Investigating Characteristics that Typify Engineering, Computer and Biological Sciences Graduates, the Differences that Occur Among and Between these Disciplines and the General Population of SUS Graduates

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Executive Summary

The purpose of this exercise was to determine whether any of the available demographic or academic variables show distinct trends in three specific discipline areas that differ from those of other areas:

- Engineering
- Computer Sciences and Studies
- Biological Sciences

Using data from 39,087 SUS graduates in 2002-03 and of 324,164 science courses these students took in the SUS, the following results occurred regarding students in these disciplines:

- They were more likely to have started as freshpersons (FTIC) than other disciplines.
- Engineering students consistently took longer to complete degrees than those in other fields, no matter what type of student they were at entry (FTIC, AA Transfer or Non-AA Transfer), with Computer Science Students second. Students in the Biological Sciences were close to those in other disciplines (Figure 2). Transfer students took longer than FTICs from their initial date of college entry.
- Females are represented among Engineering and Computer Science students at less than half their expect representation (compared with the general student population). Generally, racial-ethnic groups were represented as expected, with a slightly lower representation among Hispanic students in Computer Sciences, and higher representation among Asians in the sciences and engineering (Figure 3). Regarding details, females appear more likely to be transfers than men across all racial ethnic groups, and tend to be less prevalent in the sciences, except for the Biological Sciences than men (Table 2).
- Regarding course taking several patterns emerge from the data (Table 1):

  Business courses are by far the most frequent of all courses, and physics and mathematics, chemistry, biological sciences and business courses occur frequently in more disciplines that any other course discipline area.

  Biology students take more science courses than any other group, while Engineering students take more Engineering courses. Computer Science students take fewer science and engineering courses than students in any of the other primary discipline groups.
- The vast majority of graduates in all discipline areas (circa 76%) come from the major SUS Research Universities (UF, FSU, USF, FIU and UCF), and this is particularly true in Engineering (86%), although less so in Computer Sciences (65%) – (

Table **3**, Figure 4).

- Regarding cut courses, Biology majors take more than any other group, because of their large number of chemistry, physics and biology courses. Non-FTIC students take more of all types of these science courses in all disciplines than do FTIC students (Table 4).

Introduction

The purpose of this exercise was to determine whether any of the available demographic or academic variables show distinct trends in three specific discipline areas that differ from those of other areas:

- Engineering
- Computer Sciences and Studies
- Biological Sciences

In order to better assess the question, other disciplines were treated in two ways, first, as an all other, and secondly, broken into the following very broad sets of discipline areas:

NSF S&E –
Other Physical Sciences and Mathematics,
Health Sciences and
Psychology, Social Sciences and Other S&E Disciplines (e.g. Agricultural Economics, etc.),
NSF Non S&E -
Business and Agricultural Business
All Other Non S&E (includes Humanities, Letters, Fine Arts, Education, etc.)

Methods

The current investigation uses data from the 39,087 graduates of SUS institutions in the 2002-03 Academic year, for whom information on 324,164 science courses was available.

The following characteristics were investigated:
Race/Ethnicity
Sex
Type of Student at Entry
School graduated from
Number of Science, Technology, Engineering & Math courses completed
Number of years between entry and completion
Number of Cut Courses Completed

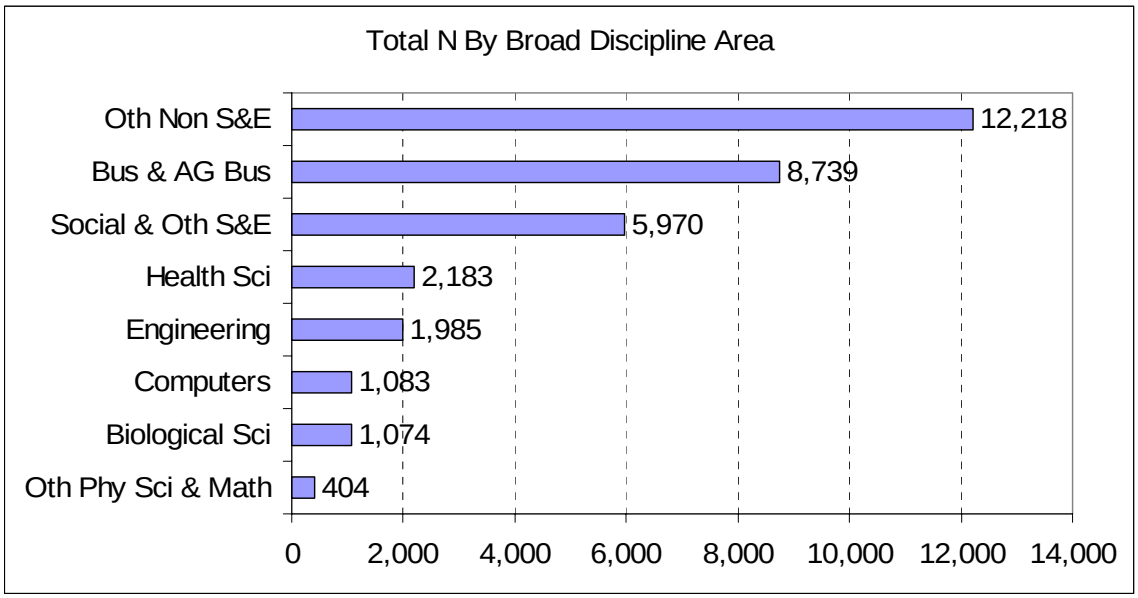
Cut Courses - These were determined by contacting USF's STEM and STEMish departments (chairs, advisors, etc.) who identified required science-type courses that majors and/or non-majors frequently had difficulty with and had to retake.

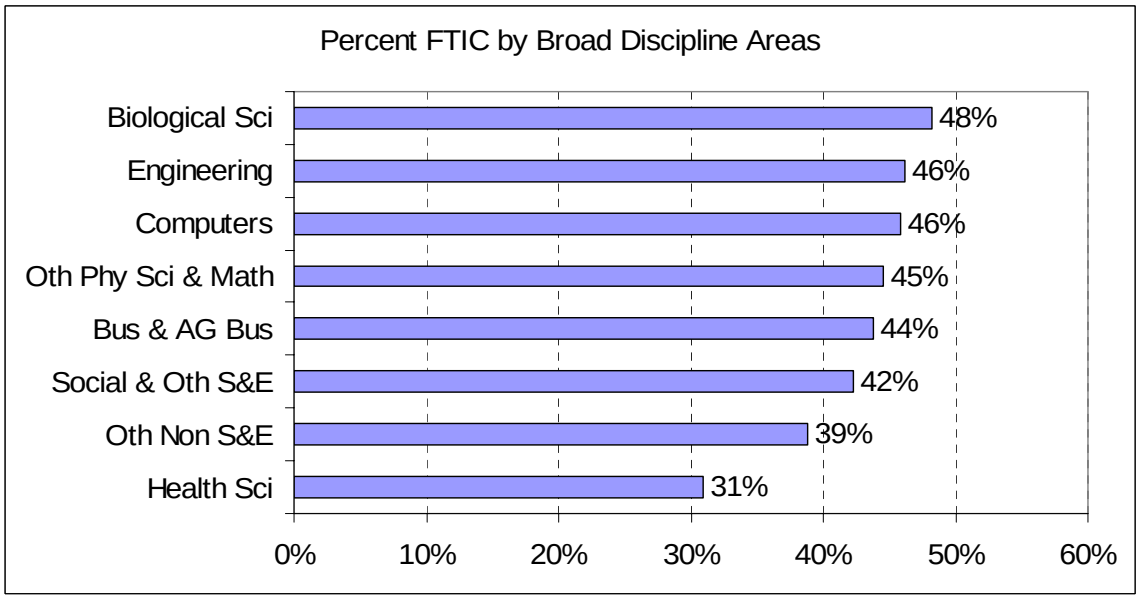
SAS PC 9.1.3 and Microsoft Excel 2003 were used for all analyses.

Results

The top panel of Figure 1 shows that approximately 4,000 students completed degrees in the three disciplines of primary interest, and the bottom panel indicates that these three disciplines graduate greater percentages of students who began in the SUS as FTICs and did not transfer, either from one SUS institution to another or from a community college as frequently as in other disciplines.

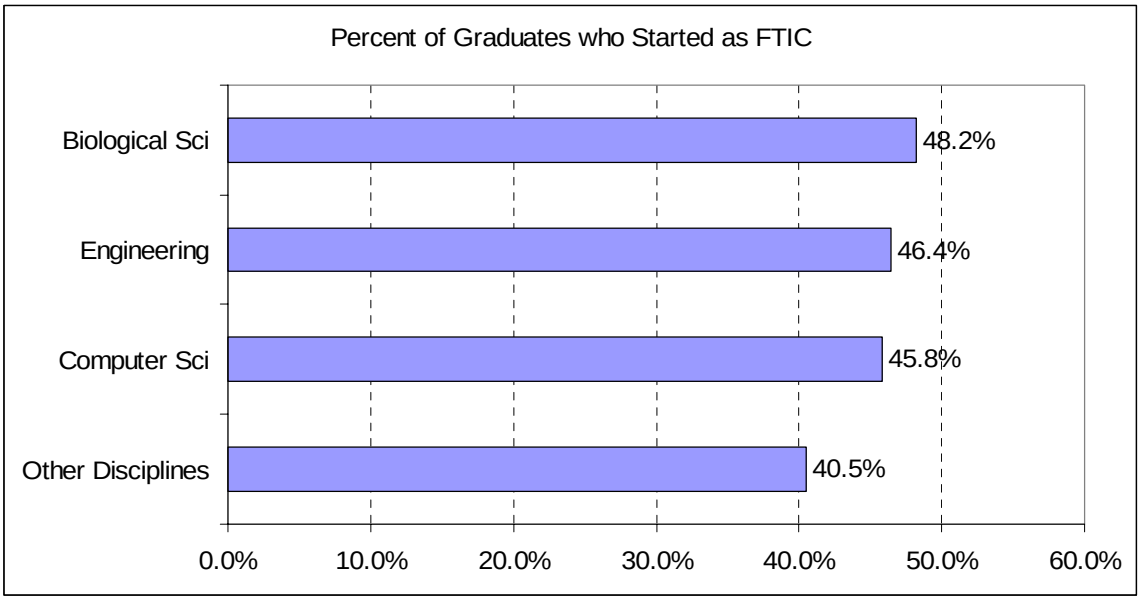
Figure 1
Sample Size and Percent FTIC Across Discipline Areas





The top panel of Figure 2 shows pretty clearly the differences between the sciences and other fields (remember that business is high also). The bottom panel shows the time costs of transferring, although for all three groups, Engineers take the longest, followed mostly by Computer Science, with Bio and Other Disciplines not far from each other. Note that for the average FTIC who gets a degree, the number of years taken is roughly 4.4-4.6.

Figure 2
Student Entry Types by Discipline Area and Mean Years to Degree



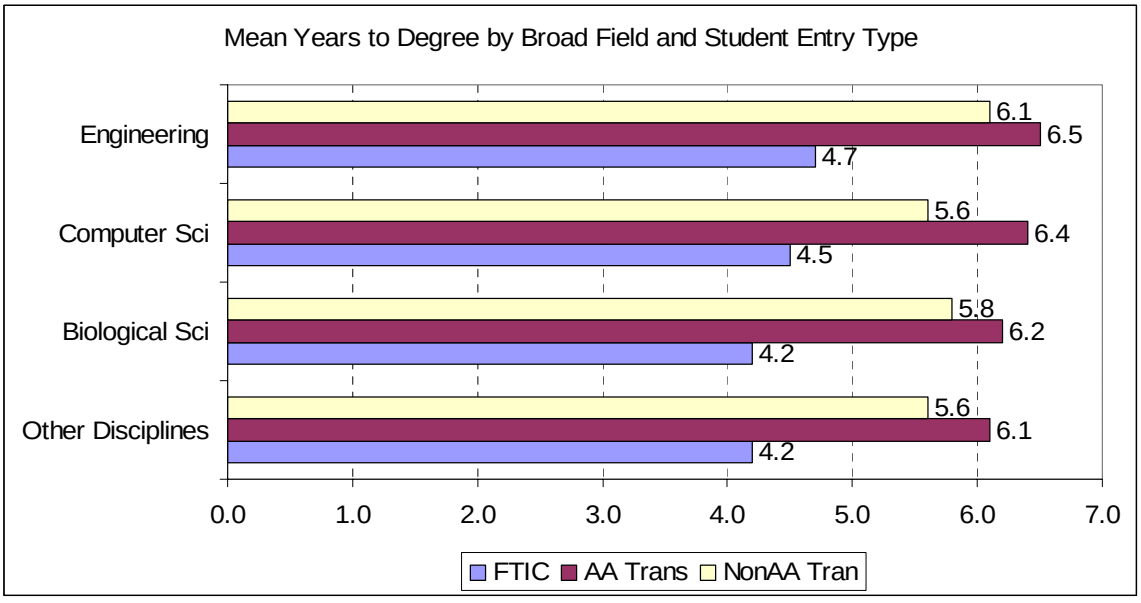
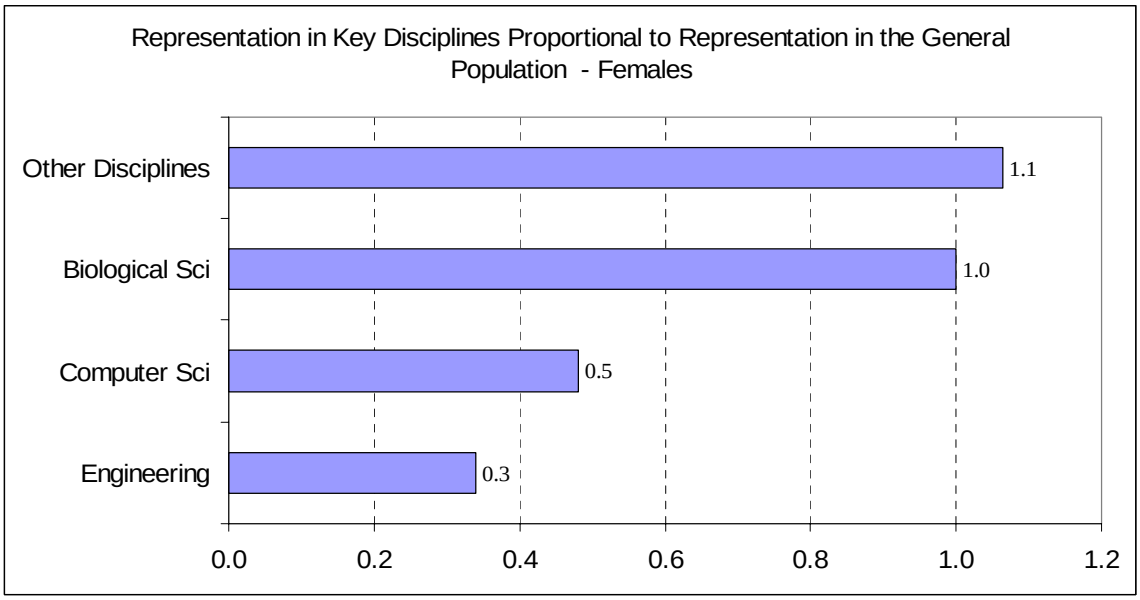


Figure 3 shows that females make up only about half as great a proportion of the computer science population as they do in the total population of graduates (2002-03), and less than a third in engineering. Race/Ethnic groups distribute fairly equally across disciplines, except for high representations among Asians in the sciences and engineering.

Figure 3
Proportional Representation by Racial-Ethnic Group and Sex Across Disciplines



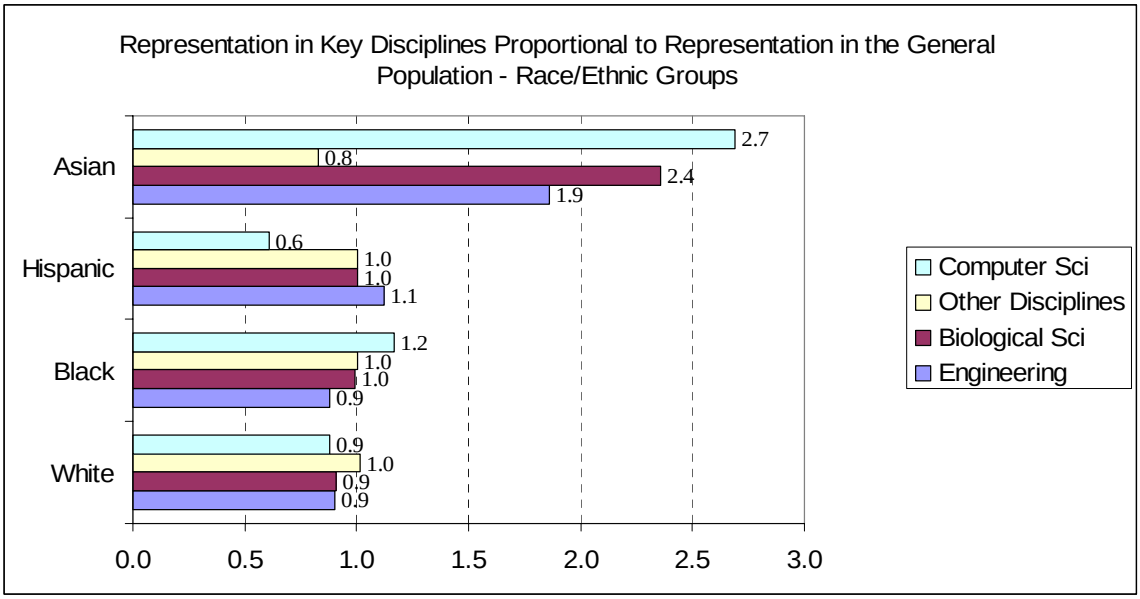


Table 1 shows the average number of courses in the databases (324,164) that were taken in the broad course areas (down the side) by students who attained degrees in the broad discipline areas (across the top). Cases where at least one course was averaged by the student population are bold and shaded. Engineering courses show strictly for engineering degrees, with only computer degrees showing even half a course on average among other disciplines. Business courses are by far the most frequent of all courses, and physics and mathematics, chemistry, biological sciences and business courses cross more disciplines that any other course discipline area.

On the left side of the table (physical sciences), we can see that physics, mathematics and chemistry are prevalent in all except the computer science degrees, and that biological sciences and physics and math (probably mostly math) are the most commonly emphasized on the right side of the table. Unsurprisingly, students with degrees in the biological sciences take many biology courses, with a lot of chemistry also, and more physics and mathematics than any group except those students in other physical sciences and mathematics. Computer students take few courses in the sciences, with only physics, mathematics and business courses being prevalent. Health sciences students unsurprisingly take mostly courses in health sciences and biological sciences. Non S&E students take primarily biological sciences, with some business, education and

Table 1
Average Number of Courses

Course Area				Degree Area							
	Totals	Total Mean		Engineering	Computers	Bio Sci	Oth Phy Sci & Math	Social Sci & Oth S&E	Bus & Ag Business	Health Sciences	Other Non S&E
N of Students =>	33,656	33,656	4,546*	1,985	1,083	1,074	404	5,970	8,739	2,183	12,218
	N of Courses	All	STEM								
Engineering	14,206	0.4	2.5	**5.4**	0.5	0.0	0.3	0.0	0.0	0.0	0.2
Business	84,921	2.5	1.0	**1.0**	**1.7**	0.6	0.7	**1.5**	**5.4**	0.7	**1.8**
Education	12,415	0.4	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.9
Social Sci	18,854	0.6	0.2	0.2	0.2	0.4	0.3	**1.2**	0.3	0.2	0.7
Psychology	14,343	0.4	0.2	0.1	0.2	0.4	0.2	0.8	0.2	0.3	0.5
Military & Aviation	593	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Life & Bio	54,358	1.6	2.1	0.7	0.9	**6.6**	**2.4**	**1.7**	0.7	**2.6**	**1.8**
Health	14,093	0.4	0.0	0.0	0.0	0.2	0.0	0.1	0.0	**5.0**	0.2
Physics & Math	49,895	1.5	2.9	**3.4**	**2.6**	**3.3**	**4.4**	**1.1**	**1.2**	**1.0**	**1.3**
Chemistry	36,271	1.1	2.2	**2.0**	0.8	**5.0**	**4.9**	**1.0**	0.4	**1.5**	0.9
Earth & Other Physical	14,915	0.4	0.2	0.2	0.3	0.1	**1.0**	0.4	0.4	0.2	0.6
Other	9,300	0.3	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.6

* STEM means only Physical Science STEM – left set of disciplines in table.

physical sciences and mathematics. We should note that many of these graduates are transfers from community colleges, and therefore, their lower-level science requirements are not reflected in these courses.

Table 2 shows the total number of degree holders by racial/ethnic background, sex and type of student across the broad disciplines of interest. The data show generally that females tend to be somewhat more likely than males to transfer, across all racial/ethnic groups, that females are more common in the biological sciences across all ethnic groups and student sources, that males are more common in engineering and computers across all ethnic groups and student sources, and that females are more common everywhere in the other discipline areas. The ratio of females to males is quite consistent across all student types and racial-ethnic groups, with females outnumbering males roughly 1.5 to 1 everywhere except in computers and engineering, where this drops to about 0.4 to 1.

Table 2
Racial/Ethnic and Sex Breakdowns Across Broad Discipline Areas by Student Source – Percents Reflect Percent of Total Discipline Area Population

			White		Asian		Black		Hispanic		Native Am		Oth, Mult, Unkn	
		Totals	Fem	Male	Fem	Male	Fem	Male	Fem	Male	Fem	Male	Fem	Male
Total		33,656	12,720	8,774	782	721	2,863	1,403	2,903	1,831	78	51	800	730
	FTIC	13,888	13.6%	10.4%	1.0%	1.0%	3.9%	2.2%	3.5%	2.5%	0.1%	0.0%	1.5%	1.5%
	AA Tran	10,361	12.4%	8.3%	0.7%	0.6%	2.1%	1.0%	2.8%	1.8%	0.1%	0.1%	0.5%	0.4%
	Non-AA Tran	9,407	11.8%	7.4%	0.6%	0.6%	2.5%	1.0%	2.3%	1.1%	0.1%	0.0%	0.3%	0.2%
Bio Sciences	FTIC	518	14.5%	10.8%	3.7%	2.0%	4.5%	2.5%	4.1%	2.9%	0.3%	0.2%	1.9%	0.8%
	AA Tran	250	7.7%	6.9%	0.7%	0.7%	1.4%	0.8%	2.7%	1.4%	0.1%	0.1%	0.4%	0.5%
	Non-AA Tran	306	11.1%	7.1%	1.7%	1.8%	2.6%	0.7%	2.2%	0.8%	0.0%	0.1%	0.4%	0.0%
Computers	FTIC	496	4.6%	16.7%	1.6%	3.1%	3.8%	4.8%	1.2%	3.8%	0.0%	0.0%	1.6%	4.6%
	AA Tran	329	6.2%	13.6%	1.4%	3.1%	1.1%	1.5%	0.3%	1.8%	0.0%	0.1%	0.4%	1.0%
	Non-AA Tran	258	3.6%	11.4%	0.9%	1.8%	1.5%	2.1%	0.4%	1.2%	0.0%	0.0%	0.3%	0.6%
Engineering	FTIC	921	4.7%	19.1%	0.4%	3.2%	1.9%	4.2%	1.4%	6.5%	0.1%	0.0%	1.2%	3.8%
	AA Tran	550	3.0%	13.6%	0.7%	2.1%	0.4%	2.1%	1.0%	3.5%	0.1%	0.1%	0.2%	1.1%
	Non-AA Tran	514	3.3%	14.1%	0.4%	1.6%	0.7%	2.0%	1.0%	2.4%	0.0%	0.0%	0.1%	0.5%
Other	FTIC	11,953	14.5%	9.6%	0.9%	0.7%	4.0%	1.9%	3.8%	2.2%	0.1%	0.0%	1.5%	1.3%
	AA Tran	9,232	13.5%	7.8%	0.6%	0.4%	2.3%	0.9%	3.0%	1.7%	0.1%	0.1%	0.6%	0.4%
	Non-AA Tran	8,329	12.7%	6.8%	0.6%	0.4%	2.6%	0.9%	2.5%	1.1%	0.1%	0.0%	0.3%	0.2%

Table **3** and Figure 4 show that the SUS Major Research Universities produce most degrees (76%) and particularly so in Engineering (86%)

Table 3
Number and Percent of Graduates in Broad Discipline Areas by Institution

	Totals	FAMU	FAU	FGCU	FIU	FSU	UCF	UF	UNF	USF	UWF	NCU
Total	33,656	1,267	3,095	547	3,980	5,322	5,616	6,563	1,826	4,095	1,237	108
Percent		3.8%	9.2%	1.6%	11.8%	15.8%	16.7%	19.5%	5.4%	12.2%	3.7%	0.3%
Bio Sciences	1,074	39	139	0	114	120	162	267	45	149	39	0
Percent		3.6%	12.9%	0.0%	10.6%	11.2%	15.1%	24.9%	4.2%	13.9%	3.6%	0.0%
Computer	1,083	74	113	0	91	276	166	91	114	76	82	0
Percent		6.8%	10.4%	0.0%	8.4%	25.5%	15.3%	8.4%	10.5%	7.0%	7.6%	0.0%
Engineering	1,985	97	84	0	246	117	353	747	77	242	22	0
Percent		4.9%	4.2%	0.0%	12.4%	5.9%	17.8%	37.6%	3.9%	12.2%	1.1%	0.0%
Other	29,514	1,057	2,759	547	3,529	4,809	4,935	5,458	1,590	3,628	1,094	108
Percent		3.6%	9.3%	1.9%	12.0%	16.3%	16.7%	18.5%	5.4%	12.3%	3.7%	0.4%

Figure 4

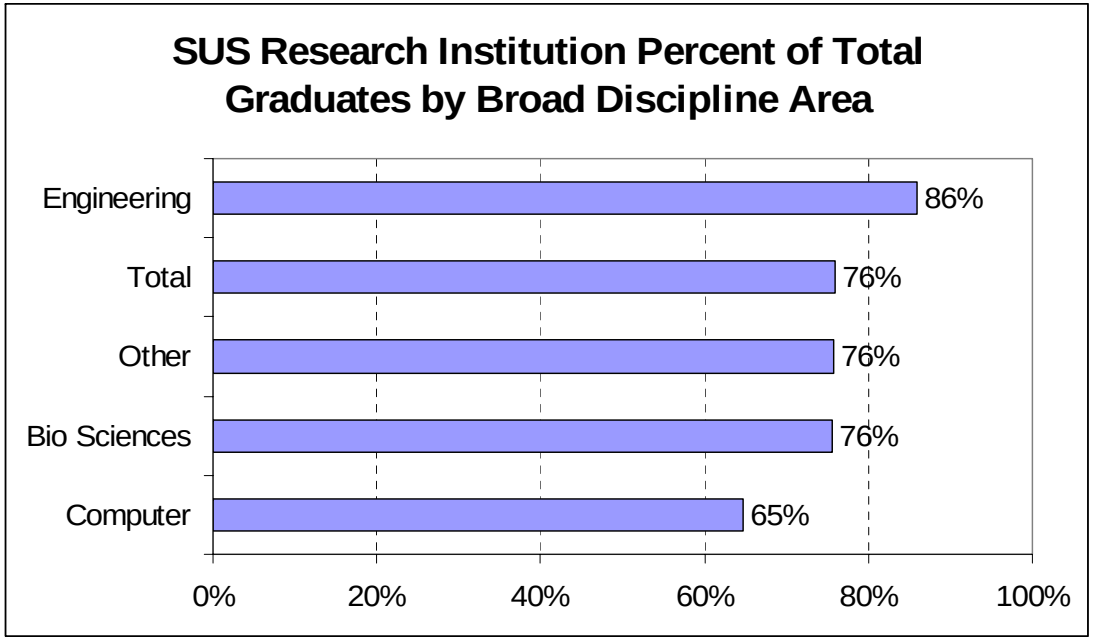


Table 4 depicts course level by type of student at entry for the four primary discipline areas of concern. Unsurprisingly, Biology majors take a comparatively large number of courses defined as cut courses. This occurs, as Table 1 shows, because so many cut courses fall in early chemistry, math and physics courses, where they take more than any other of the groups below. Because these are strictly science courses, Other Disciplines show few (mostly lower level requirements in math and sciences). Two primary distinctions occur for types of student at entry: (1) non-FTIC students generally take more of all types of courses than FTIC students, and (2) in Biology, Non-AA Transfers tend to take more cut-type courses.

Table 4
Mean N of Courses by Type and Discipline

	Biology			Computers			Engineering			Other Disciplines		
	FTIC	AA Tran	Non-AA Tran	FTIC	AA Tran	Non-AA Tran	FTIC	AA Tran	Non-AA Tran	FTIC	AA Tran	Non-AA Tran
Total N	518	250	306	496	329	258	921	550	514	11,953	9,232	8,329
Cut	5.7	5.8	6.7	1.6	1.9	1.8	2.4	2.8	2.8	1.1	1.1	1.1
Introductory	0.5	1.1	0.7	0.5	0.5	0.6	0.7	0.9	0.9	0.6	0.8	0.8
Advanced	8.4	12.5	10.5	4.5	5.8	5.3	8.7	11.3	9.7	5.0	6.7	6.2

Appendix A – List of Cut Courses

BCH035	ADVANCED BIOCHEMISTRY (U)
BCH053	GENERAL BIOCHEMISTRY (1 OF ???)
BCH054	GENERAL BIOCHEMISTRY (2 OF ???
ECH101	CHEMICAL ENGINEERING THERMODYNAM
ECH105	ADVANCED THERMODYNAMICS
EGN343	GENERAL THERMODYNAMICS
ENV012	ADVANCED ENVIRONMENTAL ENGINEERI
PHY503	THERMODYNAMICS
PHY513	THERMODYNAMICS AND KINETIC THEOR
BSC010	GENERAL BIOLOGY
BSC011	GENERAL BIOLOGY (CONT.)
BOT373	BIOLOGY OF HIGHER PLANTS
CHM045	GENERAL CHEMISTRY (1 OF 2)
CHM046	GENERAL CHEM (LAST COURSE IN SEQ
CHM210	ORGANIC CHEMISTRY
ECO100	PRICES AND MARKETS
ECO101	INTERMEDIATE MICROECONOMICS
ECO203	MACROECONOMIC THEORY
FIN403	BUSINESS FINANCE
FIN604	MULTINAIONAL FINANCIAL MANAGEMEN
ISM232	ADVANCED BUSINESS APPLICATION DE
MAC233	CALCULUS FOR BUSINESS & SOC. SCI
MAC234	CALCULUS FOR BUSINESS & SOC. SCI
NUR126	PATHOPHYSIOLOGY I
PHY043	PHYSICS FOR ENGINEERS I
PHY044	PHYSICS FOR ENGINEERS II
PHY048	GEN PHYS W/CALCULUS I (2 SEM SEQ
PHY049	GEN PHYS W/CALCULUS II (2 SEM SE
PHY323	INTM ELEC & MAGNETISM I (2 SEM S
PHY324	INTM ELEC & MAGNETISM II (2 SEM
PSY213	FOUNDATIONS OF RESEARCH METHODOL
PSY214	PRINCIPLES OF RESEARCH METHODOLO
PSY215	PRINCIPLES OF RESEARCH METHODOLO
ZOO713	COMPARATIVE VERTEBRATE ANATOMY