 3 Good Standing
  → 1 Probation

2 Semesters of Persistence
  → 1 Good Standing
  → 1 Probation

3 Semesters of Persistence → 1 Good Standing

4 Semesters of Persistence → 2 Good Standing

8 Semesters of Persistence → 1 Probation (stop-out after 6)

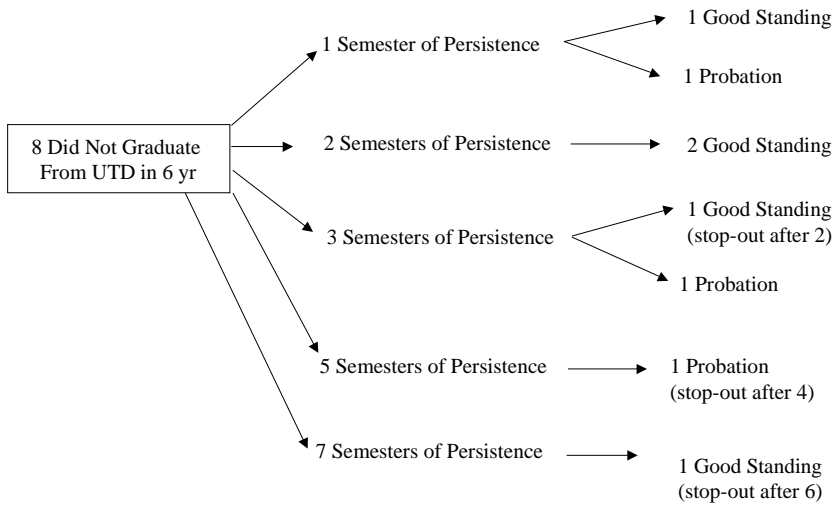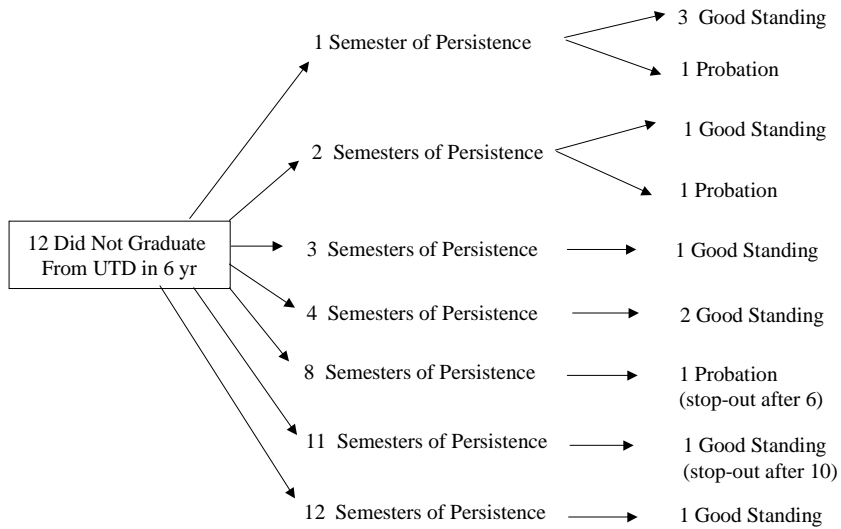11 Semesters of Persistence → 1 Good Standing (stop-out after 10)

12 Semesters of Persistence → 1 Good Standing

Performance in First-Year Courses
Courses taken during the fall and spring semesters of the cohort's first year were ranked by the percentage of students retained for the second fall semester. Table 3 contains the ranking for courses with 20 or more students. Somewhat surprisingly, introductory courses in social sciences and humanities had higher percentages of students not retained than did math and science courses.

Table 3
Retention of Students in Cohort by Courses Taken During First Year

COURSE	NOT RETAINED	RETAINED	TOTAL	% NOT RETAINED
GOVT 1301	10	13	23	43%
HST 1301	9	17	26	35%
A&H 1301	20	40	60	33%
CHM 1441	18	40	58	31%
MATH 1371	17	44	61	28%
GOVT 1302	7	23	30	23%
SOCS 1301	13	44	57	23%
CS 1330	6	21	27	22%
CHM 1442	8	28	36	22%
RHET 1301	17	62	79	22%
MATH 1372	6	39	45	13%
PSY 1301	2	25	27	7%
PHYS 1105	2	34	36	6%
PHYS 1301	2	39	41	5%

To illustrate different scenarios, grade distributions for retained and non-retained students in GOVT 1301 (American Government: An Introduction) are shown in Figure 7. None of the retained students received a grade below "C". Although 30% of the non-retained students received a grade below "C", 70% of them received a "C" or better. This would seem to indicate that something other than low grades is a factor in non-retention. Of the 27 students not retained 1 year later, 16 were in good academic standing at the end of the first semester.

Grade distributions for retained and non-retained students in MATH 1371 (Calculus I) are shown in Figure 8. Retained students are represented in all grade categories, including "W." In contrast, none of the non-retained students received a grade of "A" or "W". Unlike retained students, non-retained students who did poorly in the class did not withdraw from the class. Ultimately, this type of behavior will lead to academic probation.

Figure 7
GRADE DISTRIBUTION FOR GOVT 1301 FOR RETAINED AND NOT RETAINED STUDENTS
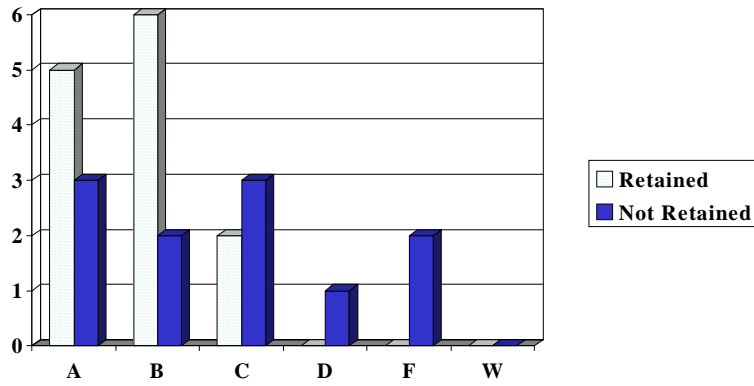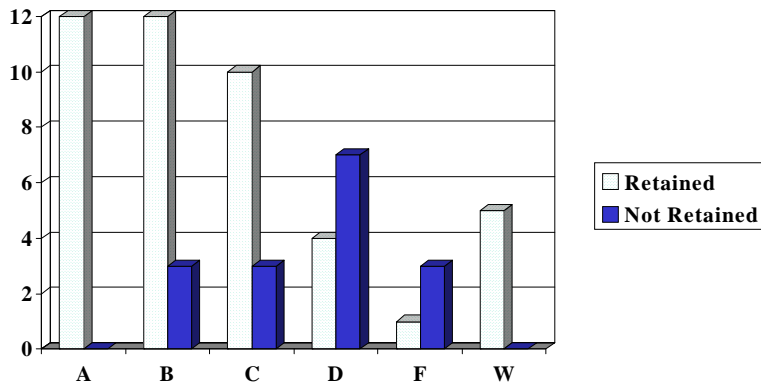

Figure 8
GRADE DISTRIBUTION FOR MATH 1371 FOR RETAINED AND NOT RETAINED STUDENTS

METHODOLOGICAL ISSUES IN STUDENT FLOW COHORT STUDY

There are a number of methodological issues one encounters when conducting a cohort study of student flow. The individual student should be the unit of analysis. Results can be impacted by restricting the analysis to the institutional or departmental level. In addition, limited academic information is available on students who transfer to another institution. Also, the length of time the cohort is tracked can influence the results.

Unit of Analysis
McLaughlin, Brozovosky, and McLaughlin (1998) suggested that institutional researchers can play a vital role in identifying student retention as a strategic issue by analyzing data at the departmental level. The data presented on students who entered as electrical engineering, biology, and undeclared majors demonstrate important dynamics occur at the departmental level that might not be evident at an institutional level. Furthermore, it is insufficient to compare data among departments without considering what is happening at the level of the individual student. For example, suppose that Departments X and Y each have 10 freshmen matriculate as majors. Department X graduates all 10 of the original students. However four students from Department Y either transfer to another department or are not retained by the university. The other six students graduate from Department Y, along with four students who transferred into Department Y. A simple, but misleading, ratio of the number of students graduated to the number of students originally matriculated would yield 100% for each department. However, the two departments differ dramatically in movement of students, which would be masked if the data were not analyzed at the student level.

Transfer to Another Institution
Students who left UTD to attend another institution were counted as not retained and were not counted in the 6-year graduation rate for this study. If one's interest is strictly in the institution where the student matriculated, then this approach is appropriate. Adelman (1998, 1999) argues that in this time of multi-institutional attendance, institutional graduation rates do not make much sense. Some policy issues cannot be adequately addressed without information about whether the student transferred to another public university and whether a degree was ultimately obtained. Data provided by the Texas Higher Education Coordinating Board (1999) only partially address these questions by providing the number of students in a cohort who transferred and graduated from other Texas public institutions. Without knowing *which* students transferred and graduated, the ability of the matriculating institution to analyze academic outcomes for these students is severely limited. Even if data files were obtained from the Coordinating Board that showed *which* students transferred and graduated from other Texas public institutions, information on students who transfer and graduate from private or out-of-state institutions would be missing. Including students who matriculate at one institution and graduate from or another can greatly impact graduation rates. For example, the 6-year graduation rate from UTD of students in this cohort was 47%. In addition, 10% of the cohort graduated within 6 years from other Texas public institutions.

Length of Longitudinal Study
Six years was chosen as the length of time to follow the 1992 UTD freshman cohort primarily because this mirrors the timeframe for the IPEDS Graduation Rate Survey and the Annual Performance Measures reported to the Legislative Budget Board. Certainly, the proportion of students who complete degrees in 6 years or less is an important piece of data; however, it presents an incomplete picture. Slightly over 5% of the 1992 UTD freshman cohort was still persisting at UTD at the end of 6 years, and almost 9% was still persisting at some other Texas public institution (Texas Higher Education Coordinating Board, 1999). The "High School &

Beyond/Sophomore Cohort" longitudinal study conducted by the National Center of Education Statistics tracked the cohort (high school class of 1982) from 1980 through 1993, when cohort members were 29 to 30 years old. Based on that study, Adelman (1998) reported that the vast majority of noncompleters were no longer enrolled in higher education by age 30. These results, in conjunction with the UTD study, indicate the need to track a cohort for more than 6 years. Different conclusions might be reached, depending upon whether information from other institutions is included and whether one extends the tracking period beyond 6 years.

CONCLUSION

Cohort analysis is useful for tracking the flow of students through the university pipeline over time; however, there are a number of factors that impact the quality of the results of this type of analysis. The cohort must be sufficiently large and tracked for at least 6 years in order to obtain objective results. Analysis of inflows and outflows must be done at the student level, not just at the institutional and departmental levels. Information on students who transfer to other institutions is necessary for a complete analysis of student flow.

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