

## **BIOMECHANICS STUDENT'S LEARNING AND PERCEPTIONS OF LEARNING DUE TO THE COVID-19 PANDEMIC AND ASSOCIATED MITIGATION**

**Brian J. Wallace<sup>1</sup> and Duane V. Knudson<sup>2</sup>**

**University of Wisconsin Oshkosh, Oshkosh, WI, USA<sup>1</sup>  
Texas State University, San Marcos, TX, USA<sup>2</sup>**

The purpose of this study was to assess the effects of the COVID-19 pandemic and associated mitigation protocols on student learning and perceptions of learning in a biomechanics course. Students (n=31) enrolled in a three credit-hour biomechanics class in the Spring 2022 semester participated. Six questions related to the effects of mitigation protocols on student perceptions of learning. Three questions asked about course-related student behaviours. Learning scores (g) were similar to those previously reported. Students believed that mitigation negatively affected getting to know and communicate with classmates (>50%), they had to implement different learning strategies (55%), and learning mathematical concepts was more difficult due to the instructor wearing a face covering (45%). The student learning environment should be a consideration when deciding what mitigation protocols to implement if proposed in the future.

**KEYWORDS: INSTRUCTION, INTERACTION, SURVEY, ONLINE**

**INTRODUCTION:** The COVID-19 pandemic has had widespread effects on global civilization for approximately three years. As of January 2023, there have been over 660 million confirmed positive tests for COVID-19 worldwide, and it has been associated with approximately 6.7 million deaths (World Health Organization, 2023). A recent meta-regression estimated the all-age infection fatality rate (IFR) of COVID-19 to be between 0.03% and 0.07% (Pezzullo et al., 2023). The pandemic has had negative effects on university students during this time. It is well-known that in Spring 2020 nearly all universities in the United States transitioned classes to a remote-learning format. By the following Fall semester most universities were at least partially face-to-face (F2F), implementing various mitigation protocols such as suggested or mandatory vaccination, social distancing measures including reduced class sizes, and mandatory face coverings with the aim of reducing the spread of COVID-19 within their campus communities (Zhou & Zhang 2021). These mitigation protocols were largely undertaken without evidence-based consideration as to the effects they would have on the student learning experience, even though young persons are at a substantially lower risk of severe adverse health outcomes from COVID-19 than persons 60 years of age or older (IFR 0-19 years 0.0003%, IFR 20-29 years 0.011%) (Pezzullo et al., 2023).

Previous studies have reported student perceptions of their remote learning experience during the pandemic (Hill & Fitzgerald, 2020; Knudson, 2020; Pokhrel & Chhetri, 2021; Zhou & Zhang, 2021). Immediate effects of mid-term change to online instruction indicated that although students preferred the F2F environment, student preference for delivery (i.e., F2F, online, either) was not associated with learning in introductory biomechanics (Knudson, 2020). Lee et al. (2021) reported qualitative survey results of biomedical engineering students' perceptions of their learning experience during a remote learning biomechanics laboratory class during the pandemic. These students commented that the remote lessons did not prepare them as well as they would have liked due to analysing existing data and not conducting laboratory experiments themselves. Additionally, they noted that the lack of peer interaction in the remote environment was especially challenging to their motivation to learn. Students seem to prefer F2F instruction, however, data on the effect of mitigation protocols during F2F instruction on student learning and perceptions of learning is lacking and is important for administrators to consider should mitigation protocols be proposed in the future. The purpose of this study was to assess the effect of the pandemic, including university implemented COVID-19 mitigation protocols, on student learning and perceptions of learning in a F2F biomechanics course. We hypothesized that students would report that they believed the pandemic and associated mitigation protocols were a deterrent to their learning experience.

**METHODS:** All students (n=31) enrolled in a three credit-hour introductory biomechanics class in a Kinesiology department at a comprehensive university in the USA participated. This was a single-sample research design. The University of Wisconsin Oshkosh's Institutional Review Board approved all study procedures, and students provided written Informed Consent. Students completed the validated and nationally normed Biomechanics Concept Inventory (BCI, version 1), and additional survey questions, electronically at the beginning and end of the Spring 2022 term when university implemented COVID-19 mitigation protocols (e.g., mandatory face coverings, vaccination messaging, social distancing) were ongoing. Gain (g) scores were calculated to assess learning during the term. A total of 9 survey questions were asked (Table 1). Six questions (1-5 and 9) were related to the effects of mitigation protocols, including face coverings, on student perceptions of their learning. Three questions (6-8) asked about course-related student behaviours due to the pandemic. Percent responses were calculated given the categorical data and descriptive nature of this study.

**Table 1: Questions and responses (%) of student perceptions regarding COVID-19 effects on learning biomechanical concepts. n=31 responses for all questions.**

	SA	A	N	D	SD
1. In general, university implemented mitigation protocols (e.g.: masks, vaccination messaging, social distancing) made learning biomechanics concepts more difficult than if the mitigation protocols were not present.	13	26	19	26	16
2. University implemented mitigation protocols other than wearing a mask (e.g.: vaccination messaging, social distancing) negatively affected my ability to get to know my classmates.	26	29	19	19	6
3. Students wearing a mask made it more difficult to hear or understand articulation of fellow students during class discussions than if not wearing a mask.	19	35	10	29	6
4. Students being required to wear a mask negatively affected my ability to get to know my classmates.	23	29	16	19	13
5. The instructor wearing a mask made learning mathematics-related aspects of biomechanics more difficult than they would have been than if not wearing a mask.	10	35	19	29	6
6. I sought out in-person help with biomechanics concepts (such as visiting office hours) more often because of the pandemic than I otherwise would have.	10	16	29	39	6
7. I met with fellow students less often to study or work on biomechanics assessments due to the pandemic than I otherwise would have.	6	29	26	32	6
8. I had to implement different learning strategies due to the pandemic than I otherwise would have to learn biomechanics content.	16	39	23	16	6
9. In general, I believe that I would have learned more in biomechanics if not for pandemic mitigation protocols.	16	32	26	16	10

Note: SA. Strongly agree, A. Agree, N. Neither agree nor disagree, D. Disagree, and SD. Strongly disagree. Results displayed as percent.

**RESULTS:** Students generally thought that the COVID-19 pandemic and associated mitigation protocols had a detrimental effect on factors associated with learning biomechanics. The most pronounced effects regarded learning strategies and communicating with their classmates. Over 50% of students "strongly agree(d)" or "agree(d)" that face coverings and other university mitigation protocols negatively affected their ability to communicate with or get to know their

classmates. A majority, 55%, also “strongly agree(d)” or “agree(d)” that they had to implement different learning strategies due to the pandemic, although it does not appear that this involved meeting with fellow students less. Forty-five percent of students “strongly agree(d)” or “agree(d)” that learning mathematics biomechanics concepts was made more difficult due to the instructor wearing a face covering. A plurality of students also “strongly agree(d)” or “agree(d)” that they would have learned more in the course if not for the pandemic (Question 9), however, the proportions that thought mitigation protocols made learning course concepts more difficult was relatively evenly distributed (Question 1). Learning scores ( $g$ ) were similar ( $g=0.36\pm 0.26$ ) to national norms for classes with labs (Knudson et al., 2009).

**DISCUSSION:** This was the first investigation to assess student perceptions of their learning during F2F instruction in a biomechanics course when mitigation protocols were present. The most notable findings of this study were specific student perceptions of negative effects mitigation strategies had on the learning environment, including hearing classmates, interacting with them, and learning mathematical concepts. A lack of in-person instructor-student and student-student interactions can lead to student loneliness, anxiety, or depression (Zhou & Zhang, 2021). Our data show that the problem of students feeling isolated during remote instruction persisted in the F2F environment where mitigation protocols existed after emergency online instruction early in the pandemic. These data are consistent with other reports of sub-optimal student mental and emotional health during the pandemic (Elharake et al., 2022), compounding the already elevated stress students commonly have related to biomechanics (Wallace & Kernozek, 2017).

The findings for how students thought mitigation protocols affected their ability to learn biomechanics concepts were not all negative, and learning scores were similar or higher than pre-pandemic (Knudson et al., 2009; Wallace et al., 2020). Gain scores were only slightly lower than non-published scores from pre-pandemic terms taught by the same instructor where the BCI was given electronically. For question 1, student responses were evenly distributed related to university mitigation protocols making learning biomechanics concepts more difficult. Responses to this question and our gain score data align with Knudson (2020), which reported that changing course format abruptly early in the pandemic did not influence learning scores even though students preferred the F2F format. Academic performance, as assessed by biomechanics course grade, was lower after switching from remote instruction back to F2F instruction (Perez et al., 2023). These authors did not mention what if any mitigation protocols remained during the F2F instruction, and hypothesized the better grades during remote instruction could have been due to students using technology to their advantage, possibly including cheating. Forty-five percent of our respondents “strongly agree(d)” or “agree(d)” that the instructor wearing a face covering made their learning of mathematics-based course content more difficult, while 35% “strongly disagree(d)” or “disagree(d).” This is problematic since students often have difficulty learning Newtonian mechanics (Hake, 1998; Knudson et al., 2009) and low perceived mathematics self-efficacy (Wallace & Kernozek, 2017).

Students did not report that their out-of-class behaviours changed considerably due to the pandemic. Pluralities “strongly disagree(d)” or “disagree(d)” that they met with fellow students less often or utilized resources such as instructor office hours more often. It is unclear if students met with each other the same as they otherwise would have, or more due to having greater difficulty with the course due to the mitigation protocols present. Similarly, it is unclear if students used out-of-class campus resources, such as visiting office hours, the same or less due to the pandemic even though they mostly did not use them more. However, when these questions are considered in the context of the responses to question 1, it is likely that students thought their behaviours were generally unchanged as a result of the pandemic. A majority, 55%, did respond that they changed their learning strategies due to the pandemic. It is presumed that for most students the disparate strategies implemented had to do with their own self-study habits based on responses to the previously discussed behaviour questions.

This exploratory survey study does have some limitations. Our sample was from a single course at a single university in the United States, so external validity may not be assumed.

The reliability of the survey is also currently unknown, particularly related to if students may respond differently to topically similar questions worded differently than in this survey.

**CONCLUSION:** Students in a recent F2F biomechanics course with university-imposed COVID-19 mitigation protocols present appeared to learn course concepts similarly to students pre-pandemic. However, students in the current study perceived that the protocols imposed greater challenges to their learning than if the protocols were not present based on their prior educational experiences. Specifically, these students perceived difficulties from face coverings in understanding and getting to know peers, and in following mathematical concepts presented by the instructor. The student learning environment should be a key consideration of administration when deciding what classroom mitigation protocols to implement if proposed in the future.

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