Work in Progress - Variations in Student Response to a Programming Class by Gender and Discipline

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Abstract - **Engineering 1221 is a two credit hour programming class taught through the Department of Engineering Education and accepted by eight of the departments in the College of Engineering as fulfillment of their programming requirement for graduation. The course is based on hands-on programming using MATLAB as the programming language. It is a follow-on to the introduction to MATLAB that occurs in the first semester ENGR 1181 course as part of the regular and scholars tracks of the first year program at Ohio State. The intent of the course is to build upon prior instruction to introduce students to working with moderately big data sets and with modestly large programs so as to prepare students for the computing tasks they will face in their majors. Students in the spring semester include first year students and students who have either postponed the class or were unable to schedule earlier. Students in the autumn also include out-of-sequence students and a higher portion of transfer students. In AU 2015 the same instructor taught all six offered sections of ENGR 1221 and taught three of six sections in SP 2016. This presents the opportunity to remove one source of variation in student experience and investigate student success by gender and by discipline within these nine classes. It was shown that the Autumn and Spring classes were significantly different, so these were analyzed separately. No statistical significance in student success was found based on gender or discipline in either semester. The lack of difference by gender is thought to be a key result.**

Index Terms – Gender, Programming

INTRODUCTION

Programming (as opposed to program writing) is an art that involves elements of problem solving, design, and logic. The ENGR 1221 course tackles this by using projects that introduce students to using computers to solve more complex problems. These experiences provide a foundation for students to draw upon later in their careers. The course is described further in the companion paper in this same conference proceedings. ENGR 1221 is an alternative programming class that is accepted by eight of the departments in Ohio State's College of Engineering as fulfillment of their programming requirement for graduation. It is accepted by three others as a technical or directed elective. Of the approximately 1700 students that take the regular and scholars first-year sequence each year, about 400 choose to take ENGR 1221. Table I provides a listing of the departments and how they treat ENGR 1221 toward graduation requirements.

TABLE I
DEPARTMENTAL ACCEPTANCE TOWARD DEGREE

Meets Programming Requirement
Engineering Physics
Industrial Systems Engineering (ISE)*
Food, Agriculture, and Biological Engineering (FABE)
Aeronautical and Astronautical Engineering (AAE)
Chemical Engineering
Civil Engineering
Environmental Engineering
Welding Engineering
Technical or Directed Elective
Electrical and Computer Engineering (ECE)
Biomedical Engineering
Aviation
No Degree Requirement
Material Science Engineering
Mechanical Engineering
Computer Science Engineering

* Except Data Analytics and Optimization specialization

In both semesters, about three-quarters of the students were male and one quarter female. Over half of the students are associated with the Civil, Aeronautical and Astronautical, or Chemical Engineering Departments. While most students take ENGR 1221 early in their careers, some postpone taking it until after they have already taken the courses in their majors that it is intended to support.

ANALYSIS BY GENDER

In AU 2015, there were 194 students that completed the course, 147 male and 47 female. Figure 1 gives a comparison of the course grades by gender. The average of grade points for the female students was 3.08 and male students 3.03.
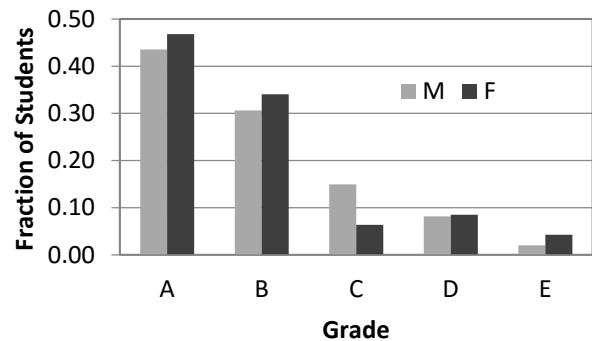

Figure 1: Gender Comparison - AU 15

This was found to not be statistically significant with p=.21. Figure 2 gives an equivalent comparison for SP 2016. In SP 2016 there were 111 students in the three courses being analyzed, 83 male and 23 female. The average of grade points for the female students was 3.64 and male students 3.49. This was also not statistically significant with a p=.23.
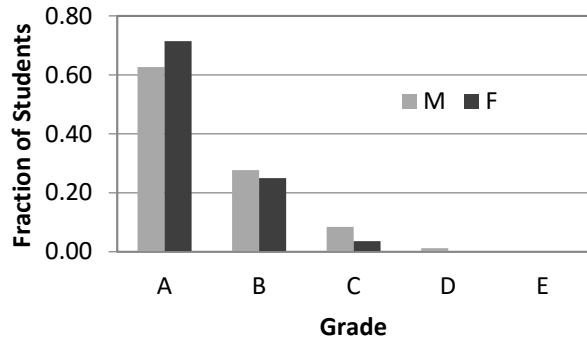

Figure 2: Gender Comparison - SP16

The increase in grades in spring semester over autumn semester has been noted anecdotally in other years. There are a number of possible sources for this, including different student populations in the different terms. For example, out-of-sequence students who take ENGR 1181 in the spring have their first opportunity to take ENGR 1221 in autumn. Because of the summer break, there will in general be a greater lag between when students have their first MATLAB experience in ENGR 1181 and when they take ENGR 1221.

For this set of courses, it's been determined that the most important difference between AU 15 and SP 16 is between transfer students in the two terms (p=.0001), and the remaining students are not statistically different (p=.131), although AU15 results are still lower.

ANALYSIS BY DISCIPLINE

Table II gives a breakdown of student results by major. Most students who take ENGR 1221 are taking it to fulfill a degree requirement for their majors, 78% as a programming requirement and 8% as an elective. Undeclared students comprised 8%. Most of these will be able to use ENGR 1221 for graduation. However, six percent of the students took the

TABLE II
RESULTS BY DISCIPLINE

Group	Overall % Students	AU15 Grade Points	SP16 Grade Points
Civil	26	2.97	3.52
AAE	15	3.21	3.47
Chemical	15	2.94	3.54
FABE	9	3.27	3.15
Environmental	7	3.20	3.60
Welding	6	3.22	3.86
ECE	6	3.82	3.57
Biomedical	2	2.74	3.50
Mechanical	3	2.33	3.67
Undeclared	8	2.67	3.63
Non-Engineering	3	3.35	3.83

course despite not needing it for graduation. These students were from Mechanical Engineering, Arts and Sciences, and a few graduate students. In the spring semester 20% of the students were first year admissions. All of the undeclared students were first year. The rest had already declared a major. With the exceptions of ECE and FABE, all groupings had higher average grade point results in the spring term compared with the autumn term. There was no statistical significance found between majors that allow ENGR 1221 to meet their programming requirement for graduation and other engineering majors or all other students.

Information is available for SP 2016 as to when students enrolled at OSU. Table III summarizes information about student results vs time at OSU. About half of SP 2016 students take ENGR 1221 as it was intended, in the first or

TABLE III
SP 16 STUDENT RESULTS BY WHEN ENGR 1221 IS TAKEN

Status	Percentage	Grade Points
1st Year NFYS	20	3.73
2nd Year NFYS	29	3.69
3rd Year NFYS	22	3.45
4+ Year NFYS	15	3.31
Transfer	14	3.23

second years, before the majority of their course work in their major. Such students perform better than those who wait.

DISCUSSION

The course structure is intended to benefit first year and second year students. Although this paper does not directly investigate student performance in later courses, there are four sources of feedback for evaluating the content and level of the material presented in the course: undergraduate teaching assistants who have taken this course and are now further along in their majors, students who are taking their programming intensive courses simultaneous with ENGR 1221, students who postponed ENGR 1221 until after the courses it was intended to support, and the occasional student who will come back either to visit or ask for help with their homework in a later class. This feedback, although generally positive, has led to important improvements in the material chosen for the course.

Assessment for the course is based half on completed HW, completed projects, and quizzes and half on exams that require students to complete original tasks similar in scope to those covered in the projects. Modelling tasks that have been used include creating a predator-prey model for wolves and moose on Isle Royale, creating a simplified clean water model for an Ohio stream, modelling a trick basketball shot, and modelling the fall of an expendable bathythermograph. Data tasks on exams include working with modestly large data sets that are introduced at the time of the exam. Examples are a data set of global energy usage and satellite based lower tropospheric temperature data. Other exam tasks are to create useful programs, such as creating a function that returns the depression of a key on a computer keyboard in response to an applied force for both down and upstrokes.

Because the grade assigned in the course reflects student ability to create original programs, course grades are used as a proxy for student success in all the student summaries shown here.

CONCLUSIONS

The most interesting conclusion when comparing across gender and disciplines is the apparent gender neutrality of the course. This is an area that will be investigated further. For example, there is no information available at this point for how students perform in the equivalent course taught by the Computer Science Engineering (CSE) department. There are a higher proportion of women taking ENGR 1221 than in the regular first year sequence. This may be due to self-selection of this course, or because a higher proportion of women are in the engineering disciplines that accept this course as a degree requirement. Research will be extended to normalize student results by how they are performing in other courses. Identifying patterns of student success can lead not only to improved instruction in ENGR 1221, but potentially in all first year courses.

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