

AC 2009-1928: DEVELOPMENT OF AN EVALUATION FOR ASSESSING STUDENT PRACTICES, INDEPENDENCE, AND RESPONSIBILITY IN DESIGN COURSES

Renee Rogge, Rose-Hulman Institute of Technology

Renee Rogge is an Assistant Professor of Applied Biology and Biomedical Engineering. She co-developed and co-teaches the biomedical engineering capstone design sequence at Rose-Hulman Institute of Technology. Renee is a member of the DEED division and has educational research interests in assessment of design.

Kay C Dee, Rose-Hulman Institute of Technology

Kay C Dee is a Professor of Applied Biology and Biomedical Engineering and the Founding Director of the Rose-Hulman Center for the Practice and Scholarship of Education. Kay C's educational research interests include student learning styles, student evaluations of teaching, and faculty development. She served as a Fellow at the National Teaching Institute and has won a number of awards for teaching, research, and mentoring.

Glen Livesay, Rose-Hulman Institute of Technology

Glen Livesay is the Samuel F. Hulber Chair and Associate Professor of Applied Biology and Biomedical Engineering; he co-developed and co-teaches the biomedical engineering capstone design sequence at Rose-Hulman Institute of Technology. Glen's educational research interests include student learning styles and the statistical evaluation of assessment instruments. He has received an NSF CAREER award, and served as a Fellow at the National Effective Teaching Institute.

Development of an Evaluation for Assessing Student Practices, Independence, and Responsibility in Design Courses

Abstract

Design courses are challenging for both students and educators. Students grapple with the open-ended nature of typical design problems, the sustained team efforts required to complete a large project with appropriate documentation, and the need to teach themselves new things in order to complete their objectives. Design instructors balance providing assistance to students with allowing students to direct the design process and make (and learn from) mistakes. As successful design courses and course sequences progress, students increasingly function as professionals, make decisions and deal with the consequences more independently, and assume greater responsibility for their learning and for the quality of their design and product.

Instructors routinely assess the quality of student design products, but less frequently obtain (non-anecdotal) information about the development of professional practices and attitudes within the student cohort. Traditional end-of-term course and teaching evaluations tend to be very instructor-centric, giving the impression that the instructor is solely responsible for creating the learning environment and the quality of student learning. Compared to traditional engineering courses, the learning that occurs in design courses is more dependent on student actions and attitudes.

We have developed a supplemental evaluation for use in design courses. Our assessment instrument provides information about the prevalence of specific professional practices and the development of student attitudes – information not typically available via traditional course evaluations. During the 2006-2007 academic year we administered a supplemental evaluation to two cohorts of engineering design students. Student ratings of overall instructional quality were correlated to ratings of their overall learning, and also to assuming more responsibility for decisions and actions as the course progressed. In this paper we present the results of revising this supplemental evaluation and administering it to a new longitudinal student cohort of biomedical engineers during the 2007-2008 academic year. Correlational analysis of the student responses revealed three themes that appear to have a major role in shaping student attitudes toward the overall design experience: attitudes regarding the transition from student to professional; varied academic hardiness characteristics that would influence efforts and attitudes toward the completion of an open-ended senior design project; and perceived work efforts (by both the individual and the team) and the quality of learning in senior design. Overall the results provide motivation for design instructors to consider helping their students manage stress in appropriate ways, to reinforce the idea that the design experience is a key opportunity to transition to professional work habits, and to encourage students to reflect on their experiences and their learning. These attributes were correlated with better overall ratings of learning and instruction.

Introduction

Design courses are, in many respects, different from other engineering courses. While students may consider traditional courses as discrete or compartmentalized “units” of learning or concepts, design experiences overtly require students to draw from and apply multiple types of accumulated experiences and knowledge. Design courses require students to complete a project that is usually larger than students have previously completed, with continued student effort over a longer period of time than typical class projects, and with more process documentation than students are accustomed to providing. Furthermore, design problems are open-ended, and the projects are, in large part, student-driven. In helping students meet these challenges, design instructors guide the transition from operating as a student to operating as a professional.

The factors that make design courses challenging for students also make design courses challenging for educators. Design instructors must draw from a wide range of experiences and knowledge to provide guidance to students in multiple technical areas and in project management. Compared to instructors of traditional lecture courses, design instructors often spend more time interacting with students one-on-one or in small groups. Design instructors who teach multi-course sequences invest their effort in developing the abilities of their students over a longer period of time than do instructors whose course enrollments change from term to term. Perhaps the most important challenge of instructing a design course is achieving the fine balance between providing specific assistance/guidance and allowing students to direct their design process and make (and learn from) mistakes as they navigate the open-ended nature of the problem. In order to let the students “learn by doing,” design instructors must relinquish some control of the learning process to the students, while still maintaining high standards for the quality of the project deliverables. Compared to the learning that occurs in traditional engineering courses, the learning that occurs in design courses is more dependent on students and their self-directed activities.

Many academic institutions use formal student evaluations of teaching to obtain feedback on perceived course quality and instructor performance. A good deal of research has demonstrated that student evaluations of teaching reflect student opinions validly, reliably, and usefully.^{1,2,3} Traditional evaluation forms tend to be focused on the course instructor and their practices (*e.g.*, “Please rate the overall performance of the instructor,” “The instructor gave well-organized lectures,” “The instructor was well-prepared for class,” *etc.*). These assessment items are most relevant to traditional lecture-based courses in which the instructor’s actions and content organization largely set the pace and direction of student learning. However, these items do not provide information relevant to many of the special challenges faced by design students and instructors. Most notably, the instructor-centered nature of these evaluations provides little or no information about student contributions to their own learning.

The assessment of student design performance has been a focus of increased work over the last several years,^{4,5,6} including a coordinated effort undertaken by the Transferable Integrated Design Engineering Education Consortium.⁷ This consortium has identified multiple roles and holistic behaviors of an engineer, including technical, interpersonal, and professional areas,⁷ and identified four broad areas (including, for example, learner development and solution development⁸) within which instructors could assess student performance. Programs seeking

ABET accreditation must assess the design skills of their students, since some of the fundamental program outcomes criteria (*i.e.*, the “a through k” criteria) required by ABET are specifically focused on design.⁹ Assessing the learning that occurs during complex tasks (involving many components/aspects, with complicated relationships between aspects¹⁰), such as the design process, is challenging. Non-traditional measures such as concept maps¹¹ or causal influence diagrams¹⁰ may help instructors and programs measure how well students have mastered design skills. However, summative demonstrations of student skills and technical analyses of project deliverables again typically yield little or no information about how students are contributing to their own learning. Having an instrument that gives some indication of how engaged¹² students are in the learning-by-doing design process, and some indication of whether a fundamental level of independent metalearning (*i.e.*, learning about learning¹³), would be helpful to design instructors.

In order to assess some of the student actions and attitudes that are important to a successful design experience, but that tend not to be addressed through formal student evaluations of teaching or through typical course/program-related assessments of student design performance, we developed a supplemental design evaluation. Our initial implementation of the supplemental evaluation provided insight to the design instructors on how students perceived the balance between receiving specific, overt project guidance and directing their own design processes and learning. A factor analysis conducted on the initial implementation of the supplemental evaluation revealed that the supplemental instrument most strongly assessed students’ ability to independently handle situations as they arise, perceptions of self-maturation and achievement, and dependence on the instructor as a guide. Interestingly, student ratings of their overall learning and of the overall instructional quality in the course reported on our supplemental evaluation were not always the same as student ratings of learning and instructional quality reported on the established institutional course/teaching evaluations, likely due to a large discrepancy in student response rates (*i.e.*, a >90% response rate to our in-class, on-paper supplemental evaluation; a <40% response rate to the official electronically-administered end-of term evaluations. To further explore the development of the student as a professional and to improve the quality of the supplemental design instrument, the supplemental evaluation was modified to include a series of questions related to the Revised Academic Hardiness scale. This paper discusses the modifications made to the supplemental evaluation and the results of this modification.

Methods

Supplemental Evaluation Instrument

The first version of supplemental evaluation (Appendix I) was revised to clarify items that appeared to be misinterpreted by students and eliminated items that provided redundant information. The most substantial improvement was the addition of questionnaire items derived from published topics of questions from the Revised Academic Hardiness Scale¹⁶ to more clearly understand student orientations to challenge and address their ability to overcome academic difficulties.

The revised supplemental evaluation consisted of 32 questions regarding student practices, student responsibilities, and instructor roles. Because traditional student evaluations of teaching already provide information regarding student perceptions of the quality their educational experiences, and since we sought to obtain new types of information about the students' educational experiences, we avoided rating scales that described levels of quality. Instead, the rating scales were designed to provide information about the prevalence of activities, amount of overt guidance provided, or perceived balance of responsibilities. For example, rather than asking students to rate the quality of the instructor's technical advice as excellent, good, fair, or poor, the supplemental evaluation asked:

“When you discussed design and technical issues with the instructor, they:

- told you exactly what you should do
- tried to convince you to take particular actions
- provided suggestions but did not make decisions for you
- listened to your concerns but gave no suggestions
- did not seem to understand your concerns and gave no suggestions”

Rating systems such as the scale shown above can be used as instructor goals change over the course of a design project or series of design courses. For example, an instructor might intend to give students more guidance early in the design experience, and less later on. The supplemental evaluation would be able to provide useful feedback to the instructor at both the early and late stages of the design experience. Other questions and types of rating systems that were intended to provide useful information throughout a design experience were, for example:

“Taking this course is helping me make the transition from being a student to being a professional.

- Strongly disagree
- Disagree
- Neither agree nor disagree
- Agree
- Strongly agree”

“As our design project progressed, I had to make choices or decisions even though I didn't know everything there possibly was to know about an issue.

- Strongly disagree
- Disagree
- Neither agree nor disagree
- Agree
- Strongly agree”

The analysis of the results from our initial instrument showed an interesting trend regarding the tendency of students to ‘back-off’ in the face of a challenge for fear of failing, and often these students would reject responsibility for their projects. To better understand why some students avoid challenging academic course work at the risk of harming their academic standing, whereas others are willing to pursue these types of challenges, we added a series of questions derived

from topics associated with the Revised Academic Hardiness Scale¹⁶ to better understand characteristics that may differentiate these two types of students.

The Revised Academic Hardiness Scale (RAHS) is a validated instrument that measures three components: control of affect, commitment/control of effort, and challenge. For example, a student with a high hardiness score will have the ability to achieve academic goals through effort and self-regulation (control), make personal sacrifices to excel academically (commitment), and view academic challenges as opportunities (challenge). The RAHS is an 18-item scale, using a 4-point response scale (1 = "completely false", 4 = "completely true"). The scores on the subscales of control, commitment, and challenge are combined for a composite score of academic hardiness. The questions asked in the RAHS were reviewed and the authors/design instructors developed a series of questions for the supplemental design evaluation that would assess a student's attitude toward commitment, control and challenge during the senior design process.

For example, the students were asked to select their level of agreement with the following statements:

“In general,

- I prefer to take classes to get “easy As.”
- With hard work, I can meet my educational goals.
- I can stay calm and learn from my mistakes.
- I choose elective that require the least amount of work.
- I seek help from professors when I am performing poorly in their class.
- I am miserable to be around when I receive a disappointing grade.
- I take difficult classes because I know they will benefit me in the long run.
- I increase my effort when I’m not performing well in a class.
- I can manage stress from difficult courses in healthy ways.
- I am willing to take a difficult class and risk getting a bad grade, if the class seems interesting.”

Evaluation Administration

The supplemental design evaluation was administered in paper form to biomedical engineering seniors in the capstone design course at Rose-Hulman Institute of Technology, at the conclusions of the Fall, Winter, and Spring 2007-2008 terms (IRB approved protocol #RHS0054). During the Fall quarter, teams of biomedical engineering seniors selected projects with corporate clients or individuals within the community, worked up at least three distinct design options, created and used merit and feasibility criteria to select one option, and completed a full design proposal for that option. During the Winter quarter the teams built and tested their designs, and completed extensive design documentation. The completed projects were delivered to clients early in the Spring quarter, and during this quarter the students served as mentors for teams of junior biomedical engineering students working through their first major design-build-test experience and completing their first design documentation.

Student participation in the supplemental design evaluation was anonymous, voluntary, and uncompensated. Supplemental evaluations were administered by a faculty member while the course instructors were out of the classroom. Data were collected from the same student cohort three times (once at the end of each academic quarter during their senior year); these three data sets were analyzed as three separate samples to see if student attitudes changed over time and with design experience. 100% of the students present in each class on the days of administration completed the evaluations as requested, yielding 32, 27, and 28 evaluations completed in the Fall, Winter, and Spring by biomedical engineering students (response rates ranging from 80% to 94% of the students registered for these courses).

Student responses to the evaluation items were numerically coded for quantitative analysis. For example, the responses “Strongly Disagree,” “Disagree,” “Neither Agree Nor Disagree,” “Agree,” and “Strongly Agree” were numerically coded 1, 2, 3, 4, and 5, respectively. Incorrectly-answered items (*e.g.*, an item left blank or an item with two different responses marked) were omitted from the data set. The responses were then investigated using correlational analyses in SPSS (v.11, SPSS, Inc., Chicago, IL). The numerical data were not normally distributed and did not meet the assumptions inherent in the (parametric) Pearson correlation coefficient [14], so the nonparametric Spearman’s rho correlation coefficient was used in this investigation.

Results and Discussion

Upon examining the full set of data from all completed evaluations, we discovered that many pairs of evaluation items were correlated. There were 17 paired correlations for the Fall Quarter, 25 paired correlations for the Winter Quarter, and 27 paired correlations for the Spring Quarter. While each of the paired evaluation items can provide meaningful information for a design instructor, several interesting and educationally relevant themes emerged from the analysis: the students’ attitudes regarding the transition from student to professional, varied academic hardiness characteristics that would influence efforts and attitudes toward the completion of an open-ended senior design project, and the role of perceived work efforts (by both the individual and the team) in evaluating the quality of learning in senior design.

Table 1 summarizes the eight evaluation items that were correlated (Spearman’s rho > 0.5) with the following item: “Taking this course is helping me make the transition from being a student to being a professional.” Most of the observed correlations were logical, considering the items involved. For example, one would expect that students who believed a design course was helping them make a transition from being a student to being a professional would be proud of what they achieved in the class – those two student attitudes are likely to be correlated. Likewise, a student that is in a state of transition from student to professional would understand the educational value of being allowed to make mistakes and to learn from the consequences of those mistakes, as well as the role of the instructor as a mentor in this process. It is also noteworthy to observe the increased number of paired evaluation items during the Winter Quarter as compared to the Fall and Spring Quarters. It is during the Winter where the students are implementing their design (*i.e.* constructing physical prototypes), conducting test plans, and interacting with their client as the team approaches a product delivery date. It is logical to expect that the students feel more like engineers than students -- they are the subject-matter experts for

their projects and have more individual responsibilities than they might have in a traditional engineering course. Therefore we would expect more evaluation items to be correlated with the “transition” attitude as the students move from learning about engineering to actually practicing in the field.

Another theme emerged regarding “Academic Hardiness”. Table 2 summarizes the eight paired survey items intended to help an instructor understand the attitudinal shifts that may occur during the course of a year-long senior design project. Most of the observed correlations were logical and to be expected. For example, it would not surprise any instructor to discover that a student who prefers to take classes for an “easy A” would also choose electives that require the least amount of work. Likewise, a student who believes that working hard will help them meet their educational goals will also rate the quality of learning higher for senior design. While these attitudes are not surprising, the timing of some of the shifts in attitude is enlightening.

It should be noted that there are no correlated evaluation items that are focused on Academic Hardiness for the Fall Quarter. The same students responded to this survey each quarter, but the ‘easy A’ attitude was not present until the final Spring Quarter, which could be linked to the often discussed ‘senioritis’ that plagues senior design projects during the last quarter of the year. Similarly, there is also a level of ‘reflection’ that occurs in the Spring of the senior year as our senior teams mentor junior teams, who are beginning to work on their first open-ended design project. The mentoring process provides an opportunity for students to reflect on their educational philosophy and some of them realize that they have effectively managed stress during difficult classes and others realize that they have tried to take the “easy A” option as often as possible. Reflection results in a larger number of “Academic Hardiness” item correlations. While instructors may not be able change the student’s attitudes, it is useful to consider this information while reflecting on student performance in senior design.

Stress management could be an area of focus for a design instructor trying to help graduating seniors become more comfortable with the design process. Students who described the learning environment as being student-directed regarding what and how they learned, also expressed that they did not manage the stress associated with a difficult course in healthy ways. Conversely, a student who reports being able to stay calm and learn from mistakes also reports that they implement successful stress management techniques in difficult classes. Therefore students who are uneasy with the open-ended and student-driven nature of senior design could benefit from instruction in stress management techniques and frequent encouragement during the difficult process of design.

Table 3 presents the correlated evaluation items associated with the perceived quality of work by the student teams and the level of effort expended on the project. Several of the most strongly correlated evaluation item pairs are associated with these factors.

It is expected that students indicating that they put a lot of effort into the design project would also state that their (self-reported) quality of work was high. This correlation was one of only two that held true for all three quarters of senior design. The second correlation that held firm for all three quarters related the quality of work of the individual to that of the team. The analysis also shows that the pride associated with the student team’s accomplishment is directly

related to the level of effort expended on the project. Interestingly, these findings are at odds with the results of the “Academic Hardiness” analysis. The analysis suggests that a student that does not put a lot of effort into the design project, will not be proud of the results of the project. As shown in the correlation analysis, this will also result in a lower perceived quality of learning in senior design, which is independent of the efforts of the instructor!

Table 1. Evaluation items correlated with “Taking this course is helping me make the transition from being a student to being a professional.”

| Evaluation Items | Quarter | Correlation Coefficient(s)* |
|---|----------------|------------------------------------|
| Rate the quality of your learning in this course | Fall | 0.572 |
| Rate the instructor’s overall performance in this course | Fall | 0.560 |
| I’m proud of what I have achieved in this class | Fall, Winter | 0.617, 0.721 |
| I was allowed to make mistakes and then learn from the consequences of those mistakes | Winter | 0.639 |
| This is a course where “you get out of it what you put into it” | Winter | 0.516 |
| I put a lot of effort into our design project | Winter | 0.601 |
| My team’s work on our project was high-quality | Winter | 0.551 |
| I could clearly explain why design courses are a defining element of an engineering education | Winter, Spring | 0.528, 0.514 |

* Correlation coefficients are Spearman’s rho

Table 2. Correlated evaluation items associated with “Academic Hardiness”. An example of the extreme correlated responses are given in brackets next to each evaluation item.

| Evaluation Items | Quarter | Correlation Coefficient(s)* |
|---|----------------|------------------------------------|
| <ul style="list-style-type: none"> • Which of the following most accurately describes the learning environment in this course . . . [<i>Completely Self Directed</i>] • I can manage stress from difficult courses in healthy ways [<i>Strongly Disagree</i>] | Winter | -0.570 |
| <ul style="list-style-type: none"> • With hard work, I can meet my educational goals [<i>Strongly Agree</i>] • I can stay calm and learn from my mistakes [<i>Strongly Agree</i>] | Winter | 0.513 |
| <ul style="list-style-type: none"> • With hard work, I can meet my educational goals [<i>Strongly Agree</i>] • I seek help from professors when I am performing poorly in their class [<i>Strongly Agree</i>] | Winter | 0.548 |
| <ul style="list-style-type: none"> • With hard work, I can meet my educational goals [<i>Strongly Agree</i>] • I increase my effort when I’m not performing well in a class [<i>Strongly Agree</i>] | Winter | 0.560 |
| <ul style="list-style-type: none"> • I can stay calm and learn from my mistakes [<i>Strongly Agree</i>] • I can manage stress from difficult courses in healthy ways [<i>Strongly Agree</i>] | Winter, Spring | 0.510, 0.833 |
| <ul style="list-style-type: none"> • When you brought team conflicts to the instructor’s attention they most often . . . [<i>Listened , You generated options and made decisions</i>] • With hard work, I can meet my educational goals. [<i>Strongly Agree</i>] | Spring | 0.534 |
| <ul style="list-style-type: none"> • When you brought team conflicts to the instructor’s attention [<i>Listened , You generated options and made decisions</i>] • I seek help from professors when I am performing poorly in their class [<i>Strongly Disagree</i>] | Spring | -0.581 |
| <ul style="list-style-type: none"> • I prefer to take classes to get “easy A’s” . [<i>Strongly Agree</i>] • I choose electives that require the least amount of work [<i>Strongly Agree</i>] | Spring | 0.664 |
| <ul style="list-style-type: none"> • I prefer to take classes to get “easy A’s” [<i>Strongly Agree</i>] • I take difficult classes because I know they will benefit me in the long run [<i>Strongly Disagree</i>] | Spring | -0.601 |
| <ul style="list-style-type: none"> • With hard work, I can meet my educational goals [<i>Strongly Agree</i>] • I can manage stress from difficult courses in healthy ways [<i>Strongly Agree</i>] | Spring | 0.500 |
| <ul style="list-style-type: none"> • With hard work, I can meet my educational goals [<i>Strongly Agree</i>] • Rate the quality of your learning in this course [<i>Excellent</i>] | Spring | 0.511 |
| <ul style="list-style-type: none"> • With hard work, I can meet my educational goals [<i>Strongly Agree</i>] • Rate the Instructor’s overall performance in this course [<i>Excellent</i>] | Spring | 0.529 |
| <ul style="list-style-type: none"> • I take difficult classes because I know they will benefit me in the long run [<i>Strongly Agree</i>] • I increase my effort when I’m not performing well in a class. [<i>Strongly Agree</i>] | Spring | 0.761 |

*Correlation coefficients are Spearman’s rho

Table 3. Correlated evaluation items associated with “Perceived Work Quality and Effort”. An example of the extreme correlated responses are given in brackets next to each evaluation item.

| Evaluation Items | Quarter | Correlation Coefficient(s)* |
|---|----------------------|------------------------------------|
| <ul style="list-style-type: none"> • Rate the quality of your learning in this course <i>[Excellent]</i> • This is a course where “you get out of it what you put into it” <i>[Strongly Agree]</i> | Fall | 0.502 |
| <ul style="list-style-type: none"> • I could clearly explain why design courses are a defining element of an engineering education<i>[Strongly Agree]</i> • I’m proud of what I have achieved in this class <i>[Strongly Agree]</i> | Fall, Winter | 0.571, 0.634 |
| <ul style="list-style-type: none"> • Taking this course is helping me make the transition from being a student to being a professional<i>[Strongly Agree]</i> • I put a lot of effort into our design project<i>[Strongly Agree]</i> | Winter | 0.601 |
| <ul style="list-style-type: none"> • Taking this course is helping me make the transition from being a student to being a professional<i>[Strongly Agree]</i> • My team’s work on our project was high-quality<i>[Strongly Agree]</i> | Winter | 0.551 |
| <ul style="list-style-type: none"> • This is a course where “you get out of it what you put into it” <i>[Strongly Agree]</i> • I could clearly explain why design courses are a defining element of an engineering education<i>[Strongly Agree]</i> | Winter | 0.560 |
| <ul style="list-style-type: none"> • This is a course where “you get out of it what you put into it” <i>[Strongly Agree]</i> • I put a lot of effort into our design project<i>[Strongly Agree]</i> | Winter | 0.552 |
| <ul style="list-style-type: none"> • I put a lot of effort into our design project<i>[Strongly Agree]</i> • My work on our design project was high quality<i>[Strongly Agree]</i> | Fall, Winter, Spring | 0.536, 0.541, 0.553 |
| <ul style="list-style-type: none"> • My work on our design project was high quality<i>[Strongly Agree]</i> • My team’s work on our project was high quality<i>[Strongly Agree]</i> | Fall, Winter, Spring | 0.685, 0.654, 0.692 |

*Correlation coefficients are Spearman’s rho

Conclusions

We have developed a supplemental design evaluation that can provide quantitative information about whether design instructors' goals are being met – for example, whether students are assuming more responsibility for their learning as the design experience progresses. The supplemental evaluation provides information that is not assessed by traditional student evaluations of teaching, or through grading/assessment of the technical quality of student-designed deliverables. The evaluation can be used by design instructors to better understand students' perceived independence, responsibility for learning, perceived “Academic Hardiness”, and prevalence of professional activities. Design instructors can then change aspects of their courses (more clearly explaining particular requirements, having different discussions about professional responsibilities, asking students to keep track of/reflect on various professional work practices, incorporating stress management techniques, etc.) to encourage desired outcomes.

Our ultimate goal is to develop and disseminate a short, robust and easily implemented instrument that could be used to obtain information particularly relevant to design courses.

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For each item below, please choose the one answer that best characterizes your design experiences.

1. When you discussed **design and technical issues** with the instructor, they *most often*:

Told you exactly what you should do.

Tried to convince you to take particular actions.

Suggested options but did not try to influence your decisions.

Helped you generate your own list of options.

Listened. You generated options and made decisions on your own.

2. When you brought **team conflicts** to the attention of the instructor, they *most often*:

Not applicable.

Told you exactly what you should do.

Tried to convince you to take particular actions.

Suggested options but did not try to influence your decisions.

Helped you generate your own list of options.

Listened. You generated options and made decisions on your own.

3. When you asked **technicians or professors other than your instructor** for help with a project, they *most often*:

Not applicable.

Essentially did the project for you.

Completed most of the project for you.

Told/ showed you what to do, and you completed the work.

Told/ showed you some of what you would need to do, and you completed the work.

Helped you figure out what you would need to do, and you completed the work.

4. Whom do you consider to be **ultimately responsible for what you learned** in this course?

Essentially the instructor.

Mostly the instructor.

You and the instructor share responsibility.

Mostly you.

Essentially you.

5. **When you felt anxious about your performance** in this course, you were *most often* concerned about whether:

Your performance would earn the course grade you desired.

You were learning things directly related to your future career.

Your performance would please the instructor.

Your performance would please your teammates.

Your design would meet the needs of your client.

6. Which of the following most accurately describes the **learning environment** in this design course?

The instructor completely directed what and how we learned.

The instructor defined broad goals or tasks, and we were expected to achieve them.

We defined and were expected to achieve broad goals or tasks, with the instructor's guidance.

We completely directed what and how we learned.

For each statement below, please choose the one option that best characterizes your level of agreement with the statement.

- | | <i>Strongly
Disagree</i> | <i>Disagree</i> | <i>Neither Agree
Nor Disagree</i> | <i>Agree</i> | <i>Strongly
Agree</i> |
|--|------------------------------|-----------------------|---------------------------------------|-----------------------|---------------------------|
| 7. Our design was student-directed and a result of our team's decision-making rather than the work of our instructor. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 8. Taking this course is helping me make the transition from being a student to being a professional. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 9. In this course, I was allowed to make mistakes and then learn from the consequences of those mistakes. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 10. This is a course where “you get out of it what you put into it” - if you take it seriously and put effort into the class, you'll learn a lot; if you treat the class like a game or a joke, you won't learn much. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 11. If asked, I could clearly explain why design courses are a defining element of an engineering education. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 12. I put a lot of effort into our design project. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 13. <i>My</i> work on our design project was high-quality. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 14. <i>My</i> team's work on our project was high-quality. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 15. I'm proud of what I have achieved in this class. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

16. Thinking about my design experience overall, **I am proudest of the following:**
(please briefly explain what you're proudest of)

For each statement below, please choose the one option that best characterizes your level of agreement with the statement.

| | Strongly Disagree | Disagree | Neither Agree Nor Disagree | Agree | Strongly Agree |
|---|--------------------------|-----------------------|-----------------------------------|-----------------------|-----------------------|
| <i>As our design project progressed, I had to:</i> | | | | | |
| 17. teach myself things in order to accomplish tasks. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 18. make choices or decisions even though I didn't know everything there possibly was to know about an issue. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 19. solve unexpected problems. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| <i>In general,</i> | | | | | |
| 20. I prefer to take classes to get "easy A's." | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 21. With hard work, I can meet my educational goals. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 22. I can stay calm and learn from my mistakes. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 23. I choose electives that require the least amount of work. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 24. I seek help from professors when I am performing poorly in their class. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 25. I am miserable to be around when I receive a disappointing grade. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 26. I take difficult classes because I know they will benefit me in the long run. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 27. I increase my effort when I'm not performing well in a class. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 28. I can manage stress from difficult courses in healthy ways. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 29. I am willing to take a difficult class and risk getting a bad grade, if the class seems interesting. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

For the final questions listed below, please choose the one option that best characterizes your opinion.

| | Poor | Fair | Satisfactory | Very Good | Excellent |
|---|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| 30. Please rate the quality of your learning in this design course. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 31. Please rate Dr. X's performance as an instructor. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 32. Please rate Dr. Y's performance as an instructor. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |