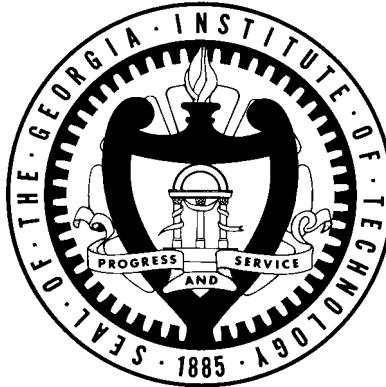




Georgia Institute of Technology

General Education Assessment Report: Science Objective Spring Semester 2004



Georgia Tech Office of Assessment
Jonathan Gordon, Assistant Director
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The Institute Undergraduate Curriculum Committee's Ad Hoc Subcommittee on General Education developed a set of nine general education objectives for all students earning a Georgia Tech baccalaureate degree. Specifically, the objectives call for:

- Technical, mathematical, and scientific competence
- An ability to communicate to and productively interact with others
- An awareness of culture and values in a diverse world
- An understanding of ethical issues surrounding one's personal and professional activities

The Science Objective as defined by the IUCC and approved by the Faculty Assembly is stated as follows:

Georgia Tech students will demonstrate an understanding and application of scientific methodology, laboratory techniques, quantitative problem solving, modeling skills, and experimental design to formulate and evaluate hypotheses.

The specific assessable learning outcomes stemming from this objective are:

Science Outcome 1: Students will be able to describe how a hypothesis to explain natural phenomena is evaluated and refined through experimentation (e.g. the scientific method).

Science Outcome 2: Students will be able to demonstrate proper analysis of experimental data (e.g., error estimation, statistical analysis, noise rejection).

Science Outcome 3: Students will be able to apply knowledge of a scientific theory to practical problem solving.

An assessment of these outcomes was conducted in service courses across the College of Sciences. Specifically, questions identified by faculty in the relevant Schools as being representative of the learning outcomes were seeded into the final exams in the following courses: Biology 1510 (Biological Principles), Chemistry 1310 (General Chemistry), and Earth and Atmospheric Science 1600 (Introduction to Environmental Science). In Physics 2211 (Intro Physics I), students were given questions from the Force Concept Inventory (FCI), (a multiple-choice test used to evaluate teaching effectiveness in Newtonian mechanics) at the beginning and at the end of the semester. In addition, two questions were included from the final examination in the course. The number of questions selected by faculty varied across Schools and outcomes. A summary of the methods used is presented below. The actual questions used are presented in the appendix.

Table 1. Methods Used to Assess General Education Outcomes

	Outcome 1 <u>Scientific Method</u>	Outcome 2 <u>Experimental Analysis</u>	Outcome 3 <u>Problem Solving</u>	Number of Students Assessed
Biology 1510	3 questions from final exam	4 questions from final exam	6 questions from final exam	148
Chemistry 1310	4 questions from final exam	5 questions from final exam	4 questions from final exam	249
Earth and Atmospheric Science 1600	4 questions from final exam	5 questions from final exam	10 questions from final exam	285
Physics 2211	None	2 questions from Force Concept Inventory (pre/post)	1 question from final exam	794

Of the students included in the assessment, GT ID's were matched to provide demographic and enrollment details. To facilitate comparisons across the outcomes, each correct response was weighted relative to the number of questions in the specific outcome. Thus, for each outcome, the highest score possible was 10. For each outcome, a one-way Analysis of Variance (ANOVA) was performed to test for group differences on the basis of gender, college, and student level and final course grade. Additionally, an ANOVA was performed on the quartile ranking of the admissions index for each student.¹ Not all groups were adequately represented in the obtained samples. For example, in CHEM 1310, only first-year students from the College of Computing, the College of Engineering and College of Sciences were enrolled in significant numbers.² Appropriate post-hoc tests were performed when a significant F statistic was found.³

The overall results for each General Education Outcome are presented in the table below. Because this is among the first assessment efforts tied to the new General Education outcomes, no attempt have yet been made to develop benchmarks. It is expected that repeated assessments will yield enough stability in the data to generate such success criteria. In each course, the lowest obtained scores were in outcome 3—problem solving. The overall mean score across all science courses on this outcome was 5.45. The overall mean for outcomes 1 and 2 were 7.24 and 7.26, respectively.

Table 2. Mean Performance Scores by Course

	Outcome 1 <u>Scientific Method</u>	Outcome 2 <u>Experimental Analysis</u>	Outcome 3 <u>Problem Solving</u>
Biology 1510	7.25	6.61	5.60
Chemistry 1310	7.81	7.16	5.15
Earth and Atmospheric Science 1600	6.66	7.84	6.32
Physics 2211	n/a	7.43 ⁴	4.73

¹ The Admission Index is the product of a regression equation that uses high school GPA and SAT Verbal and Math scores to predict first-year GPA at Georgia Tech. The Index was created by the University System of Georgia, and is used by the Office of Enrollment Services to assist with admissions decisions. To determine the quartile cut points, the Admissions Index for all undergraduate students enrolled at GT in Fall 2003 was used.

² Groups with fewer than 10 students were excluded from the analysis.

³ Tukey's HSD or the Games-Howell depending on whether the homogeneity of variance assumption was upheld.

⁴ The post-test scores from the FCI were used to determine the mean for this outcome in Physics

Science Outcome 1: Scientific Method

Students will be able to describe how a hypothesis to explain natural phenomena is evaluated and refined through experimentation (e.g. the scientific method).

Biology

There were 3 questions on the final exam relating to knowledge of the scientific method. The mean for this outcome was 7.25. There were no significant differences in performance based on gender, college, student level, or admit index. There were significant differences among final course grades and this outcome. Thus, performance on this outcome can be said to be related to performance in the course.

Table 3. Totals

Mean	7.25
SD	2.88
n	148

Table 4. By Gender

	Female (0)	Male (1)	<i>F</i>	<i>Sig.</i>
Mean	6.84	7.51	1.90	.171
SD	2.85	2.88		
n	57	91		

Table 5. By College

	College of Engineering (3)	Ivan Allen College (4)	College of Sciences (6)	<i>F</i>	<i>Sig.</i>
Mean	7.24	6.33	7.16	0.45	.641
SD	2.85	3.67	2.74		
n	93	10	34		

Table 6. By Student Level

	Freshmen (1)	Sophomore (2)	Junior (3)	Senior (4)	<i>F</i>	<i>Sig.</i>
Mean	6.60	7.80	7.86	7.05	1.89	.134
SD	3.03	2.94	2.44	2.72		
N	53	41	28	26		

Table 7. By Course Grade

	A (4)	B (3)	C (2)	D/F (1)	Tukey's HSD 4,3>2,1	<i>F</i>	<i>Sig.</i>
Mean	8.72	8.14	6.49	4.89		8.71	.000***
SD	2.17	2.13	3.05	3.05			
n	13	52	57	15			

Table 8. By Admissions Index Quartile

	Highest Quartile	Third Quartile	Second Quartile	Lowest Quartile	<i>F</i>	<i>Sig.</i>
Mean	7.63	7.50	6.79	7.18	0.55	.650
SD	2.52	2.66	3.39	2.94		
N	45	28	27	26		

Chemistry

The overall mean for this outcome was 7.72. Differences between males and females were statistically significant, with male students scoring higher than their female counterparts. No significant differences were found between the performances of students based on college. There were statistically different means based on final course grade, lending validity to the outcome measures.

Table 9. Totals

Mean	7.72
SD	2.04
n	269

Table 10. By Gender

	<u>Female (0)</u>	<u>Male (1)</u>	<u>F</u>	<u>Sig.</u>
Mean	7.13	7.95	8.98	.003**
SD	2.31	1.88		
n	75	194		

Table 11. By College

	<u>College of Computing (2)</u>	<u>College of Engineering (3)</u>	<u>College of Sciences (6)</u>	<u>F</u>	<u>Sig.</u>
Mean	7.83	7.79	7.91	0.05	.949
SD	2.11	1.92	2.53		
n	38	174	37		

Table 12. By Student Level

	<u>Freshmen (1)</u>	<u>Sophomore (2)</u>	<u>Junior (3)</u>	<u>Senior (4)</u>	<u>F</u>	<u>Sig.</u>
Mean	7.84	7.61	7.42	7.68	0.48	.699
SD	2.02	2.06	1.99	2.29		
N	154	70	31	14		

Table 13. By Course Grade

	<u>A (4)</u>	<u>B (3)</u>	<u>C (2)</u>	<u>D/F (1)</u>	<u>Tukey's HSD</u>	<u>F</u>	<u>Sig.</u>
Mean	8.15	7.68	7.13	6.93	4>2,1	3.96	.009**
SD	1.91	1.91	2.21	2.43			
n	108	98	41	22			

Table 14. By Admissions Index Quartile

	<u>Highest Quartile</u>	<u>Third Quartile</u>	<u>Second Quartile</u>	<u>Lowest Quartile</u>	<u>F</u>	<u>Sig.</u>
Mean	8.02	7.63	7.58	7.67	0.58	.628
SD	2.07	2.03	1.85	2.14		
N	63	57	59	73		

Environmental Science

The overall mean for the outcome was 6.66. There were no significant differences found based on gender, student level, or admissions index. Significant differences were found based on college—however, post-hoc tests failed to reveal the exact nature of the differences. There were also significant differences in performance based on final grade in the course.

Table 15. Totals

Mean	6.66
SD	1.51
n	285

Table 16. By Gender

	<u>Female (0)</u>	<u>Male (1)</u>	<u>F</u>	<u>Sig.</u>
Mean	6.51	6.75	1.61	.205
SD	1.64	1.43		
N	104	181		

Table 17. By College

	<u>College of Architecture (1)</u>	<u>College of Computing (2)</u>	<u>College of Engineering (3)</u>	<u>Ivan Allen College (4)</u>	<u>College of Management (5)</u>	<u>Tukey's HSD</u>	<u>F</u>	<u>Sig.</u>
Mean	6.21	6.72	6.97	6.45	6.40		2.70	.031*
SD	1.49	1.64	1.42	1.58	1.59			
n	30	16	129	44	62			

Table 18. By Student Level

	<u>Freshman (1)</u>	<u>Sophomore (2)</u>	<u>Junior (3)</u>	<u>Senior (4)</u>	<u>F</u>	<u>Sig.</u>
Mean	6.43	6.70	6.58	6.74	0.32	.815
SD	1.12	1.48	1.76	1.43		
n	17	87	73	107		

Table 19. By Course Grade

	<u>A (4)</u>	<u>B (3)</u>	<u>C (2)</u>	<u>D/F (1)</u>	<u>Tukey's HSD</u>	<u>F</u>	<u>Sig.</u>
Mean	7.65	6.92	6.08	5.56	4>3>2,1	19.51	.000***
SD	1.22	1.35	1.43	1.74			
n	49	119	96	20			

Table 20. By Admissions Index Quartile

	<u>Highest Quartile</u>	<u>Third Quartile</u>	<u>Second Quartile</u>	<u>Lowest Quartile</u>	<u>F</u>	<u>Sig.</u>
Mean	7.11	6.95	6.51	6.54	2.28	.080
SD	1.38	1.40	1.46	1.61		
N	37	59	81	98		

*p < 0.05; **p < 0.01; ***p < 0.001

Science Outcome 2: Analysis of Experimental Data

Students will be able to demonstrate proper analysis of experimental data (e.g., error estimation, statistical analysis, noise rejection).

Biology

There were four items measuring ability to analyze experimental data. The overall mean was 6.61. No significant differences were found based on gender, college, student level, or admission index. Performance on this outcome was significantly related to the final grade received in the course.

Table 21. Totals

Mean	6.61
SD	1.94
n	137

Table 22. By Gender

	<u>Female (0)</u>	<u>Male (1)</u>	<u>F</u>	<u>Sig.</u>
Mean	6.32	6.80	2.05	.155
SD	1.85	1.97		
N	55	82		

Table 23. By College

	<u>College of Engineering (3)</u>	<u>Ivan Allen College (4)</u>	<u>College of Sciences (6)</u>	<u>F</u>	<u>Sig.</u>
Mean	6.67	6.25	6.54	0.23	.795
SD	1.93	1.77	2.04		
n	93	10	34		

Table 24. By Student Level

	<u>Freshmen (1)</u>	<u>Sophomore (2)</u>	<u>Junior (3)</u>	<u>Senior (4)</u>	<u>F</u>	<u>Sig.</u>
Mean	6.15	6.96	6.70	6.90	1.57	.200
SD	2.21	1.34	2.13	1.81		
n	50	37	25	25		

Table 25. By Course Grade

	<u>A (4)</u>	<u>B (3)</u>	<u>C (2)</u>	<u>D/F (1)</u>	<u>Games-Howell 4,3>2</u>	<u>F</u>	<u>Sig.</u>
Mean	7.31	7.26	5.92	6.33		5.53	.001**
SD	2.29	1.98	1.73	0.69			
n	13	52	57	15			

Table 26. By Admissions Index Quartile

	<u>Highest Quartile</u>	<u>Third Quartile</u>	<u>Second Quartile</u>	<u>Lowest Quartile</u>	<u>F</u>	<u>Sig.</u>
Mean	7.11	6.61	6.11	6.92	1.35	.260
SD	1.92	2.07	2.11	2.48		
N	45	28	27	26		

Chemistry

Five questions tested this outcome on the final exam. The overall mean for this outcome was 7.15. No statistically significant differences were found between males and females. There were also no significant differences between students by college. Junior students scored higher than freshman and sophomores.⁵ There were also significant differences found based on final grade and admission index.

Table 27. Totals

Mean	7.15
SD	2.02
n	269

Table 28. By Gender

	<u>Female (0)</u>	<u>Male (1)</u>	<u>F</u>	<u>Sig.</u>
Mean	6.88	7.25	1.79	.182
SD	2.11	1.98		
N	75	194		

Table 29. By College

	<u>College of Computing (2)</u>	<u>College of Engineering (3)</u>	<u>College of Sciences (6)</u>	<u>F</u>	<u>Sig.</u>
Mean	7.32	7.21	6.76	0.86	.423
SD	2.19	1.99	2.23		
n	38	174	37		

Table 30. By Student Level

	<u>Freshmen (1)</u>	<u>Sophomore (2)</u>	<u>Junior (3)</u>	<u>Senior (4)</u>	<u>Tukey's HSD</u>	<u>F</u>	<u>Sig.</u>
Mean	7.13	6.80	8.19	6.71	3>2,1	3.79	.011*
SD	1.94	2.05	1.74	2.67			
N	154	70	31	14			

Table 31. By Course Grade

	<u>A (4)</u>	<u>B (3)</u>	<u>C (2)</u>	<u>D/F (1)</u>	<u>Games-Howell</u>	<u>F</u>	<u>Sig.</u>
Mean	7.72	6.84	6.93	6.09	4>3,1	6.19	.000***
SD	1.67	2.20	1.90	2.27			
n	108	98	41	22			

Table 32. By Admissions Index Quartile

	<u>Highest Quartile</u>	<u>Third Quartile</u>	<u>Second Quartile</u>	<u>Lowest Quartile</u>	<u>Tukey's HSD</u>	<u>F</u>	<u>Sig.</u>
Mean	7.81	6.84	7.05	6.85	4>3,1	3.25	.022*
SD	1.79	1.93	2.05	2.26			
N	63	57	59	73			

⁵ While the mean difference between juniors and seniors was actually higher than for other pairs, the relatively high standard errors did not produce statistically significant results.

Environmental Science

There were five questions that tested this outcome on the final exam. The overall mean for the data analysis outcome was 7.83. Significant differences were found on all independent variables; males scored higher than females; students in the College of Engineering scored higher than students in College of Management; sophomores scored higher than freshmen. Significant differences were also found based on admission index and final course grade.

Table 33. Totals

Mean	7.83
SD	1.87
n	285

Table 34. By Gender

	<u>Female (0)</u>	<u>Male (1)</u>	<u>F</u>	<u>Sig.</u>
Mean	7.46	8.05	6.59	.011*
SD	1.97	1.78		
N	104	181		

Table 35. By College

	<u>College of Architecture (1)</u>	<u>College of Computing (2)</u>	<u>College of Engineering (3)</u>	<u>Ivan Allen College (4)</u>	<u>College of Management (5)</u>	<u>Tukey's HSD</u>	<u>F</u>	<u>Sig.</u>
Mean	8.13	7.22	8.15	7.72	7.35	3>5	2.66	.033*
SD	1.81	1.83	1.86	1.86	1.88			
n	30	16	129	44	62			

Table 36. By Student Level

	<u>Freshmen (1)</u>	<u>Sophomore (2)</u>	<u>Junior (3)</u>	<u>Senior (4)</u>	<u>Tukey's HSD</u>	<u>F</u>	<u>Sig.</u>
Mean	6.74	8.13	7.67	7.89	2>1	2.93	.034*
SD	2.05	1.59	1.81	2.04			
n	17	87	73	107			

Table 37. By Course Grade

	<u>A (4)</u>	<u>B (3)</u>	<u>C (2)</u>	<u>D/F (1)</u>	<u>Tukey's HSD</u>	<u>F</u>	<u>Sig.</u>
Mean	9.04	8.24	6.97	6.63	4>3>2,1	22.23	.000***
SD	1.13	1.15	2.00	2.18			
n	49	119	96	20			

Table 38. By Admissions Index Quartile

	<u>Highest Quartile (4)</u>	<u>Third Quartile (3)</u>	<u>Second Quartile (2)</u>	<u>Lowest Quartile (1)</u>	<u>Tukey's HSD</u>	<u>F</u>	<u>Sig.</u>
Mean	8.64	8.42	7.80	7.43	4,3>1	6.23	.000***
SD	1.18	1.56	1.99	1.84			
N	37	59	81	98			

*p < 0.05; **p < 0.01; ***p < 0.001

Physics

Two questions from the Force Concept Inventory tested this outcome. The mean score on outcome 2 was 7.40. Significant differences were found based on gender, with males outscoring females. While no differences were found based on college or student level, there were significant differences based on admission index, with students in the highest quartile outperforming all other quartiles. Performance on this measure was strongly related to final grade obtained in the course. Since the FCI was administered both at the beginning and the end of the semester, a matched-pairs t-test was performed to see if performance improved over the course of the semester. The results indicate that this is in fact the case. The mean score improved from 6.64 to 7.73.

Table 39. Totals

Mean	7.40
SD	3.60
n	860

Table 40. By Gender

	<u>Female (0)</u>	<u>Male (1)</u>	<u>F</u>	<u>Sig.</u>
Mean	6.33	7.68	20.95	.000***
SD	4.01	3.42		
n	184	676		

Table 41. By College

	<u>College of Architecture (1)</u>	<u>College of Computing (2)</u>	<u>College of Engineering (3)</u>	<u>College of Sciences (6)</u>	<u>F</u>	<u>Sig.</u>
Mean	6.84	7.34	7.46	6.57	1.13	.335
SD	3.80	3.74	3.55	4.06		
n	19	47	731	51		

Table 42. By Student Level

	<u>Freshmen (1)</u>	<u>Sophomore (2)</u>	<u>Junior (3)</u>	<u>Senior (4)</u>	<u>F</u>	<u>Sig.</u>
Mean	7.53	7.16	6.34	7.50	1.73	.160
SD	3.46	3.81	4.33	4.08		
N	629	174	41	16		

Table 43. By Course Grade

	<u>A (4)</u>	<u>B (3)</u>	<u>C (2)</u>	<u>D (1)</u>	<u>F (0)</u>	<u>Games- Howell 4,3>2>1,0</u>	<u>F</u>	<u>Sig.</u>
Mean	8.98	8.17	7.31	6.51	5.66		12.85	.000***
SD	2.38	3.02	3.68	3.80	4.19			
n	98	213	288	176	83			

Table 44. By Admissions Index Quartile

	Highest Quartile (4)	Third Quartile (3)	Second Quartile (2)	Lowest Quartile (1)	Games- Howell	<i>F</i>	<i>Sig.</i>
Mean	8.64	7.32	6.44	7.18	4>3,2,1	14.24	.000***
SD	253	3.59	4.15	3.57			
N	210	250	208	177			

Table 45. FCI Performance: Early Semester vs. Late Semester

	<u>Early Semester</u>	<u>Late Semester</u>	<u>Difference</u>	<u>t-value</u>	<u>Sig.</u>
Mean	6.64	7.43	0.79	5.80	.000***
SD	3.80	3.55			
N	794	794			

Science Outcome 3: Problem Solving

Students will be able to apply knowledge of a scientific theory to practical problem solving.

Biology

There were six items relating to the ability to use scientific theories to solve practical problems. The mean for this outcome was 5.60. No significant differences were found relating to gender, college, student level, course grade, or admission index.

Table 46. Totals

Mean	5.60
SD	1.72
N	137

Table 47. By Gender

	<u>Female (0)</u>	<u>Male (1)</u>	<i>F</i>	<i>Sig.</i>
Mean	5.42	5.71	0.91	.341
SD	1.82	1.66		
n	55	82		

Table 48. By Student Level

	<u>College of Engineering (3)</u>	<u>Ivan Allen College (4)</u>	<u>College of Sciences (6)</u>	<i>F</i>	<i>Sig.</i>
Mean	5.72	5.17	5.39	0.77	.463
SD	1.85	1.23	1.48		
n	93	10	34		

Table 49. By Class

	<u>Freshmen (1)</u>	<u>Sophomore (2)</u>	<u>Junior (3)</u>	<u>Senior (4)</u>	<i>F</i>	<i>Sig.</i>
Mean	5.23	5.50	6.07	6.00	1.90	.133
SD	1.96	1.51	1.43	1.67		
n	50	37	25	25		

Table 50. By Course Grade

	<u>A (4)</u>	<u>B (3)</u>	<u>C (2)</u>	<u>D/F (1)</u>	<i>F</i>	<i>Sig.</i>
Mean	5.38	5.87	5.58	4.89	1.34	.264
SD	1.20	1.85	1.68	1.72		
n	13	52	57	15		

Table 51. By Admissions Index Quartile

	<u>Highest Quartile</u>	<u>Third Quartile</u>	<u>Second Quartile</u>	<u>Lowest Quartile</u>	<i>F</i>	<i>Sig.</i>
Mean	5.70	5.65	5.49	5.83	0.16	.926
SD	1.96	1.78	1.72	1.84		
N	45	28	27	26		

Chemistry

Four questions from the final exam were used to measure performance on this outcome. The overall mean for this outcome was 5.11. Males and females were virtually identical on the problem solving outcome. No significant differences were found between students based on gender, college, student level, or admission index. However, performance on this outcome measure was related to final course grade.

Table 52. Totals

Mean	5.11
SD	1.89
n	269

Table 53. By Gender

	<u>Female (0)</u>	<u>Male (1)</u>	<u>F</u>	<u>Sig.</u>
Mean	5.12	5.10	0.00	.948
SD	1.78	1.94		
n	75	194		

Table 54. By College

	<u>College of Computing (2)</u>	<u>College of Engineering (3)</u>	<u>College of Sciences (6)</u>	<u>F</u>	<u>Sig.</u>
Mean	5.26	5.18	4.86	0.50	.605
SD	1.83	1.87	2.19		
n	38	174	37		

Table 55. By Student Level

	<u>Freshmen (1)</u>	<u>Sophomore (2)</u>	<u>Junior (3)</u>	<u>Senior (4)</u>	<u>F</u>	<u>Sig.</u>
Mean	5.06	5.23	5.10	5.00	0.14	.939
SD	1.92	1.93	1.62	2.18		
n	154	70	31	14		

Table 56. By Course Grade

	<u>A (4)</u>	<u>B (3)</u>	<u>C (2)</u>	<u>D/F (1)</u>	<u>Tukey's HSD</u>	<u>F</u>	<u>Sig.</u>
Mean	5.91	4.82	4.44	3.73	4>3,2>1	14.75	.000***
SD	1.78	1.72	1.64	2.07			
n	108	98	41	22			

Table 57. By Admissions Index Quartile

	<u>Highest Quartile</u>	<u>Third Quartile</u>	<u>Second Quartile</u>	<u>Lowest Quartile</u>	<u>F</u>	<u>Sig.</u>
Mean	5.40	5.09	5.15	4.82	1.02	.383
SD	1.75	2.07	1.79	2.05		
N	63	57	59	73		

*p < 0.05; **p < 0.01; ***p < 0.001

Environmental Science

There were 10 questions from the final exam that were used to measure this outcome. The overall mean score was 6.32. Significant differences were found by gender, with males outscoring females. Significant differences were also found based on college, with students in the College of Engineering outperforming all other colleges. While no significant differences were seen based on student level, there were significant differences based on admission index and final course grade.

Table 58. Totals

Mean	6.32
SD	1.51
n	285

Table 59. By Gender

	<u>Female (0)</u>	<u>Male (1)</u>	<u>F</u>	<u>Sig.</u>
Mean	5.97	6.52	8.92	.003**
SD	1.38	1.55		
N	104	181		

Table 60. By College

	College of Architecture (1)	College of Computing (2)	College of Engineering (3)	Ivan Allen College (4)	College of Management (5)	Tukey's HSD	<u>F</u>	<u>Sig.</u>
Mean	6.04	5.67	6.97	5.92	5.66	3>1,2,4,5	12.72	.000***
SD	1.26	1.56	1.43	1.32	1.36			
n	30	16	129	44	62			

Table 61. By Student Level

	Freshman (1)	Sophomore (2)	Junior (3)	Senior (4)	<u>F</u>	<u>Sig.</u>
Mean	5.53	6.36	6.32	6.43	1.76	.155
SD	1.06	1.48	1.60	1.52		
n	17	87	73	107		

Table 62. By Course Grade

	A (4)	B (3)	C (2)	D/F (1)	Tukey's HSD	<u>F</u>	<u>Sig.</u>
Mean	7.90	6.37	5.72	5.04	4>3>2,1	38.73	.000***
SD	1.23	1.26	1.19	1.82			
n	49	119	96	20			

Table 63. By Admissions Index Quartile

	Highest Quartile (4)	Third Quartile (3)	Second Quartile (2)	Lowest Quartile (1)	Tukey's HSD	<u>F</u>	<u>Sig.</u>
Mean	7.31	6.50	6.00	6.22	4>3,2,1	7.36	.000***
SD	1.70	1.47	1.29	1.50			
N	37	59	81	98			

*p < 0.05; **p < 0.01; ***p < 0.001

Physics

One question from the final exam was used to measure this outcome. The mean score was 4.55. Significant differences were found in performance based on gender (with males scoring higher than females), admission index, and final course grade. No significant differences were found based on college or student level.

Table 64. Totals

Mean	4.55
SD	4.98
n	963

Table 65. By Gender

	<u>Female (0)</u>	<u>Male (1)</u>	<i>F</i>	<i>Sig.</i>
Mean	3.87	4.73	4.68	.031*
SD	4.88	5.00		
n	199	764		

Table 66. By College

	College of Architecture (1)	College of Computing (2)	College of Engineering (3)	College of Sciences (6)	<i>F</i>	<i>Sig.</i>
Mean	4.40	4.48	4.52	4.15	.10	.963
SD	5.06	5.01	4.98	4.97		
n	25	58	814	53		

Table 67. By Student Level

	Freshmen (1)	Sophomore (2)	Junior (3)	Senior (4)	<i>F</i>	<i>Sig.</i>
Mean	4.37	5.27	4.04	4.44	1.89	.129
SD	4.96	5.00	4.96	5.11		
N	691	207	47	18		

Table 68. By Course Grade

	A (4)	B (3)	C (2)	D (1)	F (0)	Games- Howell 4>3>2,1>0	<i>F</i>	<i>Sig.</i>
Mean	9.15	5.76	3.86	3.27	2.20		35.59	.000***
SD	2.80	4.95	4.88	4.70	4.16			
n	106	224	311	202	118			

Table 69. By Admissions Index Quartile

	Highest Quartile	Third Quartile	Second Quartile	Lowest Quartile	Tukey's HSD 4>3,2,1	<i>F</i>	<i>Sig.</i>
Mean	5.87	4.37	3.94	3.94		7.83	.000***
SD	4.93	4.97	4.90	4.90			
N	230	279	241	193			

*p < 0.05; **p < 0.01; ***p < 0.001

Comparison of Spring 2004 results with Fall 2003 Assessment

A table comparing factors that were found to be significant using one-way Analysis of Variance is presented for each course and each outcome. Given the lack of consistency in methods used to assess the general education outcomes in Fall 2003 and Spring 2004, caution should be exercised in interpreting these results. In future assessment iterations, more standardized methods will yield a better understanding of possible trends among these factors. Worthy of note is that course grade appears to be a significant factor in many of the assessment results (particularly in Spring 2004). This provides evidence of content validity—that what is measured here is related to faculty expectations of learning and student performance in these courses.

Outcome 1: Scientific Method

Factor	Biology		Chemistry		EAS		Physics	
	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring
Gender	+			++	n/a		n/a	n/a
College Student Level	++				n/a	+	n/a	n/a
Course Grade	+++	+++		++	n/a	+++	n/a	n/a
Admit Index	+				n/a		n/a	n/a

Outcome 2: Experimental Data Analysis

Factor	Biology		Chemistry		EAS		Physics	
	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring
Gender						+	n/a	+++
College Student Level	++			+		+	n/a	n/a
Course Grade	+++	++		+++		+++	n/a	+++
Admit Index	+++			+		+++	n/a	+++

Outcome 3: Problem Solving

Factor	Biology		Chemistry		EAS		Physics	
	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring
Gender	+					++		+
College Student Level						+++		
Course Grade	+++			++		+++	+++	+++
Admit Index	+++		+			+++		+++

+ F-statistic significant at $p < .05$
 ++ F-statistic significant at $p < .01$
 +++ F-statistic significant at $p < .001$

Conclusion

The results of the assessment of the general education science outcomes seem to demonstrate higher performance for the scientific method and experimental analysis outcomes than for the problem solving outcomes. However, no conclusions should be drawn from this finding until the assessment is repeated using a similar methodology. Results between the Fall and Spring semesters are not readily comparable as the implementation methods and items used varied across the Schools. A more consistent approach will be utilized in future iterations of the assessment, which will hopefully generate a clearer picture of student performance on these outcome measures. In the meantime, the Spring 2004 assessment serves as a useful baseline for subsequent assessment efforts.