

## FOSTERING CRITICAL THINKING: ALIGNING ASSESSMENT WITH EDUCATIONAL EXPECTATIONS

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### Abstract

Critical thinking is an often-discussed learning outcome in higher education. Critical thinking skills are viewed as important for student success in the classroom as well as for establishing a foundation of lifelong learning. Often, however, assessment measures, viewed as the ultimate test of learning, do not require students to utilize critical thinking skills in any practical or meaningful way. This sends a message to students that although critical thinking is espoused as important, it is not essential for success. Ideally, examinations should both assess and advance knowledge. Further, examination questions should test students' functional, applicable knowledge of concepts, rather than memorization and statements of facts. Examinations that allow student collaboration simulate real-world situations in which an individual's skills gathering, synthesizing, and applying information appropriately are essential. This paper presents data from an undergraduate course in speech acoustics taught over several semesters. During two of these semesters, the instructor utilized different collaborative assessment methods, allowing students to collaborate either before or after individual completion of the examination. Data from student surveys as well as examination scores demonstrate that rigorous take-home examinations with a planned opportunity for student collaboration can effectively assess student learning while also enhancing the learning opportunity for students by encouraging critical thinking skills and real-world problem-solving strategies.

**Keywords:** *Assessment, critical thinking, collaborative learning, higher education.*

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### 1. Introduction

A growing body of literature supports student collaboration, not only for activities and assignments, but also for assessment. Collaborative assessment has been shown to enhance learning (Zipp, 2007), promote deeper understanding of concepts (Cortright, Collins, Rodenbaugh & DiCarlo, 2003; Johnson, Green, Galbraith & Anelli, 2015) and improve long-term retention of knowledge (Cortright et al., 2003; Johnson et al., 2015; Vogler & Robinson, 2016). Further, collaborative problem-solving during group assessment procedures simulates "real-world" situations, requiring individuals to pool resources to solve problems (Handelsman et al., 2004; Macpherson, Lee, & Steeples, 2011). Students also tend to prefer group assessment, citing reduced test anxiety (Johnson et al., 2015; Siegel et al., 2015) and increased engagement and motivation (Macpherson et al., 2011; Simkin, 2005). Finally, researchers have noted that exams designed with student collaboration in mind tend to have more challenging questions that facilitate additional student learning (Johnson et al., 2015; Simkin, 2005). Collaborative assessment also requires essential critical thinking skills, that is, accessing, evaluating, synthesizing, and appropriately applying information.

Many instructors and investigators have attempted to determine the best way to incorporate group assessment procedures into classroom instruction while still holding individual students accountable. Most instructors assess students individually prior to group assessment (Cortright et al., 2003; Macpherson et al., 2011; Moore, 2010; Vogler & Robinson, 2016; Zipp, 2007). Such combined procedures hold students accountable for learning the material while still allowing for the additional educational benefit of the group interactions. However, if collaborative group work does promote deeper understanding of concepts and improved retention of knowledge, students might benefit from a group assessment activity prior to individual assessment. In one model, students collaborated initially for one part of the exam and then completed the remaining exam individually (Siegel, Roberts, Freyermuth, Witzig, & Izc, 2015). This current paper compares two approaches to collaborative testing, one with student collaboration following individual completion of the exam and another requiring students to collaborate prior to the exam by completing a group pre-test.

## 2. Method

In a speech acoustics course taught over several semesters, students typically completed a take-home final exam individually. However, in two semesters, students collaborated while completing the exam. This investigation compares three semesters. In Semester A, students completed a take-home exam individually, as was typical for the course. In Semester B, students completed a take-home exam individually, but then were allowed to collaborate with other students in a group to attempt to improve their answers. In Semester C, students initially worked collaboratively in groups on a practice exam before individually completing an in-class final exam. Student survey data and examination scores were then analyzed to determine the potential effects of different collaborative assessment procedures on students' perception of learning as well as demonstrated knowledge and critical thinking skills on exams.

## 3. Results

### 3.1. Post-test collaboration

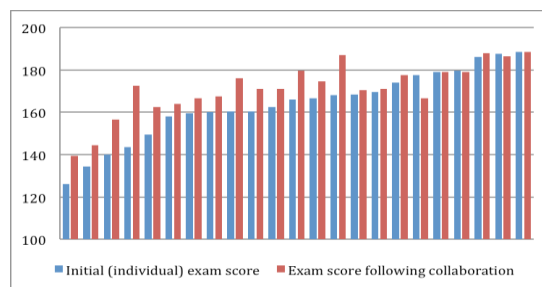
In Semester B, after completing the take-home exam individually, students were randomly placed in groups of three to four students to spend one hour discussing the exam. Following this group collaboration, students could choose to add to or revise any of their answers on the exam. The instructor told students they would receive additional credit for answers that improved following the group discussion. Following each student's revision of their exam, students completed an anonymous survey. Table 1 presents student responses to the survey.

Table 1. Student survey questions and response results for Semester B (N=23).

1. The time spent working with other students helped me learn Strongly agree Somewhat agree Neither agree nor disagree Somewhat disagree and Strongly disagree	19 (83%) 3 (13%) 1 (4%) 0	2. After working with other students, I was better able to answer exam question(s) Strongly agree Somewhat agree Neither agree nor disagree Somewhat disagree and Strongly disagree	17 (74%) 5 (22%) 1 (4%) 0
3. After working with other students: a. my exam answers were both more accurate and more detailed. b. my exam answers were more detailed. c. my exam answers were more accurate. d. my exam answers did not change significantly.	10 (43.5%) 3 (13%) 7 (30.5%) 3 (13%)	4. Which best describes your experience working with other students: a. The other students and I learned equally from each other. b. I learned more from other students than they learned from me. c. The other students learned more from me than I learned from them.	18 (78%) 3 (13%) 2 (9%)

The instructor graded each student's individually completed exam as well as their exam completed after collaboration, comparing any revised answers to determine to what extent students improved their responses. Figure 1 shows exam score results for every student, both pre- and post-collaboration with other students. Exam scores are arranged in ascending order based upon the score of the initial, individually completed exam. On average, students improved their scores by 8 points or 4%, though three students decreased their overall scores after collaboration. Lower-performing students appeared to benefit more from the group collaboration, a finding consistent with prior research (Giuliodori, Lujan, & DiCarlo, 2008).

Figure 1. Student exam scores prior to, and following, group collaboration. (Scores are arranged in ascending order based on initial exam scores.)



### 3.2. Pre-test collaboration

In Semester C, the instructor provided students with a practice exam similar in content and structure to the upcoming final exam. The instructor asked students to work collaboratively in groups of four to answer the practice exam questions. One week later, students individually completed an in-class final examination. After finishing the exam, students anonymously answered two survey questions. Table 2 shows student responses to the survey questions.

Table 2. Student survey questions and response results for Semester C (N=30).

1. Completing the practice exam with other students helped me learn the course material better. Strongly agree Somewhat agree Neither agree nor disagree & Somewhat disagree & Strongly disagree	17 (57%) 13 (43%) 0
2. Completing the practice exam with other students: a. helped me with some of the questions; I would not have been able to complete these questions on my own. b. added to my level of understanding; I was able to answer the questions more accurately and completely than I would have on my own. c. did not help me complete the exam any better than if I had completed it on my own. d. did not help me, but I was able to help them.	8 (27%) 20 (67%) 0 2 (6%)

### 3.3. Examination score comparison across semesters

Table 3 displays range and average of students' final exam scores over the three semesters with different exam delivery format. For Semester B, scores are reported both prior to collaboration and following collaboration.

Table 3. Class final exam score average and range across semesters.

Semester	Final exam format	Average final exam score (%)	Final exam score range (%)
A (N=20)	Take-home exam, completed individually	87.86	68.7-97
B (N=23)	Take-home exam completed individually, prior to collaboration	82	63-95
B (N=23)	Take-home exam completed individually, following post-test student collaboration	86.5	67.5-98.8
C (N=30)	Collaborative pre-test practice exam, with individual in-class exam	87.01	72.7-98.8

## 4. Discussion

An important component of critical thinking is the ability to synthesize information from different sources, determine what is reliable, and make decisions based on all valid evidence. Collaborative assessment allows students this opportunity. In this investigation, student survey responses support the use of collaborative testing. Whether collaboration occurred prior to or following individual completion of the exam, students think the collaboration helped them learn the material and respond to exam questions more accurately and more completely. Most student exam scores increased when collaboration followed individual completion of the exam. However, it remains a challenge to assure that students of all knowledge and skill levels have the potential to benefit equally from collaborative opportunities. Additionally, average class exam scores across the semesters do not provide insight into whether collaboration is best before or after students complete the exam individually. Future studies should continue to assess the most effective use of collaborative group testing, particularly in undergraduate science courses. Regardless of course type, exams should no longer simply be tools for instructors to assess student knowledge at a moment in time. Rather, exams should be dynamic mechanisms to advance knowledge and reinforce the importance of critical thinking and problem-solving skills in real-world situations.

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