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Work-in-Progress: Evaluating the Impact of Individual vs. Group Exams in a Biomechanics Course

Dr. Anne-Marie Ginn-Hedman, Texas A&M University

Dr. Anne-Marie Ginn-Hedman (Annie Hedman) is an instructional assistant professor at Texas A&M University with the Department of Biomedical Engineering. Dr. Hedman specializes in the Biomechanics and Engineering Education tracks.

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Introduction & Motivation

Assessment formats play a critical role in engineering education and shape how instructors evaluate student readiness to navigate real-world challenges. Traditional individual exams emphasize theoretical understanding and ability to perform calculations, which are effective for assessing knowledge retention, but often fail to replicate the collaborative nature of engineering [1-4]. Alternatively, group exams encourage team-based problem-solving seen in professional engineering settings [1-5]. This format aligns with the framework of social constructivism which states that collaborative activities enhance learning by allowing students to construct knowledge through authentic interaction with others [6,7]. Furthermore, in addition to evaluating basic student application of knowledge, the Accreditation Board for Engineering and Technology (ABET) emphasizes the need to assess other competencies such as teamwork and communication to ensure comprehensive student learning [8].

Despite their potential benefits, group exams have presented challenges, such as unequal participation and difficulty in evaluating individual contributions [4]. These limitations have encouraged ongoing research into the optimal assessment formats for engineering students [9,10]. Appropriately, this work-in-progress study contributes to this ongoing discourse by investigating the impact of individual versus group exams in a junior-level biomedical engineering mechanics course at a large R1 university. Insights from this research will drive the creation of innovative assessment strategies that will provide future engineers with the teamwork and individual skills needed for real-world success.

To explore these dynamics, this study addresses the following research questions:

1. How do group vs. individual exams impact student collaboration and peer learning?
2. How do students perceive the real-world relevance of group vs. individual exams?
3. How do group vs. individual exams influence accountability and independent learning?

Methodology

This work-in-progress study was conducted in a junior-level undergraduate biomechanics course at a large R1 university. Students completed four exams during separate lab periods: the first two as individual exams and the latter two as group exams. The exams were formatted as following:

- **Individual (Exams 1 & 2):** theoretical problems with biomedical engineering context (example: determining force at failure for a bone truss)
- **Group (Exams 3 & 4):** collaborative tasks requiring students to complete hands-on activities and compare data with theoretical calculations (example: analyzing stress in single vs. double suture configuration).

For group exams, students self-selected their groups and submitted a single exam response with a brief peer review for accountability. Each group exam included a hands-on mini-lab where students conducted experiments (e.g., stress analysis in sutures, artificial muscle mechanics) and compared results to theoretical calculations.

An open-ended survey (exempt from full IRB review under IRB2023-0053M) was administered to the students at the end of the semester. The survey asked five reflection questions:

1. What did you like about the exam formats (individual vs. group)?
2. What did you NOT like about the exam formats?
3. What would you change about the exam formats?
4. How did the exam formats affect your understanding of the material?
5. How did the formats affect your ability to apply engineering skills in a practical context?

Survey responses (n=127 out of a total enrollment of 158) were qualitatively analyzed using MAXQDA [11-13]. Text responses were used to generate word clouds to identify frequently occurring words and phrases. These were then grouped into themes based on learning theories and further refined using MAXQDA's "search and code" tool. Keywords such as *team, stress, peer,* and *collaboration* were used to generate the first theme (**"Collaborative Learning"**). The second theme (**"Real-World Applications"**) was created using the words like *hands-on, practical, application,* and *real-world*. The third theme (**"Individual Accountability"**) was developed with keywords such as *independent, accountable, study, myself,* and *hard*. The percentage of responses associated with each theme was calculated to show prevalence among students. Of note, preliminary analysis used grounded theory for initial theme generation; future work will incorporate code mapping and network analysis for more in-depth evaluation [11-13].

Results & Discussion

The following section explores the three emerging themes that were derived from the open-ended survey data. Representative student quotes are presented first followed by analysis. These themes align with key learning theories: social constructivism explains the benefits of collaboration in group exams, experiential learning highlights the value of hands-on tasks, and self-regulated learning reinforces how individual exams promote accountability.

Emerging Theme 1: Collaborative Learning (34% of Responses)

"Group exams were less stressful since we could ask each other questions and verify answers."
"[Group exams] were a realistic view into division of labor, working against a deadline, compromise, and troubleshooting."

According to the data, group assessments fostered open communication, reduced exam-related anxiety, and encouraged teamwork. Additionally, 28% of responses explicitly stated that group work improved their understanding of the material. Students expressed appreciation for being evaluated as *engineers* rather than *just students*, as they could showcase their practical skills and readiness for real-world challenges. Appropriately, these findings align with research demonstrating the importance of collaborative learning in preparing students for careers in engineering [5,9,10].

Emerging Theme 2: Real-World Applications (44% of Responses)

"Being able to perform a hands-on activity with my team […was very helpful in…] discovering things that I probably would have never looked over on an individual assignment."
"[The group exams] helped me see the real-life application of mechanics […] as well as the calculations involved."

"Working on group exams mimicked real-world engineering scenarios where teamwork and collaborative problem-solving are essential."

Survey data revealed that group exams helped students bridge the gap between theory and practice by allowing students to apply abstract mechanics concepts to practical scenarios. These findings support Kolb's experiential learning theory [14,15] which outlines the importance of learning through active engagement and reflection on real-world tasks, and Lave and Wenger's situated learning theory which highlights the role of authentic contexts for meaningful knowledge transfer [16]. Furthermore, project-based group exams exposed students to diverse perspectives typically not encountered in textbooks or traditional exams.

Emerging Theme 3: Individual Accountability (28% of Responses)
"I studied and understood more for the individual exams because I knew that there would be no outside help."
"I went into the group exams less prepared […] but I came out knowing more about the application of the concepts."

Survey data revealed that individual exams allowed students to independently master complex material through personal accountability. These finding coincide with self-regulated learning theory that states self-monitoring and personal effort drive academic success [17,18]. While group exams encourage collaboration, data suggest that individual evaluation offers unique benefits by reinforcing independence and self-discipline ensuring that all students actively engage in learning without over-reliance on teammates.

Student Suggestions
Open-ended survey responses provided valuable suggestions for improving the exam format. One student proposed starting exams individually during the *"first third of lab"* before transitioning to group discussions, creating a hybrid model that combines individual accountability with collaborative problem-solving. Another suggested requiring each participant to *"write their own part of the solution"* during group exams to ensure accountability. These ideas align with research on mixed-format assessments which emphasize balancing individual responsibility with the benefits of teamwork to enhance learning outcomes [2-4]. Future course iterations will keep group exams but require each student to submit an individual copy to ensure participation and understanding.

Conclusions and Future Work

Preliminary findings reveal that individual and group exams serve complementary roles in engineering education. Individual exams emphasize theoretical understanding and personal accountability, while group exams enhance collaboration and real-world problem-solving skills. Future work will refine data analysis and explore hybrid assessment models to balance individual accountability with collaborative learning. Expanding data collection to capture student perspectives before and after both exam formats may provide deeper insight into how assessment formats shape learning experiences. Accordingly, these findings contribute to ongoing efforts to design assessments that not only evaluate knowledge but also foster problem-solving and teamwork skills essential for engineering practice.

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