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Abstract

National Biomechanics Day (NBD) is an international celebration of biomechanics that seeks to increase the awareness and appreciation of biomechanics among the high school community. Initial research supports the positive effects of NBD on students' attitudes toward the field of biomechanics; however, quantitative evidence remains scarce. The purpose of this study was to quantify changes in high school students' perceptions toward biomechanics after participating in NBD events to better understand the impact of NBD. Data were collected at two locations during the 2019 NBD season. Surveys were collected before and after NBD events for 112 high school students from Montana and North Carolina. Paired pre- versus post-NBD surveys for the aggregate sample population suggest that students perceived biomechanics as more appealing ($p = 0.050$), exciting ($p = 0.007$), and important ($p = 0.018$) following the NBD events. Students did not report a change in whether they could see themselves in a biomechanics-related career ($p = 0.49$). These findings further support the ability for NBD events to positively impact students' perceptions toward biomechanics, although opportunities persist to increase student career interest in biomechanics. This paper presents and discusses the study's results, interpretations, limitations, and implications for future research on biomechanics outreach activities.

Keywords: STEM outreach, education, biomechanics, high school STEM, NBD

Introduction

Strengthening the science, technology, engineering, and math (STEM) workforce is critical to being competitive in an increasingly science and engineering intensive economy (National Science Board, 2015, 2019). Early exposure to STEM concepts through diverse formal and informal STEM learning environments can support this national priority by generating interest in STEM topics and careers (Holdren et al., 2013; Tai et al., 2006). STEM experiences occurring in informal learning environments hold particular promise, as they are not constrained by curriculum, time, and assessment requirements in the way that formal classroom experiences generally are (Drazan, 2020). Participation in informal STEM experiences leads to increased self-efficacy, increased student interest in content covered, and more positive attitudes toward science (Ayar, 2015; Shah et al., 2018; Wiehe, 2014), even when the experiences are short-term events such as science festivals or museum programs (Habig et al., 2020; Wiehe, 2014).

Although the study of biomechanics is often completely absent from the high school curriculum (DeVita, 2018), it may be a particularly effective focus for STEM outreach for a number of reasons. Biomechanics, by its very nature, incorporates and requires the integration of each of the STEM pillars (DeVita, 2018). Further, an increased understanding of biomechanics has the ability to improve students' mastery of fundamental physics concepts such as Newtonian mechanics (Coleman, 2001; Knudson, 2013), content which is commonly covered in the high school curriculum. Additionally, the increased presence of biomechanics in aspects of popular culture – such as sports training, video game creation, and movie animation – positions biomechanics to leverage the natural connections between fundamental STEM principles and real-world examples that naturally connect with aspects of students' lives (Drazan, 2020). The relatedness of topics to students is an innate psychological driver for their motivation and self-determination for learning (Advancing Excellence in P-12 Engineering Education and American

Society for Engineering Education, 2020; Ryan and Deci, 2000). Pliner et al. showed that when biomechanics lectures during an informal STEM summer experience were tailored to students' interests, students self-reported via surveys that they were more engaged in the lectures and demonstrated a small, albeit nonsignificant, increase in performance on a quiz of biomechanics concepts (Pliner et al., 2020). Additionally, when evaluating components of the summer experience, students rated laboratory tours the highest in terms of engagement in comparison with other teaching methods, which motivates the value of hands-on experiences that connect to real-world applications (Pliner et al., 2020). Notably, formal academic recognition of the field of biomechanics has recently been bolstered by biomechanics being added as a new Classification of Instructional Program (CIP) code (26.0913) in 2020 and as a STEM field by the United States Department of Homeland Security.

National Biomechanics Day (NBD) is an annual, single-day, informal outreach learning event where biomechanics professionals all over the world welcome their local community schools or other organizations into their labs to introduce high school students to the STEM discipline of biomechanics (DeVita, 2018; Drazan, 2020; Shultz et al., 2019; Teeter et al., 2020). Site-specific programming may include lab tours, hands-on activities, and demonstrations related to the field of biomechanics (Drazan, 2020; Shultz et al., 2019; Teeter et al., 2020). Since the inaugural NBD event in 2016, over 32,000 high school students around the world have participated in NBD events. The increase in student participation and geographical spread of participating biomechanics laboratories over these years supports the potential for NBD to reach a large and diverse group of students; however, quantitative evidence of the impact of NBD on students' interests and perceptions toward biomechanics is scarce.

Previous research on other informal biomechanics experiences have demonstrated positive impact. For example, Marshall et al. found that a four-day summer camp experience rooted in sports science resulted in increases in familiarity, perceived importance, and interest in STEM and medicine (Marshall et al., 2021), which adds to the improved student engagement that was observed by Pliner et al. when biomechanics topics tailored to students' interests were integrated into lectures (Pliner et al., 2020). However, to date, there is only one paper examining the impact of NBD. This recent single-site study provided initial evidence that NBD was associated with positive shifts in student interest, excitement, and perceived importance of biomechanics (Teeter et al., 2020). However, additional assessment is needed to determine the extent that the positive shifts in student attitudes extend across the many NBD events, which will provide important support for the ability of NBD to excite students about biomechanics.

Therefore, the purpose of this pilot study was to quantify changes in high school students' perceptions toward biomechanics after participating in NBD events. To accomplish this, we recruited NBD hosts to administer a survey to high school students before and after they attended NBD events. Our hypothesis was that NBD would increase appeal, excitement, and perceived importance of biomechanics.

Methods

High school classes were invited to participate in independent NBD events in biomechanics laboratories at two institutions with different geographical and institutional characteristics (Montana State University and Elon University). IRB-approved written informed consent and assent were obtained for 112 high school students (**Table 1**) in coordination with students' teachers. Students predominantly attended as part of high school biology, anatomy, and science classes where teachers had decided to bring their class to an NBD event (**Table 2**). Recruiting through teachers was chosen independently at each NBD location due to prior success in using the approach to improve turnout and navigate logistical challenges (e.g., transportation for students). While both NBD locations had similar gender ratios, the students attending the Elon University NBD event had fewer seniors, were attending as part of a career and technical school where they took vocational courses but belonged to different high schools in the county, and were more racially diverse compared to the students attending the Montana State University event.

To assess the effect of NBD on student perceptions toward biomechanics, a brief (~5 minute) survey was administered to students both before and immediately after the NBD event that they attended (complete surveys provided in **Supplemental Material**). Anonymous study identification numbers were used to pair pre- vs. post-surveys. The method for implementing this process differed by student group, but included distributing paper bracelets with unique numbers on them to students upon arriving for the NBD event. All surveys were administered via pen and paper.

The activities at the NBD events were not coordinated between the two institutions. A summary of the event structure, volunteer backgrounds, and activities for each event is provided (**Table 2**). In general, both events followed a structured format that involved an introduction by the host laboratory followed by groups of students rotating between activity stations on a schedule. Each activity involved interaction with NBD volunteers and provided opportunities for hands-on participation related to various biomechanics topics (see **Table 2** and **Supplemental Material**). University-themed handouts (e.g., T-shirts, prizes for winners of activity competitions) were also provided to students at each event.

To quantify student perceptions, we adapted questions from the STEM Semantics Survey (Cronbach's alpha: 0.78 – 0.94) to be tailored to biomechanics (Tyler-wood et al., 2010). Specifically, students were asked to respond to the question "To me, biomechanics is," for four pairs of adjectives: 'appealing vs. unappealing', 'exciting vs. unexciting', 'unimportant vs. important', 'boring vs. exciting', with the last question serving as a reverse-coded validation check (**Figure 1**). Responses were checked to ensure that the same student did not select both 'unexciting' for the second question and 'exciting' for the reverse-coded fourth question. Responses were on a 7-point Likert scale, and students were also given the choice of responding with 'I don't know enough about biomechanics to answer' (IDK), as we anticipated NBD may be students' first exposure to biomechanics. Students also answered questions about their interest in biomechanics-related careers ('I can see myself in a biomechanics-related career'), enjoyment of the NBD event ('I enjoyed today's biomechanics experience'), and perceived learning ('I feel like I learned a lot from today's biomechanics experience') using a 7-point Likert scale between options of 'Strongly Disagree' and 'Strongly Agree'. In addition to these questions, the survey contained several short answer questions that were intended to support feedback and future development of the survey instrument (see **Supplemental Material**).

A combination of Sign Tests and Chi-Squared tests were used to test our hypothesis for our ordinal data. Our primary analysis was on the aggregate dataset from both NBD locations and focused on questions regarding students' perceptions toward biomechanics as: 1) appealing, 2) exciting, and 3) important. Additionally, we tested for shifts in students' responses regarding their interest in a biomechanics-related career. Our decision to report on individual items resulted in our analysis being on Likert-type data that warrant statistical analyses appropriate for ordinal data (Boone and Boone, 2012). Sign Tests were used to assess whether the contrast of paired pre-post data differed from a median of zero (i.e., was there a change in student responses after NBD compared to before). Students with an IDK response for any of the four adjective pair questions on the pre-NBD survey were omitted from the primary analysis to provide a more direct assessment of trends. Post-NBD responses for students with IDK responses on the pre-NBD survey are reported separately for comparison. Students who had a missing response were also excluded from the analysis of the paired data due to the inability to calculate pre-post contrasts for these cases. To complement the analysis of the paired data, Chi-Squared tests were used to identify differences in the distribution of student responses for the Likert-type data to assess changes in overall student responses. Statistical significance was set at α=0.05 for all analyses. To contextualize the student responses, we also provide descriptive statistics for students' enjoyment of the NBD event as well as their perceived learning during the event. As a secondary analysis to characterize the potential heterogeneity in effects between the NBD locations, we also calculated descriptive statistics and repeated the statistical analyses separately for the two NBD locations.

Results

Combined across both NBD events, students' initial responses were generally positive in response to appealing, exciting, and importance (**Table 3**). Notably, these perceptions were strengthened after the NBD events, where biomechanics was more appealing (Sign Test p = 0.050), exciting (Sign Test p = 0.007) and important (Sign Test p = 0.018) following the NBD events compared to their paired pre-event responses (**Table 4**). The effect sizes of the differences were small, with paired differences having Cohen's d effect size magnitudes of 0.24, 0.38, and 0.18, for appealing, exciting, and importance, respectively. The small effect sizes are also corroborated by positive shift in medians for these questions by one on the 7-point Likert scale (**Table 3**).

Chi-squared analyses echoed the positive impact of NBD, with significant changes in responses between pre- vs. post-NBD surveys occurring for questions on appealing ($p = 0.008$) and exciting ($p = 0.006$). The response distributions also qualitatively show a shift from more normally distributed responses to being skewed toward positive responses (**Figure 2**). Additionally, the number of students selecting at least one IDK response decreased from 18% of students across the three primary adjective pair questions of interest to 0% for these three questions following the NBD events.

While a decrease in IDK responses (16% to 1%) was observed after the NBD events for the biomechanics-related career interest question, no change was observed in how strongly students saw themselves in a biomechanics career (Sign Test $p = 0.49$; median = 4 for both pre- and post-NBD surveys; see **Figure 2**).

Additional descriptive statistics of students' NBD experience suggest that students enjoyed the NBD events (mean = 6.3; SD = 1.1; median = 7 [7 being highest]) and felt that they had learned a lot during the NBD event (mean = 6.0; SD = 1.2; median = 6 [7 being highest]) (**Table 3**). Students who responded with IDK on the pre-NBD survey had similar post-NBD responses to these questions (*Enjoyed*: median = 7; *Learned*: median = 6) **(Table 3, Figure 3)**.

Isolating the paired analysis to each NBD event (**Figure 2**), a significant increase in excitement regarding biomechanics was seen in responses at the Montana State event (n=55, Sign Test $p = 0.022$) while a nonsignificant trend increase in perceived importance was observed for responses from the event at Elon University (n=25, Sign Test $p = 0.065$). Chi-squared analyses could not be conducted for the separate NBD events because the expected counts within the given

7-point Likert scale options were often less than one after accounting for the smaller site-specific sample sizes and missing or IDK responses.

Discussion

The findings of our study further support that NBD can improve students' appeal, excitement, and perceived importance of biomechanics through interactive outreach events that students enjoy. Although the persistence of these shifts in student perceptions must still be quantified, the findings corroborate those from a previous study to collectively support the ability for NBD to be leveraged as a mechanism for engaging students with STEM (Teeter et al., 2020). Additionally, the tools and approach used in this study strengthen future opportunities for assessing the impact of NBD more broadly in future NBD events.

NBD's impact on student perceptions is supported by the positive effects reported in both present and previous studies despite fundamental differences in the NBD event structures (Teeter et al., 2020). Notably, both NBD locations for our study followed a structured station format in which student groups rotated between stations on a schedule. In contrast, Teeter et al. reported that an expo-style NBD format resulted in a positive impact on student attitudes, where students were able to decide what activities they visited and when they attended them (Teeter et al., 2020). The expo style was selected in the previous study based on support for improved learning in free-choice environments (Falk, 2005). Both of the NBD locations in our study provided more structure with set rotations between the activities in order to ensure all students were exposed to each topic/activity. One reason that this more structured style was chosen was to maintain smaller group sizes that can increase the opportunities to participate and engage in the activity and increase learning and attitudes toward learning (Springer et al., 1999). Additionally, given that students were often unfamiliar with biomechanics at the beginning of the NBD events, the structured style ensured that all students were exposed to biomechanics activities/topics that they may not have otherwise visited.

The consistent, albeit small, positive shifts that were observed across NBD events of structured versus expo-style formats support that short-term changes in student attitudes/perceptions generalize across diverse characteristics of NBD events. A driving force for the positive impact across these NBD events may be the interactive nature of the events that allowed students to experience biomechanics through hands-on activities (DeVita, 2018; Vennix et al., 2016), although no data were collected to verify this speculation. Although we only assessed student perceptions toward biomechanics in this study, prior work supports the association between positive changes in biomechanics identity with more generalized increases in science and engineering interest (Teeter et al., 2020). Therefore, generating interest through biomechanics may be able to support larger educational efforts to initiate and sustain student interest in STEM (Harackiewicz et al., 2016).

It is recognized that the magnitude of the positive shifts in student perceptions were relatively small. While a number of factors may have contributed to this observation, it is noteworthy that students entered the NBD events with a slight positive bias for biomechanics, indicated by the positive-leaning means and medians for the three primary adjective pairs (**Table 3**). This may have partly been due to some background to biomechanics being provided to students by their teachers prior to attending or self-selection bias due to recruiting science classes (Drazan, 2020); however, 18% of students still reported an IDK response on the pre-NBD survey. Therefore, the small effect sizes may partly be due to students entering the NBD events closer to the ceiling of our survey instrument and therefore having less opportunity for large positive shifts.

For example, the median for the question on importance of biomechanics was a 6 out of 7 before the NBD events and increased to a 7 out of 7 in the post-event surveys. This premise suggests that the greatest potential to achieve the largest positive shifts in perceptions is with students who have lower perceptions entering the events. A post-hoc analysis of our data corroborates this point. Spearman correlations between the pre-NBD response against the corresponding pre- vs. post-NBD change in the response for the same question identified significant negative correlations for exciting ($\rho = -0.23$, $p = 0.036$), importance ($\rho = -0.45$, $p < 0.001$), and career interest questions ($\rho = -0.25$, $p = 0.019$). The negative correlation coefficients indicate that lower initial perceptions on the pre-NBD survey were associated with larger improvements in student perceptions on the post-NBD survey. It is noteworthy that students who entered NBD with little understanding of biomechanics (i.e., selected IDK responses) largely showed similar distributions in the post-NBD responses as students who felt informed about biomechanics at the start of the NBD events (**Figure 3**). Whether larger shifts in student responses would have been observed for student groups who had a lower baseline perception regarding biomechanics is unknown.

In contrast to the positive changes that were observed for student perceptions of how appealing, exciting, and important biomechanics is, we did not observe significant changes in students seeing themselves in a biomechanics-related career. The mean and median for this question was consistently 4 out of 7, and did not differ between before versus after the NBD events. This finding should be considered alongside the observation that nearly all students felt informed about biomechanics following NBD to provide a numerical response to the career-interest question (IDK responses decreased from 16% to 1% after the NBD event). It is plausible that some students who were initially unfamiliar with biomechanics became unenthusiastic about a biomechanics-related career through the NBD events. Similar findings were observed for a freshman engineering course designed to expose mechanical engineering students to what practicing mechanical engineers do (Traum and Karackattu, 2009). As students learned more about the field, some realized a different discipline was more fitting for them. Including targeted free-response questions regarding career interest on NBD assessments could help elucidate opportunities to strengthen the impact of NBD on students' interest in biomechanics careers.

The findings of this pilot study provide additional support that even a single, two-hour NBD event can have a positive impact on students' perceptions of interest and importance of biomechanics. There are several limitations that should be considered when interpreting our findings, which also motivate future opportunities to expand this work. The survey we used in this study was intentionally designed to be brief in order to maximize the time students were actually engaging in the NBD content. The survey took ~5 minutes to complete, which supported its feasibility, but resulted in limited scope of the questions. However, the focused scope of the questions for this pilot study provides evidence for the value that can be gained from introducing assessments into biomechanics outreach. Furthermore, although the validity and reliability of the survey questions are supported from prior literature which our survey questions were based upon (Tyler-wood et al., 2010), the validity and reliability of the questions for the constructs tested in this manuscript are unknown. The multiple statistical comparisons used in this pilot study also inflates the risk of Type I statistical error (Holm, 1979), and therefore confirming these results in a larger study population that is conducive to correcting for multiple comparison is needed. It is also worth noting that the surveys only characterized short-term changes in student perspectives because they were administered immediately before and after the NBD events. Future longitudinal assessments are needed to characterize the long-term impact of NBD on student perspectives toward biomechanics. Impactful research questions remain unanswered regarding how biomechanics outreach can positively impact young students to pursue and excel in STEM fields (e.g., evaluate differences between gender, race, socio-economic status, etc.). Furthermore, mastery of STEM or biomechanics-specific content was not a focus of our survey. The hands-on activities at the core of NBD are aligned with active learning approaches, which consistently demonstrates positive effects on learning (Hake, 1998; Knudson, 2013; Knudson et al., 2009; Prince, 2004). Future efforts to characterize and optimize short- and long-term learning would further demonstrate the positive impact of NBD on students.

Although this pilot study initially recruited hosts of five NBD events, only two NBD locations ended up administering the survey during their NBD events due to timing and logistical challenges. Primary obstacles to implementing the survey during NBD events included late-evolving NBD logistics at several of the candidate sites along with added logistical hurdle of consent/assent that was required for the initial institutional review board approval. Subsequent IRB amendments have approved a waiver for written consent/assent with adequate information regarding the surveys sent to parents and students ahead of the event. Lessening this obstacle along with early incorporation of pre/post surveys into NBD designs is expected to support the successful integration of assessment into future NBD events.

Including assessments during biomechanics outreach enables researchers to evaluate its efficacy at impacting its participants. Assessment also provides opportunity for biomechanics outreach to intersect with scholarly productivity (Shultz et al., 2019). Recognizing this overlap may increase participation by research laboratories and further grow the positive impact of biomechanics outreach, as well as better characterize the nature and extent of the impact of outreach events on students.

Conclusion

This study identified positive effects of NBD on student perceptions toward biomechanics that support the positive impact of NBD on high school attendees. Significant but small shifts were observed in students' perceptions on how important, exciting, and appealing biomechanics is, although opportunities exist to strengthen the impact of NBD on students' interest in pursuing a biomechanics-related career. A number of future directions for biomechanics outreach were identified to further strengthen the impact that NBD and other biomechanics outreach activities have on students.

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Conflict of Interest Statement: Paul DeVita is the founder of National Biomechanics Day and the Biomechanics Initiative, although no financial conflicts of interests in these initiatives exist. The authors have no other potential conflicts of interest to disclose.

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Figure Captions

Figure 1. Format of the four adjective pair survey questions asked to students before and after National Biomechanics Day events. The full pre- and post-NBD surveys are provided in the Supplemental Material, for reference.

Figure 2. Survey responses from students attending National Biomechanics Day events. Each row indicates a separate survey question. Columns reflect responses organized by 1) combining responses from both locations (i.e., our primary analysis), 2) only Montana State University responses, and 3) only Elon University responses. Both pre- and post-NBD responses are shown in each subfigure, with pre-NBD responses indicated by diagonal lines and post-NBD responses shown by the transparent gray bars in the foreground. Students with 'I don't know enough about biomechanics to answer' responses on the pre-NBD survey are omitted from these figures, and missing responses are not shown. Significant differences between pre-NBD vs. post-NBD survey response distributions of unpaired surveys (Chi-Squared) are indicated by asterisks (*). Significant pairwise differences in pre-NBD vs. post-NBD responses (Sign Test) are indicated for the combined dataset ([a]) and the Montana State dataset ([b]). No significant differences existed for the isolated Elon University dataset.

Figure 3. Comparison of post-NBD survey responses for students with and without IDK responses on pre-NBD survey. Responses from students with IDK responses on the pre-NBD survey are indicated by diagonal lines and responses from students who had numeric values for both pre- and post-NBD responses are shown in the transparent gray bars in the foreground. Distributions were largely similar, with the most notable difference seeming to be a larger proportion of IDK-response students having more 'Strong Disagree' responses for career interest in biomechanics.

To me, **biomechanics** is:

	1	2	3	4	5	6	7		I don't know enough about biomechanics to answer
appealing	O	O	O	O	O	O	O	**unappealing**	O
exciting	O	O	O	O	O	O	O	**unexciting**	O
unimportant	O	O	O	O	O	O	O	**important**	O
boring	O	O	O	O	O	O	O	**exciting**	O

Figure 2 (revised)

Click here to access/download;Figure;NBD2019_Figure2_R1_v2.eps

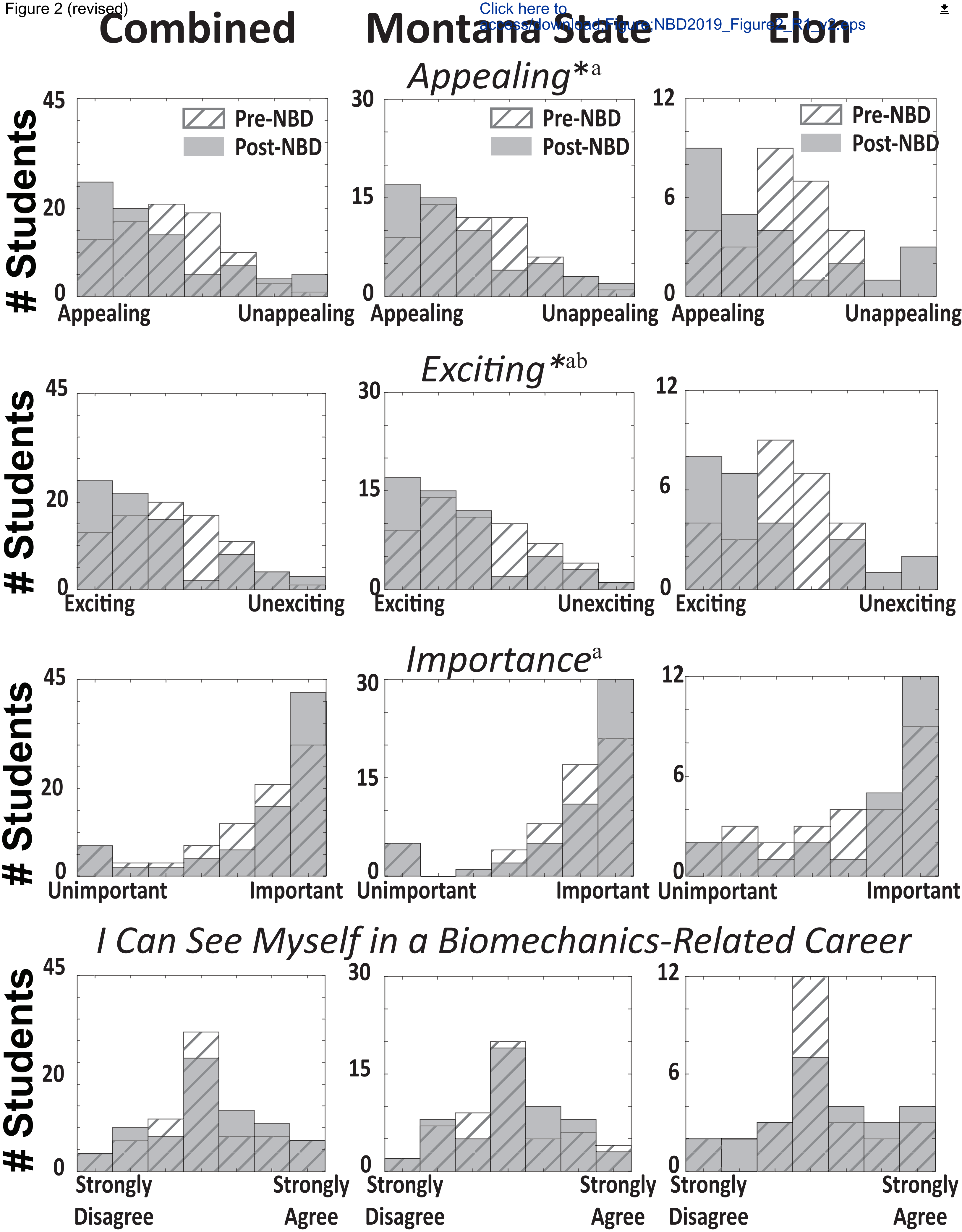

Figure 3 (new)

Click here to access/download;Figure;NBD2019_Figure3_R1_v1.eps

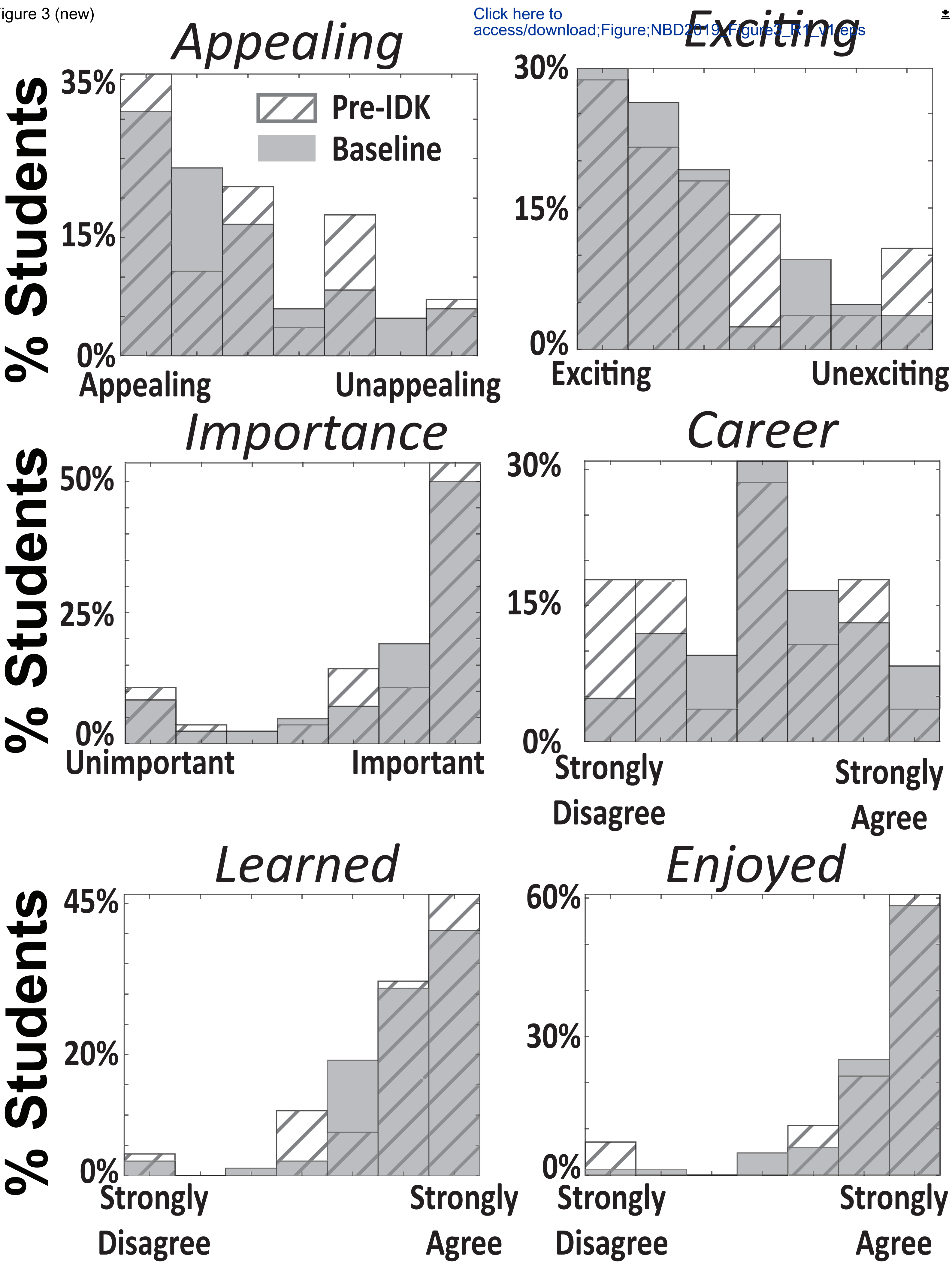

Table 1. Participant Characteristics

	NBD Event		
Characteristics	**Combined**	**Montana State University**	**Elon University**
Age (years)	16.5 ± 1.0	16.8 ± 1.0	16.1 ± 0.8
Gender (f/m)	65/38	42/25	23/13
Grade			
9	2 (2%)	0 (0%)	2 (6%)
10	35 (36%)	19 (29%)	17 (49%)
11	38 (38%)	24 (37%)	14 (40%)
12	24 (24.5%)	22 (34%)	2 (6%)
Race/Ethnicity			
American Native	2 (2%)	2 (3%)	0 (0%)
Asian	2 (2%)	0 (0%)	2 (6%)
Black/African American	6 (6%)	0 (0%)	6 (18%)
Hispanic/Latino	13 (13%)	3 (5%)	10 (29%)
Native Hawaiian/Pacific Islander	0 (0%)	0 (0%)	0 (0%)
White	77 (77%)	61 (92%)	16 (47%)

Students were able to select multiple races/ethnicities, as applicable.
Some students did not provide some or any demographic data.

Table 2. National Biomechanics Day (NBD) characteristics

NBD Characteristics	Montana State University	Elon University
Format	Structured (8 stations)	Structured (3 stations)
Welcome Presentation to Introduce Students to Biomechanics	Yes	Yes
Content	Bone mechanics, balance, locomotion, motion capture, isokinetic (muscle force properties), IMUs, biomechanics of hearing, NeuroCAVE	Balance, jumping, motion capture, running
NBD Volunteers	Faculty, graduate students, undergraduate students in engineering and health and human development working in diverse areas of biomechanics	Faculty, graduate students, undergraduate students, and DPT students across physical therapy, exercise science, dance science programs
Total NBD Duration	2 hours	2 hours
Time per Station	10 minutes	20 minutes
High School Student Cohort	Anatomy, Biology, and Sciences Classes at traditional high schools	Health Science Students from a Career and Technical School
Biomechanics Career Discussion	Mentioned, but not emphasized	Mentioned, but not emphasized
Returning Students	Some students (~15) from one of the two high school classes at the NBD event had attended an NBD event the previous year	None expected

IMUs: inertial measurement units

NeuroCAVE: interactive art exhibit utilizing brain waves measured by electroencephalography (https://www.montana.edu/cave/)

Table 3. Descriptive statistics for survey responses before (Pre) and after (Post) the NBD events.

		Combined				MSU				Elon		
	Survey Question	**n**	**Mean (SD)**	**Median (IQR)**		**n**	**Mean (SD)**	**Median (IQR)**		**n**	**Mean (SD)**	**Median (IQR)**
Pre	(1) Appealing-Unappealing (7)	84	3.1 (1.4)	3 (2)		56	3.1 (1.5)	3 (2)		28	3.1 (1.3)	3 (2)
	(1) Exciting-Unexciting (7)	83	3.1 (1.5)	3 (2)		55	3.2 (1.6)	3 (2)		28	3.1 (1.2)	3 (1.75)
	(1) Unimportant-Important (7)	83	5.4 (1.9)	6 (2)		55	5.6 (1.8)	6 (2)		28	4.9 (2.0)	5 (3.75)
	Biomechanics Career Interest (7 Strongly Agree)	78	4.1 (1.5)	4 (2)		52	4.0 (1.5)	4 (2)		26	4.3 (1.5)	4 (1)
Post	(1) Appealing-Unappealing (7)	81	2.7 (1.8)	2 (3)		56	2.7 (1.7)	2 (2.75)		25	2.9 (2.1)	2 (3.25)
	(1) Exciting-Unexciting (7)	80	2.6 (1.7)	2 (2)		55	2.6 (1.6)	2 (2)		25	2.8 (1.9)	2 (3)
	(1) Unimportant-Important (7)	79	5.7 (1.9)	7 (2)		54	5.9 (1.8)	7 (1.25)		25	5.4 (2.1)	6 (3)
	Biomechanics Career Interest (7 Strongly Agree)	80	4.2 (1.6)	4 (2)		55	4.1 (1.5)	4 (2)		25	4.4 (1.8)	4 (3)
	Enjoyed NBD (7 Strongly Agree)	81	6.3 (1.1)	7 (1)		56	6.4 (1.0)	7 (1)		25	6.3 (1.4)	7 (1)
	Learned during NBD (7 Strongly Agree)	81	6.0 (1.2)	6 (2)		56	6.1 (1.1)	6 (1)		25	5.9 (1.3)	6 (2)
Post-NBD responses for students with an IDK response on pre-NBD survey												
Post	(1) Appealing-Unappealing (7)	26	2.8 (2.0)	2.5 (4)		13	2.6 (1.4)	3 (2.5)		13	3.1 (2.4)	2 (4)
	(1) Exciting-Unexciting (7)	27	3.0 (2.0)	2 (3)		13	2.7 (1.4)	3 (3)		14	3.2 (2.4)	2 (5.25)
	(1) Unimportant-Important (7)	26	5.6 (2.1)	7 (2)		13	5.8 (1.8)	7 (2)		13	5.3 (2.4)	7 (2.5)
	Biomechanics Career Interest (7 Strongly Agree)	27	3.7 (1.9)	4 (3)		13	3.2 (2.1)	3 (4)		14	4.1 (1.6)	4 (1.75)
	Enjoyed NBD (7 Strongly Agree)	27	6.1 (1.6)	7 (1)		13	5.9 (1.7)	6 (1.5)		14	6.3 (1.6)	7 (1.25)
	Learned during NBD (7 Strongly Agree)	27	6.0 (1.4)	6 (1)		13	5.8 (1.8)	6 (2)		14	6.2 (1.0)	6.5 (1.25)

n: Number of surveys included

MSU: Montana State University

Table 4. Results of Sign Tests for paired pre- vs. post-NBD surveys. P-values for significant differences are bolded.

	Combined		**MSU**		**Elon**	
Survey Question	**# Pairs**	**P-Value**	**# Pairs**	**P-Value**	**# Pairs**	**P-Value**
Appealing-Unappealing	81	**0.050**	56	0.082	25	0.481
Exciting-Unexciting	80	**0.007**	55	**0.026**	25	0.21
Unimportant-Important	79	**0.018**	54	0.153	25	0.065
Career Interest	74	0.486	51	0.663	23	0.774

Pairs: Number of contrasts for paired surveys included in the analysis

MSU: Montana State University

Students who had an IDK on the pre-NBD survey were omitted from these analyses.