Group quizzes as a learning experience in an introductory lab

Brett Gilley (bgilley@eos.ubc.ca) and Sara Harris (sharris@eos.ubc.ca), Earth and Ocean Sciences, University of British Columbia, Vancouver, BC V6T 1Z4, Canada

Introduction - Group Quizzes and Exams at the University of British Columbia

A variety of courses are now using group exams as part of the Carl Wieman Science Education Initiative at the University of British Columbia. These exams follow a similar pattern.

Students in these courses:

- Sit an individual exam or quiz on their own
- Hand in the individual component
- Immediately get into groups of 3 or 4
- Write the same exam again but as a group with only one exam sheet, so they must agree on the answers

Discussion is permitted in the group portion of the exam or quiz (and the room quickly becomes a lively place). In most cases the majority of the student's mark for the exam or quiz comes from the individual portion and a smaller amount comes from the group exam. (Often 75%/25% or 85%/15%).

Most of the data presented here are from an introductory science laboratory course (EOSC 111: A Laboratory Exploration of Planet Earth) which has been using group quizzes since 2007. In this case, quizzes are based on prereadings students complete prior to each lab.

"Discussion over tricky questions facilitate learning immediately and the answer/concept is stuck in your brain FOREVER!"

Research questions

We analyzed quiz results, group behavior based on matched individual and group responses, and student surveys to answer a variety of questions including:

(1) What % of groups match, exceed, or score lower than the highest scoring individual?
(2) Do students "learn the wrong answer" from their group discussion?
(3) Do students learn something new while taking group quizzes ?
(4) What types of questions elicit discussion?
(5) Are the quizzes at the right level of desirable difficulty?
(6) How can we improve the quizzes?

"They allow me to see what questions I got wrong and why, while the exam is fresh in my mind."

Benefits of group exams & quizzes

- Timely feedback
- Peer feedback
  - Lower achieving students get extra explanation
  - Higher achieving students benefit from explaining to others
- Increased preparation for upcoming activities
- Develop "soft" group work skills (6)(3)
- Reduces student anxiety
- ALL students participate!
- Quieter students get a chance to contribute even in large classes (7)
- Students like it and believe it helps their learning (5),(6)
- Fewer students drop courses with group exams (6)
- Student retention of information is increased (2)

"There are several questions <where> my group helped me understand a concept or a fact"

Drawbacks of group exams & quizzes

- Social loafing and/or dominant group members
- Groups sidetracked by process
- Students could be convinced of the wrong answer
- Difficulties managing student groups (4)
- Student inexperience with groups
- Assigning marks can be difficult
- Group exams take time (longer sessions or shorter exams)

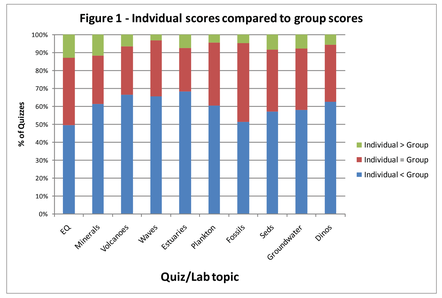
Though many of these drawbacks are concerning, some might be desirable difficulties. If handled well they could teach the skills students need to be successful.

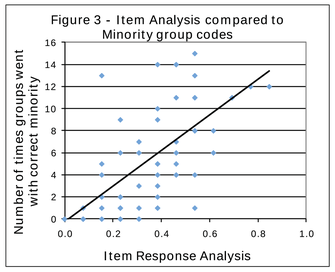
Group Quiz Results: EOSC 111

Groups are likely to exceed the individual members(Figure 1). In 60% of cases, group marks exceeded individual marks and in 92% groups meet or exceed individual marks. Surprisingly, ~7% of individuals earned higher scores than their group, different from the typical group exam situations throughout the University of British Columbia (where most groups outperform individuals). These results may be due to the small number of questions on our quizzes (6 on average), a relatively high average individual score (4.5/6, most common score is 5/6), and/or a high percentage of individuals scoring 6/6 (24%). The scores suggest that the quizzes may not be sufficiently difficult for the group quizzes to provide a learning experience for all students.

Groups tend to self-correct (Figure 2). If many individual members are correct the group is overwhelmingly likely to select the correct answer. However, even if any one person chooses the correct answer in the individual quiz the group is still much more likely to select the correct answer. The fact that groups more often choose the answer of a correct minority than of an incorrect majority implies that the minority is sufficiently persuasive in discussion. Groups are also more likely to choose the correct answer when they have each individually selected conflicting wrong answers. The only situation where groups are less likely to select the correct answer is when all group members have individually selected the same incorrect answer.

Discriminating questions foster discussion (Figure 3). Though overall the quizzes in EOSC 111 may be too easy, some questions show promise. Questions that are discriminating based on item analysis (1) are often also those in which groups selected the answer of a correct minority, or chose the correct answer after all group members answered incorrectly on the individual quiz. This implies that discriminating questions were also questions that encouraged discussion and learning. Future quizzes will be improved by ensuring that each quiz has at least two highly discriminating questions that are likely to promote peer discussion.





"Great idea! The group exams give you a chance to go over your answers to the exam while you still care about the questions."

Sample Discriminating Questions

Imagine that you find a mineral shaped like a cube. You hit it with a hammer and it breaks into smaller cubes. How many cleavage planes does it have?

A) 1 B) 2 C) 3 D) 4 E) 6

City A below recorded the first P wave arrival from this earthquake at 10:00 am and the first surface waves at 10:03 am. If the first P wave arrival at City B occurred at 10:30 am, when would the first surface waves arrive at City B?

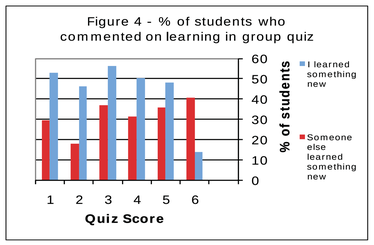
A) Before 10:33 am
B) At exactly 10:33 am
C) After 10:33 am
D) Not enough information

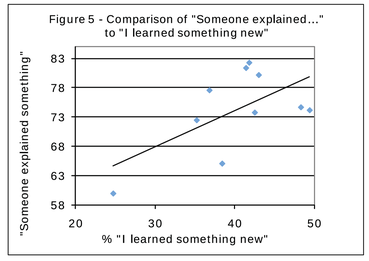
Surveys

After each class, students in EOSC 111 complete an online survey asking a variety of questions about the laboratory session. Several questions about the group quiz were added to this survey. In one group of questions we asked what behaviours they engaged in during their group quiz:

a. Compared answers (e.g. "I got B", "I got C"...).
b. Someone explained why they thought a particular answer was correct or incorrect.
c. People argued for different answers to the same question.
d. The group reached a consensus (all agreed) on an answer to a particular question.
e. The group did not reach a consensus on an answer to a particu lar question, and someone made a decision what the group answer would be.
f. You realized that you now understood the answer to a particular question, but you hadn't understood it during the individual quiz.
g. Someone else (not you) indicated that they now understood the answer to a particular question, but they hadn't understood it during the individual quiz.

Of students who miss at least one question on the individual quiz, about 50% report having learned something new in the group quiz process (Figure 4). 15% of those who answered all the questions correctly as individuals also report learning something new. The student-reported behavior most highly correlated with "learning something new" is "someone explained why they thought an answer was correct/incorrect" (r=0.6). (Figure 5)





"You actually learn what you got wrong right away from a student perspective"

Figure 2 - Results of 1528 Questions Answered By Groups

How group members perfomed individually	All individuals in group correct	Majority of individuals in group correct	50% of individuals in group correct	Minority of individuals (>1) in group correct	All individuals different answers - 1 correct	All individuals wrong More than one answer	All individuals- wrong - same answer
(#of instances) % of instances	(600) 39%	(448) 29%	(197) 13%	(144)	(84) 5%	(38) 3%	(17) 1%
Group performance	Group Correct / Group Incorrect	Group Correct / Group Incorrect	Group Correct / Group Incorrect	Group Correct / Group Incorrect	Group Correct / Group Incorrect	Group Correct / Group Incorrect	Group Correct / Group Incorrect
(# of instances)	(600) / (0)	(436) / (12)	(169) / (28)	(92) / (52)	(64) / (19)	(30) / (8)	(1) / (16)
% of instances)	100% / 0%	97% / 3%	86% / 14%	60% / 40%	74% / 26%	79% / 30%	6% / 94%

For almost 40% of questions all individuals in the group got the correct answer. ***The quizzes may be too easy***

If any one student in a group has the correct answer, the group itself is far more likely to get the correct answer. ***Groups tend to self correct***

If all individuals are wrong but the group has a variety of incorrect answers, groups are ***still*** much more likely to get the correct answer

The only instance where groups are more likely to choose the incorrect answer is when all individuals have the same wrong answer. ***Consensus can be dangerous.***

"They facilitate discussion amongst group members and people who know the material well can reason with others and improve everyone's understanding. For material everyone is only partly familiar with, discussion can help groups piece together the puzzle, so to speak."

Conclusions and future work

- Group exams are a learning experience for most students in EOSC 111
- Students are not frequently lead astray by group discussion
- In most cases, student groups equal or exceed individual scores
- Questions which are shown to be discriminating based on item analysis are more likely to encourage good student discussions
- Our quizzes can be improved by increasing the difficulty of the ques tions and adding more discriminating questions to the quizzes.

Future work on this project will include experiments to determine if students who engage in group discussion on a concept are more likely to retain the information then students who do not.

Acknowledgments

The authours would like to thank Alison Jolley, Sarah Henderson, Erin Lane, Joshua Caulkins, Francis Jones and the support of the Carl Wieman Science Education Initiative.

References

(1) Collins, J. 2006. Education Techniques for Lifelong Learning, Writing Multiple-Choice Questions for Continuing Medical Education Activities and Self-Assessment Modules, RadioGraphics, 26, 543-551.
(2) 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
(3) McLaughlin, M. 1992. "Employability Skills Profile: What Are Employers Looking For?" (Report 81-92-E). Ottawa, ON: Conference Board of Canada.
(4) Michaelsen, L.K., Watson, W., Cragin, J.P. and Fink, L.D. 1982. Team Learning: a Potential Solution To the Problems of Large Classes Journal of Management Education 7; 13
(5) Shindler, J.V. 2004. "Greater Than the Sum of the Parts?" Examining the Soundness of Collaborative Exams in Teacher Education Courses. Innovative Higher Education Volume 28, Number 4
(6) Stearns, S. A. 1996. Collaborative Exams as Learning Tools College Teaching, Vol. 44, No. 3 (Summer, 1996), pp. 111-112
(7) Wieman, C. 2010. *Personal communication*