



1st-Year Engineering Students and Their Perceptions of Academic Progress

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Dr. Peter J. Partell, Binghamton University

Peter J. Partell is an alumnus of Binghamton University and began his career as Associate Dean for Academic Affairs and Administration in the Thomas J. Watson School of Engineering and Applied Science in 2008 after serving as Director of Institutional Research and Planning for the university. Partell received his doctoral degree in Political Science from Binghamton University in May 1999 and his bachelor's degree from the State University of New York, College at Buffalo. In his role as Associate Dean, Partell is responsible for the Watson School's academic programs and policies, academic support programs, curricular planning, accreditation, space planning, and enrollment planning and management. Some of his accomplishments as Associate Dean include spearheading the graduate enrollment growth strategy that resulted in an increase in graduate enrollment of 400 students over a 4-year period, managed a \$4 million teaching and graduate assistant budget which lead to a significant increase in the number of teaching assistants, led a cross-school committee to revamp mathematics education for engineering and computer science students, and served as co-chair of the University's Strategic "Road Map" Committee focused on "Student Success." He currently serves on the "Road Map" Steering Committee. As Director of Institutional Research and Planning, Partell advised administrators on the efficient use of resources and provided contextual information to guide strategic planning. His office coordinated research studies and reporting pertaining to progress on strategic plan, enrollment and revenue forecasting, faculty workload and instructional costs, student satisfaction, retention and graduation, admissions, space utilization, and staffing. Dr. Partell serves on many school-based and university-wide committees whose missions focus on items ranging from communications to accreditation to strategic planning.

Mrs. Meghan Crist, Binghamton University

Meghan graduated from Binghamton University in 2010 with a BS in electrical engineering and went to work for BAE Systems in Endicott, NY. As a participant in their Engineering Leadership Development Program, she earned her master's degree in systems engineering from the Watson School in 2013, developed a strong technical background, pursued extensive leadership training and experienced recruiting for entry level engineering positions. As an engineer, her primary roles were systems testing of flight and actuator controls on multiple commercial and defense programs. In June of 2018, Meghan changed career focus and became an undergraduate Academic Advisor in the Watson School at Binghamton University. Meghan is an open book, passionate about STEM and is more than willing to share her industry insight with students. She also works closely with the Financial Aid Services Office and is a resource for students who have questions related to their aid. In addition to her role as an Academic Advisor she is also a FYE instructor, the advisor for SWE and involved with the Binghamton Girls Who Code chapter.

Work In Progress: First-Year Engineering Students and Their Perceptions of Academic Progress

Introduction

First-year engineering students are often under extreme amounts of stress. In their first semester, they are making the transition from high school to a college or a university where the rigor of the coursework is above and beyond what they have experienced in the past. Typically, first-year engineering students are expected to be calculus ready and take a calculus course in their first semester. They also take a laboratory science course, either chemistry or physics, but sometimes both. In addition to these two courses, students usually take an introductory engineering course and round out their studies with a liberal arts course, if the college or university has a general education requirement.

Along with this difficult field of study and rigorous course load, they are adjusting in general to life at a new school and new independence: being away from home for perhaps the first time, setting their own schedule, making new friends, navigating campus and finding the resources available, and getting involved with extracurricular activities, etc. The question that presents itself is “How well are these students monitoring and reacting to their academic progress in the face of all of these new and somewhat unique challenges?”

Half-way through their first semester, the first-year engineering students in the Engineering Design Division (EDD) at Binghamton University are surveyed. They are asked twenty-four multiple choice questions and one short answer question. These questions are designed to understand how well students are adjusting to university life. For example, are they familiar with and taking advantage of the academic services and resources offered to students? How do they think they are doing in some of their courses, especially science and mathematics?

In this WIP study, the final grades earned by the first-year engineering students in their science courses are compared with the grades they reported in the mid-semester survey. The results of this correlation are compared to the reported degree to which students took advantage of the various campus services designed to help them adjust to university life and the increased difficulty of their coursework. Is their perceived academic performance accurate? Are they utilizing university academic services in response to their perceived academic performance? Does their perceived academic performance correlate to the amount of time students report studying?

One unexpected result of the study was it was found that students who took the survey had statistically higher science grades and overall grade point averages (GPAs) than students who did not take the survey.

Project Approach

Surveys are frequently given to college students, especially those in their first-year. Surveys are given in an effort to foretell retention [1], [2], ascertain student understanding of engineering [3]

and better understand their choice of engineering major [4]. Perhaps most important, surveys can also be used to gain insight into the attitudes, values, and behaviors of engineering students that might affect their success and satisfaction in their major in the long term [4] – [6].

Mid-fall semester surveys of first-year engineering students at Binghamton University began in October 2012. The surveys have consisted of 25 questions with very little variation in their wording from year to year. Table 3 in the Appendix shows the survey questions that will be given in fall 2020. There are only minor changes for clarifications from previous years. For example, Q10 and Q16 refer to a couple of campus locations, where students can receive help with their math and science courses. The names of these locations have changed every few years.

The primary intent of the survey was two-fold: 1) to determine how students were adjusting to university life; and 2) to identify any challenges students were having with their first and second calculus courses. First-year engineering students reported having difficulty with their calculus courses, especially the second calculus course involving techniques of integration and infinite series. The responses to the survey contributed to a significant change to the first-year calculus courses in 2016.

With the aforementioned challenges in calculus greatly reduced, the focus has now shifted to the performance of students in their science courses. The survey questions that pertain to this WIP study are highlighted in Table 1:

- Q14 – How do you think you are doing in your science course?
- Q15 – Have you received any extra help outside of class from your science instructor or graduate teaching instructors?
- Q18 – About how many hours outside of class each week do you spend studying material in your science course?

The responses to these three questions, along with final science grades, are used to answer the following questions:

- What is the relationship between surveyed science grades and whether or not a student asks their science instructor or laboratory graduate teaching assistant for extra help?
- What is the relationship between surveyed science grades and how much time each week is spent studying outside of class?
- What is the relationship between surveyed science grades and final science grades?

The final part of this WIP study is a look at the differences in final science grades and end of semester overall grade point averages (GPAs) between students who took the survey and those who did not. It had been suggested to the authors that this might provide additional insight into student behaviors and their effects on academic performance. This was found to be the case, as will be discussed later.

Results and Discussion

Students Who Did and Did Not Receive Help– A Comparison of Surveyed Science Grades

It is a common assumption in higher education that students who need academic help will seek it. Is this truly the case?

This section looks at Q14 – How do you think you are doing in your science course? and Q15 – Have you received any extra help outside of class from your science instructor or graduate teaching assistant?

The results are given in Tables 1 and 2. To calculate the mean surveyed science grades a 4, 3, 2, and 1 were assigned to A, B, C, and D or F, respectively. If a student answered not sure, that response was not included in the calculation of the mean. The results indicate that in each of the three years the mean surveyed science grade of the students who did not get help was slightly higher than the mean surveyed science grade of the students who got help. The spread, i.e. variances of the two groups were close. The only year in which the mean differences is very statistically significant is 2019 (t Stat is greater than both t Critical one-tail and t Critical two-tail). The results for 2017 are somewhat statistically significant.

Table 1 - Surveyed Science Grades – Students Who Did Not and Did Get Help

Surveyed Science Grade	2017		2018		2019		Combined	
	No Help	Help	No Help	Help	No Help	Help	No Help	Help
A	17 (58.6%)	12 (41.4%)	31 (73.8%)	11 (26.2%)	12 (66.7%)	6 (33.3%)	60 (67.4%)	29 (32.6%)
B	66 (62.3%)	40 (37.7%)	86 (59.3%)	59 (40.7%)	55 (57.3%)	41 (42.7%)	207 (59.7%)	140 (40.3%)
C	37 (50.7%)	36 (49.3%)	42 (53.2%)	37 (46.8%)	44 (49.4%)	45 (50.6%)	123 (51.0%)	118 (49.0%)
D or F	8 (50.0%)	8 (50.0%)	12 (54.5%)	10 (45.5%)	10 (29.4%)	24 (70.6%)	30 (41.7%)	42 (58.3%)
NS	5 (71.4%)	2 (28.6%)	4 (66.7%)	2 (33.3%)	14 (70.0%)	6 (30.0%)	23 (69.7%)	10 (30.3%)

Table 2 - Surveyed Science Grade T-Test – Students Who Did Not and Did Get Help

T-Test Elements	2017		2018		2019		Combined	
	No Help	Help	No Help	Help	No Help	Help	No Help	Help
Mean	2.719	2.583	2.795	2.607	2.57	2.25	2.707	2.474
Variance	0.597	0.667	0.670	0.603	0.614	0.711	0.637	0.683
Observations	128	96	171	117	121	116	420	329
Hypoth. Mean Diff.	0		0		0		0	
df	199		258		232		693	
t Stat	1.257		1.979		3.026		3.887	
P(T<=t) one-tail	0.105		0.0244		0.0014		5.570E-05	
t Critical one-tail	1.653		1.651		1.651		1.647	
P(T<=t) two-tail	0.210		0.049		0.003		1.110E-04	
t Critical two-tail	1.972		1.969		1.970		1.963	

An inspection of Table 1 indicates that if students thought they were earning an A or B, they were much less likely as a percentage to receive help, than if they thought they were earning a C, D, or F. This, of course, is not surprising. What is a bigger concern is that there were not a larger percentage of students, who thought they were earning a C, D, or F, who received help.

Overall, fewer than half (43.9%) of 749 students surveyed sought help. Of the 313 students expecting a C, D, or F, 51.1% sought help. Of the 436 students expecting an A or B just 38.8% sought help. The results suggest that students who expect lower grades are significantly more likely to seek help than those expecting higher grades.

Student Time Spent Studying – A Comparison of Surveyed Science Grades

This section looks at Q18 – About how many hours outside of class each week do you spend studying material in your science course? Several patterns are apparent. Students who thought they were getting a B or C in their science course generally studied more each week compared to students who thought they were either getting an A or D or F. This was the case in each of the time spent categories with a few exceptions. Figure 1 summarizes the data for 2017, 2018, and 2019. The percentages provided are of time spent studying for each surveyed science grade. The question that must be asked is “How are students investing their time?” Time management is important for new college students and engineering students in particular.

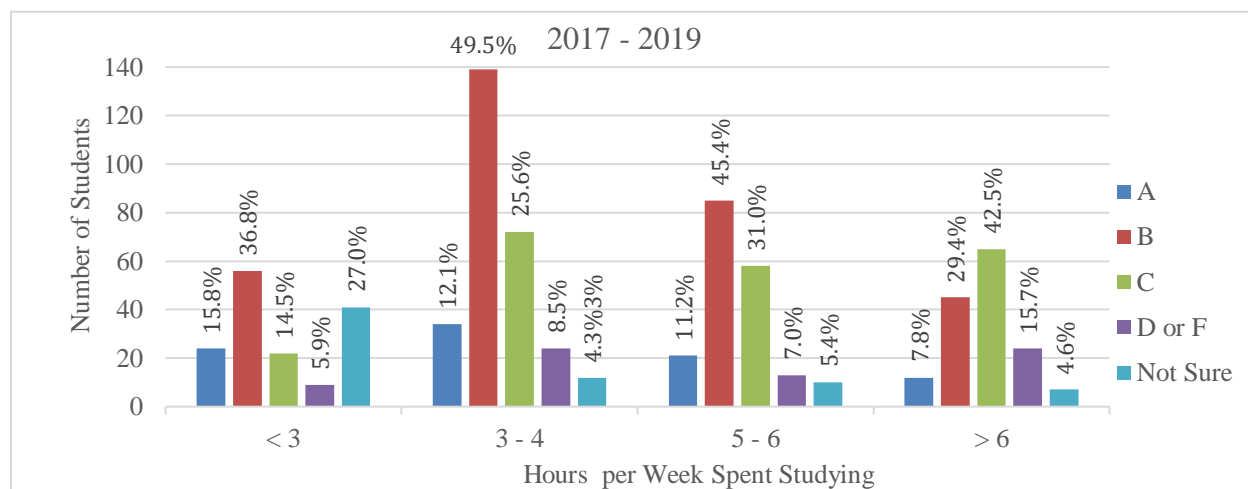


Figure 1 - 2017 to 2019 Surveyed Science Grade and Time Spent Studying

Comparison of Surveyed Science Grades and Final Science Grades

This section looks at Q14 – How do you think you are doing in your science course? and compares it to the final science grade received. Figure 2 summarizes the data for 2017, 2018, and 2019. The percentages provide the percentage of students within each surveyed and final science letter grade. ‘UnAns’, ‘W’, and ‘P’ mean ‘Unanswered, Withdrew, and Passed, respectively.

The most notable result of this survey question is that students in each of the three years thought they were doing more poorly than the final science grades indicated. This is a result that the authors plan to study further.

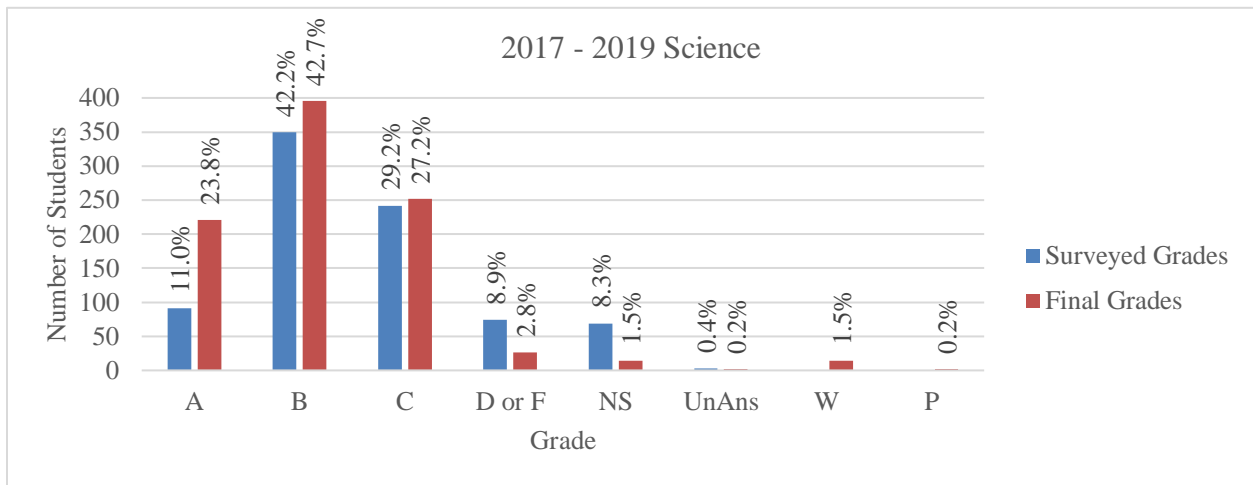


Figure 2 - 2017 to 2019 Surveyed and Final Science Grades

Final Science Grades – Students Who Took the Survey and Those Who Did Not

This section looks at final science grades and whether or not the student completed the survey. The results are given in Tables 3 and 4. This final result is arguably the most interesting. In two of the three years (2017 and 2019) students who took the survey had a statistically higher mean final science grade than those who did not take the survey. And in 2018 while the results are not statistically significant (the absolute value of t Stat is less than both t Critical one-tail and t Critical two-tail), nevertheless, the mean final science grade of the students who did not take the survey is less than those who did. A similar result was found regarding GPA between students who took the survey and those who did not.

Table 3 - Final Science Grades – Students Who Did Not Take/Did Take Survey

Final Science Grade	2017		2018		2019		Combined	
	Did Not Take Survey	Took Survey	Did Not Take Survey	Took Survey	Did Not Take Survey	Took Survey	Did Not Take Survey	Took Survey
A	1 (2.9%)	33 (97.1%)	2 (6.1%)	72 (93.9%)	2 (5.6%)	34 (94.4%)	5 (1.1%)	439 (98.9%)
A-	3 (7.1%)	39 (92.9%)	0 (0.0%)	41 (100.0%)	3 (8.6%)	32 (91.4%)	6 (5.1%)	112 (94.9%)
B+	8 (21.1%)	30 (78.9%)	1 (1.9%)	53 (98.1%)	0 (0.0%)	33 (100.0%)	9 (7.2%)	116 (92.8%)
B	6 (12.2%)	43 (87.8%)	1 (1.9%)	53 (98.1%)	5 (8.5%)	43 (91.5%)	12 (7.9%)	139 (92.1%)
B-	9 (21.4%)	33 (78.6%)	1 (2.4%)	40 (97.6%)	1 (2.6%)	37 (97.4%)	11 (9.1%)	110 (90.9%)

Final Science Grade	2017		2018		2019		Combined	
	Did Not Take Survey	Took Survey	Did Not Take Survey	Took Survey	Did Not Take Survey	Took Survey	Did Not Take Survey	Took Survey
C+	14 (28.6%)	35 (71.4%)	3 (8.3%)	33 (91.7%)	7 (15.2%)	39 (84.8%)	24 (18.3%)	107 (81.7%)
C	3 (17.6%)	14 (82.4%)	1 (4.0%)	24 (96.0%)	6 (20.0%)	24 (80.0%)	10 (13.9%)	62 (86.1%)
C-	11 (78.6%)	3 (21.4%)	2 (10.5%)	17 (89.5%)	4 (25.0%)	12 (75.0%)	17 (34.7%)	32 (65.3%)
D	2 (40.0%)	3 (60.0%)	1 (33.3%)	2 (66.7%)	2 (33.3%)	4 (66.7%)	5 (35.7%)	9 (64.3%)
F	7 (77.8%)	2 (22.2%)	1 (14.3%)	6 (85.7%)	3 (23.1%)	10 (76.9%)	11 (36.7%)	19 (63.3%)

Table 4 - Final Science Grades T-Test – Students Who Did Not Take/Did Take Survey

T-Test Elements	2017		2018		2019		Combined	
	Did Not Take Survey	Did Take Survey	Did Not Take Survey	Did Take Survey	Did Not Take Survey	Did Take Survey	Did Not Take Survey	Did Take Survey
Mean	2.230	3.021	2.331	2.908	2.209	2.815	2.235	2.909
Variance	1.039	0.529	1.267	0.628	1.121	0.810	1.08	0.664
Observations	64	235	13	300	32	268	108	804
Hypoth. Mean Diff.	0		0		0		0	
df	81		13		37		125	
t Stat	-5.821		-1.829		-3.103		-6.478	
P(T<=t) one-tail	5.642E-08		0.045		0.002		9.670E-10	
t Critical one-tail	1.664		1.771		1.687		1.657	
P(T<=t) two-tail	1.128E-07		0.090		0.004		1.934E-09	
t Critical two-tail	1.990		2.160		2.026		1.979	

Overall Grade Point Average – Students Who Took the Survey and Those Who Did Not

This section looks at overall GPA and whether or not the student completed the survey. The results are given in Tables 5 and 6. It should be noted that as one goes down the Combined – Did Not Take Survey column the percentages increase. Whereas, as one goes down the Combined – Took Survey column the percentages decrease. This supports the idea that the students who do not take the survey tend to do more poorly overall. This trend does not occur, when simply looking at science grades, as shown in Table 3.

Table 5 - Grade Point Average – Students Who Did Not Take/Did Take Survey

GPA Letter Grade	2017		2018		2019		Combined	
	Did Not Take Survey	Took Survey	Did Not Take Survey	Took Survey	Did Not Take Survey	Took Survey	Did Not Take Survey	Took Survey
A	3 (4.3%)	66 (95.7%)	2 (3.1%)	62 (96.9%)	5 (7.1%)	65 (92.9%)	10 (4.9%)	193 (95.1%)
A-	7 (8.8%)	73 (91.2%)	1 (1.1%)	92 (98.9%)	5 (5.6%)	84 (94.4%)	13 (5.0%)	249 (95.0%)
B+	9 (15.8%)	48 (84.2%)	3 (4.3%)	66 (95.7%)	1 (2.4%)	40 (97.6%)	13 (7.8%)	154 (92.2%)
B	11 (32.4%)	23 (67.6%)	1 (2.7%)	36 (97.3%)	5 (11.4%)	39 (88.6%)	17 (14.8%)	98 (85.2%)
B-	11 (32.4%)	23 (67.6%)	2 (7.4%)	25 (92.6%)	11 (24.4%)	34 (75.6%)	24 (22.6%)	82 (77.4%)
C+	9 (52.9%)	8 (47.1%)	2 (12.5%)	14 (87.5%)	1 (7.1%)	13 (92.9%)	12 (25.5%)	35 (74.5%)
C	3 (50.0%)	3 (50.0%)	0 (0.0%)	8 (100.0%)	4 (40.0%)	6 (60.0%)	7 (29.2%)	17 (70.8%)
C-	4 (66.7%)	2 (33.3%)	0 (0.0%)	5 (100.0%)	1 (50.0%)	1 (50.0%)	5 (38.5%)	8 (61.5%)
D	2 (67.7%)	1 (33.3%)	1 (50.0%)	1 (50.0%)	2 (66.7%)	1 (33.3%)	5 (62.5%)	3 (37.5%)
F	4 (100.0%)	0 (0.0%)	0 (0.0%)	1 (100.0%)	2 (66.7%)	1 (33.3%)	6 (75.0%)	2 (25.0%)

Table 6 - Grade Point Average T-Test – Students Who Did Not Take/Did Take Survey

T-Test Elements	2017		2018		2019		Combined	
	Did Not Take Survey	Did Take Survey	Did Not Take Survey	Did Take Survey	Did Not Take Survey	Did Take Survey	Did Not Take Survey	Did Take Survey
Mean	2.479	3.298	2.750	3.199	2.559	3.216	2.535	3.234
Variance	0.953	0.293	0.950	0.356	1.079	0.358	0.984	0.339
Observations	63	247	12	310	37	284	112	841
Hypoth. Mean Diff.	0		0		0		0	
df	72		11		39		121	
t Stat	-6.408		-1.584		-3.764		-7.294	
P(T<=t) one-tail	6.699		0.071		2.750E-04		1.708E-11	
t Critical one-tail	1.666		1.796		1.685		1.658	
P(T<=t) two-tail	1.340		0.142		5.500E-04		3.416E-11	
t Critical two-tail	1.993		2.201		2.023		1.980	

Concluding Thoughts and Future Work

This WIP has looked at the relationships between both surveyed and final science grades, the amount of time students reported studying, and whether they received help with their science course. These results are not surprising. Students who thought they were receiving an A or B reported seeking less help than students who thought they were receiving a C, D, or F. Students who thought they were receiving a B or C, studied more each week, than students who thought they were receiving an A, suggesting they were very motivated to improve to an A. There was very little pattern in hours spent studying each week for those students who thought they were receiving a D or F.

The somewhat surprising result of this study is the final science grade and overall GPA between those students who took the survey and those who did not take the survey. Students who did not take the survey had statistically lower final science grades and overall GPA than those students who took the survey. This was a little less true in 2018 than in 2017 and 2019 for reasons that are not apparent, but over the course of the three years, very true.

Perhaps one method of identifying students in need of academic assistance or support adjusting to university life is to give a survey, then reach out to those who do not take it.

Beginning with the 2017-2018 academic year Binghamton University began requiring all 1st-year engineering students to have a meeting in their academic advising office. Watson Advising wanted assurances that the students knew where their office was located and knew of the services offered to students. In future work the authors plan to review the academic performance of students who actually attended these meetings and those who did not to determine if there exists a similar pattern to that found with students who took the surveys and those who did not.

Question Q20 – How do you think you are doing in your engineering courses? – was only added to the mid-semester survey in the fall 2019 semester. The main motivation when the survey was first done was assessing student performance in their mathematics and science courses. The authors plan to report on results of this newer survey question in future work.

References

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Appendix

Table 7 - Mid-Semester Fall Survey Questions

Question		Answers
Q1	Has your transition to college life at Binghamton University been a smooth one?	a) Yes b) No c) Not Sure
Q2	Have the social and extracurricular activities to meet other students and to more involved been about what you expected?	a) Yes b) No c) Not Sure
Q3	Has residence hall living facilitated your transition to college life and helped you adjust to college life?	a) Yes b) No c) Not Sure
Q4	Has your academic workload and Binghamton University's expectations been about what you expected?	a) Yes b) No (less) c) No (more)
Q5	Have you met with someone in Watson Academic Advising to discuss your adjustment to Binghamton University?	a) Yes b) No c) Not Sure
Q6	Have you met with any of your engineering instructors to discuss your adjustment to Binghamton University?	a) Yes b) No c) Not Sure
Q7	What math course are you taking?	a) MATH 224/225 b) MATH 226/227 c) Other d) None
Q8	How do you think you are doing in your mathematics course?	a) A b) B 3) C c) D or F d) Not Sure
Q9	Have you received any help outside of class from your mathematics instructor?	a) Yes b) No c) Not Sure
Q10	Have you received any extra help in your mathematics course from the Math Help Room, the Center for Learning and Teaching (CLT) ?	a) Yes b) No c) Not Sure
Q11	Is the difficulty of your math course about what you expected?	a) Yes b) No (less) c) No (more)
Q12	About how many hours outside of class each week do you spend studying material in your math course?	a) Less than 3 b) 3 to 4 c) 5 to 6 d) More than 6
Q13	What science course are you taking?	a) CHEM 111 b) PHYS 131 c) PHYS 132 d) Other e) None
Q14	How do you think you are doing in your science course?	a) A b) B 3) C c) D or F d) Not Sure
Q15	Have you received any extra help outside of class from your science instructor or graduate teaching instructors?	a) Yes b) No c) Not Sure

Question		Answers
Q16	Have you received any extra help outside of class from the Center for Learning and Teaching (CLT)?	a) Yes b) No c) Not Sure
Q17	Is the difficulty of your science course about what you expected?	a) Yes b) No (less) c) No (more)
Q18	About how many hours outside of class each week do you spend studying material in your science course?	a) Less than 3 b) 3 to 4 c) 5 to 6 d) More than 6
Q19	Is the difficulty of your engineering courses (EDD 103 & EDD 111) about what you expected?	a) Yes b) No (less) c) No (more)
Q20	How do you think you are doing in your engineering courses?	a) A b) B c) C c) D or F d) Not Sure
Q21	Have you received any extra help outside of class from any of your engineering instructors or graduate teaching assistants?	a) Yes b) No c) Not Sure
Q22	About how many hours outside of class each week do you spend studying material in your engineering course?	a) Less than 3 b) 3 to 4 c) 5 to 6 d) More than 6
Q23	Based on your experience so far at Binghamton University are you still planning on majoring in engineering?	a) Yes b) No c) Not Sure
Q24	Please comment on your experience so far at Binghamton University We are especially interested in anything you have to say about your mathematics, science, or engineering courses.	Open responses
Q25	Do you believe you need any additional assistance with your course work or adjusting to Binghamton University? If you do, we would like to encourage you to talk with someone in Watson Academic Advising or EDD. You can either stop by our offices or email one of the advisors or EDD faculty members. We are here to help.	a) Yes b) No c) Not Sure