ASSESSMENT OF STUDENT PERCEPTIONS OF FIRST-YEAR ENGINEERING

Sheryl A. Sorby[1], Norma L. Boersma[2]

Abstract *— In the fall of 2000, Michigan Tech adopted a common first year program for all engineering students. The program consists of various math, science, and general education courses as well as one engineering course each semester. When voting whether or not to adopt the program, support was nearly unanimous in all departments in the College of Engineering. Two exceptions were in Electrical and Computer Engineering and in Chemical Engineering. Faculty in these two departments expressed concern that the first year engineering courses were too weighted towards mechanical/civil applications and they therefore felt that the courses would not be of interest nor utility to their students. After implementation of the program, students were surveyed regarding their level of satisfaction with various features of the engineering courses. The reactions of chemical, computer, and electrical engineering students to these questions were of primary interest, based on previously-expressed faculty concerns about the courses. This paper will present the results from the survey with particular attention paid to responses by major and by gender.*

Index Terms — core requirements, freshman programs, student surveys.

THE MICHIGAN TECH FIRST-YEAR PROGRAM

First-year engineering programs are gaining widespread popularity in the U.S. through several educational reform efforts [1-3]. In the fall of 2000, we implemented a common first-year engineering program at Michigan Tech at the same time that the university switched from a quarter calendar to one based on semesters. The curriculum template for the first year program at Michigan Tech is presented in Table I. Most students start the program during their first semester, however, approximately 30% of each entering class is unprepared for Calculus during their first semester on campus. This group of students enrolls in pre-calculus and other courses during their first semester and starts the first year engineering program during their second semester.

At the core of the Michigan Tech first-year program are two courses designed to introduce engineering, problem solving, and design to our students. Each course is taught in a technology-rich setting and active, collaborative learning is the primary instructional method employed. Students complete several team assignments and projects throughout.

TABLE I
CURRICULUM TEMPLATE FOR FIRST-YEAR PROGRAM

First Semester	Second Semester
Chemistry I	Physics I
Calculus I	Calculus II
Engineering I	Engineering II
General Education	General Education
Physics Lab I	One Course by Major

The first of the two engineering courses, ENG1101, primarily focuses on developing basic skills. Instructional modules in this course are: 1) basic computing skills including spreadsheets, internet searches, and a mathematical solver (MathCAD), 2) verbal and written communication, 3) engineering ethics, and 4) introduction to the design process. The second of the two courses, ENG1102, focuses on graphics, computer aided design, and programming with MATLAB.

Each of the first engineering courses includes a team design project. In ENG1101, the design project is typically a design/build/test exercise that involves development of a vehicle powered by one or more standard mousetraps and which is capable of performing a specified task. For example, in the spring 2001 semester, the ENG1101 assignment was to develop a vehicle that could travel a given distance, drop a payload on a target, and then return to its starting position. Vehicles were judged based on their accuracy in performing these various tasks. In ENG1102, the design project is typically one that is accomplished entirely with the aid of 3-D modeling software. For example, during the spring 2001 semester, the ENG1102 design project involved researching relevant safety standards and designing modular playground equipment in their 3-D CAD software package.

In addition to the design projects, teams are also required to complete an “Ultimate Team Challenge” (UTC) during each course. In the UTC, teams are assigned a challenging, realistic problem that they must solve using an

[1] Sheryl A. Sorby, Michigan Technological University, Engineering Fundamentals Department, 1400 Townsend Drive, Houghton, MI 49931 sheryl@mtu.edu
[2] Norma Boersma, Michigan Technological University, Engineering Fundamentals Department, 1400 Townsend Drive, Houghton, MI 49931 norma@mtu.edu

appropriate computer tool. In ENG1101, the UTC must be solved with MathCAD; in ENG1102 the UTC must be solved using MATLAB. Student teams are given approximately 24 hours to complete the UTC and are expected to turn in their solution along with a cover memo.

STUDENT SURVEY

As part of our assessment of the first-year engineering program, students were administered a survey at the end of the spring 2001 semester. This survey was administered along with regular course evaluations and consisted of ten additional multiple choice questions. Questions on the survey were developed to assess students perceptions of the course overall as well as to assess perceptions regarding the design project and UTC. In addition, workload for the courses was often cited negatively by students, so questions on the survey were included to ascertain the validity of this claim.

Workload Analysis

In America, the general rule of thumb is that university students should expect to spend 2-3 hours outside of class studying and completing assignments for every hour that is spent in class each week. Students were asked on the survey to estimate the number of hours they spent on outside work for their four core classes during that semester. Figures 1 and 2 represent that data gathered from these survey questions.

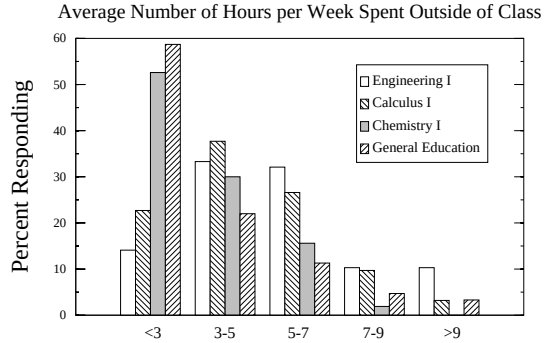

FIGURE 1. SURVEY RESPONSES FOR ENG1101

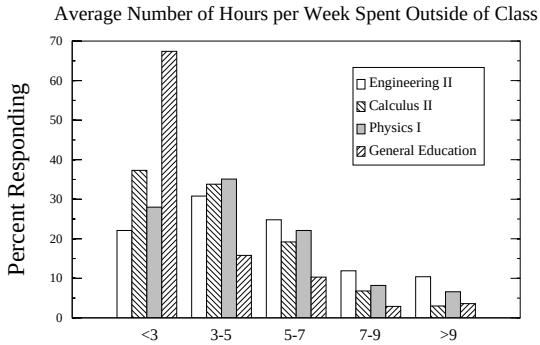

FIGURE 2. SURVEY RESPONSES FOR ENG1102

ENG1101/1102 are three-credit courses. This means that students should expect to spend 6-9 hours per week outside of class studying and completing assignments for these courses. In each case, around 90% of the students in our classes reported that they are spending less than 9 hours per week completing our assignments. Responses for the students regarding course workload are clustered around the responses of 3-5 and 5-7 hours per week. Thus, it seems that the students are spending about the "correct" amount of time working on our assignments for each course.

Calculus, Chemistry and General Education are all 4-credit courses. This means that students should be spending around 8-12 hours per week outside of class studying and completing assignments for these classes. As it can be seen from the data presented in these figures, our students report spending far fewer than 8-12 hours on these courses. In fact, for General Education and for Chemistry I, the majority of the students responded that they are spending *less than* 3 hours per week on outside work. Thus, it seems that the workload for the engineering courses is not too "high," but that the workload for the other core courses is too "low." The result is that the students *perceive* that they are working too hard in our courses when in reality they are not working hard enough in their other classes.

In addition to the questions regarding workload for individual courses in which they were enrolled, students were also asked a global question regarding their perceived workload in the engineering courses. Table II includes the data obtained from this question.

TABLE II
SURVEY RESPONSES FOR OVERALL COURSE WORKLOAD

	The total amount of time I spent on this course was:				
	Way Too Much	Too Much	About Right	Too Little	Way Too Little
ENG1101 (n=153)	23 (15.5%)	55 (35.9%)	62 (40.5%)	11 (7.2%)	2 (1.3%)
ENG1102 (n=546)	105 (19.2%)	154 (28.2%)	240 (44.0%)	40 (7.3%)	7 (1.3%)

As it can be seen from the data presented in Table II, about half of our students think that the workload for each course is about right or not enough, with the remaining half reporting that they felt the workload was too much. Thus, even though they are reporting that they are generally spending only around 5-9 hours per week on these classes, their perception is that this is still too much time spent.

Design Project and Ultimate Team Challenge

Students were also asked to rate their two significant team

experiences each semester, i.e., their team design project and their UTC. Figures 3 and 4 show response rates overall and by gender for the survey question regarding the design project in ENG1101 and ENG1102, respectively.

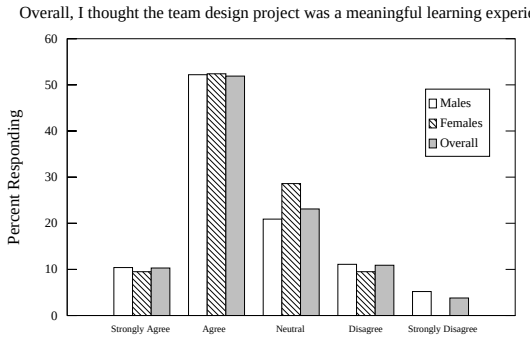

FIGURE 3. SURVEY RESPONSES FOR ENG1101

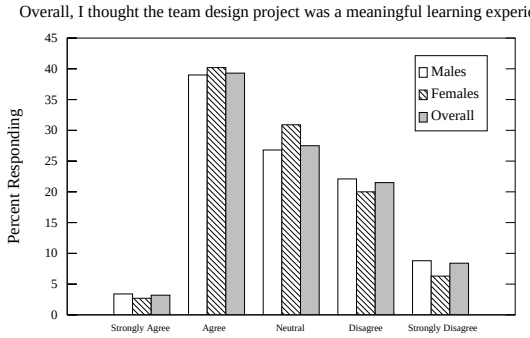

FIGURE 4. SURVEY RESPONSES FOR ENG1102

As it can be seen from the data presented in Figures 3 and 4, the students generally felt that the design project was a meaningful learning experience. It is interesting to note that the design project was rated more favorably in ENG1101 than it was in ENG1102. This is perhaps due to the different nature of the project in each of these courses. It seems likely that the students enjoy the design/build/test aspect of the ENG1101 design project more than simply design on the computer alone.

Students were also asked to rate the perceived level of difficulty of the UTC in each course. Figures 5 and 6 present the data obtained from this survey question. From the data presented in these figures, it seems that most students perceive the level of difficulty to be about right for the UTC, however, a larger percentage of ENG1102 students indicated this response when compared to their counterparts in ENG1101. This could be due to the fact that ENG1102 students had already participated in a UTC the previous semester and therefore had more realistic expectations the second time around.

Overall Course Rating

The student survey also included one question regarding

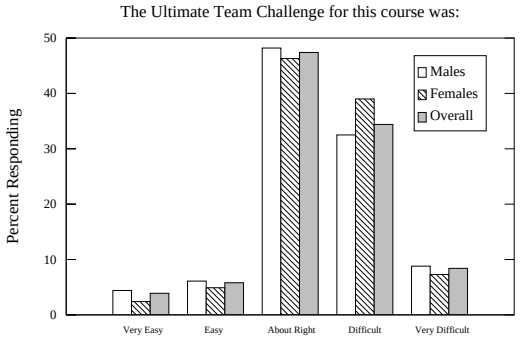

FIGURE 5. SURVEY RESPONSES FOR ENG1101

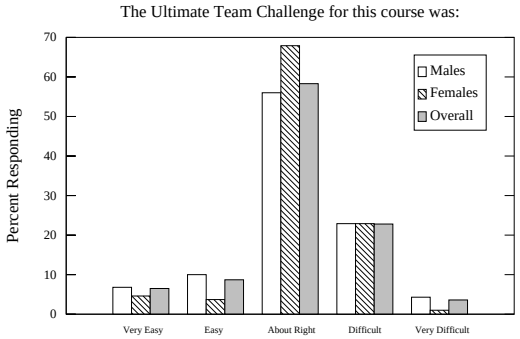

FIGURE 6. SURVEY RESPONSES FOR ENG1102

their overall level of satisfaction with each of the courses. In addition, a question on the standard MTU course evaluation queries their expectations going into any given course. (We have found that a student's expectations going into a course sometimes strongly influence their perceived level of satisfaction at the end of the course.) Figures 7 and 8 show student responses for ENG1101 and figures 9 and 10 show corresponding responses for ENG1102.

For ENG1101, we note the following trends in the data: 1) the majority of the students were either positive or neutral towards the course going into it, 2) student ratings at the end of the semester closely mirror their reported expectations at the beginning of the semester, and 3) male students' expectations and ratings for the course were generally higher than those of their female counterparts. For ENG1102, however, the response pattern is very different. Once again we find that overall course ratings closely mirror course expectations for this group of students, however, the majority of the students, both male and female, responded that they did not want to take the course nor did they consider it to be an excellent course.

The differences in responses for ENG1101 compared to ENG1102 could be the result of several factors. First and foremost, the students in ENG1102 had taken ENG1101 the previous semester (Fall 2000). The fall 2000 offering of ENG1101 was the very first time the course was taught with five first-time faculty. Needless to say, there were several problems encountered during the fall 2000 offering of

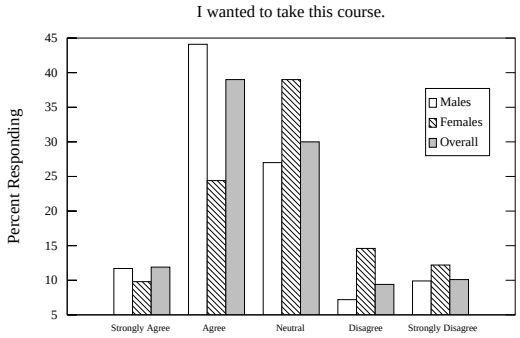

FIGURE 7. SURVEY RESPONSES FOR ENG1101

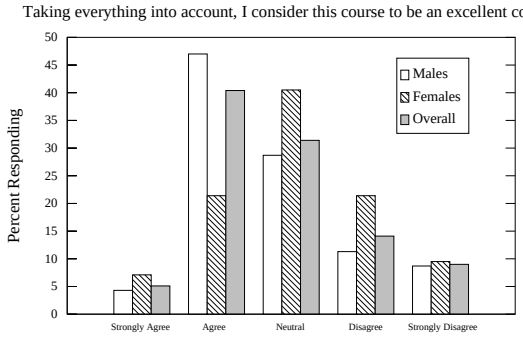

FIGURE 8. SURVEY RESPONSES FOR ENG1101

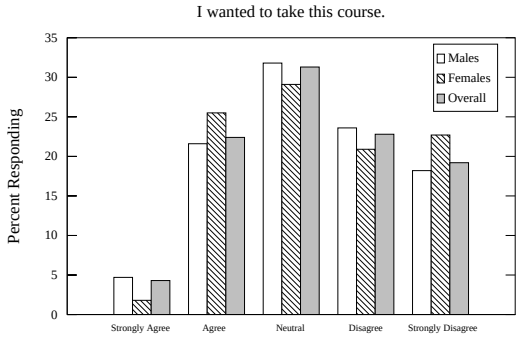

FIGURE 9. SURVEY RESPONSES FOR ENG1102

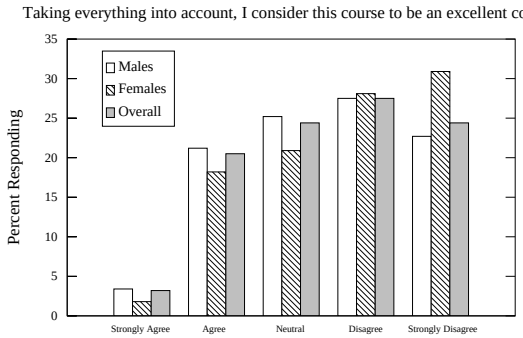

FIGURE 10. SURVEY RESPONSES FOR ENG1102

ENG1101 which likely resulted in lower expectations from this group of students for the first-time offering of ENG1102 during the spring 2001 semester. Another likely source of difference between the responses for each course was that the students enrolling in ENG1101 in the spring began their studies during the fall 2000 semester in pre-calculus and were not allowed to enroll in the first-year engineering program right away. As a result, they were more likely to be anxious to enroll in the first-year engineering courses for the spring semester.

Student Responses by Major

Early criticism from faculty in Electrical/Computer and Chemical Engineering of the first year program was that both courses were geared more towards Mechanical and Civil Engineering and were therefore of little use to the students in their majors. This criticism was particularly directed towards ENG1102 due to its emphasis on graphics and 3-D Computer Aided Design. Student responses to questions of overall course satisfaction were analyzed by major for each course. In addition, student responses regarding the semester design project were also analyzed by major. Figures 11 and 12 show overall course initial expectation and final ratings by major for ENG1101.

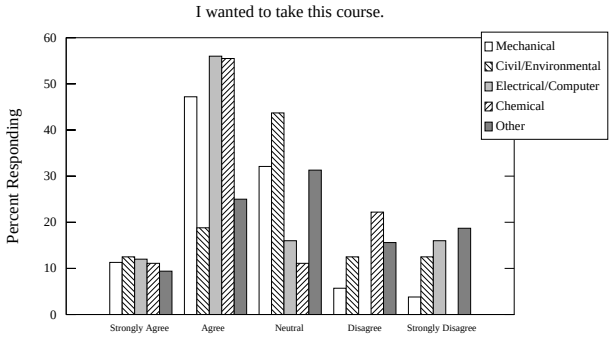

FIGURE11. SURVEY RESPONSES FOR ENG1101

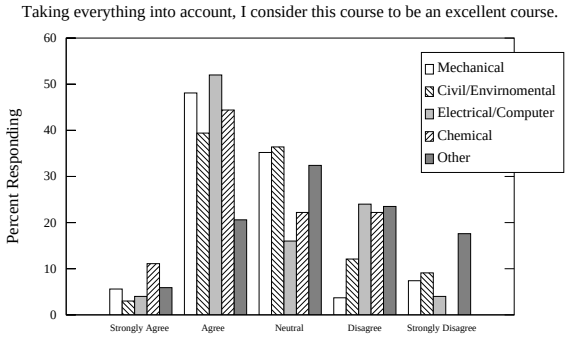

FIGURE 12. SURVEY RESPONSES FOR ENG1101

As seen from the data presented in these figures, the majority of the students of our four largest majors (mechanical, civil/environmental, electrical/computer, and chemical) were generally positive about ENG1101 both in their reported expectations as well as their overall final rating.

Students in the "Other" category were primarily from our Mechanical Engineering Technology program, which also requires both ENG1101 and ENG1102. For the students in the "Other" category, "Neutral" regarding both expectations and final rating was the most commonly selected response.

Figures 13 and 14 show the responses by major for students enrolled in ENG1102. As it can be seen from the data

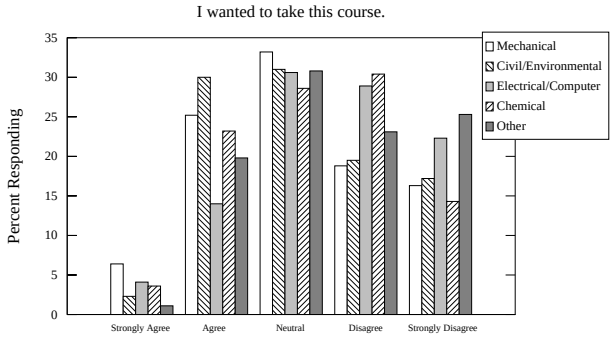

FIGURE 13. SURVEY RESPONSES FOR ENG1102

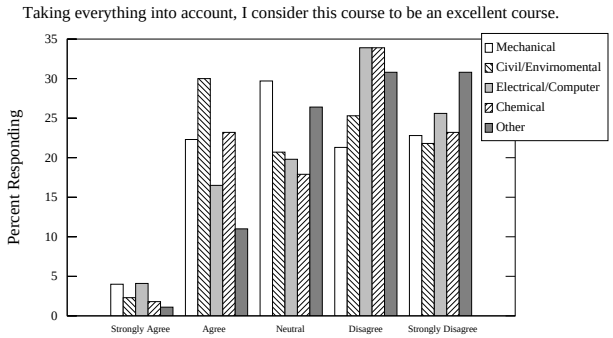

FIGURE 14. SURVEY RESPONSES FOR ENG1102

presented in these figures, ENG1102 is rated higher by Mechanical and Civil/Environmental Engineering students, and rated lower by students in Electrical/Computer, Chemical, and Other engineering disciplines (in this case, students in the "Other" category are primarily biomedical, materials, mining, and geological engineering). One factor that could contribute to this difference in responses by major is that faculty and advisors from Electrical/Computer and Chemical Engineering formed negative opinions about the ENG1102 course (even before it was offered for the first time) and conveyed these opinions to their students.

The design projects in the courses have also been criticized by faculty and chairs as being too "mechanical" in nature and thus of little interest to students outside of mechanical engineering. Student responses to the survey question regarding the design project were also analyzed by major, with the results presented in Figures 15 and 16. As it can be seen from the data presented in these figures, the majority of ENG1101 students of all disciplines rated the design project as a meaningful educational experience. In fact, nearly 100% of all students who had declared a major of Chemical Engineering thought the design project was worthwhile. For ENG1102 students, the design project was mostly rated favorably by all majors except for Electrical/ Computer Engineering.

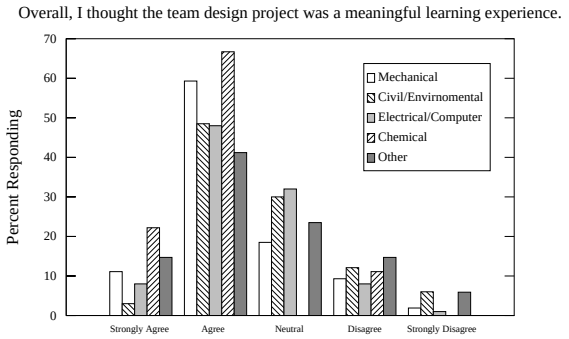

FIGURE 15. SURVEY RESPONSES FOR ENG1101

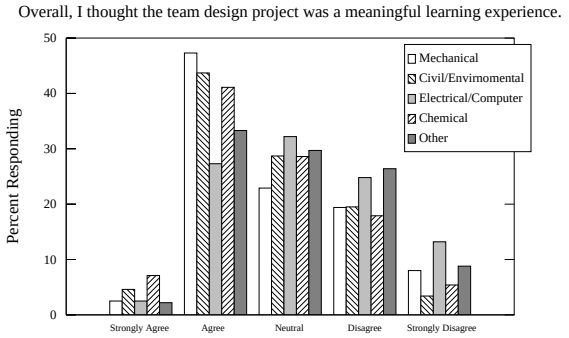

FIGURE 16. SURVEY RESPONSES FOR ENG1102

First-year attrition rates for students in Electrical/Computer and Chemical Engineering were also examined to determine if the first year engineering program had an adverse affect on retention for these disciplines. The results from this analysis are presented in Table III. From the data

TABLE III
FIRST-YEAR RETENTION RATES FOR ELECTRICAL/COMPUTER AND CHEMICAL ENGINEERING AT MICHIGAN TECH

	Fall 1997	Fall 1998	Fall 1999	Fall 2000
Electrical/ Computer	77.7%	72.5%	72.0%	77.4%
Chemical	84.5%	80.0%	78.9%	83.1%

presented in this table, it seems that the first-year engineering program had a positive impact on the retention rates for students in these disciplines when compared to historical data (1997, 1998, and 1999). Thus, it seems that while the faculty in these departments do not think that the first-year engineering program is ideal for their students, many of the students have responded positively to the program.

Course Evolution

Based on student feedback and other assessment measures, ENG1101 and ENG1102 have been modified substantially over the 2001-02 academic year. The survey instrument utilized in the spring 2001 semester has been administered in each course, results analyzed, and comparisons made between previous offerings of the courses. Data for fall 2001 and spring 2002 have been gathered, however, data by gender and/or major is not available for these students. Aggregate data for students in the courses has been compiled and analyzed with average values for each course offering computed based on student responses.This data is presented in Tables IV and V.

TABLE IV
AVERAGE OVERALL RESPONSES FOR ENG1101

Question	Spring 2001 n=155	Fall 2001 n=332	Spring 2002 n=129
I wanted to take this class (Strongly Agree=+2, Agree=+1, Neutral=0, Disagree=-1, & Strongly Disagree=-2)	+0.33	+0.34	+0.63
Overall, I thought the team design project was a meaningful learning experience. (Strongly Agree=+2, Agree=+1, Neutral=0, Disagree=-1, & Strongly Disagree=-2)	+0.54	+0.67	+0.80
The total amount of time I spent on this course was: (Way Too Much=+2, Too Much=+1, About Right=0, Too Little=-1, Way Too Little=-2)	+0.56	+0.35	+0.28
Taking everything into account, I consider this course to be an excellent course. (Strongly Agree=+2, Agree=+1, Neutral=0, Disagree=-1, & Strongly Disagree=-2)	+0.19	+0.18	+0.63

From the data presented in these tables, it seems that steady progress has been made in improving the content and expectations from a student perspective, particularly for ENG1101. Responses regarding course ratings have steadily gone up while responses regarding perceived workload have steadily decreased. For ENG1102, however, while some progress has been made in improving this course over its initial offering, there still seems to be room for improvement.

CONCLUSIONS

New educational programs are likely to experience problems and pitfalls during their early stages. Through careful examination of assessment data, including the results from student surveys, programmatic improvements can be achieved.

TABLE V
AVERAGE OVERALL RESPONSES FOR ENG1102

Question	Spring 2001 n=556	Fall 2001 n=144	Spring 2002 n=302
I wanted to take this class (Strongly Agree=+2, Agree=+1, Neutral=0, Disagree=-1, & Strongly Disagree=-2)	-0.30	+0.07	-0.13
Overall, I thought the team design project was a meaningful learning experience. (Strongly Agree=+2, Agree=+1, Neutral=0, Disagree=-1, & Strongly Disagree=-2)	+0.07	+0.27	-0.01
The total amount of time I spent on this course was: (Way Too Much=+2, Too Much=+1, About Right=0, Too Little=-1, Way Too Little=-2)	+0.57	+0.52	+0.37
Taking everything into account, I consider this course to be an excellent course. (Strongly Agree=+2, Agree=+1, Neutral=0, Disagree=-1, & Strongly Disagree=-2)	-0.49	-0.16	-0.14

Changes in the first-year engineering program at Michigan Tech have been implemented based on the results from student surveys and ratings have generally improved as a result.

ACKNOWLEDGMENT

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