

## **Student Perception of Teamwork Skills and Experiences Across Prerequisite Courses in Transportation Engineering at The Citadel**

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### **Abstract**

Teamwork is an important professional skill for engineering students to obtain knowledge, develop proficiency, and attain constructive experience during their undergraduate education program of study. This paper describes student team formation, assigned teamwork activities, and student perception of teamwork activities for a series of connected transportation engineering prerequisite courses extending across all four years of the undergraduate curriculum. Teamwork assignments within the transportation engineering course prerequisite thread include: laboratory teams, problems solving sessions, homework assignments, class presentations, proposal preparation, design projects, and design project presentations. Student perceptions of team formation, collaboration, learning, leadership and effectiveness were obtained through a survey questionnaire instrument. Survey results will be presented with the intention of providing further insight on how the curriculum is performing on this crucially important professional skills outcome.

### **Keywords**

teamwork skills, team formation, student perception, indirect measures

### **Introduction**

The American Society of Civil Engineers (ASCE) Body of knowledge (BOK) specifically identifies teamwork as one of ten profession skill outcomes, from a total 24 learning outcomes, that should be attained to prepare students for successful careers as practicing engineers<sup>1</sup>. Criteria identified in the BOK suggests students should be able to function effectively as a member of an intradisciplinary team, which would satisfy Bloom's Level of Cognitive Achievement 3, Application, pertaining to a student's ability to apply learned concepts in familiar and unfamiliar situations.

The undergraduate civil engineering curriculum at The Citadel emphasizes preparation of graduates to serve as principled leaders in design, construction, maintenance and operation of the built-environment. In support of this vision, department faculty adopted a series of outcomes focusing on professional skills needed to prepare graduates for successful engineering careers, with teamwork as a crucially important outcome extending across all four years of the curriculum. Course material, assignments and activities are provided throughout the transportation course prerequisite thread emphasizing student development of teamwork skills needed to establish a foundation for successful careers and student preparation for professional practice. Working with public officials, special interest groups, community leaders and the public to develop successful transportation engineering designs requires graduates who are prepared to address a myriad of problems through effective teamwork solutions.

## Literature Review

The Accreditation Board for Engineering and Technology (ABET) defines teams as follows: “A team consists of more than one person working towards a common goal and may include individuals of diverse backgrounds, skills and perspectives”<sup>2</sup>. ABET criterion on student outcomes continue to emphasize the need for students to “develop the ability to work on diverse multidisciplinary teams”<sup>2</sup>. There has been an emphasis on collaboration within diverse multidisciplinary teams in the professional work environment, and as a result teamwork as a pedagogical technique has become increasingly important in providing a well-rounded college experience. Research has shown that teamwork is viewed favorably by students and positively affects student learning<sup>3,4</sup> specifically increase in self-efficacy<sup>5</sup>.

## Summary of Transportation Curriculum Teamwork Activities

The transportation course prerequisite thread includes a total of seven courses, beginning with Introduction to Civil Engineering in the freshman year and culmination with Capstone engineering Design in student’s senior year. Teamwork assignments, exercises and activities specific to these courses are summarized as follows:

Introduction to Civil Engineering (CE 103) Students work in teams of two to four on a variety of entry level engineering projects including an environmental engineering water quality test, simulated bridge design using bridge designer software, and comprehensive site development /parking lot layout plan. Teams are self-selected and composed of two to four students.

Surveying (CE 205) Students work in teams on a variety of assigned in-class problems focused on survey leveling, traversing, area calculations, and roadway alignment, often through competitions involving clicker responses or student prepared white board solutions. Teams are assigned and comprised of two to four students.

Surveying Laboratory (CE 235) Students work together on surveying crews to collect and analyze survey field data collected through leveling, distance measurement, traversing, and construction staking of a horizontal curve. Crews are self-selected and consist of four students.

Geospatial Representation (CE 208) Students work in teams to develop presentations on GPS Satellite Systems including US NAVSTAR, US OCX, Russian GLONASS, European GALILEO, Indian GAGAN and others. Team presentations are peer evaluated and ranked for effectiveness. Teams are self-selected and consist of three to four students.

Geomatics Laboratory (CE 239) Students work together on surveying crews to collect and analyze survey field data collected by traversing, planimetric mapping, topographic surveys, and GPS position surveys. Crews are self-selected and consist of four students.

Highway Engineering (CE 302) Students work in teams to develop a design of a two-lane highway extending through rural rolling terrain, with design elements including horizontal alignment, vertical alignment, cross sections, drainage, earthwork and construction deliverables. Teams are randomly assigned and comprised of two to three students

Capstone Engineering Design (CE 432) Students work to conduct project development analysis, evaluated design alternatives, prepare permit applications, prepare design deliverables and present engineering findings to a professional panel for a comprehensive real-world highway interchange design project currently under design in the local area. Teams are comprised of four to five students, determined through CATME team maker software (Comprehensive Assessment of Team-Member Effectiveness, public use software developed through NSF grant funding)<sup>6</sup>.

### Student Perception Survey

A student perception survey was administered to a total of 159 undergraduate civil engineering students including freshmen (n=47), sophomores (n=37), juniors (n=34) and seniors (n=41). The survey instrument, informed consent and survey protocol received approval from The Citadel's Institutional Review Board (IRB). Data was collected during Fall semester 2016. See Table 1 for survey categories, questions and 1-5 Likert scale responses.

Category	Student Self-Assessment	Likert Scale
Overall educational experience	1.) I believe learning teamwork skills are important in preparing me for a successful engineering career.	1 2 3 4 5 0
	2.) Teamwork projects and assignments in my civil engineering courses have provided positive learning experiences.	1 2 3 4 5 0
	3.) My engineering courses have prepared me to work successfully on engineering teams.	1 2 3 4 5 0
	4.) My ROTC instruction, Citadel leadership training and barracks life have prepared me to work successfully on engineering teams.	1 2 3 4 5 0
	5.) My work experience has prepared me to work successfully on engineering teams.	1 2 3 4 5 0
Seven relevant transportation courses	1.) The means used for student team formation were effective.	1 2 3 4 5 0
	2.) My team worked in a positive collaborative manner	1 2 3 4 5 0
	3.) I provided leadership in completing team assignments.	1 2 3 4 5 0
	4.) My team had to address conflict to complete team assignments.	1 2 3 4 5 0
	5.) Teamwork activities were effective in learning teamwork skills.	1 2 3 4 5 0
	6.) Teamwork activities were effective in learning course material.	1 2 3 4 5 0

Likert definitions: 1=strongly disagree, 2=disagree, 3=unsure, 4=agree, 5=strongly agree, 0=cannot rate

Table 1. Survey Instrument for Student Perception of Teamwork in Transportation Courses

### Survey Data and Analysis

Survey data was tabulated and analyzed to compare differences in student perceptions for various team performance characteristics occurring across all four years of the curriculum. Courses surveyed by year include: one course for Freshmen, three courses for Sophomores, five courses for Juniors, and seven courses for Seniors. Mean student scores were determined for

student responses using 1-5 Likert scores. Mean Likert scores were converted to percentages based on percent of the five-point scale, and standard deviation was converted to percent based on percent of the mean. Aggregated results for overall teamwork experiences are presented in Table 2. It is interesting to note the importance of teamwork skills in preparing students for successful engineering careers remained high across all four years (93-96%) with a small standard deviation (8-11%) indicating a high level of agreement. The result of work experience in preparing students to work successfully on engineering teams was similarly high (85-89%) across all four years. Surprisingly the other three areas all trended slightly down from freshman to senior year, possibly indicating the optimism of freshman abating as the ups and downs of rigorous academic learning takes its toll on student's views. The most surprising finding was student perception of ROTC and barracks life at a military college decreased (81 to 72%) over the four-year undergraduate period, reflecting some concerns of student disenfranchisement.

	Fresh. (n=47)		Soph. (n=37)		Junior (n=34)		Senior (n=41)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1.) Teamwork importance	96%	8%	94%	11%	93%	10%	96%	8%
2.) Positive learning exp.	94%	11%	91%	12%	89%	12%	87%	13%
3.) Courses eff. prepared	89%	15%	87%	15%	88%	12%	84%	14%
4.) ROTC eff. prepared	81%	21%	81%	27%	78%	23%	72%	25%
5.) Work exp. prepared	87%	18%	85%	15%	85%	16%	89%	16%

Table 2. Overall Student Perception of Teamwork Experiences and Preparation

Aggregated results for all transportation courses by year are summarized in Table 3. It is interesting to note when asked if teams had to address conflict to compete team assignments, student perceptions increased from 70 to 79%, indicate more difficult projects as students progressed though the curriculum lead to increased team conflict. Surprisingly all five other areas trended down from freshman to senior year, possibly indicating optimism of freshman abating as the ups and downs of rigorous academic learning takes its toll on student's views.

	Fresh. (n=47)		Soph. (n=37)		Junior (n=34)		Senior (n=41)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1.) Eff. team formation	88%	13%	85%	15%	86%	15%	77%	24%
2.) Positive collaboration	93%	10%	87%	14%	88%	13%	81%	20%
3.) Provided Leadership	87%	16%	85%	14%	87%	16%	82%	17%
4.) Addressed conflict	70%	34%	78%	24%	79%	22%	79%	23%
5.) Learned team skills	92%	12%	86%	14%	86%	14%	82%	19%
6.) Learned material	91%	13%	88%	13%	87%	15%	84%	19%

Table 3. Student Perception of Teamwork in Transportation Courses Aggregated by Year

Some interesting trends were noted from changes in perceptions of senior students as they progressed through all seven transportation courses for specific questions. As shown in Figure 1 regarding team formation, students were most dissatisfied (66%) with a rigorous highway engineering project that formed teams randomly, conversely students were most satisfied (87%) with capstone design teams formed using CATME software. As shown in Figure 2, student perception indicated that the need to address conflict increased from 68% freshman year to 89% senior year. Lastly, Figure 3 shows that student perception of effectively learning teamwork skills increased slightly (81-87%) with the standard deviation noticeably lower for their capstone engineering design course indicating a high level of agreement.

Figure 1. Senior Student Perception of Effective Team Formation (n=41)

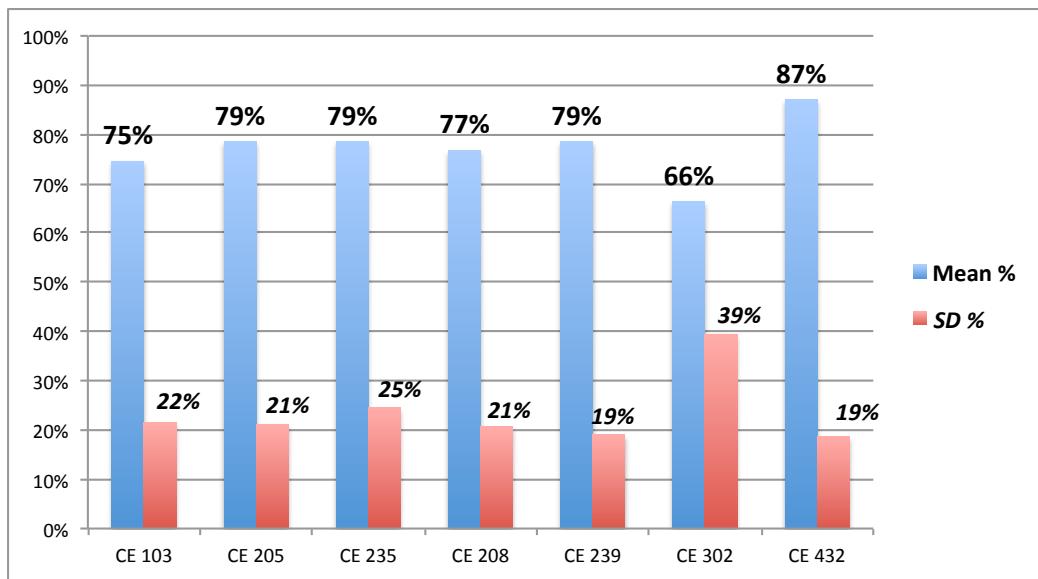


Figure 2. Senior Student Perception of Need to Addressing Team Conflict (n=41)

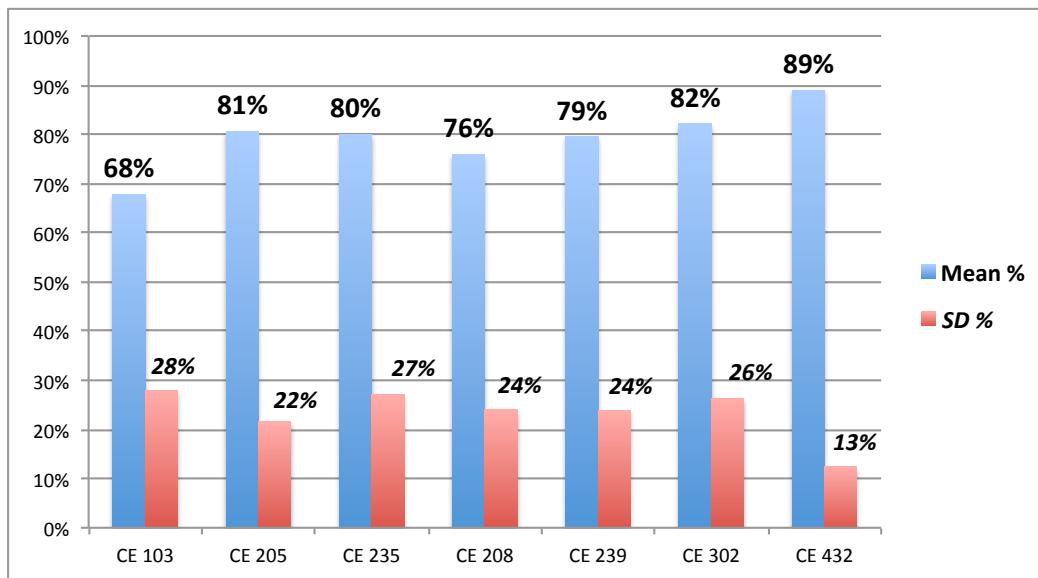
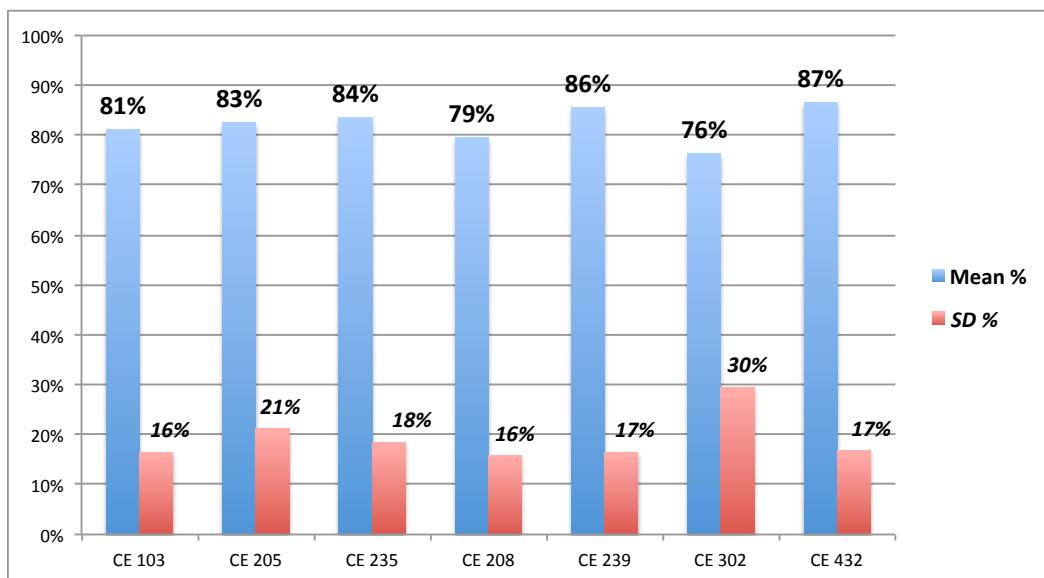


Figure 3. Senior Student Perception of Effectively Learning Teamwork Skills (n=41)



## Summary of Findings

Results from the student perception survey provided some useful insight to how satisfied students are with differing means of team formation. The most positive feedback was received for teams formed using CATME software routines. Student respondents appear to value development of teamwork skills in preparing them for successful professional careers. The degree to which students have to address conflict to compete team tasks was shown to increase from freshman through senior years, which validates the relationship between more complex assignments resulting in more conflict. Lastly, findings from this student perception survey merely comprise an indirect measure of assessment. It would be beneficial to compare this data to direct measures such as student performance on teamwork activities and course embedded indicator scores. Faculty could use this insight of student perspectives to further enhance and scaffold the departmental curriculum.

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