Measuring Added-Value Using a Team Design Skills Growth Survey

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Abstract

Assessing student learning in design courses is essential for giving them feedback on their integration of a wide range of knowledge and skills. This paper describes the Team Design Skills Growth Survey, which is easy to administer and interpret in discerning design capabilities of students in introductory engineering design classes. This tool measures student perceptions about their professional growth and correlates these with perceived course emphasis on learning outcomes for design skills, teamwork skills, and communication skills endorsed by the Washington Council for Engineering and Related Technology Education (WCERTE).

Several versions of the Team Design Skills Growth Survey have been used over the last ten years in sections of an introductory engineering design course at Tacoma Community College. Results generated from the survey are consistent with pre- and post-testing, verbal protocol analysis, team interviews, and a variety of reflective writing assignments. Results include an analysis of the difference between the means for class-averaged growth and class-averaged emphasis in each of the WCERTE outcome areas.

For students, the greatest impact of using this tool is increasing their understanding of their learning with respect to the intended learning outcomes. As such, the Team Design Skills Growth Survey can support efforts to increase students' self-confidence in engineering, leading to better retention of engineering students. For faculty, the greatest impact of using this tool is measuring the value-added of different activities in introductory engineering design classes, which can be used to improve course design, provide insight to class management issues, and determine the appropriateness of performance indicators. This paper also addresses best practices for implementing and expanding the Team Design Skills Growth Survey and extending it to other disciplines.

Introduction

The assessment tool described in this paper is designed to assess students' development of skills in and knowledge of the engineering design process when enrolled in an introductory engineering design course. (See Appendix for the complete version of the "Team Design Skills Growth Survey.") It expands the use of surveys into a new dimension that can be used to measure student achievement and growth relative to specific course outcomes. The survey is best suited to assess meta-cognitive processes and efficacy (self-worth as a learner) like those that are found in communication, teamwork, and design process skills[1,2].

The survey was administered twice during each half of an introductory engineering design course to measure students' perception of the "Class Emphasis" and their "Personal Growth" in the class. Elements in the survey include teamwork and communication skills, and the five fundamental and inclusive elements of the Transferable Integrated Design Engineering Education (TIDEE) engineering design process. Process elements are information gathering, problem definition, idea generation, evaluation and decision-making, and implementation.

This survey uses methodologies that were previously developed for surveys that measured students' growth in a broad category titled "Working and Living Cooperatively." These surveys are similar to one that was used in this survey and were beta-tested in a variety of courses across the curriculum that included a biology majors' sequence, an emergency medical program introductory course, an environmental science course, a history course, a physical science course and an engineering design course. Results from these predecessors provide a broad base of experience from which a more meaningful and valid design assessment tool was created for engineering design.

The analysis of this survey includes data from three introductory engineering design classes at one institution and data from a significantly different introductory design class at another institution. These two institutions used different design education methodologies and emphasized different aspects of the design process.

Results of this survey compare favorably with previous work using other TIDEE assessment tools, which includes a Design Team Readiness Assessment[3,4] that measures team design skills of student teams as they engage in a short design project, team interviews[5], a verbal protocol analysis[6], and continuous classroom improvement assessment activities[2]. Deployment of the Design Team Growth Survey provides a relatively quick and reliable feedback mechanism with a goal of increasing student learning through the improvement of the curriculum, development of better classroom management techniques and creation of more effective methods and pedagogies.

<u>System for Data Collection and Analysis</u>

The Washington Council for Engineering and Related Technical Education (WCERTE) endorsed the elements of the TIDEE engineering design process as being foundational elements of the engineering design process[1]. These TIDEE elements, (teamwork, communication, information gathering, problem definition, idea generation, evaluation and decision making, and implementation), provide a fundamental skill set that all engineering students must be able to do at a high level of performance if they are to create quality products through the application of an engineering team-design processes[7].

Within each element are components that describe skills and knowledge that would be expected of engineering students after completing their sophomore year in an engineering degree program.

This set establishes a baseline from which (1) institutions have the flexibility to develop design courses and curriculum appropriate to their institutional needs, (2) assessment tools can be developed, and (3) design courses can be structured so that students can seamlessly transfer between institutions within the state and across the nation. The development of a common set of standards was critical in the State of Washington, because Washington has a much higher percentage of students who graduate with a B.S. degree in engineering that have transferred from community colleges. The national average is 40%[8].

Design of Instrument

The Team Design Skills Growth Survey uses the TIDEE elements as categories, and describes several components within each of the categories. The language used defines the element by describing what is expected rather than describing levels of performance. The first item in each of the categories in the survey is the basic definition of that element. For example teamwork is defined as "Individuals participate effectively in groups or teams." The next items in that category are components (or performance indicators) of that element. For teamwork, there are four characteristic items:

- Individuals understand their own and other member's styles of thinking and how they affect teamwork
- Individuals understand the different roles included in effective teamwork and responsibilities of each role
- Individuals use effective group communication skills: listening, speaking, visual communication
- Individuals cooperate to support effective teamwork

Students are able to use the statements in the Team Design Skills Growth Survey to assess their perception of class emphasis in each area along with their perceived growth during the course. Students' perception of their growth depends to a great extent upon past experiences, and particularly the range of growth that they have encountered in other experiences or classes. Any absolute measure of their skills and knowledge will need to be done by an outside evaluator. For example, a student who enters the course without many of the desired skills might report a high level of growth, but may still be at a low level of performance.

Because there is no absolute meaning for what is meant by different levels of growth, different students often bias their selection of values by concentrating their responses to one end of the scale. Thus, it is important to use the averages of many students to be able to achieve meaningful results for a class.

Rating Scales

The survey is based upon a five-point scale, where 5 represents tremendous growth and adding many new skills; 4 significant growth and adding several skills; 3 some growth and gaining a few skills; 2 using previous skills and little growth; and 1 not using the skill. This is different from a Likert Scale, which is typically used in opinion surveys and has a neutral reading at 3. The survey needs multiple applications before meaningful results can be gained. These scores should be validated against results from other assessment tools.

The "Class Emphasis" category provides an opportunity for students to describe what is being covered in the course and a baseline from which to judge the growth of students. Including both "Class Emphasis" and "Personal Growth" categories provide a mechanism to judge how effective the class is in developing specific skills. When a particular section has not been emphasized during the course, it provides a check whether students are responding appropriately to the statements through multiple selections of a score of 1.

The language used within each of the categories was chosen so that it implied similar meaning. For example, the base of 1 uses "Did not discuss" for the Class Emphasis and "Did not use this skill" for Personal Growth. Another correlation used "Significant emphasis -- Significant growth and added several new skills," respectively.

Administering the Survey

This survey was designed to be given at midterm and at the end-of-term to assess students' development of skills and knowledge that fit with the repetitive structure of the class. This selection was reinforced because it was at this time that teams were changed in order to provide two opportunities for students to learn how to develop quality design teams. Thus, it became possible to determine student growth during each team experience. The instructional pattern for each team included:

1) Creating new teams and developing teaming skills
2) Engaging the newly formed teams in a short structured design project
3) Engaging these teams in a multi-week guided design project

Guidelines for Validating Results

A systemic method was needed to compare the results of this survey's "Personal Growth" to the results derived from the application of other assessment tools. In order to develop a meaningful conclusion, all of the data sets should be used in the analysis. These included using the definition of each element (teamwork, communication, information gathering, idea generation, problem definition, evaluation and decision making, and implementation), the stated performance criteria for the components of each element, the average value for the component of each element, and a composite score that averaged the definition with the average component score.

The data should be analyzed by ranking the items relative to each other, looking at growth vs. emphasis, examining components that were not emphasized, observing irregularities between classes, and comparing the results between institutions.

Three consistency checks emerged during the development of the survey. These involve averaging component scores and comparing with definition scores.

1. *When the average score of the components of an element is approximately equal to the score of the definition this set describes a reasonable representation of the components within an element.* While this may not be an exclusive set, this analysis provides a method to determine whether the sum of the individual indicators has been appropriately identified. For example, in pilot testing of this survey there was good agreement between all of the TIDEE process elements and their components. However, care should be taken to insure that this is a complete list of

components. Other components might be added, especially when there are only two components for an element, like Information Gathering, Evaluation and Decision Making, and Implementation.

2. Conversely, w*hen the average score of the components of an element isn't approximately equal to the score of the definition, then the indicators aren't a reasonable representation of what makes up that element.* To obtain a better representation of an element, the definition should be examined to determine if it correctly represents the element, the components should be checked for appropriateness and/or additional components might be generated. For example, in pilot testing this survey the average score of the teamwork and communication components were significantly less than the definition score for each element. We concluded that there should be additional components or indicators included within each of these skill sets in order to fully represent all of the skills in each of these elements.

3. *When one of the components in an element is not being developed within the course, then the average score of the components is skewed downwards and the two previous rules can't be applied*. When this occurs, then the course objectives should be reviewed to determine whether or how this skill or knowledge should be addressed within the class. For example, this occurred in Idea Generation and Evaluation and Decision Making. One institution did not emphasize using library resources and the other did not emphasize using matrix techniques.

Course Survey Results

The results of the survey for the three introductory design classes at the same institution are listed in "Table 1: Course Survey Results." Although this is a work-in-progress, there is sufficient data to determine outcomes and trends in measuring student growth in the engineering design process. Results are consistent with other TIDEE assessment methods that have already been administered and analyzed. The data in the three classes were combined and analyzed as a single data set, which was used to compare results from the earlier survey. Results from both surveys indicate that students grew more in almost all of the competencies during the second half of the term than they did during their first teaming experience.

This has been confirmed during team interviews when students are asked to discuss this issue. A typical response is that they experienced more growth during the second team experience because during the first half they were learning *what the design process was* and that during the second half they were *learning how to apply it.* This indicates an increase in critical thinking skills, which results in a better understanding of the concepts and processes. The students also report that the knowledge becomes *substantially more internalized* and that they *have gained the confidence that they need to apply the newly developed skills to new situations*.

The ranking of student growth was done by analyzing data using two different methods, (1) a composite score that averages the 'definition' and the 'overall performance average of individual components,' and (2) the definition. In general, the composite score was found to be a better measure of students' perception of their growth because it provides information from two different perspectives; global from the definition and focused from the components.

Table 1: Course Survey Results

	1st half		2nd half	
	Emphasis	Growth	Emphasis	Growth
TEAMWORK: Definition	4.24	3.73	4.39	4.10
Understand the effects of learning styles	3.88	3.72	4.05	3.89
Understand team roles and responsibilities	3.93	3.81	4.05	3.90
Use effective group communication skills	3.72	3.51	3.97	3.79
Support effective teamwork	4.08	3.89	4.38	4.00
Component Average	3.91	3.73	4.11	3.89
Composite (Definition & Component Average)	4.07	3.73	4.25	4.00
INFORMATION GATHERING: Definition	3.41	3.20	3.47	3.53
Use visual and oral techniques to gather information	3.66	3.39	3.84	3.56
Use library resources effectively	2.07	2.24	2.39	2.41
Component Average	2.87	2.82	3.12	2.99
Composite (Definition & Component Average)	3.14	3.01	3.29	3.26
PROBLEM DEFINITION: Definition	4.00	3.51	4.10	4.05
Understand the open-ended nature of problems	3.86	3.59	3.98	3.85
Develop specific goal statements at appropriate time	3.97	3.46	3.84	3.81
Recognize importance of problem definition	4.14	3.66	4.05	3.87
Develop problem definition with goals and criteria	4.16	3.71	4.31	4.10
Component Average	4.03	3.60	4.04	3.91
Composite (Definition & Component Average)	4.01	3.56	4.07	3.98
IDEA GENERATION: Definition	4.12	3.69	4.13	3.79
Utilize environment	3.53	3.44	4.03	3.71
Brainstorm effectively	4.14	3.90	4.30	4.02
Individual generation of ideas	3.70	3.47	4.11	3.92
Synthesize ideas to increase idea generation	4.00	3.53	4.10	3.74
Component Average	3.84	3.58	4.14	3.85
Composite (Definition & Component Average)	3.98	3.64	4.13	3.82
EVALUATION AND DECISION MAKING: Definition	3.88	3.53	4.00	3.86
Use iterative approach	3.90	3.42	3.92	3.73
Apply matrix techniques	3.76	3.45	4.11	3.92
Component Average	3.83	3.44	4.02	3.82
Composite (Definition & Component Average)	3.86	3.48	4.01	3.84
IMPLEMENTATION: Definition	3.93	3.71	3.89	3.71
Effective time management	4.00	3.86	4.17	3.78
Follow plans	3.69	3.68	3.88	3.85
Component Average	3.85	3.77	4.03	3.82
Composite (Definition & Component Average)	3.89	3.74	3.96	3.76
COMMUNICATION: Definition	4.12	4.09	4.19	3.92
Practice effective listening skills	3.61	3.82	3.90	3.83
Exhibit appropriate non-verbal mannerisms	3.32	3.52	3.89	3.75
Give and receive constructive feedback	4.22	3.96	4.00	3.92
Record team activities and outcomes	4.27	3.88	4.08	3.78
Produce acceptable technical papers	2.93	2.88	3.48	3.22
Produce acceptable oral presentations	4.30	4.30	4.23	4.08
Develop graphical drawings and sketches	3.98	4.00	3.92	3.70
Component Average	3.80	3.76	3.93	3.75
Composite (Definition & Component Average)	3.96	3.93	4.06	3.84

Consequently the composite score (Definition & Component Average) was used to draw conclusions about our findings. Information Gathering was not included in the ranking because it contains a component that was not emphasized or used within the class.

Composite Score for Emphasis

Students respond that the course placed a heavy emphasis on Teamwork. (See Table 2: Student Perception of Course Emphasis.) They also perceived that all of the elements had a strong class emphasis, but ranked the emphasis for all of the elements higher in the second half.

The elements in the first half of the term were ranked at a similar emphasis. During the second half there was more spread between the emphasis scores with teamwork significantly out in front. Idea generation followed closely behind and slightly out ahead of the other elements. The ranked data in order of emphasis are:

Table 2: Student Perception of Course Emphasis

Ranking	First Half	Second Half
1	Teamwork (4.07)	Teamwork (4.25)
2	Problem Definition (4.01)	Idea Generation (4.13)
3	Idea Generation (3.98)	Problem Definition (4.07)
4	Communication (3.96)	Communication (4.06)
5	Implementation (3.89)	Evaluation & Decision Making (4.01)
6	Evaluation & Decision Making (3.86)	Implementation (3.96)

Composite Score for Growth

Students' indicate they had a more selective growth in each of the elements during the first half of the term, which is demonstrated by a large spread between the top and bottom scores of the elements and by the significantly different values for each of the elements. (See Table 3: Student Perception of Personal Growth for the ranked data for the survey in order of growth.) Students indicate that "Communication" skills were their highest growth while "Evaluation and Decision Making" was the least.

Table 3: Student Perception of Personal Growth

Ranking	First Half	Second Half
1	Communication (3.93)	Teamwork (4.00)
2	Implementation (3.74)	Problem Definition (3.98)
3	Teamwork (3.73)	Evaluation & Decision Making (3.84)
4	Idea Generation (3.64)	Communication (3.84)
5	Problem Definition (3.56)	Idea Generation (3.82)
6	Evaluation & Decision Making (3.48)	Implementation (3.76)

During the second half of the term, the students perceived that the growth was more nearly equal with "Teamwork" and "Problem Definition" the top rated growth items. The other elements had similar values and were slightly below the top two elements. The high ranking of "Problem Definition" reflects differences in the emphasis of the curriculum between the first and second half, in which "Problem Definition" was a focused topic during the second half of the term in both the short structured design process and in the multi-week guided project.

The overall results of the students' perception of growth correlate well with the previous survey results that were based upon students' perception of significant growth within each of the elements of the design process. For example, during the second half of the term the top rated elements in both surveys were "Teamwork" and "Problem Definition" in which perceived growth rates were significantly higher than any of the perceived growth rates within the other elements. In addition, in that survey the students indicated that they had a larger growth during the second half compared to the first half, which follows the same trend found in this survey.

Differences between Composite Scores

As students' knowledge of the process increased, they are better able to judge the growth in their learning and are more discerning about how their learning in the second half of the course relates to the elements and components. This was demonstrated by students' perception of a greater emphasis and a greater growth during the second half of the term compared to the first half of term even though the class process and methodologies used in each half were similar.

The difference between perceived emphasis and growth was more pronounced in the first half of the term than the second half. This is comparable results from other surveys used in other classes where we have found that a perception of course emphasis is almost always higher than perceived growth.

The one exception was in "Communication," which had almost no difference between perceived course emphasis and perceived growth during the first half of the term. During the second half of the term perceived course emphasis exceeded perceived growth, just like all of the other elements. This can be interpreted to mean that there was a larger growth in communication skills during the first half of the term than in the second half.

In our judgment, if the difference between perceived emphasis and perceived growth is larger than 0.2 then skill growth is not optimal and efforts should be initiated to modify course design and delivery to promote higher levels of skill development.

Comparing Different Class Sections

Another outcome of the survey is that differences between class sections can be used to diagnose classroom management issues. For example, one of the three classes in the study had significantly different teamwork growth scores. This triggered a conference with the instructor in which the instructor revealed that three of the five teams were dysfunctional with respect to cooperation, team synergy and communication between team members. The instructor tried a number of interventions such as individual counseling, team counseling, and altering team composition. In this class, team performance reviews at the end of the semester were quite intense. Students reaffirmed that dysfunctional team behavior repressed growth that otherwise might have occurred.

Extension to Other Classes

The methodology that is used in this survey provides a first step towards creating a course assessment system. It is easy to assemble because the survey could be aligned with general outcomes of the course. The survey items would be composed of definitions and general statements concerning what students should be able to know and do. It would not be necessary to create rubrics with scoring levels, which is time-consuming, complex, and difficult to validate.

The methodology is best suited for investigating student ability to engage and apply steps within a process. Good soft skill candidates for this survey are teamwork and communication. The survey could also include dealing with diverse viewpoints and relevance of information; recognition of bias, stereotyping and manipulation; analysis of cultural and minority issues; and developing a learning community that gives members meaningful roles and responsibilities, develops synergy among members, creates meaningful goals and develops a commitment to learning.

Within the survey, components under of each of the elements are appropriate indicators if the average score of the components is equal to the score of the definition of the element. Results can provide information about how well different topics are being covered by ranking the different elements and/or components to determine if: (1) there are significant differences between elements; (2) some elements have low scores indicating that a component was not emphasized or did not produce significant growth; and (3) the difference between the emphasis and growth is not too large. The survey instructions should be changed to reflect cumulative course emphasis as well as cumulative growth. This modification would work better in a course that doesn't repeat the same methodologies during each half of the term.

It is important to apply the survey to multiple classes within the same curriculum or at different institutions in order to determine a norm or baseline. This will provide information about which aspects of the curriculum are most effective. These will also provide input about what course features need modification.

Conclusions

This survey is an effective assessment tool that measures students' development of communication, teamwork and engineering design process skills in introductory engineering design classes. It efficiently and reliably gathers assessment information about personal skill development rather than just their impressions about a course. The results from this survey correlate well with all of the other assessments that have been administered to students who have taken similar introductory design courses. The results provide information that can be used to improve and modify instructional design and methods of delivery to meet course objectives prescribed by ABET 2000 Criteria 3 and 4. By using the survey, students appreciate and understand the development of skills that they can immediately use in their daily lives. The results from this survey are also motivating to students who are considering engineering as a profession. The authors welcome anyone who would like to use this survey and send results to the lead author of this paper, kgentili@tcc.ctc.edu. The survey can be downloaded from www.tidee.wsu.edu.

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Author Biographies

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Kenneth Gentili has been an instructor at Tacoma Community College for 35 years as an instructor in engineering and physics. He is currently on leave at the National Science Foundation serving as a Program Director in the Division of Undergraduate Education. He has developed curriculum and assessment tools in engineering design, introductory physical science, and critical thinking. He has won numerous teaching and service awards.

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Jim Lyons worked for the Boeing Company for seven years and the Westinghouse Electric Corporation for thirty-one years as an engineer and engineering manager before retiring in 1999. In 2001 he began a second career as an engineering instructor at Green River Community College and Tacoma Community College. He is an active participant in developing and testing curriculum and assessment tools in engineering design.

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Eric Davishahl is an Instructor of Engineering at Everett Community College. In less than two years after he became a faculty member in 2001, he received the "You Made a Difference Award" for completely modernizing the engineering curriculum, involving the college in synergistic partnerships and "making his classes challenging, yet fun!" His students have successfully competed in a human powered paper vehicle contest.

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Steven Beyerlein is professor of Mechanical Engineering at the University of Idaho, where he coordinates the capstone design program and regularly participates in ongoing program assessment activities. For these efforts he won the UI Outstanding Teaching Award in 2001. He received a Ph.D. in M.E. from Washington State University in 1987. His research interests include catalytic combustion systems, application of educational research methods in engineering classrooms, and facilitation of professional development activities.

Appendix

Team Design Skills Growth Survey

Instructions: This survey is intended to measure personal growth within each of the elements of the TIDEE engineering design process. The survey is to be taken twice during an introductory design course, once at mid-term and the other at the end of the term. All responses should be given relative to what has been learned during each half of the term. Thus, the second survey should reflect only what has been accomplished during the second half of the design course. A score of 5 indicates a strong class emphasis and/or personal growth.

Class Emphasis			**Personal Growth during this Half of the Term**	
Major emphasis	**5**		**I experienced a tremendous growth and added many new skills**	**5**
Significant emphasis	**4**		**I experienced a significant growth and added several skills**	**4**
Some emphasis	**3**		**I grew some and gained a few new skills**	**3**
Minor emphasis	**2**		**I used previous skills and had little growth**	**2**
Did not discuss	**1**		**I did not use this skill within this class**	**1**

TEAMWORK	Class Emphasis	Personal Growth
Individuals participate effectively in groups or teams	1 2 3 4 5	1 2 3 4 5
Individuals understand their own and other member's styles of thinking and how they affect teamwork	1 2 3 4 5	1 2 3 4 5
Individuals understand the different roles included in effective teamwork and responsibilities of each role	1 2 3 4 5	1 2 3 4 5
Individuals use effective group communication skills: listening, speaking, visual communication	1 2 3 4 5	1 2 3 4 5
Individuals cooperate to support effective teamwork	1 2 3 4 5	1 2 3 4 5

INFORMATION GATHERING	Class Emphasis	Personal Growth
Individuals gather information, use various sources and techniques, analyze validity and appropriateness	1 2 3 4 5	1 2 3 4 5
Individuals use important visual and oral techniques (questioning, observing) for information gathering	1 2 3 4 5	1 2 3 4 5
Individuals use library resources effectively in accessing relevant information	1 2 3 4 5	1 2 3 4 5

PROBLEM DEFINITION	Class Emphasis	Personal Growth
Individuals define problems, which includes specific goal statement, criteria and constraints	1 2 3 4 5	1 2 3 4 5
Individuals understand the open-ended nature of problems	1 2 3 4 5	1 2 3 4 5
Individuals develop specific goal statements after gathering information about a problem (need)	1 2 3 4 5	1 2 3 4 5
Individuals recognize the importance of problem definition for development of an appropriate design	1 2 3 4 5	1 2 3 4 5
Individuals develop problem definitions with specific criteria and constraints	1 2 3 4 5	1 2 3 4 5

IDEA GENERATION	Class Emphasis	Personal Growth
Teams and individuals utilize effective techniques for idea generation	1 2 3 4 5	1 2 3 4 5
Teams and individuals identify and utilize environments that support idea generation	1 2 3 4 5	1 2 3 4 5
Teams brainstorm effectively	1 2 3 4 5	1 2 3 4 5
Individuals apply effective techniques in their own idea generation	1 2 3 4 5	1 2 3 4 5
Teams use techniques that synthesize ideas to increase overall idea generation	1 2 3 4 5	1 2 3 4 5

EVALUATION AND DECISION MAKING	Class Emphasis	Personal Growth
Teams and individuals utilize critical evaluation and decision making skills and techniques, including testing	1 2 3 4 5	1 2 3 4 5
Teams follow an iterative approach that employs evaluation repeatedly in their design process	1 2 3 4 5	1 2 3 4 5
Teams and individuals apply simple matrix techniques for evaluating proposed solutions	1 2 3 4 5	1 2 3 4 5

IMPLEMENTATION	Class Emphasis	Personal Growth
Teams implement the design to a state of usefulness to prospective clientele	1 2 3 4 5	1 2 3 4 5
Teams manage time and other resources as required to complete their project	1 2 3 4 5	1 2 3 4 5
Team members follow instructions provided by others in implementation	1 2 3 4 5	1 2 3 4 5

COMMUNICATION	Class Emphasis	Personal Growth
Individuals communicate with team members at all stages of development and implementation of design solutions	1 2 3 4 5	1 2 3 4 5
Individuals practice effective listening skills for receiving information accurately	1 2 3 4 5	1 2 3 4 5
Individuals exhibit appropriate nonverbal mannerisms (e.g., eye contact) in interpersonal communication	1 2 3 4 5	1 2 3 4 5
Individuals give and receive constructive criticism and suggestions	1 2 3 4 5	1 2 3 4 5
Individuals record group activities and outcomes, ideas, date, etc. in personal design journals	1 2 3 4 5	1 2 3 4 5
Individuals produce technical papers and memos in acceptable style and format	1 2 3 4 5	1 2 3 4 5
Teams present design information in group oral presentations	1 2 3 4 5	1 2 3 4 5
Individuals communicate geometric relationships using drawings and sketches	1 2 3 4 5	1 2 3 4 5