Work in Progress: Engaging Early Career Students in Bioengineering with Student-Specific Content

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In her work for the EERC and Pitt-CIRTL, April Dukes collaborates on educational research projects and facilitates professional development (PD) on instructional and mentoring best practices for current and future STEM faculty. As an adjunct instructor in the Department of Neuroscience at the University of Pittsburgh since 2009 and an instructor for CIRTL Network and Pitt-CIRTL local programming since 2016, April is experienced in both synchronous and asynchronous online and in-person teaching environments.

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Dr. Kurt Beschorner is an Associate Professor of Bioengineering at University of Pittsburgh. His research mission is to use competencies in tribology, biomechanics and ergonomics to prevent slip and fall accidents. His teaching mission is to develop and deliver courses that increase student motivation by aligning course content with career goals.

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Dr. Mahboobin is an assistant professor at the department of Bioengineering, Swanson School of Engineering. His research interests include computational and experimental human movement biomechanics, bio-signal processing, and engineering education. Specific areas of biomechanics and bio-signal processing research include developing muscle-actuated forward dynamic simulations of gait (normal and pathological), analysis and modeling of human postural control, and time-varying signals and systems. Engineering education research includes curriculum and laboratory development of biomechanics and bio-signal processing concepts.

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Introduction

The number of bachelor's degrees earned in engineering by women and minorities does not reflect their presence in the US population [1]. This lack of diversity impacts the relevance of engineered solutions to our diverse population. Thus, there is a need to increase diversity in the engineering field. Engaging underrepresented students in engineering early in their educational careers can transition to a diversity increase in the engineering field.

Tailoring engineering content to students' interests is a potential link to engaging underrepresented students in engineering. Value in what is being learned is an essential component of student engagement [2]. Thus, relating engineering content to student interests may increase a student's value in what is being learned, facilitating engagement. Furthermore, previous research has been successful in engaging students with diverse interests by combining arts and storytelling with robotics [3]. Similar to this technique, using student-specific interests may engage students in engineering. Thus, the purpose of this study is to determine if interest-tailored lectures can increase student engagement in bioengineering. To answer this question, our proof-of-concept study will investigate student engagement between generic and interest-tailored lectures.

Methods

Students entering the 10th grade who are underrepresented in the engineering field were recruited to participate in a Science, Technology, Engineering and Mathematics (STEM) summer program. Specifically, the program was geared towards black, Latinx, Native American and female students in public schools in the Pittsburgh area, but students from any gender or ethnic group could participate if they had a grade point average of 2.75 or higher with a 3.0 or higher in math and science. The STEM program was a 5-week college preparatory program between the months of June and July. Attendance was a full school day (9 am – 3 pm) for 4 days a week (Monday – Thursday). In the morning, students strengthened their course knowledge in mathematics, science and writing courses. In the afternoon, students participated in bioengineering workshops. The bioengineering workshops were two hours in length. These workshops included a lecture and hands-on activity (e.g., heart dissection, building a dynamometer). The first three weeks of the program, the students received generic lectures on bioengineering content (i.e., content delivered without any known connection to student interests). The fourth week of the program, the students received interest-tailored lectures on bioengineering content (i.e., interests from the students were incorporated into the lectures to relate and explain content). The fifth week, the students received generic lectures (this week is not assessed). Five graduate students instructed the bioengineering workshops. Instructors were consistent across generic and interest-tailored lectures.

Interest-tailored lectures were developed from student interest forms. Specifically, students were asked to list careers, sports, athletes, celebrities and hobbies that interested them. Interests were consolidated and at least two interests were incorporated into the lectures for each student as visual aids (i.e., text, images, videos). For example, a visual metaphor was provided relating movement of Simone Biles completing a vault routine to the movement function of the musculoskeletal system. Visuals of Zac Efron and Dwayne (The Rock) Johnson completing a tire flip were used to stress the importance of designing tasks that fit individual strength levels. Thus, student interests were used to reference biomechanical content, stimulate discussion of important biomechanical topics, explain biomechanical measurements, and to show what biomechanics is used for.

Students completed surveys after three weeks of generic lectures and after the week of interest-tailored lectures. The surveys asked the students if they were interested in biomechanics, engaged during lecture and enjoyed the hands-on activities. Students selected an agreement response from a 7-point Likert scale using integers from -3 to 3 (corresponding with strongly-disagree, disagree, somewhat-disagree, neutral, somewhat-agree, agree, and strongly-agree). The Likert rating is referred to as the score (regardless of question). Response data from 30 students in 2017 was assessed. Approval was obtained by the Institutional Review Board at the University of Pittsburgh.

Wilcoxon Rank-Sum tests were performed for each survey question, pre and post interest-tailored lectures. A $p < 0.05$ would denote statistical significance. Statistical software (JMP®, Version 14. SAS Institute Inc., Cary, NC.) was used to perform analysis.

Results

The mean (standard deviation) scores pre interest-tailored lectures were 0.70 (1.34), 0.87 (1.41), and 1.43 (1.41) for interest in biomechanics, engagement during lecture and enjoyment in activities, respectively. The mean (standard deviation) scores post interest-tailored lectures were 0.80 (1.61), 1.73 (1.05), and 1.77 (1.28) for interest in biomechanics, engagement during lecture and enjoyment in activities, respectively. Interest-tailored lectures increased student engagement during lecture ($p = 0.015$) but did not increase interest in biomechanics ($p = 0.611$) or enjoyment in activities ($p = 0.314$) when compared to generic lectures (Figure 1, Table 1).

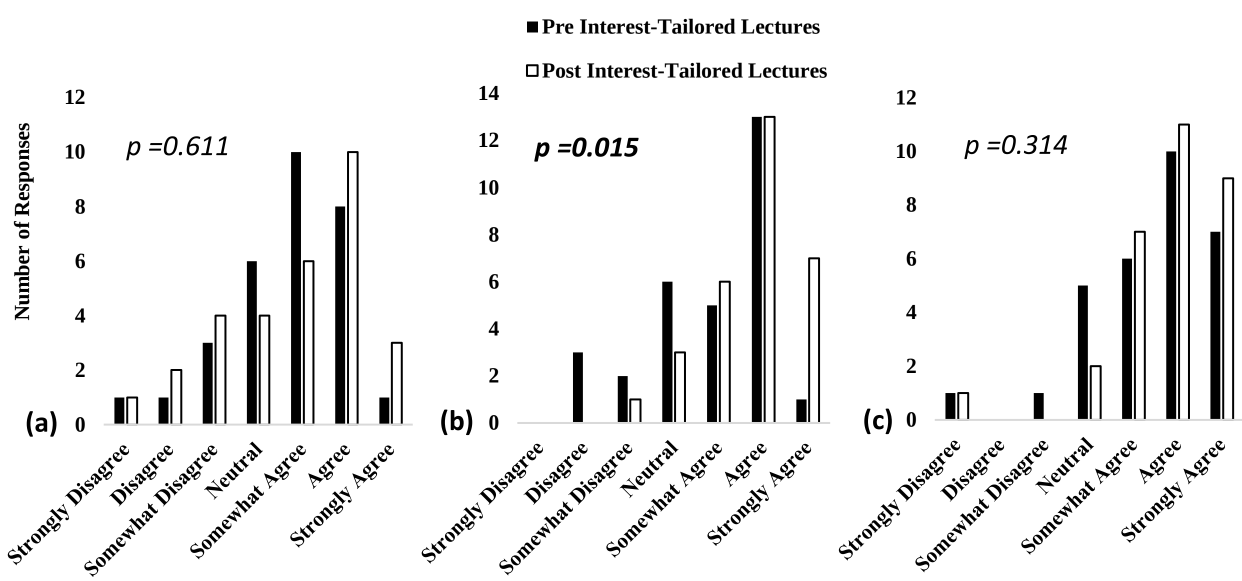

Figure 1: The number of student responses (n = 30) per Likert score rating for interested in biomechanics (a), engaged during lecture (b) and enjoyed the hands-on activities (c) pre (black bars) and post (white bars) interest-tailored lectures. A bold *p*-value denotes a statistically significant difference in score between pre and post interest-tailored lectures.

Table 1: Mean [median] (standard deviation) score across questions pre and post interest-tailored lectures.

	Interested in biomechanics	**Engaged during lecture**	**Enjoyed the activities**
Pre interest-tailored lectures	0.70 [1] (1.34)	0.87 [1] (1.41)	1.43 [2] (1.41)
Post interest-tailored lecture	0.80 [1] (1.61)	1.73 [2] (1.05)	1.77 [2] (1.28)
Difference pre and post interest-tailored lecture	0.10 [0]	0.87 [1]	0.33 [0]

Discussion

Interest-tailored lectures increased engagement during lecture. This agrees with theory and practice on student engagement [2, 3]. Motivation is a key component of student engagement that is influenced by a student's value in what is being learned [2]. Therefore, linking bioengineering content to student interests likely increased their perceived value in what was being learned. Furthermore, our findings are similar to work that has engaged students in robotics from activities that paired arts and storytelling with coding [3]. We do not believe the increase in lecture engagement was attributed to the content being learned, as students did not show a large change for interest in biomechanics pre and post interest-tailored lectures. Student enjoyment scores on hands-on activities did not increase with interest-tailored lectures. This is not surprising as only the lectures were enhanced to student interests and not the hands-on activities. Notably, there was a small difference between engagement in lecture and enjoyment in activities post interest-tailored lectures. This shows interest-tailored lectures as a pedagogical technique may raise engagement in lecture to levels similar to student enjoyment in hands-on activities.

There are limitations in this study. This study did not assess student engagement from student participation in the workshops. Future studies should assess the number of students participating, questions asked, etc. to better understand the effects of interest-tailored lectures on student engagement. Furthermore, this work is preliminary, a larger and more controlled design on the influence of interest-tailored lectures on student engagement is needed to confirm these results.

This preliminary study found interest-tailored lectures to increase student engagement in bioengineering lectures. This suggests that student engagement can be increased by tailoring the delivery of engineering content to student interests. This may be a useful technique in facilitating the growth of diversity in the engineering field.

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