

Impact of Laboratory Section Size on Student Perception of Learning in Materials Laboratory Course

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Abstract

Various research studies on the impact of class size on students' perception of learning have unanimously agreed that the smaller the class size, the more positive students' attitude is toward the subject. This study examines the impact of laboratory section size on student perception of learning in Mechanics of Materials laboratory course at The Citadel. The laboratory section sizes have ranged from eight students to 23 students during the study period. The laboratory material, experiments, pedagogical techniques, and reports have stayed the same over the period of study. The influence of laboratory section size on student perception of learning is assessed using the institution's online, end-of-semester surveys of student evaluation of instruction data over a span of several semesters. Preliminary results show that a relatively small increase in the laboratory section size negatively influences the students' perception of learning.

Keywords

Class size, Perception of Learning, Indirect Assessment.

Literature Review

The impact of class size on learning outcomes has been examined extensively in the literature. Although there is a perception that smaller class sizes may foster greater student learning, the actual effects of class size on student learning have been found to be mixed in a number of studies. Several studies have suggested that smaller classes are linked to stronger learning outcomes¹⁻⁵. However, Williams et al.⁶ and Karakaya et al.⁷ found that students perform academically as well in larger university classes, and class size has no impact on student overall grades, respectively. Hattie⁸ and Pedder⁹ found similar results at the primary and secondary school levels: that class size does not significantly alter student performance.

Studies that have examined student evaluation of a course all agree that the class size has a negative impact on student course evaluations. For example, Allendoerfer et al.¹⁰ found that student perceptions of faculty support are significantly influenced by class size. Likewise, Bedard and Khun¹ and Walia¹¹ examined several semesters of student evaluations of economics courses at the Santa Barbara University and Kansas State University. They found a negative and statistically highly significant impact of class size on student evaluations of instructor effectiveness.

Materials Laboratory Course at The Citadel

At The Citadel, Civil and Mechanical Engineering majors are required to take Mechanics of Materials laboratory course in the first semester of junior year and second semester of

sophomore year, respectively. This one-credit course meets once per week for 2 hours. The course is offered in the fall, spring and summer semesters. The main topics of the course include tensile testing, torsional deformation testing, bending stress, deflection testing, and column buckling testing. For this study, the spring, summer, and fall cohorts are treated as equivalent. Data from eight sections of the course that were taught during 2015-2018 by the same instructor have been used. The smallest section consisted of eight students while the largest section had 23 students. However, the course content, the laboratory material, experiments, pedagogical techniques, and reports have stayed the same over the period of study. The student perception of learning has been evaluated by using the institutional procedure for course evaluations. The learning outcome has been directly assessed with a material properties quiz.

Study Method

The student perception of learning was measured through an end-of-semester survey that was completed by approximately 90% of the students registered in all lab sections. The material properties learning outcome was assessed based on a quiz used in all sections. These data are presented and discussed in this section.

The data were collected during the study period 2015-2018. The survey was conducted in electronic format only and students had access to the survey during the last four weeks of the semester. Students were asked to respond to the statements shown in Table 1. The questions in the survey were specifically aimed at comprehending the students' perception of their own learning, their professor effectively challenging students to think, and the instructor's availability to assist students. Students responded to the questions on a five point Likert scale (1-5), with '1' representing a strong disagreement with the survey statement and '5' representing a strong agreement with the survey statement. Students were asked to respond to the following statements in the survey:

Table 1. Institution's online student perception survey.

Question	
Q1	I learned a lot in this course
Q2	My professor effectively challenges me to think
Q3	My professor is readily available for consultations

For the purposes of this study, the term smaller lab section refers to a section with 15 or fewer students and the term larger lab section refers to a section with 16 or more students in it. The institution's online student perception survey responses were converted to a percentage scale in the standard way, with a score of 5 being considered equivalent to 100. In this manner, an equivalent mean and standard deviation percentages were obtained for the perception questions 1 through 3.

Figure 1 illustrates the mean and standard deviation of responses for each survey question, respectively. Figure shows that the mean scores for the smaller lab sections are slightly higher than the mean scores for the larger lab sections for all three questions. Figure 1 also illustrates much lower variability in student perception in smaller lab sections compared to the larger sections. This indicates that the student perception of learning is higher in the smaller lab sections of Mechanics of Materials.

Figure 1 also reveals that the class size has a negative impact on the survey questions regarding amount learned, professor effectively challenges student to think, and professor availability for consultations. It can be seen that the larger the lab section size, the lower the self-reported amount learned, effectiveness in communicating the material, and the availability of instructor. These findings demonstrate that course attributes important to student learning suffer when class size increases.

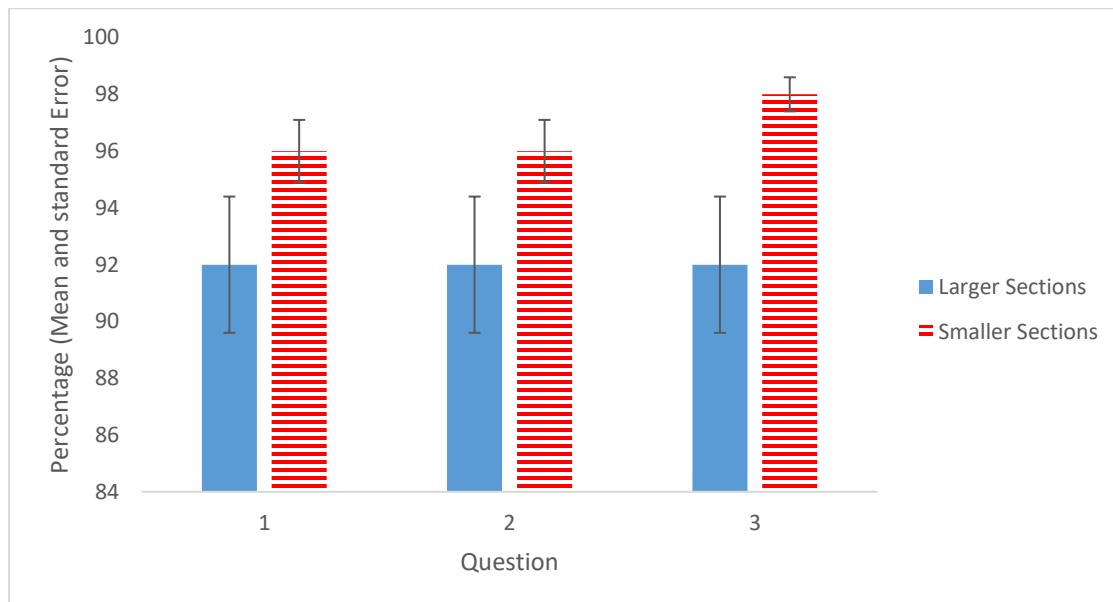


Figure 1. Mean and standard error of student perception scores in lab course.

Similar trends can be seen in Figures 2 and 3 at each lab section for each question. The smallest lab section ($n = 8$), resulted in means of 100%, 98%, and 100%, for the amount learned, professor effectively challenges student to think, and professor availability for consultations, respectively. The largest lab section ($n = 23$), resulted in mean values of 88% for all three questions.

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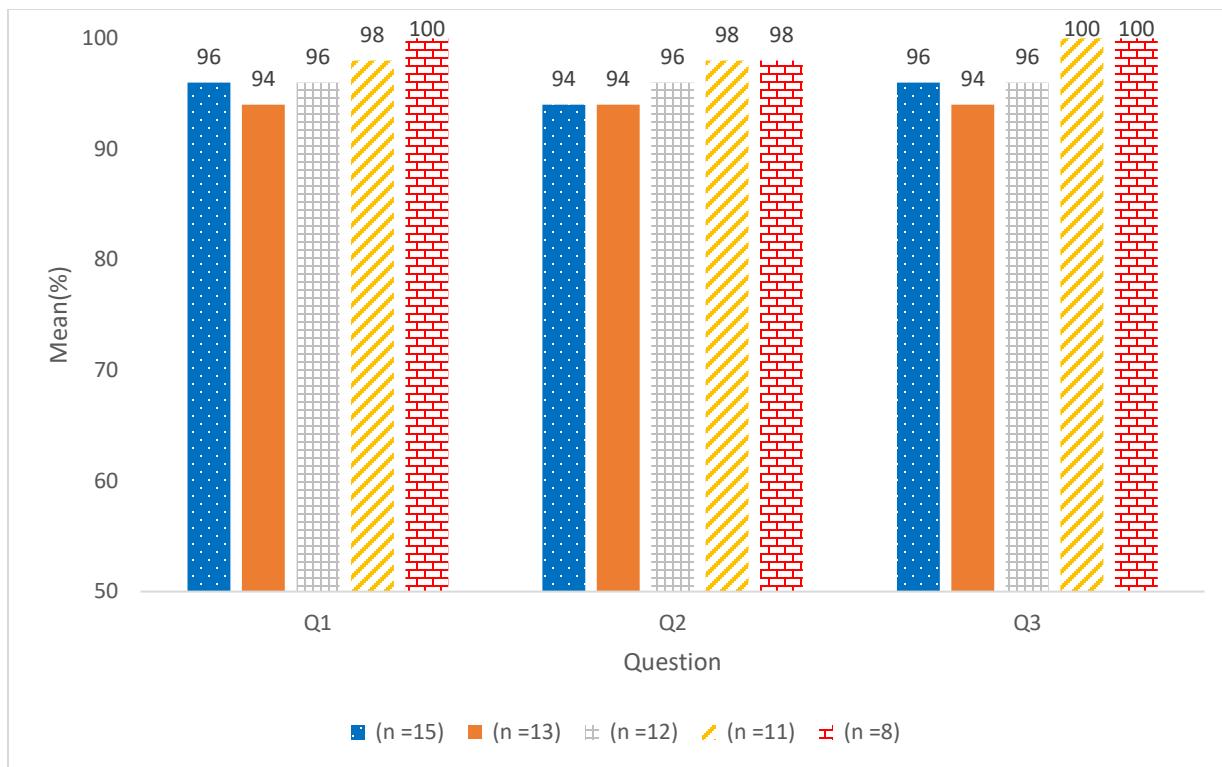


Figure 2. Student perceptions in smaller lab sections.

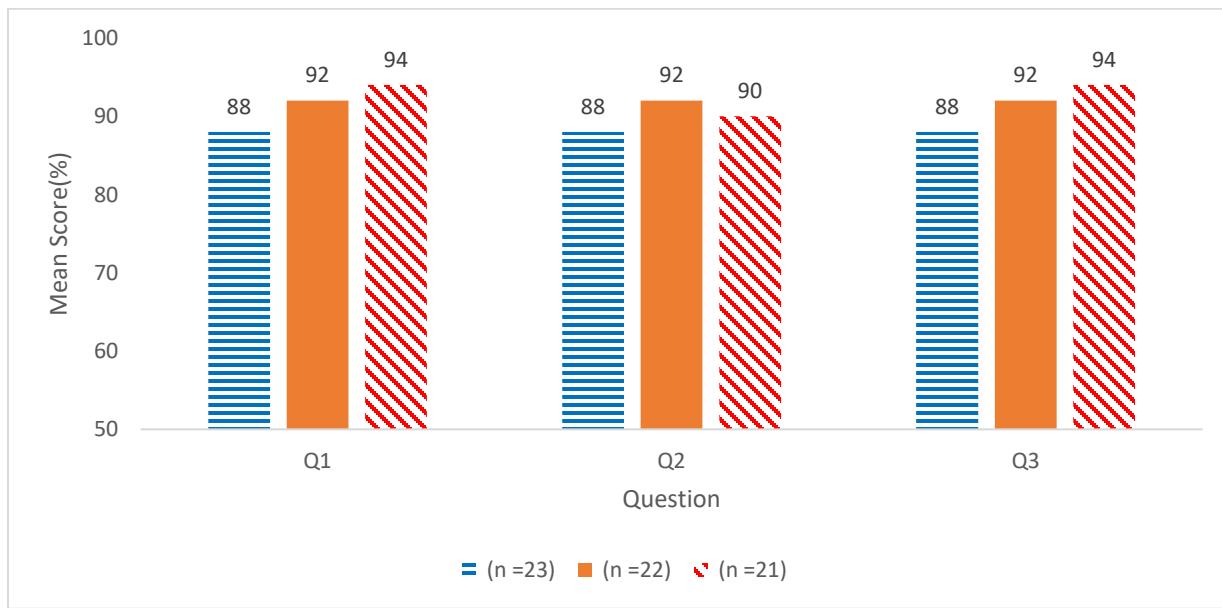


Figure 3. Student perception in larger lab sections.

Direct assessment data were collected during the study period and consist of student performance on a material properties quiz. This quiz (see Table 2 and Figure 4) was administered in all sections during the study period.

Table 2. The material properties quiz

Q1	Which material is the most ductile in Figure below?
Q2	Which material is the most brittle in Figure below?
Q3	Which material has the largest modulus of elasticity in Figure below?
Q4	Estimate the yield stress for 1060 CR Steel in Figure below using an acceptable approach.

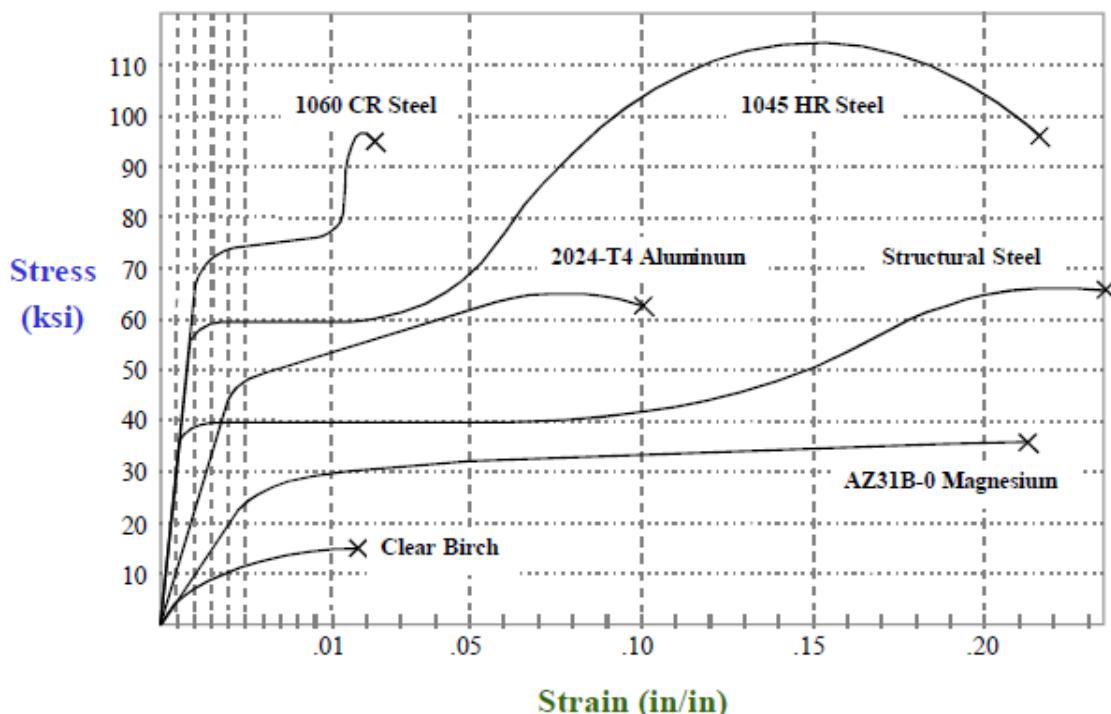


Figure 4. Stress-strain plots of several materials utilized for the direct assessment

Figure 5 illustrates the average student scores from direct assessment quiz by section. It can be seen from Figure 5 that there is 4%-7% increase in the performance of the students in questions #1, 3, and 4 associated with the smaller sections.

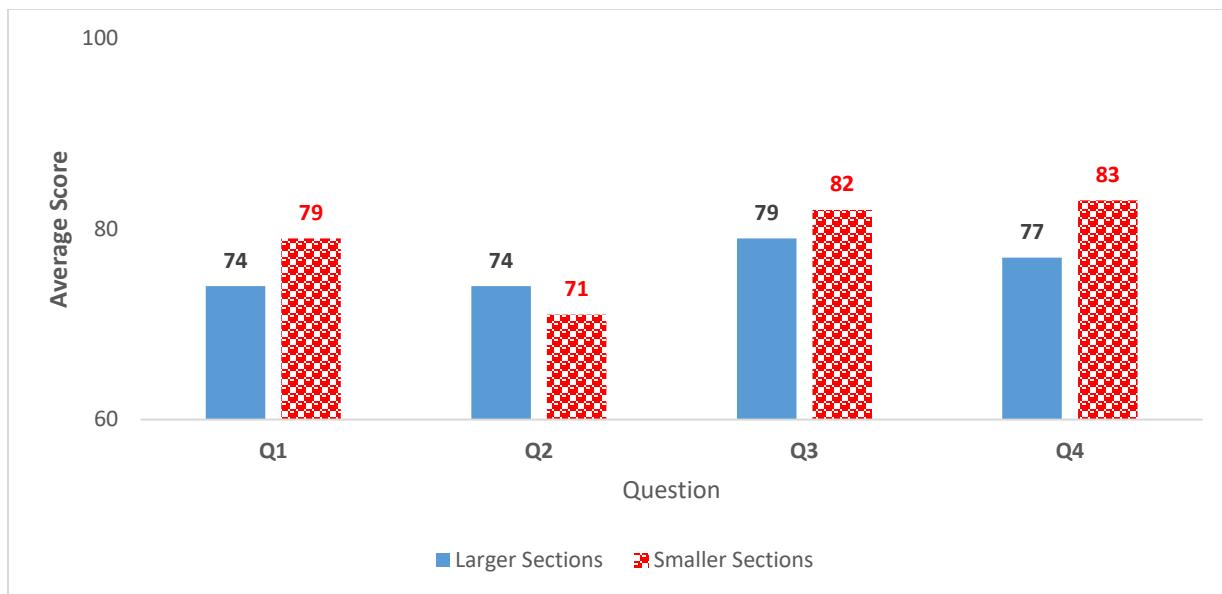


Figure 5. Mean scores on material properties quiz.

Conclusions

An investigation into the impact of class size was carried out in this study.

- The results of this study clearly indicate that the student perception of learning in the smaller section is more positive, as can be seen from the student response to all the survey questions.
- The evaluation of learning outcome through the material properties quiz clearly demonstrates that students in the smaller sections outperformed students in larger sections.
- The results suggest that university materials laboratory courses should contain smaller class sizes.
- Future studies should more precisely research the tipping point at which lab class size becomes large, so that future courses may include optimal course maximums.

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