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# Can a Web-Based Classroom Response System Improve Geology Education? A Case Study

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## Abstract

The University of Mississippi Department of Geology and Geological Engineering, in an attempt to improve student attendance, retention, and performance, tested the use of a web-based Classroom Response System (CRS) in three core geology classes at the freshman, sophomore, and junior level. Students purchased a license to the application, which they could access via their cell phone, tablet, or laptop computer. Quantitative comparisons of attendance, retention, and test performance were made with data from previous, non-CRS enabled classes. Classroom attendance is recorded using automated ID scanners. Some improvement was made in lecture attendance over prior years. No significant change was found in retention, possibly because course drop deadlines were relatively early in the schedule, before CRS use became effective. Grades presented a mixed signal. There was a statistically significant improvement of 26% in the freshman class (Historical Geology) average over previous years. There was no statistically significant difference in class average for the sophomore class (Sedimentology and Stratigraphy) compared to previous years. Possibly because of changes in instructor and class organization, there were mixed results for the junior class (Structural Geology). Student evaluations of the use of CRS were varied. Positive reviews indicated a benefit to being able to view lecture slides in conjunction with questions, as well as improving student ability to “keep up with notes”. Most negative concerns were associated with a portion of their grade being based on CRS participation and the weighting of points given for correct answers versus merely participating. The use of CRS requires more effort and preparation by the instructor, but the potential value seems to outweigh the costs both to the student and instructor. The positive effect seen in the freshman class suggests that if introduced early in the curriculum students may be more likely to accept the technology and use it to their advantage.

## Methods

The Department of Geology & Geological Engineering evaluated the use of a Web-based Classroom Response System (Top Hat® from Tophatmonocle Corp., Toronto, Ontario, Canada) in 3 core courses in the Spring semester 2016: Geol 106 - freshman Historical Geology, Geol 314 - sophomore Sedimentology and Stratigraphy, and Geol 303 - junior Structural Geology.

There were 2 years of previous records for Geol 106, which had been taught all years by the same instructor. There were 4 years of previous records for Geol 314, which was taught in 2012, 2013, and 2016 by the same instructor, and in 2014 and 2015 by a different instructor. There were 2 years of previous records for Geol 303, which was taught in 2014 and 2015 by the same instructor, but in 2016 by a different instructor.

Grade distributions, which were assumed to be drawn from a normal population, were compared using a 2-sample t-test to test the null hypothesis that the means of any two samples are drawn from the same distribution. The null hypothesis was rejected for p-values < 0.05 (95% confidence level). Attendance records were available for Geol 106 (a class for which students are graded on attendance). Attendance (which is not normally distributed) was compared using a 2-sample Kolmogorov-Smirnov test to test the null hypothesis that the samples are drawn from the same distribution. The rejection criterion was a p-value < 0.05% (95% confidence level).

## Freshman Results – Historical Geology

**Geol 106:** The strongest statistically significant results obtained from this study were at the freshman level. The use of the Top Hat® CRS resulted in a 26% improvement in the overall class GPA and also an apparent improvement in attendance. There are, however, two aspects of the course that need to be considered. (1) The same instructor taught the class all 3 years – reducing the concern regarding teaching styles. (2) Class enrollment fell, from 107 in 2014, to 94 in 2015, to 69 in 2016 – which may have a confounding effect on student outcomes.

In class evaluations, there were few positive comments regarding the use of the Top Hat® CRS, but about 15% of the class had a negative opinion – most of which centered on being graded based on their participation and responses.

## Sophomore Results – Sed/Strat

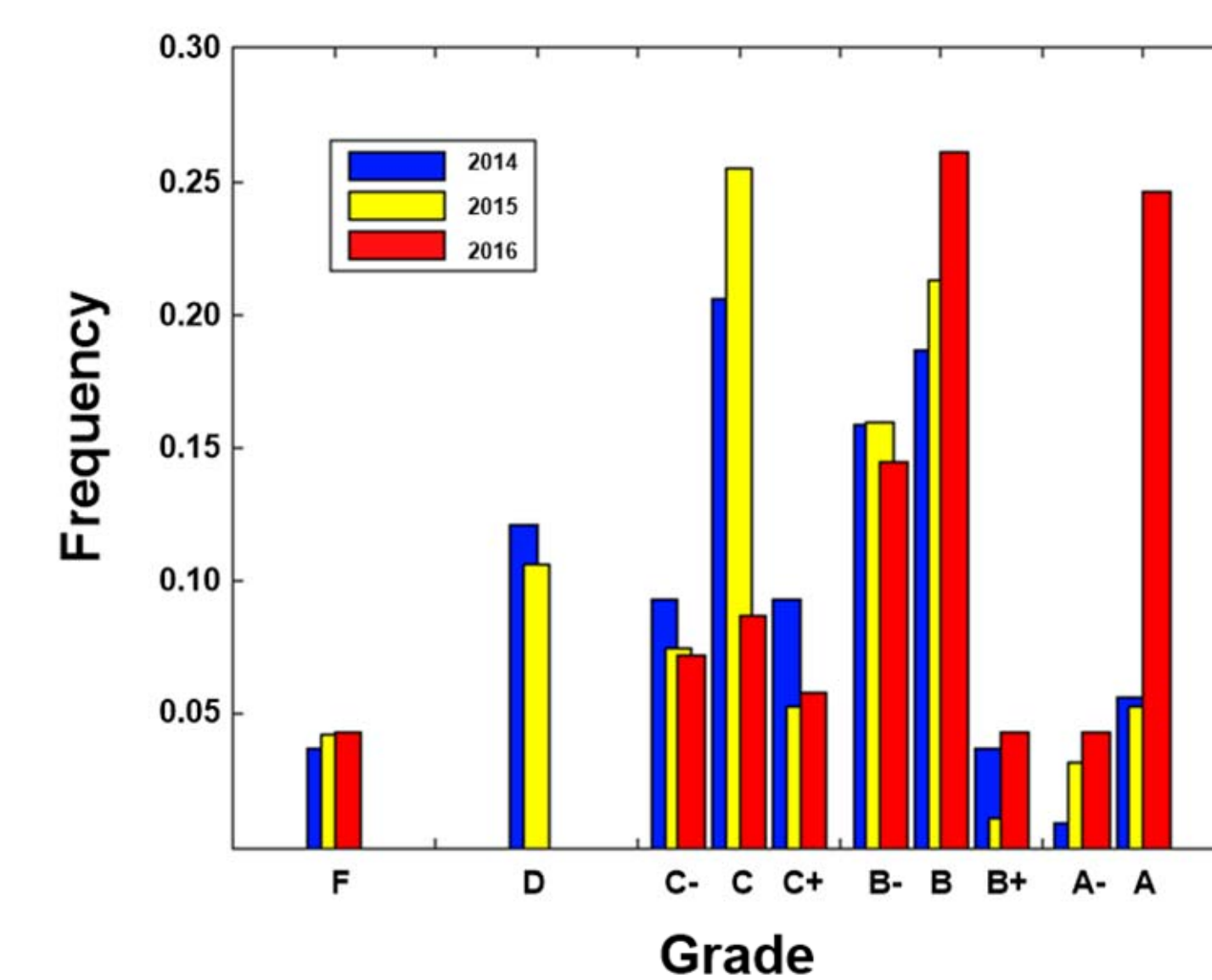
**Geol 314:** There was no statistically significant indication that the use of the Top Hat® CRS resulted in any improvement in the overall class GPA or attendance. In contrast to the freshman class, however, two different instructors taught the class in different years (one in 2012, 2013, and 2016; the other in 2014 and 2015); and class enrollment rose, from 40 in 2012, 49 in 2013, 66 in 2014, to 77 in 2015, and then fell slightly to 67 in 2016.

In class evaluations, there were few positive comments regarding the use of the Top Hat® CRS, but about 15% of the class had a negative opinion – most of which centered on being graded based on their participation and responses.

## Junior Results – Structural Geology

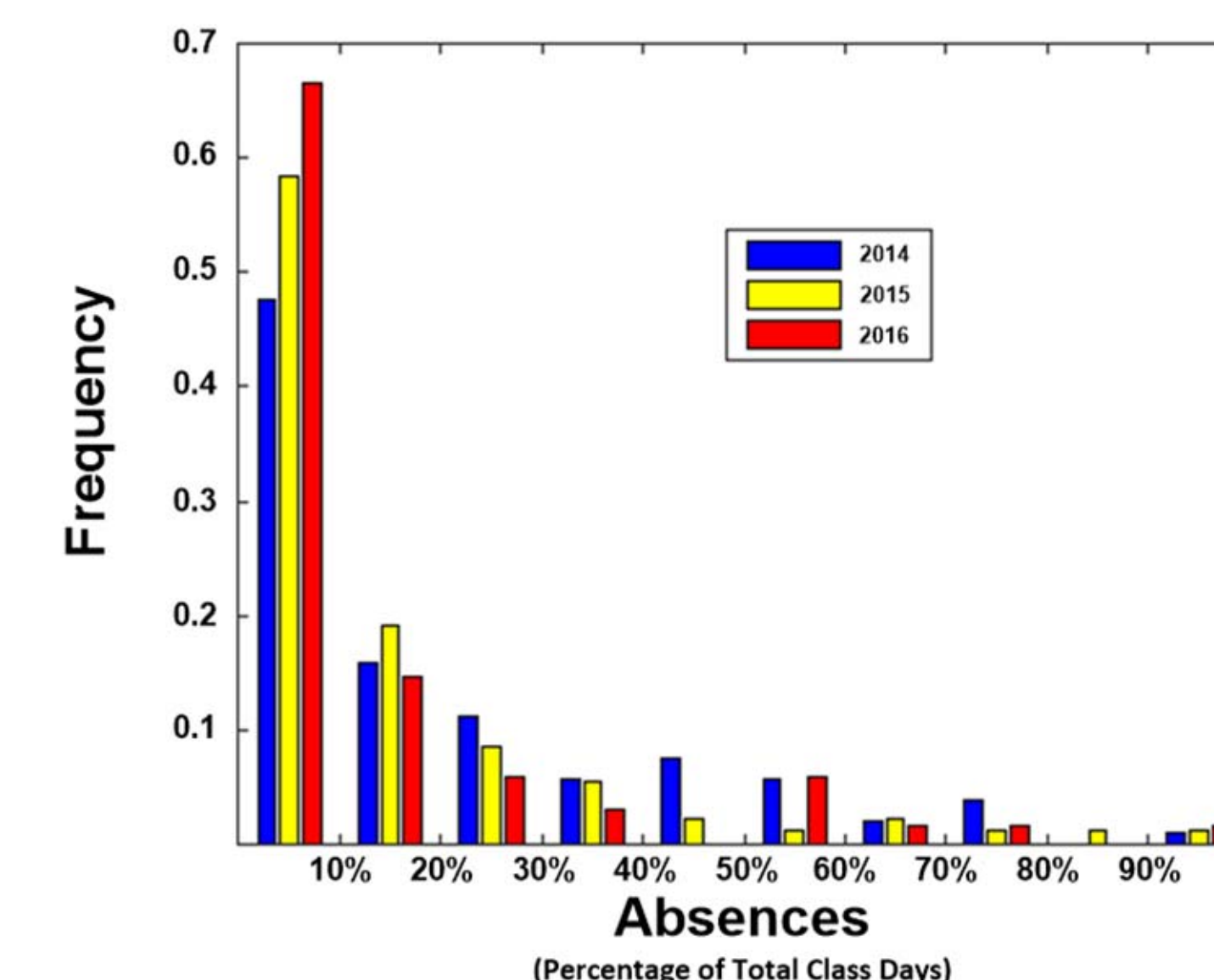
**Geol 303:** Mixed results were obtained from this study at the junior level. The use of the Top Hat® CRS resulted in a 19% improvement in the overall class GPA over 2014 (the only statistically significant result). There are, however, two aspects of the course that need to be considered. (1) The same instructor taught the class the first 2 years of record, with a different instructor in 2016. (2) Class enrollment rose, from 39 in 2014, to 63 in 2015, to 73 in 2016 – which may have a confounding effect on student outcomes.

In a class poll (63% response), 65% liked using the Top Hat® CRS, but about 15% of the class had a negative opinion, with the remaining 20% not sure – with negative comments centered on being graded based on the correctness of their answers vs. simple participation and responses.



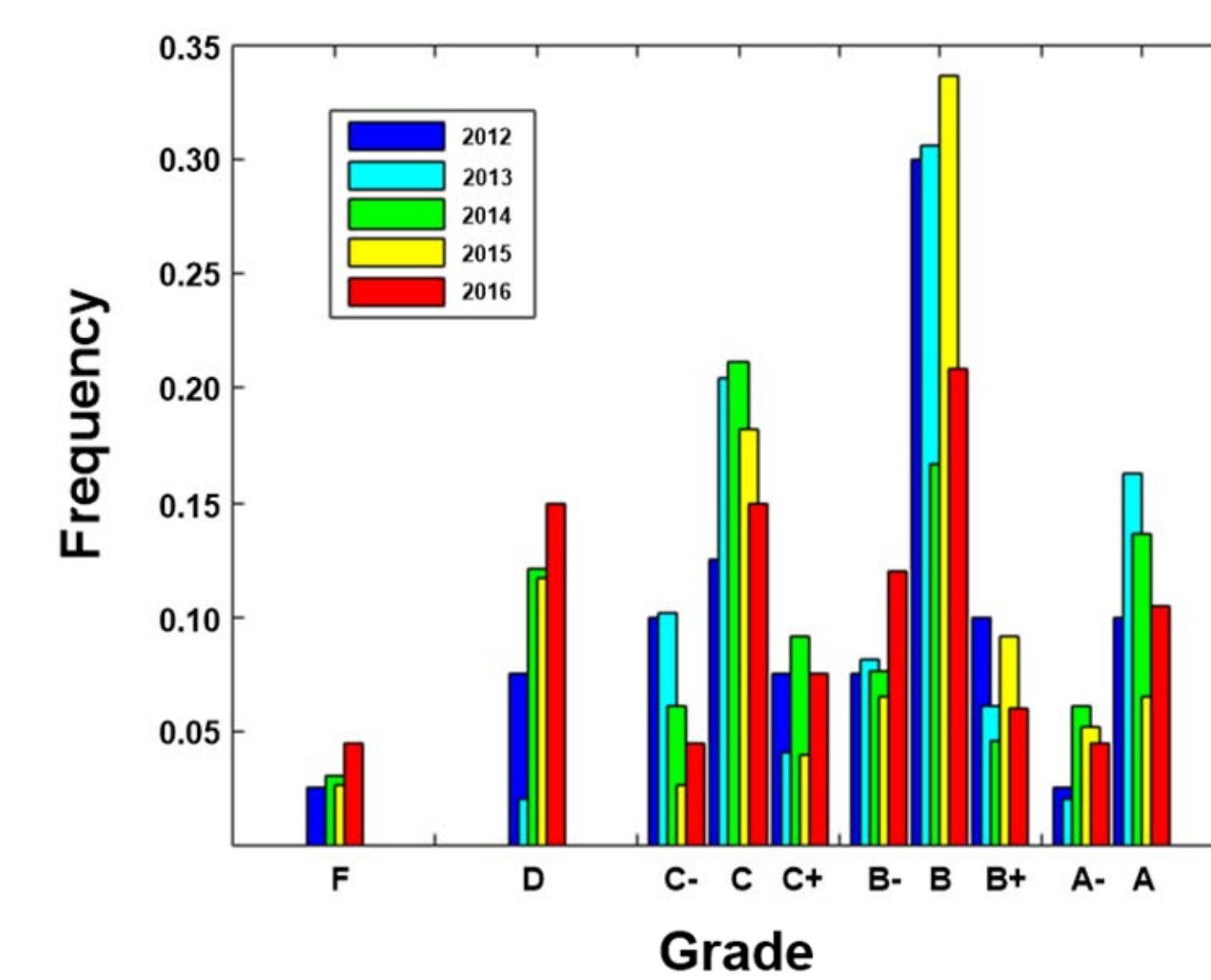
Comparison of Geol 106 grade distributions

There was a highly significant change in the mean of grades for 2016 ( $p < 0.05$ ), showing an overall 26% improvement in the average grade point over the previous 2 years.



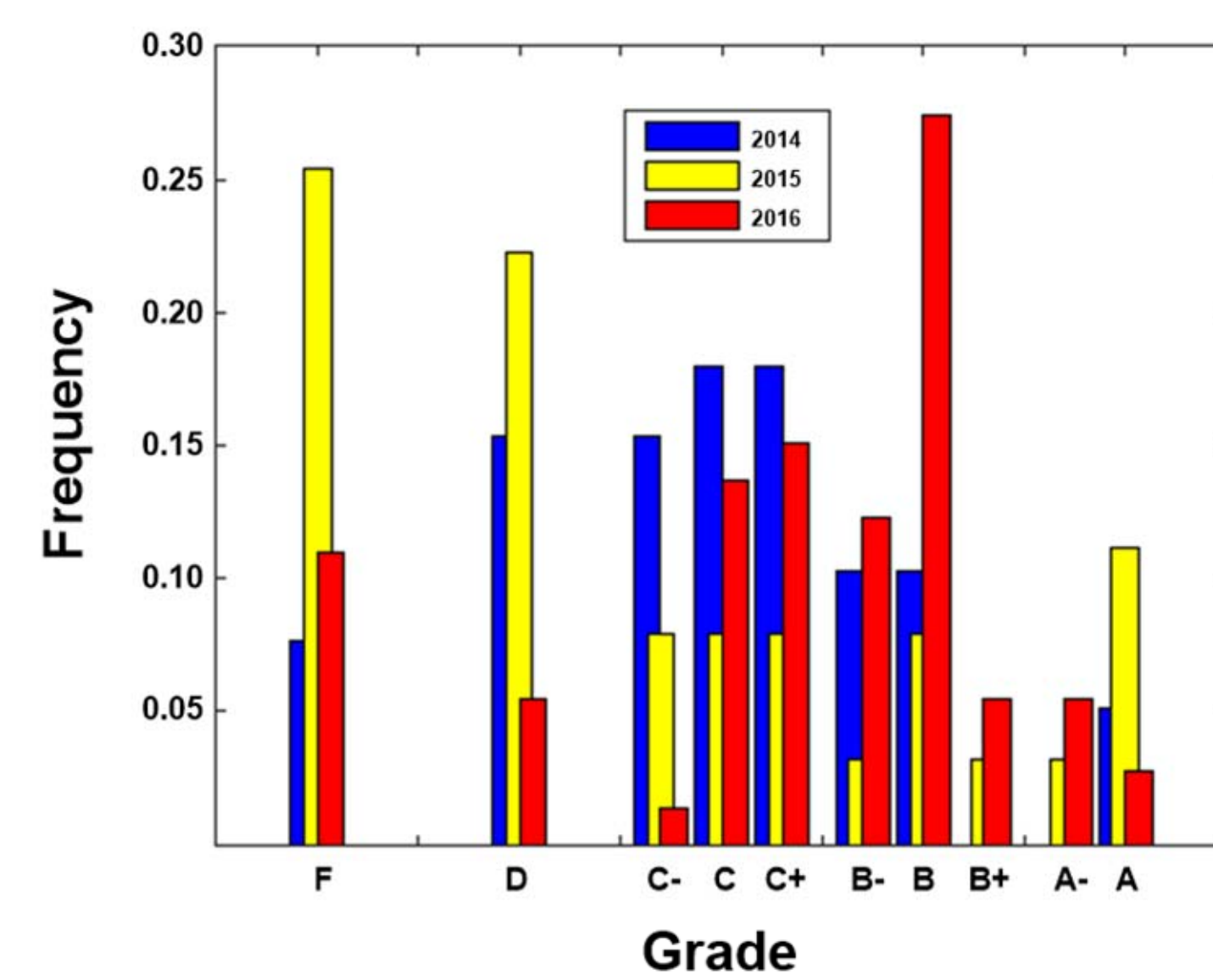
Comparison of Geol 106 attendance distributions

Although there was no significant change in the overall distribution of attendances over the 3 years (Kolmogorov-Smirnov  $p > 0.5$ ), The number of students missing less than 10% of total classes increased from 48% (2014) and 59% (2015) to 67% in 2016.



Comparison of Geol 314 grade distributions

There was no significant change in the distribution of grades for 2016 ( $p > 0.5$ ), compared with the previous 4 years.



Comparison of Geol 303 grade distributions

There was a significant change in the mean of grades for 2016 vs. 2014 ( $p < 0.05$ ), showing an overall 19% improvement in the average grade point) but not significant for 2016 vs. 2015 ( $p = 0.07$ ).

## Conclusions

1) The disparity between results from the freshman and higher level classes suggests that CRS technology should be introduced early in the curriculum.

2) CRS technology may be more advantageous in classes that are predominantly lecture-based (Geol 106) than classes with significant lab and field modules (Geol 314 and Geol 303).

3) Student acceptance will be improved if students are not directly graded on their participation with the CRS.

4) The apparent improvement in student attendance could be a result of students feeling they were participating more in the class, thereby making the lectures more interesting (or perhaps more entertaining).

5) Although the results were mixed among the 3 courses studied, the effect of using the CRS was neutral at worst, thus there does not appear to be a downside to using the technology.



## Acknowledgments

We thank Brian Platt and Terry Panhorst for supplying grade data for their courses. We also thank our many students who so willingly agreed to participate in this experiment (we should note that in no cases were their grades negatively affected by CRS participation).