

BOARD # 30: Work in Progress: Student Use of Online Resources and AI for Learning in Biomedical Engineering Courses

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Introduction

Students are more frequently engaging with the virtual world for courses [1-3]. Studies show that online resources significantly and equitably improve students' performance in courses [4,5]. Additionally, online resources are comparable to traditional learning resources, such as textbooks, in terms of student course performance [6]. Additionally, artificial intelligence (AI) provides even more opportunities for improved learning in courses [7]. Identifying how students use online resources and AI is especially critical for the field of biomedical engineering (BME), whose multidisciplinary scope may require students to use online resources not necessarily created specifically for BME audiences or that are supplied directly by the course instructor. The goal of our IRB-approved study (IRB # 18018) is to identify BME students' current use of online resources and AI by surveying both BME students and instructors about how online resources and AI are being used by BME students and instructors to support learning in BME courses.

Methods

We emailed a Qualtrics survey to undergraduate students and instructors enrolled in or instructing eleven different BME undergraduate courses offered during the Fall 2024 (FA24) semester (**Appendix A**). All invited participants were members of the Stephenson School of Biomedical Engineering at the University of Oklahoma. Courses included eight lecture-based courses, two lab-based courses, and one project-based course. We designed the survey workflow to ask participants different questions based on whether the participant was an undergraduate student (**Appendix B**) or an instructor (**Appendix C**). The survey provided definitions for various online resources (**Appendix D**) to support completion of the survey. Here, we define "online resources" as any video, simulation, webpage, document, worked/interactive example problem, forum, or other interactive tool accessed through the internet that enhances student learning. We also collected demographic information from participants. As an incentive for participation, we entered all participants into a raffle for \$50 Amazon gift cards.

The student survey (**Appendix B**) comprised 20 questions per course enrolled. We asked students questions about the types of online resources provided by the instructor (i.e., instructor-provided online resources), the types of online resources students used other than what the instructor provided (i.e., independent online resources), students' perceptions of the frequency of online resource use, students' perceptions of the efficacy of online resources, and students' perceptions on AI use and incorporation in their courses. We also asked students what online resources they would like to see implemented in their courses and how they thought AI could be better incorporated into their courses. The instructor survey (**Appendix C**) comprised 14 questions per course taught. We asked instructors questions about the types of online resources they provided to students during the course, instructor perceptions of the efficacy of the instructor-provided online resources, and instructor perceptions on AI use and incorporation in their courses. We also asked the instructor what online resources they would like to see implemented in their courses and how they thought AI could be better incorporated into their courses. For our current results, in cases

where the same student or the same instructor submitted surveys for multiple courses, each survey was recorded for our current analysis of trends. As the study continues, participant responses will be separated by course to assess data on the basis of course topic.

Results

We invited 285 undergraduate students and 9 instructors to participate in our study. Upon survey completion, we received consenting participation from 14 students (5% response rate) and 3 instructors (33% response rate). We received responses from the student participants for 10 of the 11 possible courses. We received responses from the instructors for 5 of the 11 possible courses. Based on how we defined responses for the purposes of our analysis, we received $N = 30$ student survey responses and $N = 6$ instructor survey responses. Given this limited response, our current conclusions are focused around general observations of the perceived value of and opportunities for online resources and AI use across surveyed courses. Currently, statistical testing is not performed based on the limited number of independent responses.

We asked both students and instructors what the expected final letter grade of students will be in surveyed courses (Scenario I). We also asked what the expected final letter grade would be if students did not have access to instructor-provided online resources (Scenario II) or independent online resources (Scenario III). To quantify the perceived effect of instructor-provided and independent online resources on expected final student grades, we equated the letter grades with scores using the United States of America (USA) grade point average (GPA) system.

Both students (**Figure 1A**) and instructors (**Figure 1B**) perceive that access to online resources has a perceived impact on students' final expected grades. Specifically, our data indicates that instructor-provided online resources are perceived to have more impact compared to independent online resources. Further, our results suggest that student and instructor expectations for final letter grades are aligned relative to perceived value of online resources (**Figure 1C**).

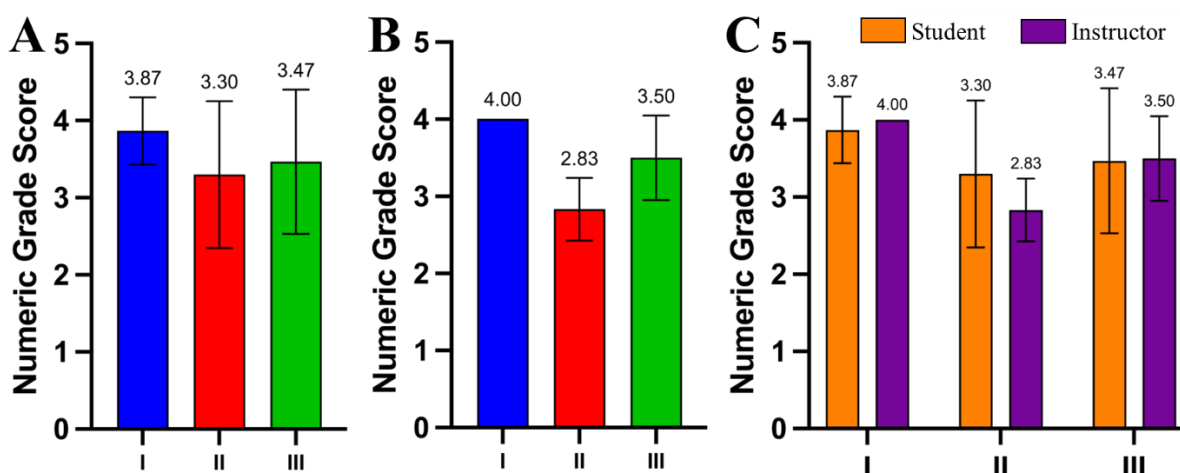


Figure 1. Quantification of participant letter grade expectations Survey participants predicated final letter grades based on described Scenario I (I), Scenario II (II), and Scenario III (III). The value shown above the bar is the mean predicated GPA value across all survey responses. (A)

Student responses on their expected final letter grades across described scenarios. Bar graphs show mean predicted letter grade as correlated with numerical score based on the USA GPA system, with error bars representing measured standard deviation. N = 30 survey responses for each scenario. **(B)** Instructor responses on student expected final letter grades across described scenarios. Bar graphs show mean predicted letter grade as correlated with numerical score based on the USA GPA system, with error bars representing measured standard deviation. N = 6 survey responses for each scenario. **(C)** Combination of student and instructor responses to identify possible differences in expected final grades based on online resource access.

In addition to the demonstrated importance of online resources on perceived student performance, our survey also reveals opportunities identified by both students and instructors for improved AI implementation in BME courses (**Table 1**). Largely, both students and instructors indicate that inclusion of more opportunities for AI use and instruction can benefit students' ability to understand course materials, perform on assignments, and connect concepts with applications. In particular, students indicate a desire to learn how AI can be used. Instructor responses mostly focus on the limits of AI both generally and for their own courses.

Table 1. Selected Responses to Appendix B Question 20 and Appendix C Question 14

Student Responses	Instructor Responses
<i>Showing how AI can be used to conduct initial research into a subject and find appropriate sources.</i>	I think that students could improve at their use of sequential prompts. I think students would benefit from [the] use of more diverse AI tools (i.e., in addition to ChatGPT). I think that students should use AI more to generate practice problems and summaries from lectures (i.e., to help them study at their own pace and be more self-directed in review of class materials). <i>I think we need to keep working on our class rubrics to penalize students who are using AI as a crutch</i> (i.e., to do the work or thinking) and reward students who are using AI in an efficient and responsible manner (e.g., to structure arguments, outline, refine text, brainstorm, edit tone, etc.).
<i>Asking AI for ideas of how to start problems or explain the current flow in circuitry to better understand how they interact.</i>	
<i>Have [AI] write more of the [project] document. Most of the work is busy work, wanting a specific format and order anyway. The AI can do it better in seconds with the same information.</i>	
<i>Since AI is still new, sometimes we might have not discovered all the potential [it] has. To be directed towards its great potential, we can have some assignments that we have to use AI on it.</i>	
<i>Used to explain the steps of the code when [I'm] confused</i>	<i>Provide more clarity on the limits and applications of AI both for accessing course knowledge and how AI is used in the field.</i>
<i>Learn how to ask clarifying questions to ChatGPT</i>	
<i>Possibly to troubleshoot codes</i>	I do not have any specific guidance on where and when AI can and should be used. I have a generic statement in my syllabus, but <i>I would like to give students more direction on the usefulness of AI</i> . I would like to do this via pre- and post-lab assignments where AI is required.
<i>Compiling examples of when these topics and tools are used in the real world</i>	
<i>Using AI to give an outline of how to complete a problem if [we are] lost. Or using AI to summarize notes?</i>	
<i>I do not think AI improved my class experience; I believe the answers it generates are generally inferior and/or wrong compared to my work. We were instructed to use it in some specific cases by the instructor, though I deliberately avoided its usage where possible.</i>	Yes, I certainly think [AI could] be used more effectively, I did not have the bandwidth this semester to consider its integration.

Conclusions

In this study, we present insights from our current survey data regarding the impact of online resources on perceived student performance based on expected final letter grades and perspectives on AI use in courses from students and instructors. We are revising our recruiting and surveying strategy to improve participation. We are also considering a longitudinal study to gauge how participant perceptions of online resources and AI improve over time. We invite interested collaborators to work with us in collecting data from other institutions. Through collaborating, our hope is to gather a more representative set of data. with which we can identify new opportunities for developing and implementing both online resources and AI to enhance student mastery of course content.

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Appendix A: Surveyed Courses

Course and Response Information

Course Number and Name	Course Type	Student Responses?	Instructor Responses?
BME 2333 Fundamentals of Biomedical Engineering	Lecture-based	Yes	No
BME 3133 Bioelectricity	Lecture-based	Yes	Yes
BME 3143 Biomechanics	Lecture-based	Yes	Yes
BME 3153 Molecular, Cellular, and Tissue Engineering	Lecture-based	Yes	Yes
BME 3171 Biomedical Engineering Lab 1	Lab-based	Yes	Yes
BME 3531 Bioinstrumentation Lab	Lab-based	Yes	Yes
BME 3533 Biomedical Instrumentation	Lecture-based	Yes	Yes
BME 3722 Numerical Methods in Biomedical Engineering	Lecture-based	Yes	No
BME 4373 Tissue Engineering	Lecture-based	Yes	No
BME 4533 Neural Engineering	Lecture-based	No	No
BME 4713 Biomedical Engineering Design 1	Project-based	Yes	No

Appendix B: Student Survey Questions

The below student survey questions were asked of all students for each class (BME XXXX) they indicated they were enrolled in when completing the survey.

1. Which of the following best describes BME XXXX?
 - a. Lecture-based course
 - b. Lab-based course
 - c. Project-based course
 - d. Other: _____
2. What percentage of the course assignments and assessments in BME XXXX require you to understand or apply quantitative skills and information?
3. For BME XXXX, what online resources, as defined above, did course instructor(s) provide to you during the course? Select all that apply.
 - a. Video
 - b. Simulation
 - c. Webpage
 - d. Document
 - e. Worked/Interactive Example Problems
 - f. Code or Script
 - g. Other (please specify): _____
4. For BME XXXX, approximately how many hours per week did you spend using each instructor-provided online source?
5. Rank order the BME XXXX instructor-provided online resources in terms of how well they supported your learning of the course material (1 being "most effective").
6. For BME XXXX, what online resources, as defined above, did you find and use *independent* of instructor-provided online resources? Select all that apply.
 - a. Video
 - b. Simulation
 - c. Webpage
 - d. Document
 - e. Worked/Interactive Example Problems
 - f. Code or Script
 - g. Other (please specify): _____
7. For BME XXXX, approximately many hours per week did you spend using each independent online resource?
8. For BME XXXX, rank order the *independent* online resources you found and used in terms of how well they supported your learning of the course material (1 being "most effective").
9. For BME XXXX, the instructor-provided online resources greatly supported my ability to learn the course material.
 - a. Strongly agree
 - b. Somewhat agree
 - c. Neither agree nor disagree
 - d. Somewhat disagree

- e. Strongly disagree
10. For BME XXXX, the *independent* online resources greatly supported my ability to learn the course material.
- a. Strongly agree
 - b. Somewhat agree
 - c. Neither agree nor disagree
 - d. Somewhat disagree
 - e. Strongly disagree
11. What specific online resources, whether instructor-provided or independently found, have you found useful in learning the course material for BME XXXX? These can be specific websites, channels, forums, etc. that you used frequently during the semester.
12. I expect to get a(n) " _ " final letter grade in BME XXXX.
- a. A
 - b. B
 - c. C
 - d. D
 - e. F
13. Without the instructor-provided online resources, I expect I would get a(n) " _ " final letter grade in BME XXXX.
- a. A
 - b. B
 - c. C
 - d. D
 - e. F
14. Without the *independent* online resources, I expect I would get a(n) " _ " final letter grade in BME XXXX.
- a. A
 - b. B
 - c. C
 - d. D
 - e. F
15. What is an online resource you would like to see developed and integrated into BME XXXX that could improve learning the course material?
16. How have you used artificial intelligence (AI) in learning the course material for BME XXXX? Select all that apply.
- a. Checking my understanding
 - b. Clarifying topics I found unclear
 - c. Connecting course material with real-world examples
 - d. Summarizing key points from lectures or notes
 - e. Directing me to additional learning resources
 - f. Other (please specify): _____
 - g. I did not use AI to learn course material

17. How have you used artificial intelligence (AI) in completing assignments for BME XXXX? Select all that apply.
- a. Checking my work
 - b. Helping me get started on an answer/solution
 - c. Generating/debugging code
 - d. Generating figures/images
 - e. Generating/editing written text
 - f. Other (please specify): _____
 - g. I did not use AI to complete assignments
18. My instructor for BME XXXX encourages me to use AI to learn course materials.
- a. Strongly agree
 - b. Somewhat agree
 - c. Neither agree nor disagree
 - d. Somewhat disagree
 - e. Strongly disagree
19. My instructor for BME XXXX encourages me to use AI to complete assignments.
- a. Strongly agree
 - b. Somewhat agree
 - c. Neither agree nor disagree
 - d. Somewhat disagree
 - e. Strongly disagree
20. How do you think AI could be better incorporated, used, or encouraged in BME XXXX?

Appendix C: Instructor Survey Questions

The below instructor survey questions were asked of all instructors for each class (BME XXX) they indicated they were instructing when completing the survey.

1. Which of the following best describes BME XXXX?
 - a. Lecture-based course
 - b. Lab-based course
 - c. Project-based course
 - d. Other: _____
2. What percentage of the course assignments and assessments in BME XXXX require your students to understand or apply quantitative skills and information?
3. For BME XXXX, what online resources, as defined above, did you as the course instructor provide during the course? Select all that apply.
 - a. Video
 - b. Simulation
 - c. Webpage
 - d. Document
 - e. Worked/Interactive Example Problems
 - f. Code or Script
 - g. Other (please specify): _____
4. Rank order your BME XXXX instructor-provided online resources in terms of how well you think they supported your students in learning the course material (1 being "most effective").
5. What specific online resources did you find useful in teaching or supporting student learning of the course material for BME XXXX? These can be specific websites, channels, forums, etc. that you used frequently during the semester.
6. I expect most students to get a(n) "_" final letter grade in BME XXXX.
 - a. A
 - b. B
 - c. C
 - d. D
 - e. F
7. Without my instructor-provided online resources, I expect most students would get a(n) "_" final letter grade in BME XXXX.
 - a. A
 - b. B
 - c. C
 - d. D
 - e. F
8. Without *independent* (i.e., not instructor-provided) online resources, I expect most students would get a(n) "_" final letter grade in BME XXXX.
 - a. A
 - b. B

- c. C
 - d. D
 - e. F
9. What is an online resource you would like to see developed and integrated into BME XXXX that could improve students learning of the course material?
10. How do you think students are using artificial intelligence (AI) to learn the course material for BME XXXX? Select all that apply.
- a. Checking their understanding
 - b. Clarifying topics they found unclear
 - c. Connecting course material with real-world examples
 - d. Summarizing key points from lectures or notes
 - e. Directing them to additional learning resources
 - f. Other (please specify): _____
 - g. I do not think students are using AI to learn the course material
11. How do you think students are using artificial intelligence (AI) to complete assignments for BME XXXX? Select all that apply.
- a. Checking their work
 - b. Helping them get started on an answer/solution
 - c. Generating/debugging code
 - d. Generating figures/images
 - e. Generating/editing written text
 - f. Other (please specify): _____
 - g. I do not think students are using AI to complete assignments
12. Which statement below best describes your agreement with the following statement:
"I encourage my students in BME XXXX to use AI for learning course materials."
- a. Strongly agree
 - b. Somewhat agree
 - c. Neither agree nor disagree
 - d. Somewhat disagree
 - e. Strongly disagree
13. Which statement below best describes your agreement with the following statement:
"I encourage my students in BME XXXX to use AI to complete assignments."
- a. Strongly agree
 - b. Somewhat agree
 - c. Neither agree nor disagree
 - d. Somewhat disagree
 - e. Strongly disagree
14. How do you think AI could be better incorporated, used, or encouraged in BME XXXX?

Appendix D

When answering the following questions for BME XXXX, please consider these definitions for online resources.

- Video - a recording of moving visual elements that demonstrates or presents some problem, concept, or solution for educational purposes. Can include audio but is not required to.
- Simulation - an interactive platform that allows users to manipulate variables, environments, or similar elements and see the outcome of applied changes in real-time. Outcomes can be visual, numeric, graphical, or auditory.
- Webpage - a static text- or image-based website that presents information. Possesses limited if any interaction.
- Document - any file that is primarily text- or image-based that presents information. Can be saved or edited by users.
- Worked/Interactive Example Problems - text-based step-by-step solutions of qualitative or quantitative questions and problems. Can be interactive, requiring users to provide input before the next step is shown.
- Code or Script - sections or general versions of programming languages used in the course.