Using Oral Presentations and Cooperative Discussions to Facilitate Learning Statistics

Abeer Hasan
Humboldt State University

Sayonita Ghosh Hajra
Hamline University

In this paper we report on a study of assessment-based oral presentation tasks in a statistics course at a public university in the United States. We examine student attitudes towards using oral presentation tasks in learning statistics and their disposition towards statistics as well as their knowledge of the statistical concepts. Our results suggest that use of oral presentation improves students’ mastery of statistical concepts and their disposition towards statistics. Moreover, responses to the anonymous course evaluation questionnaire provide insights on the benefits of using oral presentation tasks in statistics courses for students.

Keywords: Attitudes, beliefs, oral presentation, statistical significance

Introduction

There is a long-standing scholarly dialogue on how to deal with recurring concerns about student motivation and achievement, and how to improve student understanding of the role of statistics in providing answers to real-world problems (Meng, 2009). Ograjenšek and Gal (2016) propose re-examining the role of qualitative thinking in the early stages of learning statistics and integrating selected elements of qualitative research methods into statistics curricula. Cobb (2007) calls for further use of technology in teaching and more focus on simulation-based instruction. The use of technology to introduce and reinforce these essential concepts has also been promoted in the Guidelines for Assessment and Instruction in Statistics Education (GAISE) for introductory statistics at the college level (ASA, 2005). Using technology in teaching statistics has been discussed in a series of publications (e.g., Chance, Ben-Zvi, Garfield, and Medina, 2007). Gordon (2004) discusses the unique challenges faced by students and instructors of statistics in a service course. Issues with background deficiencies and lack of motivation are among the most critical factors when teaching occasional users of statistics.

One of the authors teaches statistics as a service course offered for a wide range of science majors. She designed the course with a focus on conceptual understanding and an emphasis on real-world applications and automated computations. These changes enriched students’ learning experience and enhanced the overall course instruction. Technology can support conceptual understanding and data visualization. However, we believe that a change in the culture of teaching statistics and the way we interact with our students is needed. In this study, we consider pedagogical strategies that could improve students’ conceptual understanding of statistics, thereby also improving their statistical awareness.

One of the strategies we discuss here is use of oral presentations in class for active learning. Fan and Yeo (2007) describe oral presentation as a classroom practice where students share their ideas verbally, and check their own doubts. They discuss that oral presentation provides students an opportunity to share their understanding about a concept in their own words. These verbal communication skills are believed to promote conceptual understanding (Berry and Houston, 1995) and are believed to increase students’ confidence (Butler and Stevens, 1997). Recently, in Ghosh Hajra and Hasan (2016), we discussed using assessment-based oral presentation tasks in a mathematics content course for pre-service teachers. We found that our pre-service teachers gained confidence in their ability to teach mathematics and also improved their disposition towards mathematics.
Another strategy we discuss here is the use of cooperative discussions in class for active and meaningful learning. Cooperative learning environments encourage students to interact, critique one another, and learn from each other socially (Slavin, 1996). In this setting, students work in groups, share common goals, and are each responsible for the success of their group (Johnson and Johnson, 1994). Leikin and Zaslavsky (1999) propose four necessary components, which form a cooperative learning environment—learning in small groups, group interdependence, individual accountability within groups, and equal opportunity for interaction and communication for all participants.

Various studies (Meeuwsen, King and Pederson, 2005; Sutton, 1992; Webb, 1991) suggest multiple interpersonal and intrapersonal benefits of cooperative learning. These benefits include improved communication among students and enhanced creative thinking in students. Other studies have shown connection between disposition and learning (Maas and Schlöglmann, 2009; McLeod and Adams, 1989, Philipp, 2007). Disposition is one’s attitudes, beliefs, and aptness to act in positive ways (NCTM, 1989). Attitude is a mental concept representing favorable or unfavorable feelings for identifiable entities, and a belief is known or perceived information about an object (Koballa, 1998). For example, statements about likes or dislikes reflect one’s feelings toward an object; a statement such as, “Statistics is hard” represents one’s beliefs. One is most likely to perform an action if one has a favorable attitude towards it (Fishbein and Ajzen, 1975). In particular, if students have favorable feelings and beliefs about oral presentations, they are more likely to use them in their own learning.

In this study, we investigate students’ general beliefs and attitudes toward the use of oral presentation tasks in learning statistics. We examine if using oral presentation activities changes student dispositions towards statistics.

**Theoretical Framework**

Our theoretical framework is based on three theories: theory of constructivism, social constructivism, and multiple intelligence. Theory of constructivism hypothesizes that an individual constructs meanings through his own experiences (von Glasersfeld, 1995). Theory of social constructivism hypothesizes individuals’ meanings are constructed through experiences in social interaction (Brooks and Brooks, 1993). From the viewpoint of multiple intelligence theory, every individual has different learning styles. Therefore, each individual needs different forms of learning opportunities (Fan and Yeo, 2007). Hence, we use oral presentations with cooperative discussions as a learning tool in class, in addition to other formal writing assignments, quizzes, and exams. We ask our students to discuss problems in groups and present their solutions to the class.

**Methodology**

**Study participants and course description**

This study took place at a public university in the United States of America. Two sections of a statistical modeling class were involved, one designated as control and the other as the treatment group. The two sections had the same instructor, same resources, and same written assessments. The participants were science majors who took an introductory statistics course as a prerequisite to this class. This course was their second course in statistics. The majority of the students were biology majors who took the course either as an elective or as a part of the requirement for their statistics minor. This course was designed as an undergraduate course, but
some graduate students took it to supplement their statistical background and to prepare for the quantitative research component for their master’s theses.

**Study design**

We applied an experimental design in this course. One of the two sections was assigned to the treatment group (19 students) and the second section (26 students) was assigned to the control group. This assignment was made before the start of the semester, and the students were unaware of such arrangements. The lecture notes, homework assignments, and tests were identical in both sections. The only difference was that oral presentation with cooperative discussion activities were used for the treatment group and not for the control group during the lecture and statistics lab sessions.

Base groups were formed in the first week of the semester with 3–4 students in each group in the treatment group. Base groups are groups that stay together for the entire course period (Barkley, Cross and Major, 2005). Members in a group were selected randomly according to the class roster after sorting them alphabetically by last name.

The instructor implemented two assessment-based oral presentation tasks in the treatment group: pre-structured oral presentation and impromptu presentation (Fan and Yeo, 2007). Fan and Yeo (2007) described pre-structured oral presentations as tasks that are prepared by the students in advance and impromptu presentations as tasks that are performed without rehearsals. Below, we describe the two tasks in the context of this study.

**Task 1: Pre-structured oral presentation:** Presentations were used in the treatment group during the lab sessions. In these sessions students were using the software R to perform data analysis. The class was given a handout with a list of solved data analysis problems. Each group was assigned one example to discuss. Twenty minutes were allotted for cooperative discussion. The problems were usually a data set with a research question. Students were given some programming code, description of the dataset, and research question. Students were required to understand, discuss, and interpret the code, along with interpreting the output and answering the research question. Each group had to elect a representative to explain their assigned problem to the class. Each student presented at least twice during the semester. The instructor was available to help during the cooperative discussion, but students were instructed to ask the instructor for help only after the entire group discussed the problem.

**Task 2: Impromptu oral presentation:** We implemented two forms of spontaneous presentations in the treatment group: a) Student presenters had to answer instant questions related to the presentation from the audience and the instructor after the pre-structured oral presentation. b) Each student had to summarize the day’s lesson twice throughout the semester in the form of a 2-minute presentation. The software R was used to randomly choose a presenter at the end of each class. Students had to take notes and be prepared for presenting their 2-minute summary each day because they did not know whose name would be chosen at the end of the class.

We used weighted assessment categories for grading both classes. For the treatment group, oral presentation activities counted 5% and written homework counted 10% of their weighted total grade. For the control group, written homework counted 15% towards the total grade and there was no oral presentation component. Cooperative lab discussions were used only in the treatment group. However, students in both groups had the option to collaborate on some written homework assignments and on a major group projects outside class.
**Data collection**

We collected data in the form of pre-and post-surveys (modified survey questionnaire from Fan and Yeo (2007) (see Table 1), pre- and post-tests, and end-of-term online course evaluations. The pre- and post-survey consisted of questions on students’ general beliefs and attitudes toward the use of oral presentation tasks, their beliefs in their own ability to use statistics in their own research and in their own dispositions towards statistics. The pre-and post-tests/surveys were conducted on the first day and last day of class respectively. Pre-and post-tests had a question with 5 parts on analyzing some R output from a simple linear regression model. We used the anonymous online course evaluation surveys at the end of the semester as our third data source. This survey included 10 questions where students ranked the instructor on a scale of 1–5 and answered two open-ended questions reflecting their thoughts about the most engaging and exciting aspects of the class and any recommendation for improvement.

<table>
<thead>
<tr>
<th>Table1</th>
<th>Survey questions.</th>
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<tbody>
<tr>
<td>1.</td>
<td>Oral presentations improves my understanding of statistical concepts</td>
</tr>
<tr>
<td>2.</td>
<td>Oral presentation skill is important in learning statistics</td>
</tr>
<tr>
<td>3.</td>
<td>Oral presentation skill is important in scientific research</td>
</tr>
<tr>
<td>4.</td>
<td>Oral presentation makes me feel inadequate</td>
</tr>
<tr>
<td>5.</td>
<td>Listening to other classmates’ presentations help me understand other’s perspectives</td>
</tr>
<tr>
<td>6.</td>
<td>Oral presentation is a waste of time</td>
</tr>
<tr>
<td>7.</td>
<td>I am very worried about presenting statistical concepts in front of my classmates</td>
</tr>
<tr>
<td>8.</td>
<td>I see statistics as practical and useful</td>
</tr>
<tr>
<td>9.</td>
<td>I would like to have more oral presentations for my statistics classes</td>
</tr>
<tr>
<td>10.</td>
<td>Preparing for oral presentations helps me gain deeper understanding of statistical concepts</td>
</tr>
<tr>
<td>11.</td>
<td>I am confident in my ability to communicate statistical concepts</td>
</tr>
<tr>
<td>12.</td>
<td>I feel confident in my ability to use statistics in my research or course projects</td>
</tr>
</tbody>
</table>

**Results**

**Quantitative analysis**

**Pre-Post Surveys and Tests**

To analyze the data from the two surveys, we use a numerical scale to code the responses on a scale of 1–5, where 1=Strongly Disagree and 5=Strongly Agree. Our study is twofold—we aim to investigate changes in student attitudes toward oral presentations and changes in their disposition toward statistics. Hence, we divide the survey into two categories. Questions 1–7 and 9–10 addresses general attitudes and beliefs toward oral presentations. Questions 8, 11, and 12 represent student disposition toward statistics. We create the following score functions:

Oral presentation score = (Sum of responses to questions 1–7 and 9–10)/45*100

Disposition toward statistics score = (Sum of questions 8, 11, and 12)/15*100

Here we note that 45 and 15 are the maximum possible scores for each of the above scores respectively and can be obtained by multiplying the number of questions by 5 which is the score of a Strongly Agree response. The numerical scores of questions 4, 6, and 7 were inverted to account for the negative wording of the statement in these questions.

We consider the responses of each student as paired data. We used the averages to replace missing values for students who filled out one survey but missed the other. The paired
differences in the three scores passed Anderson-Darling’s normality test at the LOS=0.01, thus we apply a paired $t$-test to see if the observed sample differences are significant. Table 2 summarizes the results of our statistical inference. We have a strong evidence of improvement in the disposition towards statistics in both groups. However, the treatment group showed a 13% mean increase in their disposition towards statistics score compared to a 7% mean increase in the control group. Both the treatment and the control groups did not show a significant improvement in their oral presentation scores.

Table 2
Summary of the statistical tests on the three score function. The data is considered normally distributed if the $p$-value of Anderson-Darling’s test exceeds 0.01. The observed sample difference is significant if the $p$-value of the paired $t$-test is less than 0.01.

<table>
<thead>
<tr>
<th>Group Assignment</th>
<th>Score functions</th>
<th>$p$-value for the normality test</th>
<th>Mean sample of differences (After-Before)</th>
<th>$p$-value for the paired $t$-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment $n = 19$</td>
<td>Oral presentation score</td>
<td>0.753</td>
<td>-0.662</td>
<td>0.5526</td>
</tr>
<tr>
<td>Treatment $n = 19$</td>
<td>Disposition towards statistics score</td>
<td>0.0472</td>
<td>12.918</td>
<td>0.0014</td>
</tr>
<tr>
<td>Control $n = 26$</td>
<td>Oral presentation score</td>
<td>0.471</td>
<td>-1.345</td>
<td>0.4303</td>
</tr>
<tr>
<td>Control $n = 26$</td>
<td>Disposition towards statistics score</td>
<td>0.131</td>
<td>7.703</td>
<td>0.0007</td>
</tr>
</tbody>
</table>

Figures 1 and 2 display side-by-side boxplots for each of the two scores we introduced. The graphs show improvement in the disposition towards statistics scores at the end of the semester in both groups. It is interesting that neither of the two groups showed improvement in their attitudes towards oral presentation. On the contrary, some of them had slightly more negative opinion towards oral presentation at the end of the semester. Few students found public speaking stressful despite the fact that they learned a lot from presenting their ideas. It is also worth noting that students in both sections were either seniors or graduate students and at this stage of their career they had fixed ideas on oral presentations. Their overall responses were favorable of the practice and the treatment group had slightly more positive attitude towards oral presentation at the beginning of the semester.

To assess learning in the two groups, we administered a test before and after teaching a unit in the class. Both groups showed significant improvement in the post-test scores compared to their pre-test scores. This can be attributed to the collective learning activities that were used in class. Figure 3 shows a comparison of the pre-test scores and the post-test for the two groups. The treatment group had lower pre-test scores compared to the control group. The post test scores highlight the discrepancy between the two groups as the treatment group outperformed the control group.

To compare the test scores of the two groups, we apply Wilcoxon’s rank-sum test with continuity correction. The rank-sum test on the pre-test scores resulted in a $p$-value = 0.9645. Thus, there was no significant difference in the pre-test scores between the treatment and control groups. Applying the same test to the post-tests resulted in $p$-value = $4.497 \times 10^{-5}$. This provides strong evidence that the post-test scores for the treatment group were significantly
higher than those of the control group. The median of the post test scores for the treatment group is 95% compared to 73.75% for the control group.

Figure 1: Boxplots for the survey responses on attitude scores for the control group before and after the oral presentation tasks.

Figure 2: Boxplots for the survey responses on the attitude scores for the treatment group before and after the oral presentation tasks.

Figure 3: (Left) Comparison of the pre-test scores between the control and treatment groups. (Right) Comparison of the post-test scores between the control and treatment groups.
End-of-Term Online Course Evaluation Surveys

We used University’s anonymous voluntary online course evaluation to solicit student feedback on their classes. It was interesting to compare and contrast the survey responses for the treatment and the control groups. The average instructor rating for the treatment group \((n = 11)\) was 4.3 on a 5-point scale with a standard deviation of 0.8. The average for the control group \((n = 14)\) was 3.9 with a standard deviation of 1.2. Overall, the treatment group had more positive comments about their experience in the class compared to the control group. The sample sizes are too small for this difference to be statistically significant. However, a difference of 8% in ranking the same instructor who used the same teaching material is probably due to the only difference in the instructional design, namely, the use of oral presentations and cooperative group discussions. Here are some written comments from the treatment group:

- “In class it was really nice to consistently experience an active, excited discussion about the limitations and possibilities of statistical analyses.”
- “Overall, the environment of this course made one feel that there was a strong support system to understand and apply statistics.”
- “I think forcing all the public speaking was unnecessary and less helpful than other aspects of the class but I recognize that others may have benefited from it more.”

This course was taught again by the same instructor after completing this study. This time only one section was offered, and oral presentations and cooperative discussions were used in the class. Students’ resistance to oral presentation activities seemed to diminish when they did not have another section to compare themselves to and they were not informed that they were a part of an experiment.

Conclusions

Our quantitative analyses provide evidence that implementing oral presentation with cooperative discussion tasks in teaching statistics resulted in significant improvement in the student disposition towards statistics as a field as well as their basic knowledge of the course content. Students came to class with a prior opinion on the use of oral presentations which did not change much during the class. It was an interesting coincidence possibly that the treatment group had an already more favorable attitude on the use of oral presentation tasks compared to the control group, and that the overall attitude scores did not change significantly at the end of the semester. This discrepancy could be due to the fact that the treatment group knew that they will be required to present their work before they filled the survey and their responses were influenced by the desire to please their instructor who required this additional activity in class. The students who took the class were mostly senior or graduate students, and they probably had fixed opinions on oral presentations based on their experience with other classes.

Limitations of the study

Due to the nature of the study, it was not feasible to randomly assign the students to either group. However, it is assuring that the pre-test scores indicated no significant difference between the groups. Lurking factors might include the class time (the treatment group met at 9 a.m. while the control group met at 11 a.m.). The course evaluation survey was a voluntary response survey and both sections had response rates below 60% of the total number of enrolled students. Generally, voluntary response sampling schemes tend to over represent people with strong opinions. Based on the course evaluation survey, 92.9% of the respondents in the control group were required to take the course compared to 63.3% in the treatment group. It is possible that students who elected to take the class are more motivated than those who are required to take it.
References


