CWSEI – PHYS & ASTRO Newsletter

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Our department has always been committed to high standards in education. With support and leadership from the CWSEI, we have made increasing progress in successfully implementing research-based educational methods in our classrooms. This newsletter is meant to keep you up-to-date with the latest CWSEI efforts.

In this issue, we introduce an exam format that supports learning and an active learning environment.

Two-Stage (Group) Exams

By PHAS-CWSEI team

In our last newsletter we talked about active learning in lecture courses, in particular about peer instruction: students think about a conceptual question or a problem question first individually, then exchange ideas with their peers, and finally come to a consensus. Two-stage exams employ this format during the examination. Students first write the exam individually and then again in small groups. From our experience, two-stage exams are fairly easy to implement and offer great benefits. In the following, we describe our format for implementation of workable two-stage (or group-) exams and the resultant benefits. Two-stage exams have recently been given in Phys 101(summer) and Phys 250.

Two stage exams – a workable format.

Our two-stage (or group) exams are conducted in two stages:

- stage 1: (~2/3 of the examination time) A standard formal examination that students take individually as usual;
- stage 2: (~1/3 of the examination time) The group portion begins after all individual exams are collected. Students work in groups of three or four students on (mostly) the same problems as in the individual portion. They must come to a consensus on the answers and hand in one copy with the names and IDs of all group members.

Grades from the individual and the group portion are combined for the total examination mark, weighted between 75% and 90% for the individual portion and 10% and 25% for the group portion. Hence there is a smaller influence of the group score on the overall mark. (A 75/25 split was used in Phys250; a 85/15 split was used in Phys101).

What are the benefits of two-stage exams?

Studies have shown that group exams can increase learning and in particular retention of content. [1] [2]. The general idea is that during a high-stake examination, students are heavily invested in figuring out the correct answers. All students, having committed to an answer in the individual portion, are ready to discuss their approach in a group. In these discussions, students get immediate feedback on their solutions from their peers, which helps them learn from their mistakes. The intense discussion of approaches and solutions leads to increased understanding and better retention. Lower achieving students benefit from extra explanation at their level and higher achieving students benefit from explaining concepts to others, and everyone benefits from critiquing each others ideas. Additional benefits are:

- Development of group skills. Observations show that students discuss the question until all members agree.
- Close to 100% engagement. Students that are usually too shy to speak up during in-class activities will defend their answers during a group exam.
- Increased engagement during in-class peer activities after a group midterm exam (see below).

The high-stakes situation of an examination seems to really drive home the message that peer learning works. The instructor could use the experience and point out that the group exam follows the same ideas as the in-class peer instruction, thus underlining the importance of in-class participation. Even with an already high number of student participation in class before the midterm, the instructors of Phys 101 summer class reported an increase in engagement during the in-class activities after the midterm. Clicker participation numbers support this observation: The average attendance was 163 out of 178 students, with the lowest attendance being 159 on the second day of classes and a maximum attendance being 166.

Much of the same has been observed in Phys 250 (70 students), where four different instructors in four consecutive years have

implemented two-stage midterm exams. A study is underway to compare the effectiveness of standard vs two-stage exams. Preliminary results of the study show that students learn and retain more of the exam material when the test is in a group format.

What students think about two-stage exams

Complementing the results of the 'two-stage exam' study in Phys 250 are some of the comments made by students in the exit interviews conducted ~6 months after the end of the summer Phys 250 course. When students were asked to try and remember the part of the course where they might have learned (or finally understood) a particularly difficult concept, they mentioned 'group exams' most often.

In Phys 101 we gave the midterm and final exams in a group format this past June and surveyed the students about their experience. While the vast majority of students (75%) supported this format, a significant number had concerns about "weak students unfairly gaining marks". However, generally student comments were positive: when asked to describe their experience with the group exam, the most common responses – each mentioned equally by about half the class – were 'it was helpful for my learning (and/or understanding) of the material' and 'it was helpful to compare answers and to listen to how others approached the question'. Here are a few students' remarks:

Student A*: "I was able to instantly learn form my mistakes."*

Student B*: "It was good to compare methods and answers with others, and it allowed us to be more confident."*

Student C: *"It was surprisingly very helpful … When I got a different answer I always commented why I chose the answer that I did and our group would discuss it."*

Student D: *"Interesting. All had different ways [of] approaching the question. Very helpful to understand everyone's response and why they thought their answer was correct."*

Another issue that came up was that some students viewed the group exam mostly as a learning tool for the final exam. Hence they liked the format for the midterm, but did not see it as beneficial for the final exam. It seems that since Phys 101 is the last physics course for most of these students, retention or learning from their mistakes on the final exam did not seem to be a priority.

We would therefore recommend conducting two midterm exams in a two-stage format and the final examination as usual, in an individual format.

How to implement two-stage exams

- Students should be used to working with their peers from lectures and/or tutorials on a regular basis.
- Tell your students on the first day of classes that examinations will be conducted in this format and why you are doing it this way. *(This is arguably the most critical step).*
- Implement a policy that the group score cannot be lower than the individual mark. This will address concerns about fairness and affect only a few high-performing students: groups perform equal or better than individual students in almost all cases.
- Give clear instructions during the individual-to-group transition: Students should remain seated and hand their individual exam to a TA. After all exams are collected, students should quickly assemble into groups and then raise their hands to receive a copy of the exam. Remind them to put all their names and student numbers on the group exam. (Check this when collecting the group exam copies.) Instruct them that exam papers should not be divided up.
- Do not let students work on their own during the group portion. TAs and instructors can help with forming groups.
- Don't worry if groups are speaking loudly, or listening to groups around them, cheating is much less of a concern for this type of exam.

The biggest challenge is time. A two-stage exam in a 50-minute lecture timeslot is doable but very challenging. Having a 1:20 timeslot or an evening exam is much better. Concerns about the length of an exam could be addressed by repeating only the conceptual questions of the individual part in the group portion, thus greatly reducing the time needed for group work.

[1] Cortright, R.N., Collins, H.L., Rodenbaugh D.W., and DiCarlo, S.T. 2003. Student retention of course content is improved by collaborative-group testing, Advan. Physiol. Edu. 27: 102-108 pp, 2003

[2] Stearns, S. A. 1996. Collaborative Exams as Learning Tools, College Teaching, Vol. 44, No. 3 (Summer, 1996), pp. 111-112