National Trends in the Civil Engineering Major Design Experience: Part Deux

Dr. Tonya Lynn Nilsson P.E., Santa Clara University

Tonya Nilsson is a full-time lecturer in the department of Civil Engineering at Santa Clara University. Previously she was on the faculty at California State University, Chico where she was a tenured associate professor. Dr. Nilsson has her professional license and has worked in industry on structural engineering projects. Dr. Nilsson worked for a number of years with ASCE's ExCEED Teaching Workshops and served for four years on the national ASCE Committee on Faculty Development. She is currently a member of the Santa Clara University School of Engineering ENGAGE team working on Everyday Examples in Engineering.

Dr. Kevin D. Hall, University of Arkansas
Dr. Ronald W. Welch, The Citadel

Dr. Ron Welch, P.E., received his B.S. in Engineering Mechanics from the United States Military Academy in 1982. He received his M.S. and Ph.D. in Civil Engineering from the University of Illinois, Champaign-Urbana in 1990 and 1999, respectively. He became the dean of Engineering at The Citadel in July 2011. Prior to his current position, he was the department head of Civil Engineering at The University of Texas at Tyler from Jan. 2007 to June 2011. Dr. Welch served in the Corps of Engineers for over 24 years, eleven of which he spent as faculty at the United States Military Academy.

National Trends in the Civil Engineering Major Design Experience: Part Deux

Introduction

According to the 2012-2013 ABET Criteria for Accrediting Engineering Programs, "Students must be prepared for engineering practice through a curriculum culminating in a major design experience based on the knowledge and skills acquired in earlier course work and incorporating appropriate engineering standards and multiple realistic constraints".[1] How have programs implemented this requirement into their curricula? To help answer this question the authors conducted a national survey of Civil Engineering departments across the United States during fall 2011. One hundred-one departments responded, with 99 indicating they had a culminating major design experience. A paper summarizing the general results of this survey was presented at the June 2012 American Society of Engineering Education National Conference.[2] The first paper focused on identifying common trends in the culminating design experience.

The current paper attempts to look for deeper patterns and correlations in the survey data to provide additional assistance to schools looking to develop or modify their culminating design experience. Associated questions include:

- Do most schools use rubrics for assessment? Are peer and industry assessments likely to have a greater weight in the overall student grade if rubrics are used?
- Does the design team size affect content taught and/or assessed in the course?
- What does it mean to "involve" an industry mentor? Does the use of industry mentors influence the project types, assessment, grading practices, or use of rubrics?
- Does the school type: Ph.D. granting, Undergraduate and Masters (UM), or Undergraduate Only (UO), affect the design experience?

Rubrics and Project Assessment

Rubrics have become a common tool in assessment[3] and much has been covered in the literature regarding their effectiveness.[4] The department survey determined the use of rubrics in assessment was overwhelming. Figure 1 indicates the count of the schools that indicated they used peer, industry or faculty assessment and whether or not the assessment was completed using rubrics. Interestingly, for programs that do not require all groups performing assessment to use a rubric, peer assessment is the most likely to be done without a rubric. Of the 63 schools that indicated their students complete peer assessments, sixteen (25.4 percent) noted the assessment was done without a rubric versus eighteen percent for industry and twelve percent for faculty assessments performed without using a rubric.

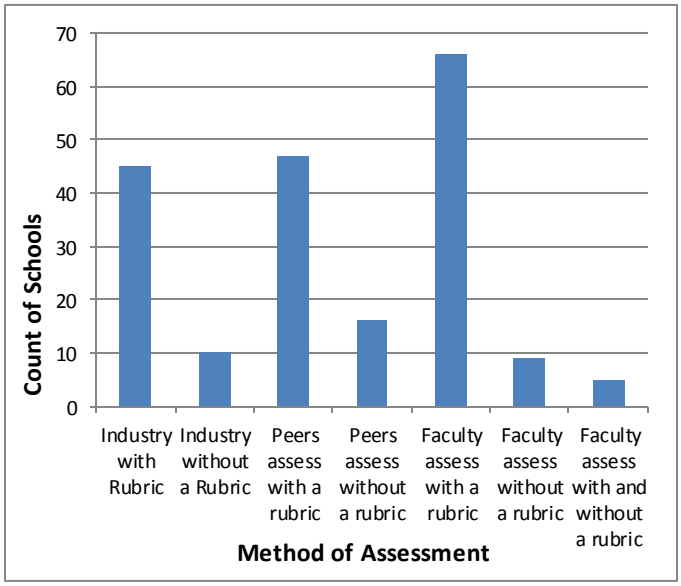

Figure 1: Count of schools reporting using shown methods of assessment.

How does the use of rubrics relate to practices for determining a student's grade? Figure 2 illustrates responses from seventy-six schools reporting the relative weight given to faculty, industry, and peer assessment on the final grade assigned. These responses reveal the following:

- Fifty-seven (75 percent) base the majority of the students' grade on faculty assessment;
  - Forty-nine (of the 57) report that faculty perform their assessment using a rubric.
- Three base the majority of the students' grade on an industry mentor's assessment;
  - In each of the three cases, the industry mentors' assessment is performed using a rubric.
- Six base the majority of the students' grade on a peer assessment;
  - Five (of the six) report that student peers perform their assessment using a rubric.
- Ten (14 percent) weight some combination of faculty, industry, and/or peer assessments equally when determining students' grades;
  - In all ten cases, assessments are prepared using rubrics.

A question closely associated with the *use* of rubrics concerns the relationship between assessment (with and without rubrics) and student grades. Table 1 and Figure 3 provide a breakdown, by percent, of schools that indicated assessment was done by a specific assessment tool and if that assessment was then included in the student's final grade. The data show that schools were more likely to include or give weight to an industry assessment if the assessment was done with a rubric. For example, ten schools indicated industry mentors assess student projects without using a rubric. Of these ten:

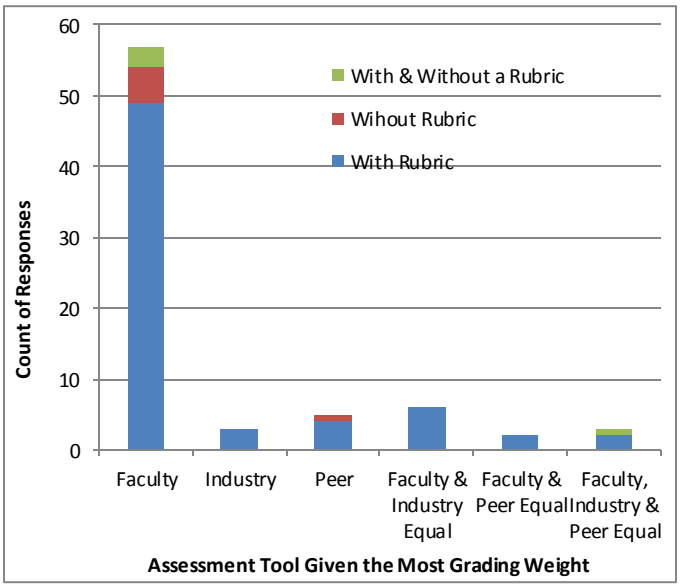

Figure 2: Count of the assessment tool that school's indicated held the most weight in a student's final grade. 25 schools did not indicated weights.

- Only five schools, or 50 percent, specified these assessments were included in the final grade at weights ranging from 5 percent to 30 percent of the total grade.
- Three of the ten departments, or 30 percent, noted that these industry assessments completed without rubrics were not included at all in the final grade and two schools did not provide any percent distribution.

Conversely, of the 45 schools that require industry mentors to assess with a rubric:

- Forty-two of these schools (93.3 percent) include the industry assessment in the final grade.
- Only one school (2.2 percent) indicated the rubric-based industry assessment was not included in the student's final grade.
- Two of the 45 schools did not provide a weight breakdown.

In addition, 15.6 percent of schools, who require industry mentors to assess with rubrics, weigh the industry assessment as 50 percent or more of the final grade and 68.9 percent weigh the industry assessment as 20 percent or more of the final grade. This is significantly higher than schools that include industry assessments without a rubric; zero percent reported these assessments held 50 percent or more weight and only 30 percent reported the industry assessments without a rubric held 20 percent or more weight in the student's final grade.

Table 1: Common Assessment Tools and Influence of Assessment by a Rubric

Assessment Tool	Count of schools that use this assessment tool	% of the count that include the assessment in student final grade	% of the count that weighs the assessment 50% or more in student final grade	% of the count that weighs the assessment 20% or more in student final grade	% of the count that indicated the assessment was not included in the final grades	% of the count that indicated using the assessment tool but did not provide any weights
Industry with Rubric	45	93%	16%	689%	2%	4%
Industry without a Rubric	10	50%	0%	30%	30%	20%
Peers assess with a rubric	47	98%	4%	40%	0%	2%
Peers assess without a rubric	16	94%	6%	38%	0%	6%
Faculty assess with a rubric	66	96%	79%	88%	0%	4%
Faculty assess without a rubric	9	89%	56%	89%	0%	11%
Faculty assess with and without	5	80%	60%	60%	0%	20%

Interestingly, peer assessments did not show as significant a difference between assessment with a rubric and assessment without a rubric. In fact, of the sixteen schools that had peer assessment without a rubric, fifteen indicated the assessment was included in the final grade. Forty-six of the 47 schools that use rubric peer assessment include those assessments in the grade. There appears to be little difference in the weights given peer assessments in the final grades, regardless of whether the assessment was done with a rubric. However, of the six schools shown in Figure 2 that give the peer assessment the greatest weight in the overall finals student grade, five require the peer assessment be completed using a rubric.

Table 1 also confirms that students' grades are based primarily on the assessment of the faculty. However, the percentage of programs reporting that faculty assessment is weighted "more than 50 percent" of the final grade drops from 79 percent when a rubric is used to 56 percent when a rubric is not used (it is noted that the count of programs featuring faculty rubrics is significantly higher – 66 to 9 – than programs featuring faculty assessment without a rubric).

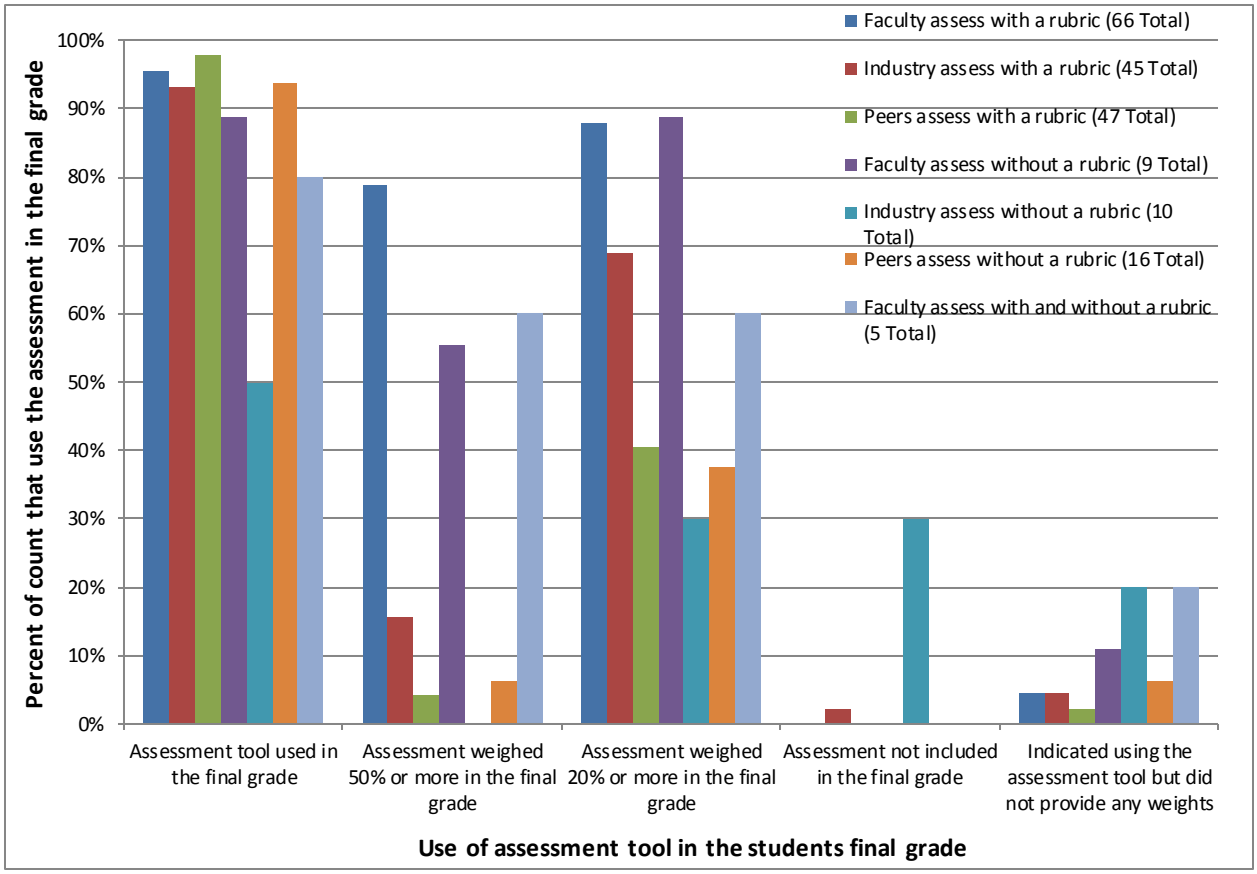

Figure 3: Breakdown of the use of and the weight given a particular assessment tool in the student's final grade.

Team Size, Peer Assessment, and Course Content

What is the appropriate team size? Large teams run the risk of students who do not do their share of the project. Small teams can result in both increased work load for faculty and smaller, less comprehensive projects for students. The original paper reported:

- Four to five team members (the predominant size):
  - 65 percent of schools *allow* this team size.
  - 45 percent of schools *require* this as the only team size.
- Two to three team members:
  - 26 percent of schools *allow* this team size.
  - 3 percent of schools *require* this as the only team size.
- Six or more team members:
  - 21 percent of schools *allow* this team size.
  - 14 percent of schools *require* this as the only team size.
- No school required students work as individual but six percent did allow them.[2]

This paper does not attempt to recommend an optimum team size. Other literature recommends preferred team size based on student experience and faculty workload.[5] From this survey it is possible to report trends in peer assessment, course topics assessed, and course content based on team size.

A review of the survey results showed that peer assessment was implemented more often and held greater weight in the student's final grade for larger team sizes, as shown in Tables 2 and 3. Table 2 reports peer assessment information for any school that indicated they allow a specific team size. However, these schools may also allow other team sizes; therefore, the results may be misleading. For example, the six schools that allow students to work as individuals also appear to use peer assessment for these student's grades. It is possible that students peer evaluate projects or project presentations for other teams but this level of detail cannot be derived from the survey results. To remove any ambiguities, Table 3 reports results from schools that only allow one team size. Table 3 also shows that schools with larger teams make greater use of peer assessment. Further, the peer assessment holds more weight in the student's final grade as the team size increases. Interestingly, there is no difference between the results from six or more person teams between Tables 2 and 3.

Table 2: Effect of Team Size on Use of Peer Assessment Based on All School Responses

Team Size (Schools may allow multiply team sizes)	**Count of Schools**	**Percent Using Peer Assessment**	**Percent weighing peer assessment 20% or more**	**Percent who did not indicate weights**
Individual	6	50.0%	16.7%	16.7%
2-3 Persons	26	61.5%	26.9%	15.4%
4-5 Persons	65	67.2%	24.6%	6.15%
6 or More Persons	21	71.4%	42.9%	14.2%

Table 3: Effect of Team Size on Use of Peer Assessment Based on Schools That Only Allow One Team size

Team Size (Schools allowing only one team size)	**Count of Schools**	**Percent Using Peer Assessment**	**Percent weighing peer assessment 20% or more**	**Percent who did not indicate weights**
Individual Only	0	0.0%	0.0%	0.0%
2-3 Persons Only	8	50.0%	0.0%	12.5%
4-5 Persons Only	45	71.1%	24.4%	15.5%
6 or More Persons Only	14	71.4%	42.9%	14.2%

Figure 4 presents department responses to a list of topics and skills assessed from the design experience, as a function of team size. Overall, patterns initially identified in the 2012 paper – regarding specific topics/skills assessed – are reflected for all team sizes. For example, most programs (70-plus percent) assess communication skills; Figure 4 confirms that this is the case regardless of team size. Conversely, relatively few programs assess asset management; Figure 4 also confirms this is the case regardless of team size. However, general observations related to a differential effect of team size are possible. Smaller teams are more likely to be assessed on engineering theory, software and technical skills, as well as an ability to meet deadlines. Larger teams are more likely to be assessed on the design process, problem solving skills, and, not surprisingly, teaming/leadership skills. It should also be noted that the *majority* of the few (six) schools reporting allowing students to work as individuals also indicate that many, if not most, of the topics/skills identified are assessed for the design experience. In general, the data do not allow definitive statements regarding an effect of team size on the topics/skills assessed as part of the design experience.

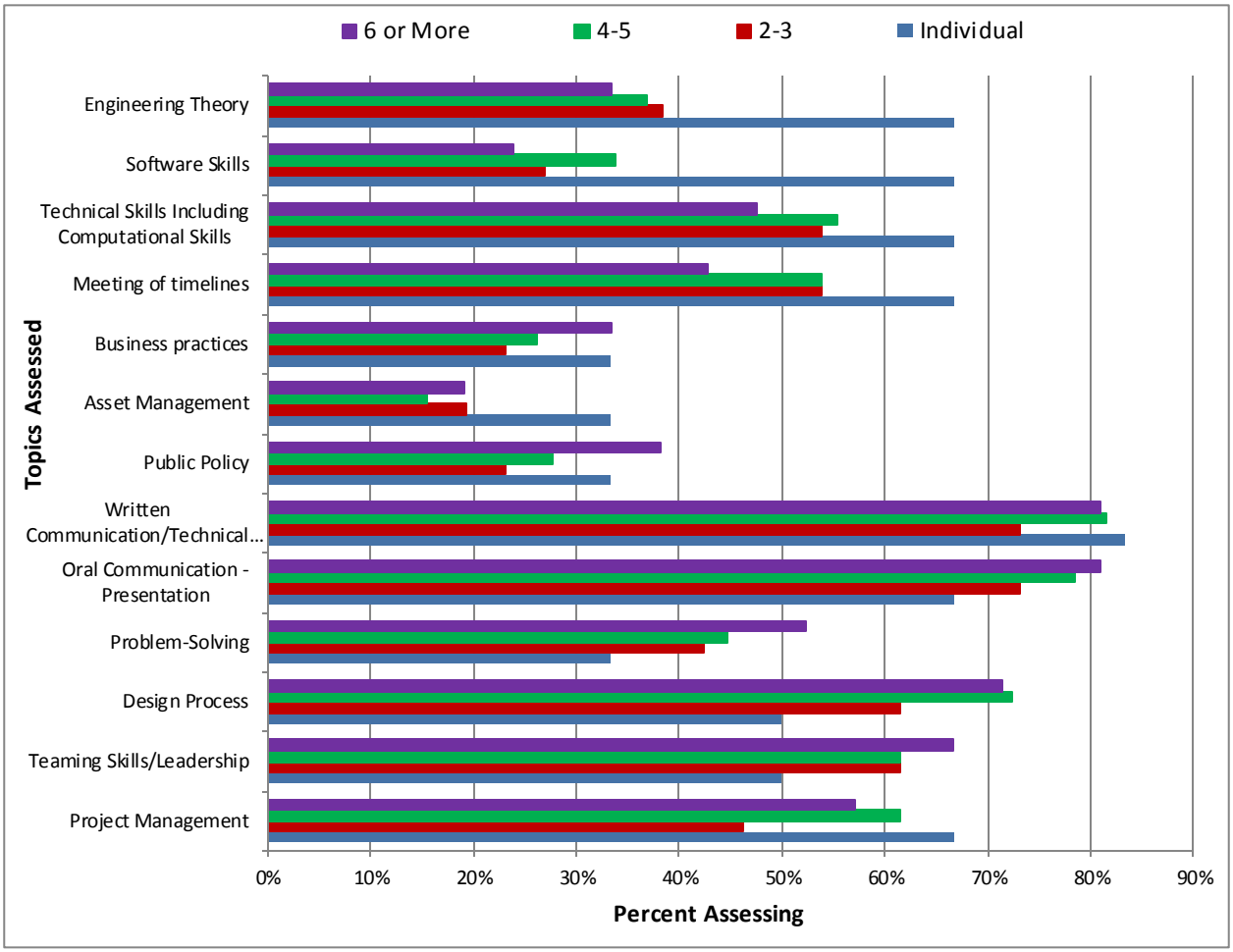

Figure 4: Topics assessed based on team size.

Figure 5 presents department responses to a list of topics and skills taught with the design experience, as a function of team size. Overall, patterns initially identified in the 2012 paper – regarding specific topics/skills taught – are reflected for the most common team sizes (2-3 students; 4-5 students). For example, most programs (70-plus percent) teach communication skills, teamwork skills and project management; Figure 5 confirms that this is the case regardless of team size. Conversely, relatively few programs teach asset management; Figure 5 also confirms this is the case regardless of team size. However, there are some interesting general observations related to a differential effect of team size. A larger percentage of schools allowing six team members report teaching the 'soft topics' of public policy and business practices. Schools that report allowing students to work as individuals appear to include the least amount of overall instruction with the exception of engineering theory and software skills. In general, the data do not allow definitive statements regarding an effect of team size on the topics/skills taught as part of the design experience.

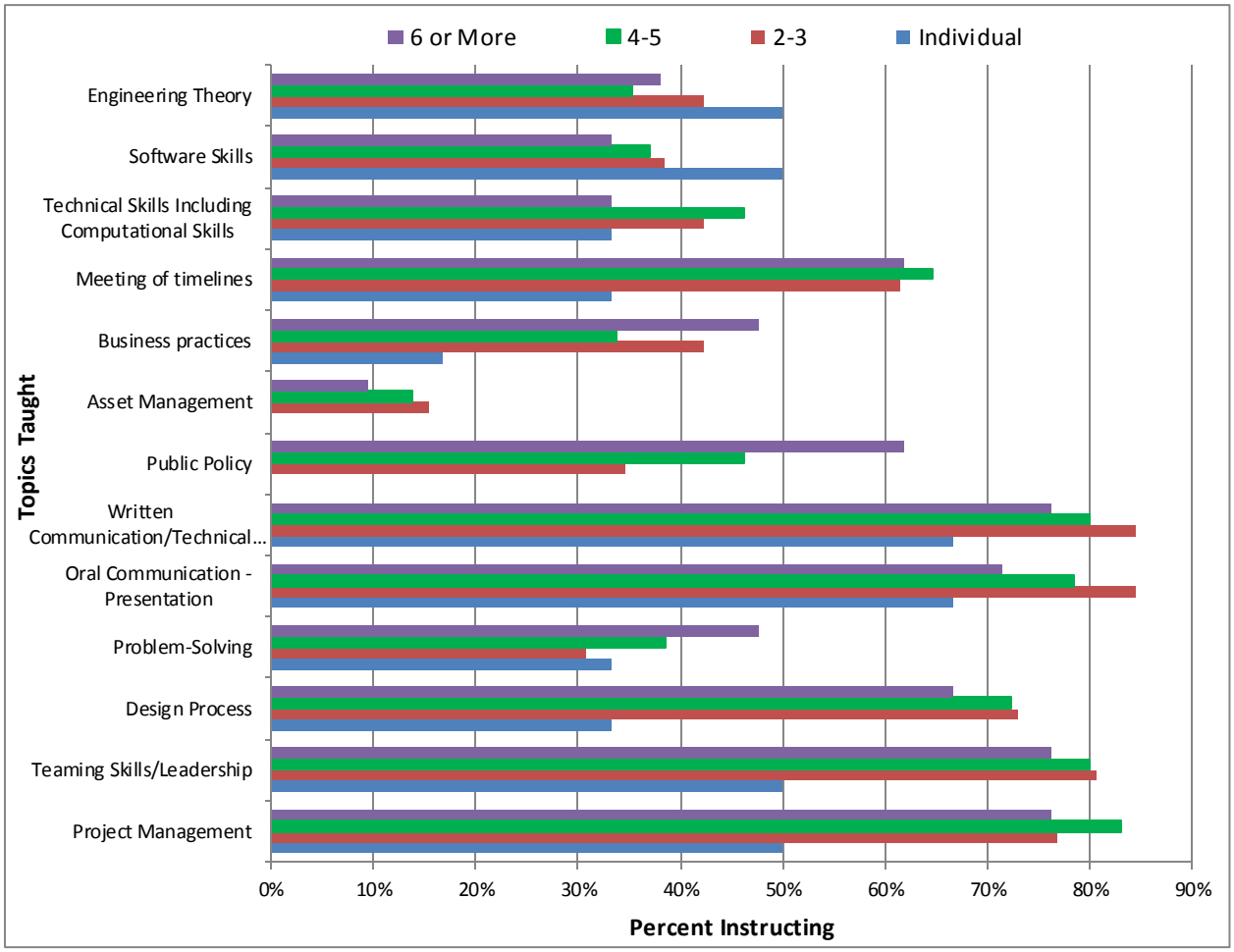

Figure 5: Topics taught based on team size.

Use of Industry

Use of industry mentors is a common practice in the senior design experience. Nine percent of surveyed schools indicate using industry mentors as a primary mentor and 38 percent report using both faculty and industry mentors.[2] However, grading is still predominantly done by faculty. In fact, no school that uses industry mentors as the primary mentor gives greater weight in the student's final grade to the industry mentor's assessment and only one department indicates giving the industry mentor's assessment equal weight to the faculty's assessment. Of those schools that use both industry and faculty mentors:

- Sixty-three percent give greater weight to faculty assessment than industry in the student's grade.
- Eleven percent report that industry mentor assessment has no weight in student grades.
- Forty percent base 20% or less of the student's final grade on industry mentor assessment.
- Fourteen percent weigh faculty and industry mentor assessment equally.
- Only 11.4 percent give greater weight to industry mentor assessments over faculty assessments.
- Eleven percent of schools did not indicate weights.

Industry is also heavily relied upon for project ideas. Departments were asked to estimate what percentage of projects came from government agencies, university coordination, student ideas, industry partners, and faculty interest or research. Of the 88 schools that responded to this question, 39 indicated that 50 percent or more of their project ideas come from industry partners. As shown in Figure 6, this is more than double the number of departments that indicated more than 50 percent of project ideas come from faculty interests or research, which was the second most common source of ideas. Four schools did indicate 50 percent or more of projects come from "Other" but the description of "Other" for these four schools was an industry partner. These four were included in the 39 count above.

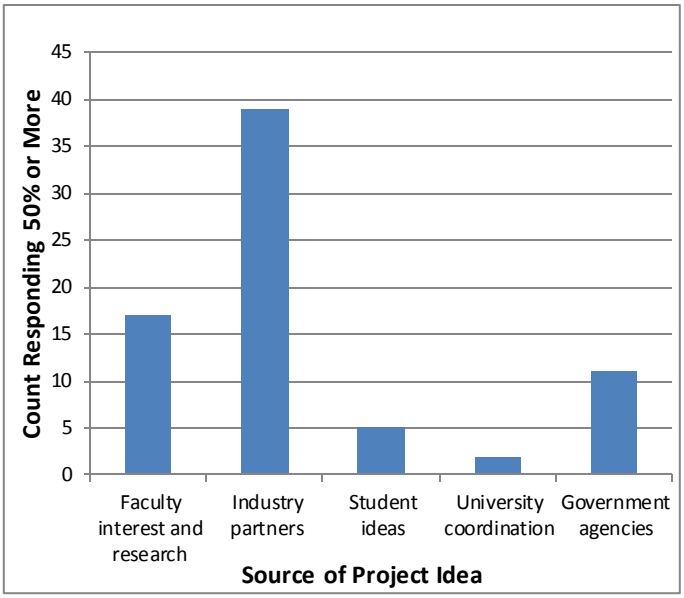

Figure 6: Count of schools reporting that 50 percent or more of project ideas come from the indicated source. Eighty-eight schools responded to this question.

To determine if the use of industry affected the project type, the types of projects were looked at for each school reported in Figure 6. Schools were allowed to indicate multiple project types so

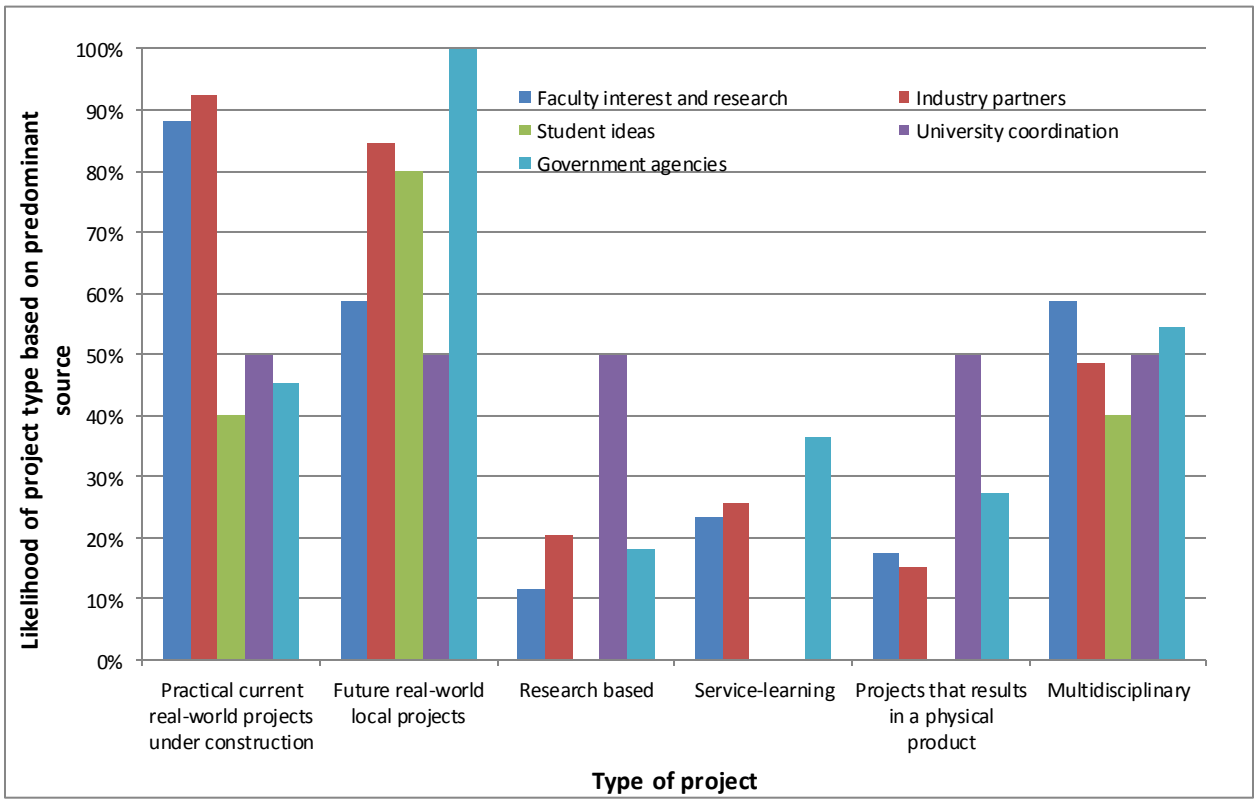

Figure 7: Common project types based on predominant project idea source. Source is considered predominant if department indicates that 50 percent or more of project ideas come from that source.

that the percentages do not sum to 100. As Figure 7 shows, using industry partners increases the likelihood of the culminating design experience being based on a current or future real-world project and being multidisciplinary. Schools that reported the majority of their projects come from government agencies also reported the majority of projects are based on future real-world projects.

The source of project ideas versus the primary mentor was also compared. The percentages in Figure 8 are based on all responding schools. Since only nine percent of schools indicated their primary mentor was an industry mentor, the percentages in this category are the smallest. However, Figure 8 does show that if industry is used in mentoring, either as the primary mentor or in conjunction with faculty, the most common source for project ideas is industry partners or government agencies. For departments that use faculty who are not the course coordinator to mentor students, the majority of project ideas come from student ideas. This is significant depending on what a department may want to see in typical student projects. As shown in Figure 7, departments where the majority of projects stem from student ideas report projects that are the least likely to be based on current real-world projects, be multi-disciplinary, result in a physical project, be research based, or include a service-learning component. However, student generated projects are generally more focused on future real world local projects where it is expected they can interact with the real players.

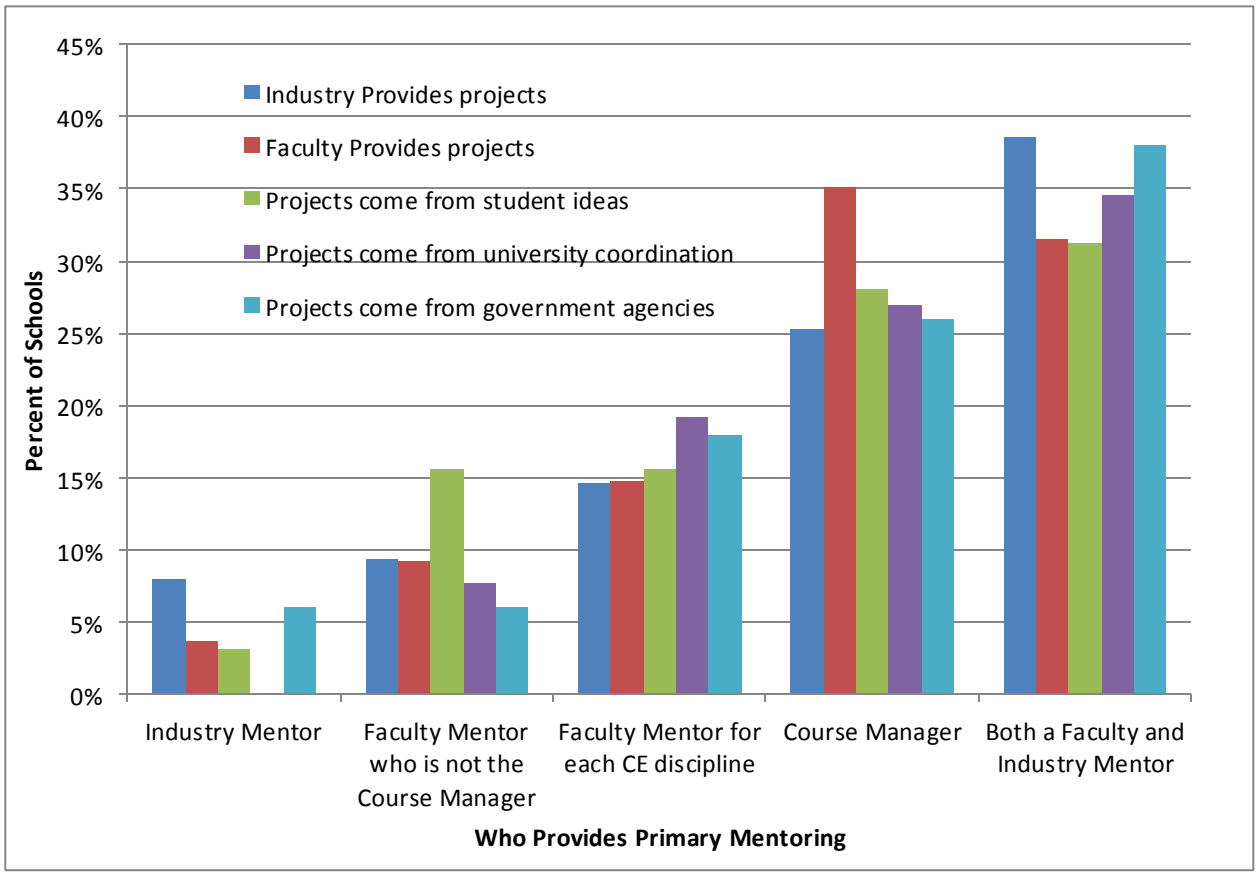

Figure 8: Percent of schools indicating source of project ideas versus the primary student mentor.

Institution Type Differences

It is often discussed that the strategic goals of Ph.D. granting, Undergraduate and Masters (UM), and Undergraduate Only (UO) institutions differ. Faculty at UO institutions typically have larger teaching loads than their colleagues at Ph.D. granting institutions. Faculty at Ph.D. granting institutions are often faced with a "publish or perish" environment. Does the terminal degree an institution offers affect the senior project experience? Does it matter if the university is private or public? To determine if any significant differences exist based on the institution type, survey responses were separated based on school type. Responses considered include:

Table 4: Institution type breakdown of 99 schools with a culminating design experience.

	Public	Private
Undergraduate Only	4	4
Undergraduate and Masters	8	9
Ph.D. Granting	61	13

- Team size
- Course length
- Expected time commitment
- Team assignment
- Source of project ideas and types of projects
- Use of mentors
- Assessment
- Topics taught and assessed

The majority of responding departments were from Ph.D. granting, public institutions as seen in Table 4. Interestingly, 82.4 percent of the responding Ph.D. granting institutions are public universities; the responding universities that do not offer Ph.Ds. are approximately half public and half private.

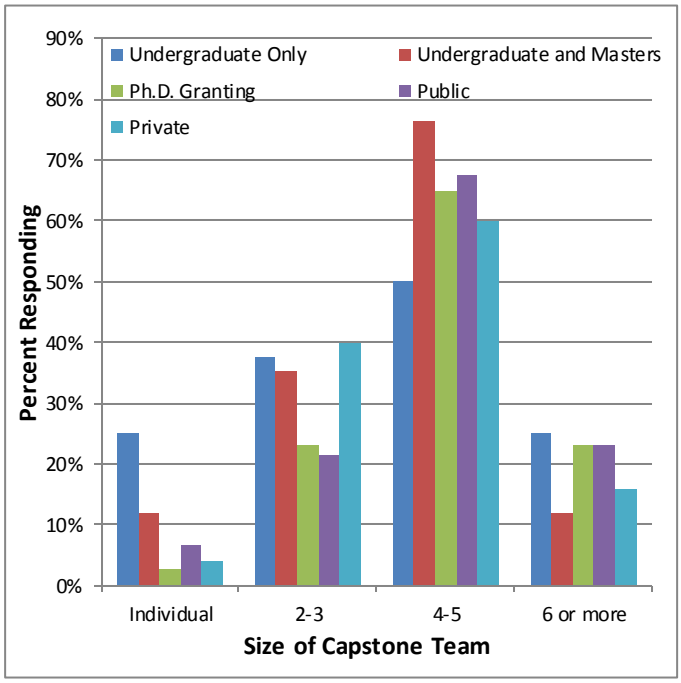

Figure 9: Student team size based on institution type.

Logistics of the Course

In respect to the basic logistics of the culminating design experience: team size, course length, course units and required weekly work hours per unit, there are some differences between the institution types as highlighted in Figures 9 – 13. Undergraduate Only institutions are the most likely to have individual projects, while UM and Ph.D. universities have a strong preference for team sizes of four to five students. Semester long courses are the most common lengths and definitely predominant for Ph.D. granting and public institutions. Departments at UO, UM, and private universities are more likely to have yearlong programs.

The data show no significant differences between the average units given for each course length based on the institution type but UO departments averages are lower for courses shorter than one year and higher for yearlong courses. Figure 11 highlights that differences are apparent when looking at the maximum and minimum units. The maximum units for semester long programs at

public, Ph.D. granting schools are more than double the average units for all institution types and the maximum for either UO or UM universities. For these same programs with semester long courses, Figure 12 demonstrates the departments at Ph.D. granting institutions also require slightly more weekly hours on average and have a distinctly higher maximum, though notably not double the other school types as in the case of the course units. Figures 11 and 12 also highlight that the quarter long programs require the most hours per unit. This is further highlighted in Figure 13 that shows the required hours per unit with the units normalized to a semester length. The two-quarter, semester and yearlong programs all require similar hours per equivalent unit, while the quarter long programs require approximately 50 percent more hours per equivalent unit on average.

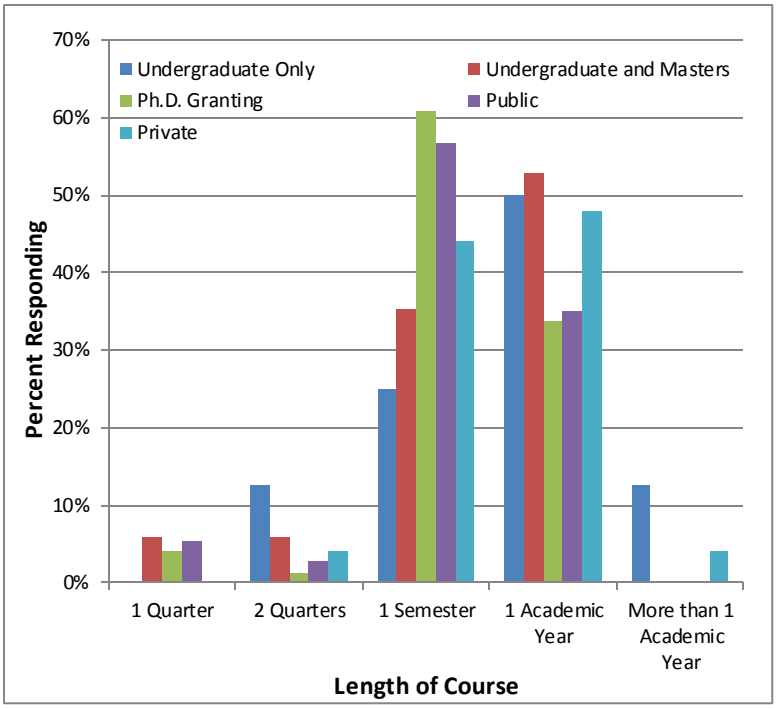

Figure 10: Course length based on institution type.

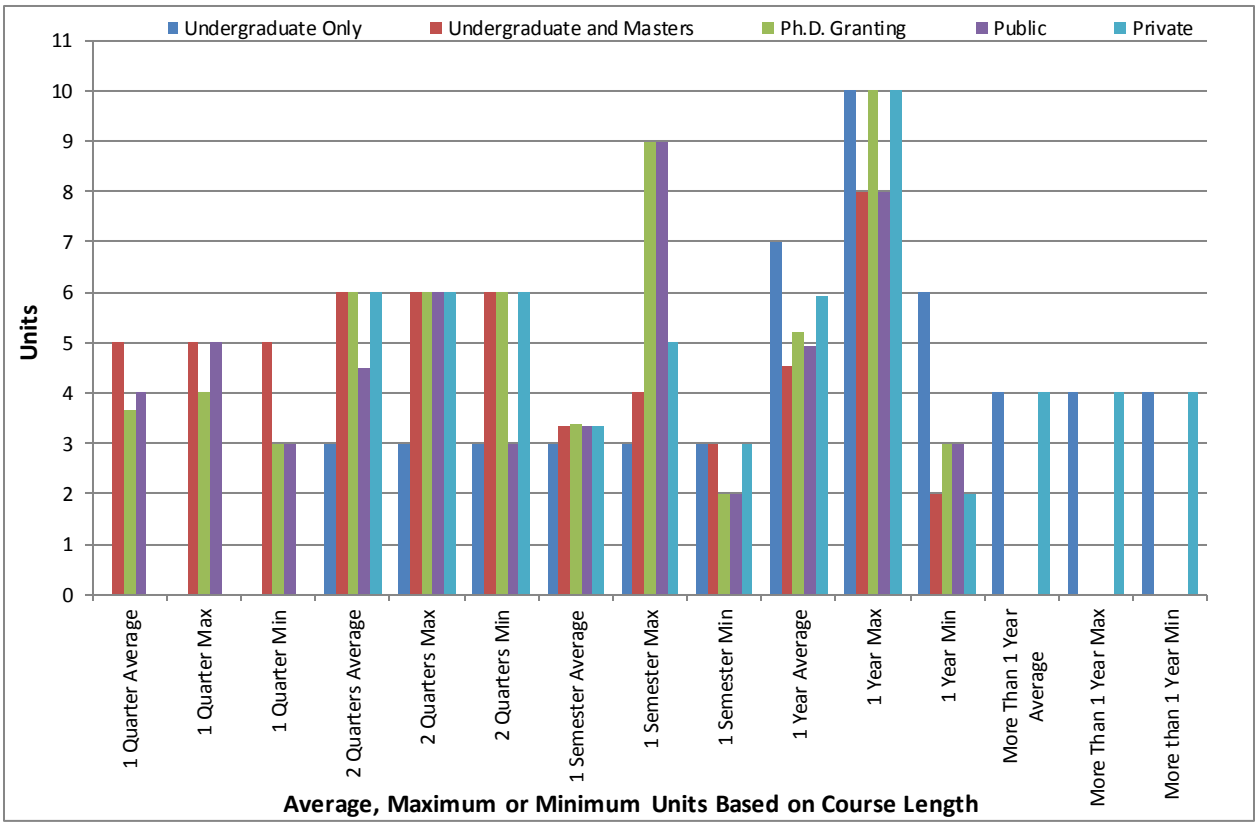

Figure 11: Assigned course units based on course length and institution type.

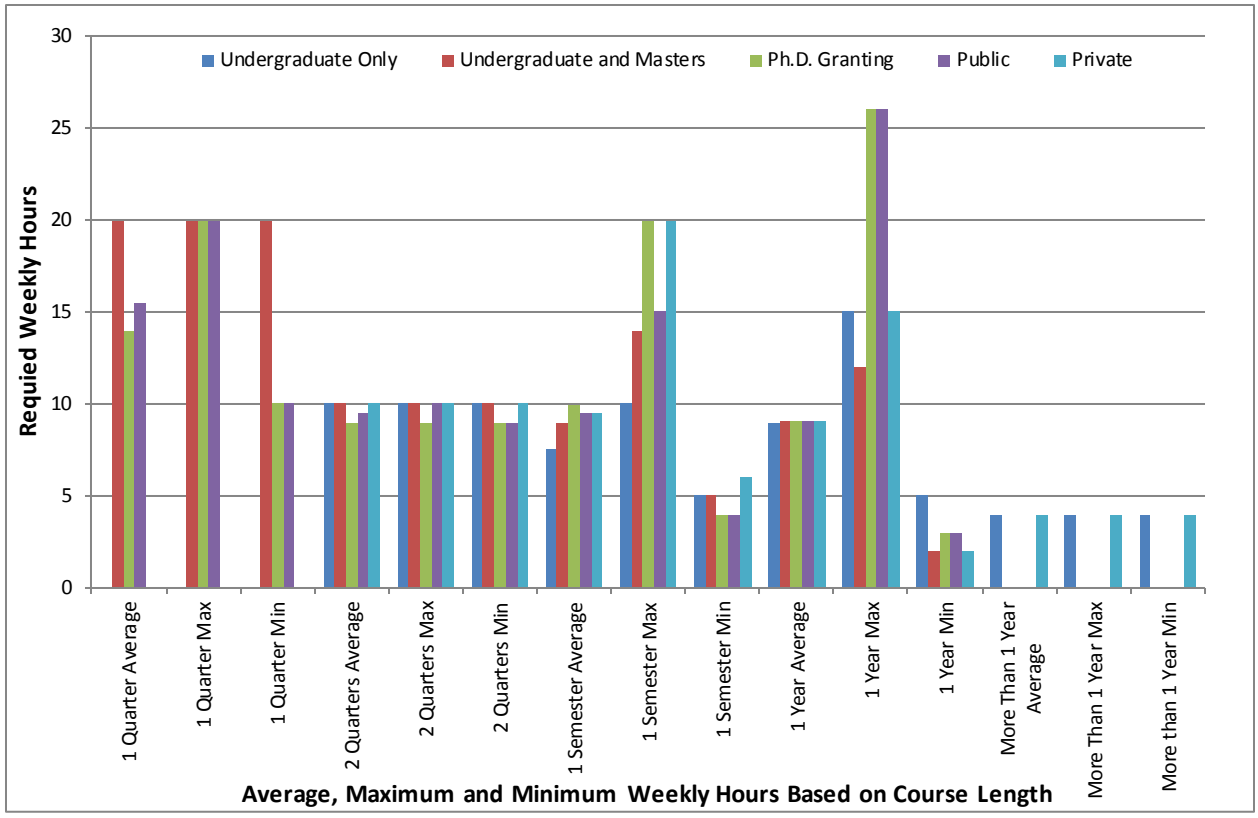

Figure 12: Required student work hours per week based on course length and institution type.

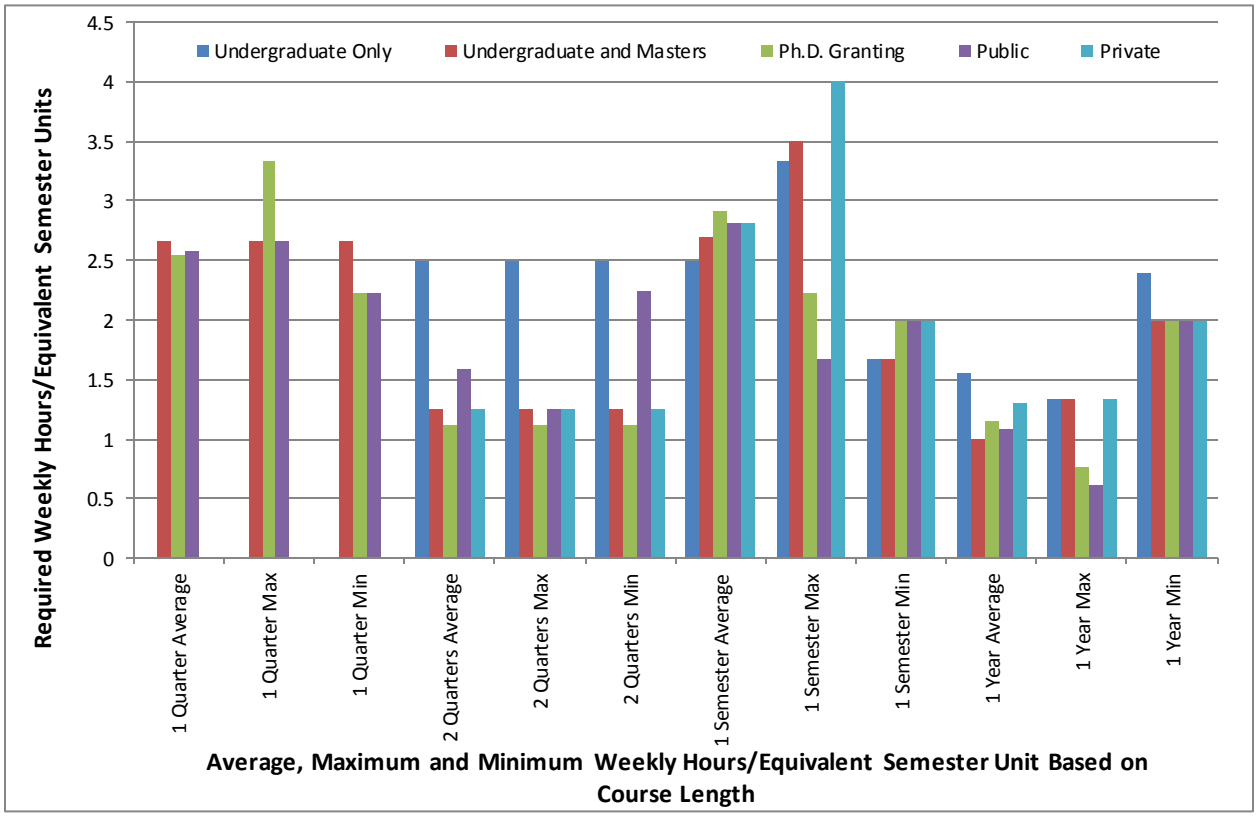

Figure 13: Required student weekly work hours per equivalent semester units based on course length and institution type.

Team Assignment

Regardless of the institution type, the assignment of teams was heavily weighed by student preferences on discipline or team members as seen in Figure 14. Ph.D. granting schools and private institutions are more likely to use student self-selected teams, while UO universities are most likely to require faculty to assign teams based on student's choice of discipline. Undergraduate and Masters schools tend to require faculty to assign teams based both on student teammate preferences and choice of discipline. The least likely methods of team assignment were using teaming software, learning styles indexes, past success in CE sub-discipline coursework, and only student teammate preferences. It is unclear from the survey data why these are the least likely but it is possible faculty are not familiar with effective teaming software, such as catme.org[6], and that assigning teams based on learning styles indexes or past success in CE sub-disciplines may be considered prohibitively time consuming. As the data indicate, Ph.D. granting institutions are the least likely to use these three methods of team assignment. The fourth method, faculty assigning using only student teammate preferences, may result in teams similar enough to self-selected teams that faculty do not feel it justifies the effort.

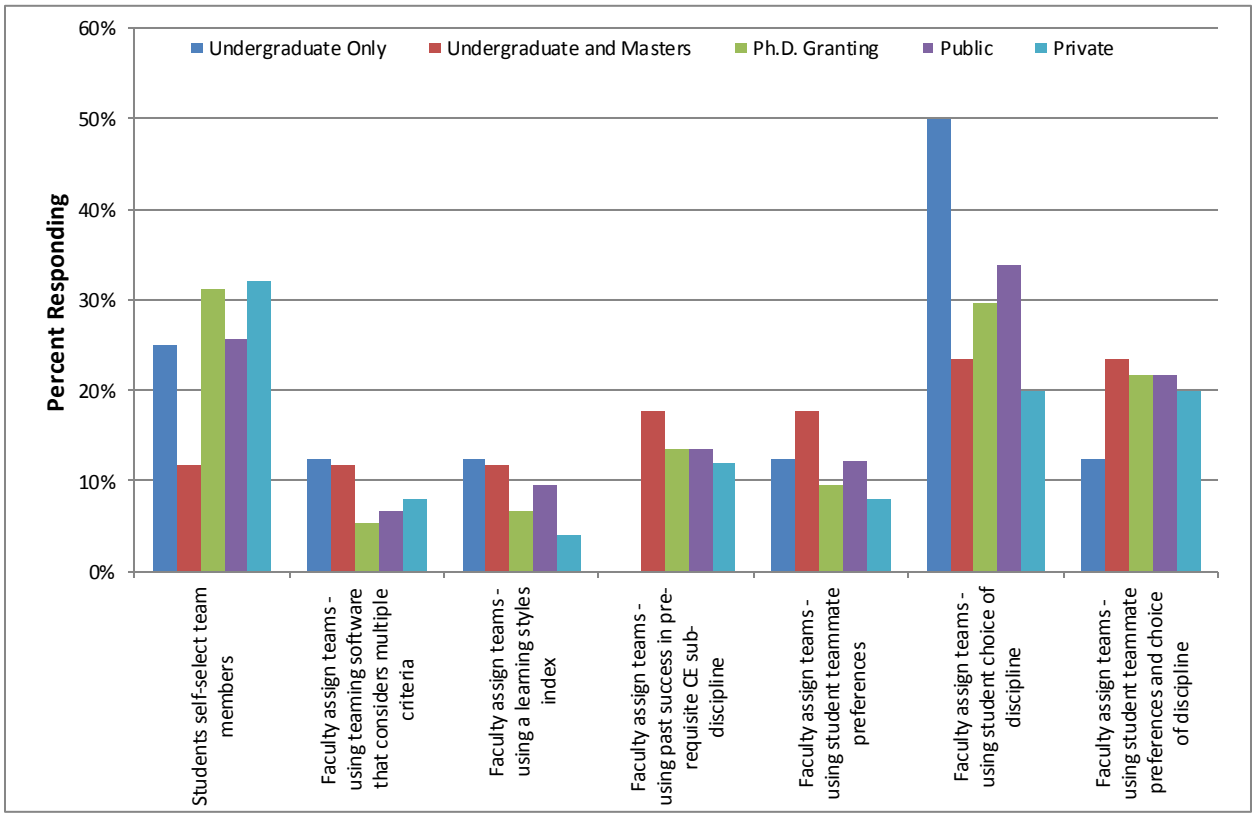

Figure 14: How student teams are assigned based on institution type.

Project Idea Source and Project Types

It was conjectured that there would be differences in the sources of projects based on institution types, especially with respect to faculty research and interest. Due to the high research demand at Ph.D. granting institutions, it was assumed these schools would be more likely to have projects that resulted from faculty research areas. However, as shown in Figure 15 there is not a significant difference, less than ten percent, between UO, UM and Ph.D. granting universities in

regards to projects ideas that came from faculty interest, with UM institutions reporting the largest percent. There is, however, an eighteen percent difference between private and public universities, with 68 percent of departments at private universities indicating projects come from faculty interests and research versus only 50 percent at public. For the remaining project sources, student ideas and university coordination are the least likely sources of projects.

- Project ideas generated from industry partners are the most common source of projects and displayed the greatest discrepancy with:
    - eighty-one percent of Ph.D. granting institutions indicating this as a project source,
    - fifty percent of UO universities noting the same thing, and
    - sixty-five percent of UM institutions reporting projects generated from industry partners.
- Nearly double (50 percent) of UO institutions indicate projects come from university coordination in comparison to Ph.D. granting schools (30 percent).
    - No department at an UM institution reported projects come from university coordination.
- Undergraduate and Masters institutions are the most likely to have projects come from students ideas with 41 percent of departments reporting this option.
    - Only 25 percent of UO departments report this source, while 30 percent of Ph.D. granting institutions allow projects to come from student ideas.
- Government agencies are also a common source with only ten percent difference between any school type.

The types of projects displayed some of the largest differences between university types, as shown in Figure 16. Private universities are 2.8 times more likely than public universities to have service-learning projects. Likewise, UO institutions are 1.3 times more likely than UM universities and 2.9 times more likely than Ph.D. granting schools to have service-learning projects. Undergraduate Only institutions are the least likely to have a project that is based on a current or future real world project, while over 90 percent of UM institutions report having current real-world projects. Undergraduate

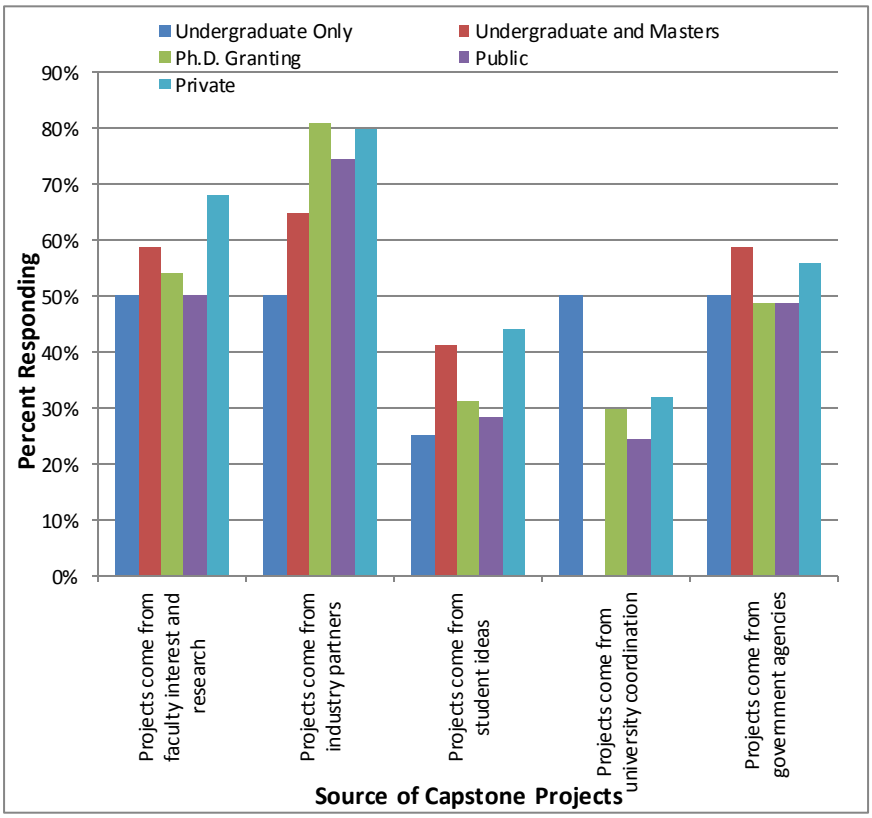

Figure 15: Source of projects based on institution type.

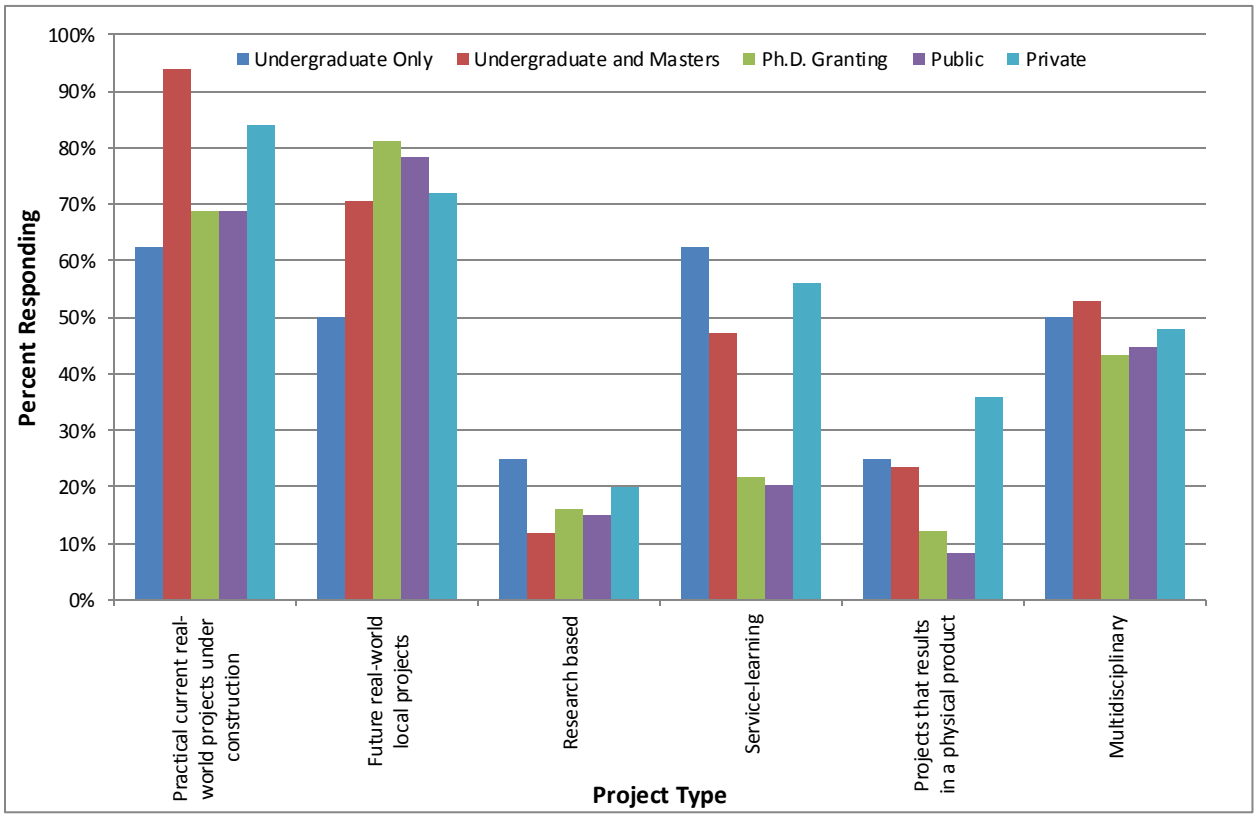

Figure 16: Types of projects based on institution type.

Figure17: Types of mentors based on institution type.

Only institutions report the highest percentage of research-based senior projects. This may be due to the lack of graduate students to assist faculty with research. They also report the highest percentage of projects that result in a physical product. Private schools are 4 times more likely to have projects that result in a physical product than public schools. There was very little difference in the percentage of school types that have multidisciplinary projects but Ph.D. granting did report the lowest percentage.

Use of Mentors

In comparing the types of mentoring students receive in the culminating design experience, Figure 17 highlights the predominant mentoring at all school types is a combination of faculty and industry mentors, with 34 to 41 percent of departments indicating this method depending on school type. Departments at UO institutions (25 percent) are also likely to use a course manager or faculty for each CE sub-discipline as mentors. Course managers are also common (25 percent again) for Ph.D. granting and public schools. Percentages of schools using a faculty mentor who is not the course director or primarily industry mentors are low for all types of institutions. Undergraduate and Masters institutions are the most likely to include industry in their programs, either as the primary mentor or in conjunction with a faculty member.

Assessment

The distribution of schools that reported the peers, industry mentors and faculty did assessment with or without a rubric does not vary greatly between the institution types as shown in Figure 18. In all cases, faculty assessment with a rubric is the most likely form of project assessment and industry mentor assessment without a rubric is the least likely. Departments at UO institutions reported the highest percentage (87 percent) of faculty assessing with a rubric. No UO institution reported faculty assess without a rubric. Similarly, among departments at UM universities, if industry assessment is completed (52 percent responded it is) it is done with a rubric. No UM department reported industry assessment without a rubric.

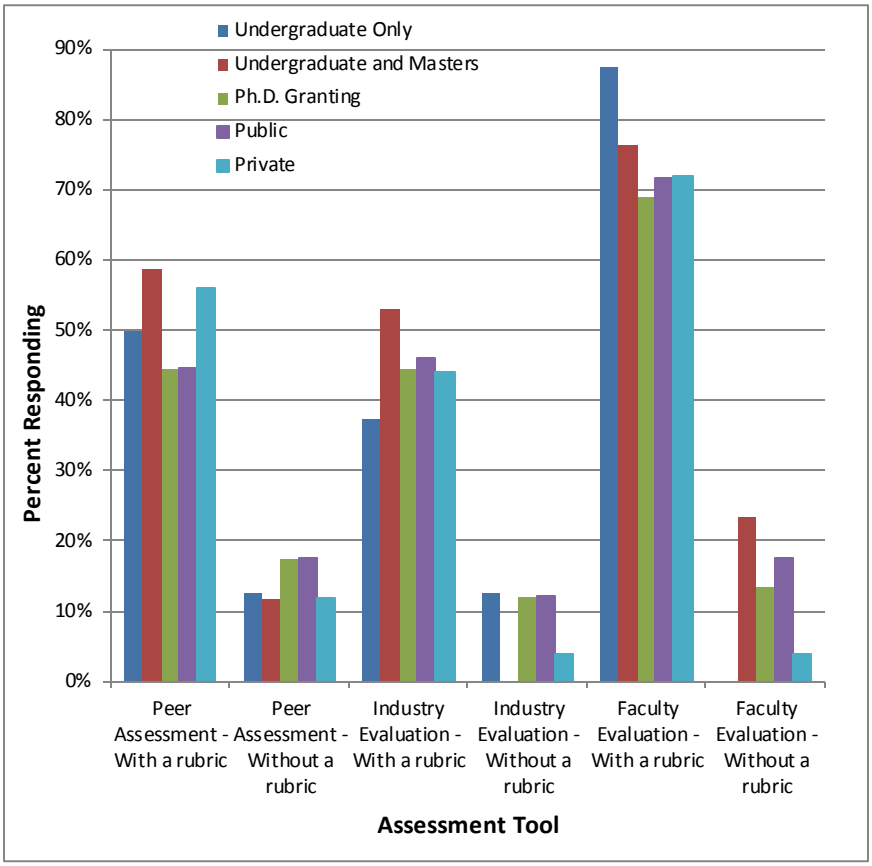

Figure 18: Common assessment tool based on institution type.

As asked earlier in the paper, does the use of rubrics give greater weight

to an assessment and does this weight vary by institution type? Based on the departments that provided weights for each type of assessment, one hundred percent of all departments that require faculty to assess student projects also include this assessment as some percentage or weight of the student's final grade, regardless of institution type. This was not the case for peer and industry mentor assessment, as seen in Figure19. At UM universities, 80 percent indicate peer assessment is included in the final grade but none of these departments weight the assessment 20 percent or more. Undergraduate Only departments are the least likely to include a completed peer or industry mentor assessment in a student's final grade and, if it is included, assign the assessment a small weight in the student's grade. Ph.D. granting schools are the most likely to include peer and industry assessment even though Ph.D. granting schools are the least likely to have peer assessment completed with a rubric. This appears to follow trends seen in Figure 17 where more of the mentoring is completed by faculty at UO and UM institutions.

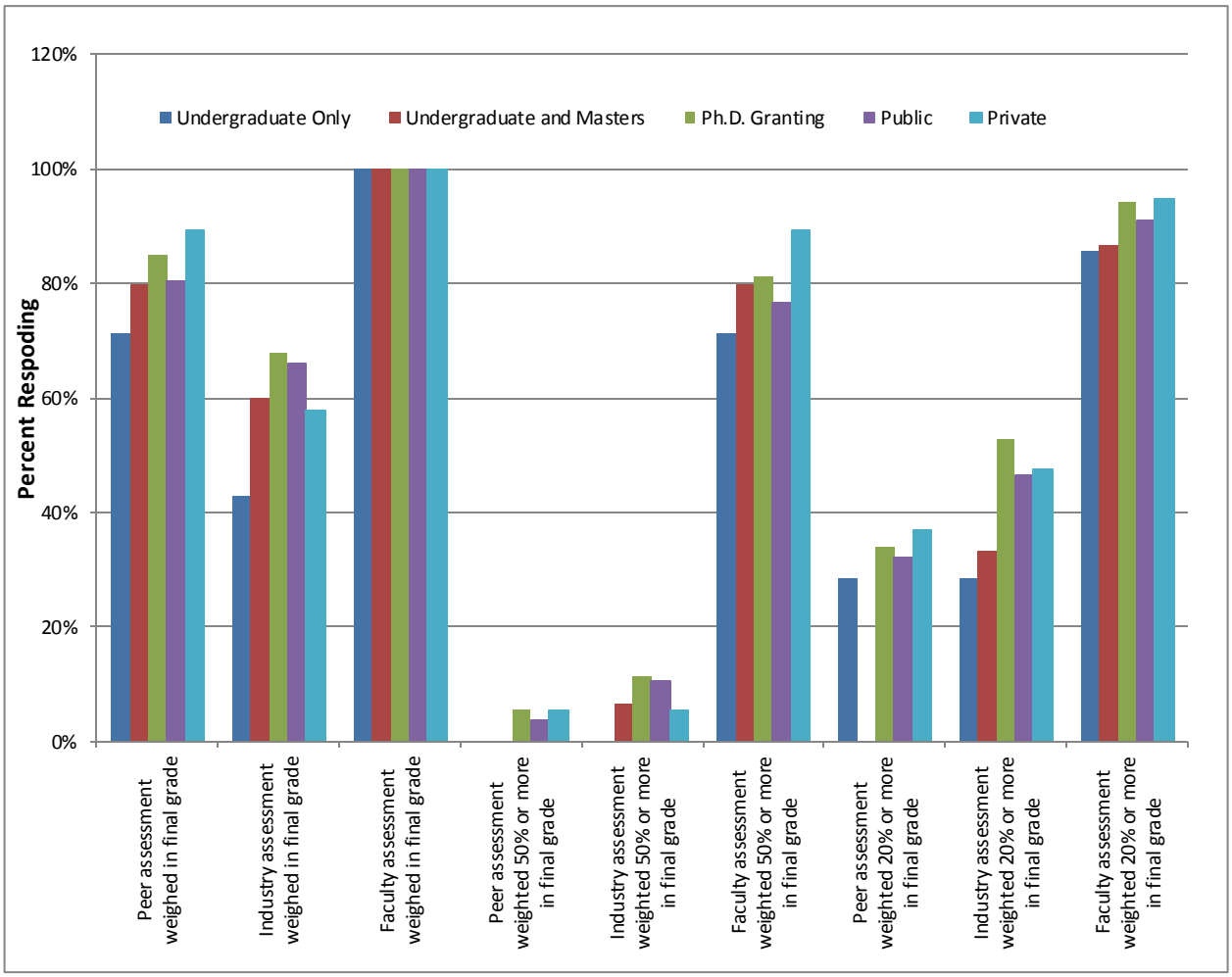

Figure19: Weight given an assessment tool in the student's final grade. Percent based on the total number of schools that responded to this question. This figure does not include departments that indicated assessment was completed but did not provide grading weights.

Topics Taught and Assessed

Does the type of institution affect the topics taught and assessed in the culminating design experience? The data show definite differences exist as seen in Figures 20 and 21.

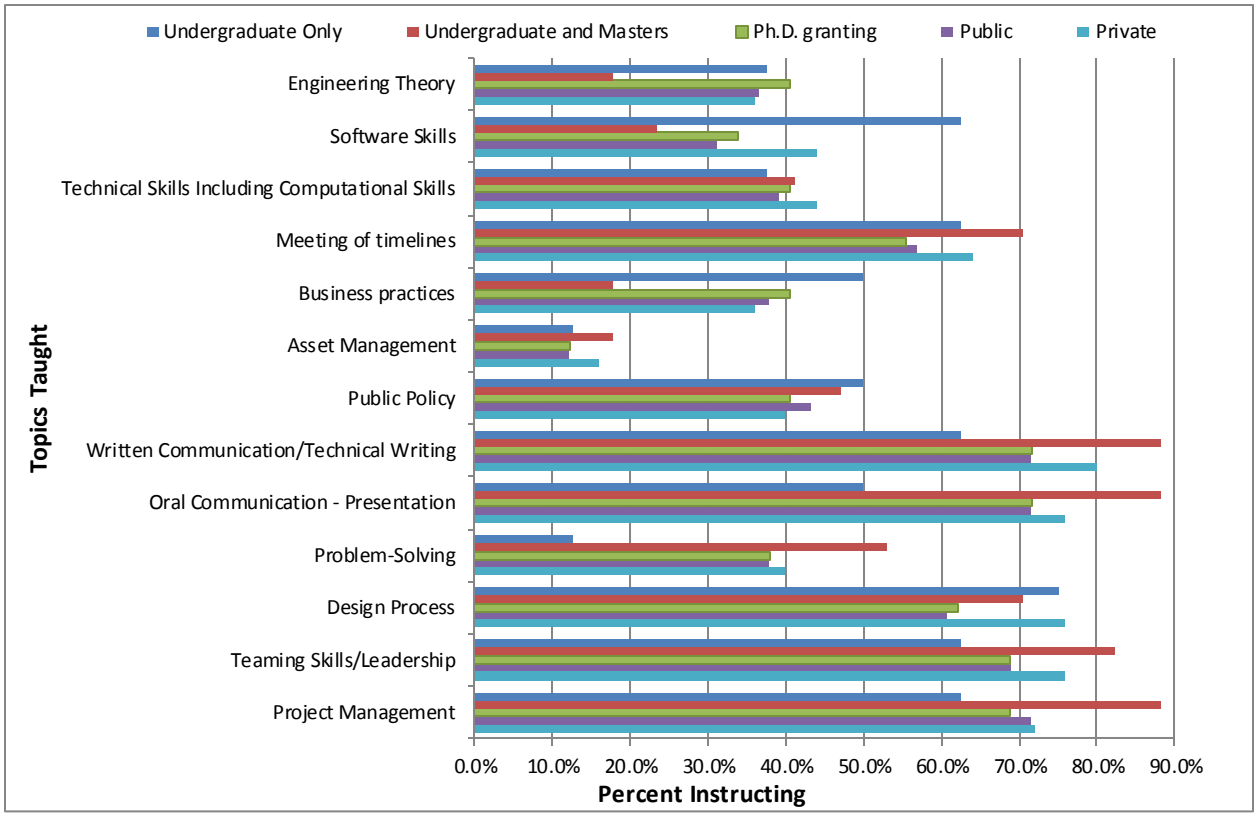

Figure 20: Percent of institution types reporting teaching shown topics in the culminating design experience.

Departments at UM and private universities are significantly more likely to teach the "soft skills" of meeting timelines, asset management, communication both oral and written, teaming/leadership and project management. Undergraduate Only institutions are more likely to teach the "hard skills" with these departments leading the way for teaching software skills and the design process and reporting basically equivalent percentages as Ph.D. granting institutions for engineering theory and technical skills. Business practices and public policy are also taught most commonly at UO institutions. Overall Ph.D. institution's results typically fell in the mid-range for each teaching topic.

But how do topics taught compare with topics assessed? Departments at both UO and UM universities indicate assessing significantly more topics than Ph.D. granting institutions. Similarly, private schools report completing more topic assessment than public schools. Also noted, the civil engineering discipline specific topics of public policy, asset management, and business practices are assessed much less than the usual ABET directed topics. It appears that many schools are either just incorporating these topics into the curriculum as they move closer to their ABET visit, assessing them elsewhere, or still struggling with when/where/how to assess them.

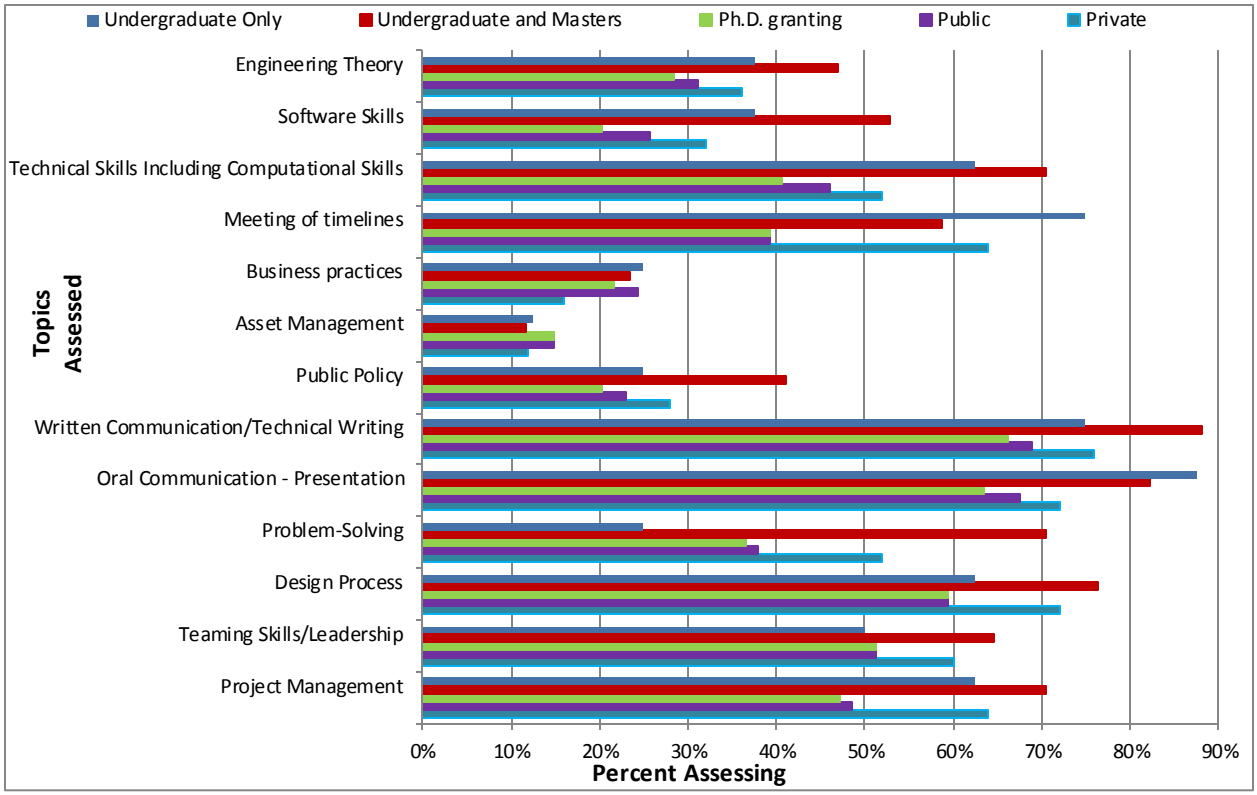

Figure 21: Percent of institution types reporting assessing shown topics in the culminating design experience.

Summary

Data from the 2011 survey were reexamined to investigate the questions "Do most schools use rubrics for assessment?" and "Are peer and industry assessments likely to have a greater weight in the overall student grade if rubrics are used?" The data clearly indicate that the use of rubrics for assessment – for faculty, industry mentors, and peers – is much more prevalent than assessment without rubrics. The data also strongly suggest that assessment performed by faculty and industry mentors using a rubric is weighted more heavily in a student's grade than assessments performed without a rubric. What is not clear in the data is specifically what each group is being asked to assess (design process; final written report; oral presentation; teamwork; work effort; etc.) -- and how these specific items relate/are weighted to the overall grade. To determine this, a more comprehensive survey, phone interviews, and/or other efforts would be required. Indeed, one important follow-up study to this effort could be a detailed examination of specific rubrics used for the various constituent groups (faculty, industry, peers) with an objective to relate the assessment questions to grading practices.

The 2011 survey data were also reexamined to investigate the question "Does the design team size affect content taught and/or assessed in the course?" The data do not clearly indicate that team size has a significant effect on course content – either taught or assessed. The largest differences noted in the data involve large (six students) or small (individual student) teams. It is likely that the differences suggested by the data are influenced by other aspects of the culminating design experience – project selection processes, the use of external mentors, and others. The survey conducted for this effort does not yield data that would allow a more comprehensive analysis of these interactions.

This paper also looked at the 2011 survey data to determine "What does it mean to "involve" an industry mentor?" The data clearly indicate that the primary use of industry mentors relates to identifying and selecting projects. The value of this use is demonstrated by projects being more likely to be 'real-world' and multidisciplinary. Industry mentors are also called upon to provide assessments of student projects. Interestingly, however, an industry mentor's assessment is not typically weighted heavily in determining the students' grade for the culminating design course – even when the industry mentor uses a provided rubric. It is possible that industry mentors provide additional services to the design experience, i.e. instruction, one-on-one or team-based direction on specific project tasks, etc.; however, the data generated from this survey do not provide such detail. Indeed, one important follow-up study to this effort could be an examination of specific responsibilities required of industry mentors in the culminating design effort.

In reviewing the data, it was also identified that projects that are generated from student ideas are the least likely to be based on current real-world projects, be multi-disciplinary, result in a physical project, be research based, or include a service-learning component. Departments are more likely to have projects generated from student ideas if the faculty mentor is a faculty member who is not the course coordinator. This is not to imply that student generated projects are less valuable as they are more focused on future real world local projects where it is expected students can interact with the real players.

Finally, even though the banter heard during previous best practices presentations of major design experiences eludes that there might be great differences in how the major design experiences are built and executed based on institution type, there are differences, but the differences are rather minimal. It appears that everyone is experimenting and developing the type of major design experience that best meets the needs of their students based on the faculty team, interests, requirements, and strategic goals of the institutions.

Bibliography

1. Engineering Accreditation Commission, "Criteria for Accrediting Engineering Programs - Effective for Evaluations During the 2012-2013 Accreditation Cycle," ABET, Inc, Baltimore, 2011.

2. Nilsson, T.; Hall, K.; Welch, R. "National Trends in Civil Engineering Major Design Experience", American Society of Engineering Education Conference, San Antonio, TX, June 2012

3. Leydens, J.A., Moskal, B.M., Pavelich, M.J., "Qualitative Methods Used in Assessment of Engineering Education", Journal of Engineering Education, January 2004, pg 65-72

4. Shuman, L.J., Besterfield-Sacre, M., McGourty, J., "The ABET Professional Skills" – Can They Be Taught? Can They Be Assessed?", Journal of Engineering Education, January 2005, pg 41 – 55

5. Griffin, P.M., Griffin, S. O., Llewellyn, D.C., "The Impact of Group Size and Project Duration on Capstone Design", Journal of Engineering Education, July 2004, pg 185-193

6. www.catme.org