STUDENT PERCEPTION OF TUTORIALS

At the end of the quarter we asked students for feedback on the tutorial component of the course. They were asked to rate their agreement with the statements below on a 6-point scale: strongly agree, agree, somewhat agree, somewhat disagree, disagree, and strongly disagree.

Q1. The tutorials were helpful to my learning.
Q2. I would like to see tutorials in other advanced courses (*e.g.,* E&M or classical mechanics).

Figure 1 shows the average for each third of the class, where strongly disagree was given a value of zero and strongly agree a value of five. The highest performing students, those in the top third, rated the tutorials higher than the others. In fact, every student in the top third agreed with both statements to some degree.

The average score on the survey is consistent with our observations from each year that we have used the tutorials on quantum mechanics. The majority of students have consistently requested that more time be devoted to tutorials in the small group sections. In part, because of student experiences with the tutorials in quantum mechanics, upper-division electro-magnetism tutorials [12] have been introduced into the recitation sections at the request of students.

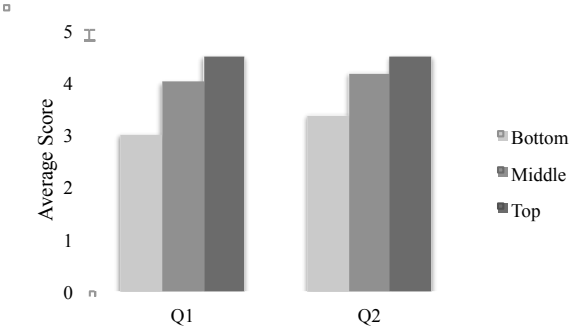

FIGURE 1. Responses to the survey questions for the top, middle, and bottom thirds of the course as defined by their scores on the lecture exam questions.

CONCLUSION

This article describes methods for assessing curriculum that we are finding useful for upper-level courses. In cases where the populations are smaller, tutorial attendance can become a significant factor in the analysis. The findings are encouraging and suggest that there can be significant benefits from the use of *Tutorials in Physics: Quantum Mechanics* in a junior-level course on quantum mechanics. The results indicate an overall improvement in conceptual understanding on a variety of topics for students who attended the tutorials. In addition, we have shown that these students are better able to answer tutorial exam questions than their peers who did not attend the relevant tutorial(s). This difference in performance was greatest for students in the middle and bottom thirds of the class. Although we did not see a statistically significant difference for the top third of students, this may have been due to the small number of students in that population who do not attend tutorials. However, we have found that these students overwhelmingly believe that the tutorials are of benefit to their learning.

In the future we plan to extend this analysis as well as to report on the development and assessment of individual tutorials. We will also document instructional strategies that have proved effective at addressing student conceptual and reasoning difficulties. In addition, we will document findings from faculty who are using these materials at other institutions.

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[9] For information on the iterative cycle of research and curriculum development, see Ref. [8].
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[11] Results for 'all students' were not tested for significance due to unequal representation from each third of the class.
[12] Based on EM tutorials from CU-Boulder: colorado.edu/physics/EducationIssues/cts/index.htm