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SHARE: Homework Interviews in BME: Driving Deep Content Mastery and Fostering Professional Communication Skills

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SHARE: Homework Interviews in BME: Driving Deep Content Mastery and Fostering Professional Communication Skills

Motivation or Challenge: Due to the interdisciplinary nature of Biomedical Engineering (BME), BME students require high competency in technical skills, oral communication, and teamwork. Additionally, ABET's standard seven student outcomes require that students should be proficient in both technical mastery (outcome 1, 2, 6) and professional skills like communication (outcome 3) and teamwork (outcome 5) [1]. These essential non-technical skills are often not addressed in traditional lecture and assessment formats. Still, even in well-designed homework assignments that give students practice with technical problem solving, students can view these as procedural tasks they need to complete rather than a deep learning opportunity. In a junior-level BME solid mechanics course, while students were encouraged to work with other students on homework to promote discussion of content and teamwork skills, it was apparent that some students didn't work with others and ended up stuck on challenging homework problems, and among groups that did work together, there was often an inconsistent level of content understanding across individuals. Research in other engineering disciplines supports that assigned group work combined with individual accountability promotes high engagement from group members and students report it helps them learn more than a traditional assignment (e.g., [2, 3]). To address these gaps, I implemented a system of group homework supported by one-on-one student homework interviews with the instructor. I have found this approach provides several key benefits: 1) it allows the instructor to identify and address gaps in students' understanding before a high-stakes summative assessment (ex., midterm exam)[4], 2) provides students a low-stakes, formative practice in articulating complex technical knowledge during an interview, 3) enables the instructor to personalize instruction by adapting interview questions to individual student proficiency, and 4) guarantees students at least three focused, one-on-one interactions with their instructor.

Learning Objectives: This instructional approach was designed to improve technical competency in the course content and provide students practice with oral communication, teamwork, and professionalism and preparedness in interviews. It is expected that at the end of a course which implements the combined group homework and one-on-one interview, students will be able to:

1. Apply fundamental principles of course content to model and solve engineering problems related to biological tissues and systems.
2. Effectively articulate complex biomedical concepts and processes orally in an interview
3. Demonstrate effective engagement in a team to collectively solve complex biomedical engineering deliverables while internalizing the underlying technical concepts
4. Apply knowledge gained in the homework to altered problem constraints/conditions and to new scenarios

Implementation: In a semester long course students work in groups of three to complete nine homework assignments which are a variety of solid mechanics problems that are solved by hand or with programming and many of which are applied to the human body. Groups of three were chosen because evidence suggests small groups (2-4) are ideal for collaborative learning in technical courses [5-7] and sustain a feasible instructor workload. Students self-select their group members or can ask the instructor to be placed in a group. They complete a group contract prior to their first group homework assignment to support group formation and encourage students to proactively think about how they will work effectively together and how to deal with group conflicts (Appendix A, [8]). If group conflicts arise, students are asked to refer to their group contract and if the conflict persists to contact the instructor to resolve the issue. Students are given the opportunity to change groups after the first three group homework assignments. The homework assignments are assessed for correctness, and the group grade and feedback on the assignment is given to all members of the group. To assess a student's individual understanding of the submitted homework, each student is assigned to complete three one-on-one homework interviews with the instructor. Each homework interview is ~7-10 minutes and covers content from one homework assignment. The instructor assigns students to the homework for which they will be interviewed and the student signs up for one of the instructor's Zoom meeting slots in advance. The available time slots for the interview occur soon after the group homework is submitted, either later that same day or the following day. During the interview, students share their screen with their submitted homework. The instructor asks students to describe (as if to another engineering student not taking this course) one or more of their homework solutions selected by the instructor. The instructor probes their rationale behind key engineering decisions and asks students to apply their content knowledge to modified problem constraints. Student performance in the interview counts as a homework grade evaluated on a rubric, with technical competence weighted highest, followed by communication effectiveness, and professionalism and preparedness (Appendix B). Since few students have experienced oral examinations and a one-on-one interview can be stressful [3, 9], the first interview is more instructional, graded on an easier scale, students are asked to reflect on their interview experience through a short survey, and students are given extensive written feedback on what aspects they did well on and what they may should consider when going into the next interview.

Situational Factors: A main barrier to implementation of this method is instructor time. The author implemented this method in SP 23, 24, and 25 which had class sizes of 66, 37, and 48, respectively. Since homework is submitted in a group rather than individually there is a decrease in instructor time needed to grade the homework assignments, but the decrease does not make up for the increased time for the instructor to complete the interviews. The method can be adapted to smaller or larger classrooms by adjusting the number or duration of homework interviews. Larger courses may also use qualified teaching assistants to help conduct one-on-one interviews. The zoom interview format was chosen to provide students and instructors with more scheduling flexibility but in-person interviews may be used to provide a better student-instructor connection.

Appendix A - Group contract

The group homework assignments are set up primarily for you to more deeply understand the course content by working through challenging problems together. I have found that for the majority of BME 345 students, the group homework assignments are much more effective learning approach than having you complete homework individually. Still, everyone knows what it's like to work in an ineffective group. My hope is that by sitting down to have a conversation about expectations and come to an agreement on how you want the group to function, you create a positive, collaborative group. Plus, employers want to hire people that can work effectively in groups and this exercise, establishing group expectations and responsibilities, is a good tool you can talk about in an interview or use in the workplace.

Instructions:

In a bulleted outline, I want you to address at least the following –

- How will you communicate with each other (e.g., text, email, slack, telepathically, etc.)?
- What are your expectations of how the work will be completed?
- What will you do when a group member is not following the above group-defined expectations? When will someone be given credit versus when will they not be given credit?
- You may want to outline specific warnings and consequences for – neglecting to respond to the group communications, neglecting to attempt their homework by the specified time, neglecting to contribute or show up to meetings, etc. What will you give 1-2 warnings on, at what point will you leave their name off the submitted work, at what point will you inform the instructor, etc.?

Note that the more specific a contract you make with each other the more you will understand what is expected. Here are some additional things to consider talking about or, including in, your contract:

What is each group member's weekly schedule like? When will you meet up? What format will your meet-up be (e.g., in-person, zoom)? What do you expect everyone to have completed before meeting up? Who will submit the work? By when will the work be submitted? How will all group members know the work is submitted? Will you attend office hours – together, separately or not at all? What is your stance on using AI? What do you consider plagiarism or cheating? What are your strengths in terms of mechanics, materials, and programing? How will you share documents, code, homework? Are there times in the semester where you are out-of-town or may have a conflict that the others should know about? Once the group members agree to the terms of the contract have each person in the group print and sign their name and date their signature. One contract should be uploaded to Gradescope with all group members added to the submission (https://help.gradescope.com/article/m5qz2xsnjy-student-add-group-members).

Appendix B - Rubric

The homework interviews are graded out of 75 points.

Professionalism and preparedness	The interviewee was not meeting 3 or more of the professionalism/preparedness standards ***0 points***	The interviewee did not meeting 1 of the professionalism/preparedness standards ***5 points***	The interviewee did not meeting 1 of the professionalism/preparedness standards ***10 points***	The interviewee scheduled their session ahead of time, was in the virtual waiting room on time, was able to share their screen with the appropriate homework and was clearly prepared for the meeting. The interviewee made eye contact during the interview and acted in a professional manner. ***15 points***
Communication	The interviewee could not communicate with clarity. The interviewer had extreme difficulty following or understanding the interviewee's thought process or approach. The interviewee may have stayed silent for much of the interview, even when directly addressed by the interviewer. ***5 points***	The interviewee communicated with their interviewer adequately throughout the interview. The interviewer may have needed to ask the interviewee follow-up questions about their thought process, the approach, etc multiple times. ***10 points***	The interviewee communicated with their interviewer adequately throughout the interview. The interviewer may have needed to ask the interviewee follow-up questions about their thought process, the approach, etc. ***15 points***	The interviewee communicated with their interviewer adequately throughout the interview. The interviewer did not need to ask the interviewee follow-up questions about their thought process, the approach, etc. ***20 points***
Technical Knowledge	The interviewee could not correctly answer the technical questions indicating they need substantial review of the technical concepts ***0 points***	The interviewee's answers were only partially correct or only partially described correctly indicating they do not have a full grasp on the technical concepts. ***24 points***	The interviewee's answer was correct but they had some difficulty describing the technical aspects clearly or completely. OR The interviewee's answer was originally incorrect but when told what was right, they were able to correct their misconception and describe the technical content, suggesting they have a good grasp of the concepts. ***32 points***	The interviewee's answer was correct and they were able to describe the technical aspects clearly, displaying a deep understanding of the content. ***40 points***

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