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The Effect of Content Delivery Media on Student Engagement and Learning Outcomes

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Abstract

To gather more objective information about effective teaching and levels of student engagement, research in higher education has shifted to increased observations within the college classrooms and is focused more on the collection of systematic data. Despite the attempt by instructors to implement various pedagogies and use different instructional approaches in the classroom setting, research into teaching and learning suggests that it may depend less on what the instructor is doing and more on the relationship between teaching and student learning, and to what degree students are engaged. A number of studies have been designed to compare and contrast various methods for delivering content, with most of the research leading to mixed results. In this particular study, results indicated the media in which an instructor delivers content does not necessarily translate to greater student learning outcomes. The purpose of this study was to systematically analyze the effect of content delivery media on student engagement, learning outcomes, and instructor behavior in two sections of the same lecture-based college Biomechanics course. Educating and encouraging instructors to implement more interactive and active teaching methods will assist them in fostering student engagement.

Keywords: Student engagement, learning outcomes, content delivery.

For those in the teaching profession, there is an inherent desire to capture the interest of students and engage them in the subject matter being taught and learned (Smith, Jones, Gilbert, & Wieman, 2013). Although many in higher education understand the importance of student engagement as a prerequisite to learning, there are still many questions surrounding why and when students choose to engage, and ultimately which teaching methods are most likely to increase engagement, and thereby improve learning (Berrett, 2014; Perrotta & Bohan, 2013; Smith, Jones, Gilbert, & Wieman, 2013; Wieman & Gilbert, 2014). In an attempt to foster student engagement and stay on pace with the latest technological advances in teaching, higher education instructors are starting to shift from traditional lecture-based formats to more interactive methods and techniques (Hora & Ferrare, 2014; Kuh, Kinzie, Buckley, Bridges, & Hayek, 2006; Perotta & Bohan, 2013). Despite attempts by some instructors to implement various pedagogies and use different instructional approaches in the classroom setting, research into teaching and learning suggests that it may depend less on what the instructor is doing in class and that

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the relationship between teaching and student learning is more dependent in the degree to which students are engaged with the content (Hora & Ferrare, 2014; Lukowiak & Hunziker, 2013).

Hu and Kuh (2002) succinctly define student engagement as, "the quality of effort students themselves devote to educationally purposeful activities that contribute directly to desired outcomes" (p. 555). In addition to student engagement, teaching and learning are dependent on many contextual factors, including the instructor, learner, subject matter, environment(s), teaching or delivery methods (Meo et al., 2013; Zepke & Leach, 2010), and the activity in which the students are involved (Shernoff & Csikszentmihalyi, 2009). Instructors can select from a wide range of content delivery methods and media to present course content, including chalkboard, PowerPoint presentations, hybrid formats, and completely online media. According to Seth, Upadhyaya, Ahmad, and Moghe (2010), the predominant medium to deliver content in the college classroom setting is still the chalkboard, although PowerPoint is becoming increasingly more popular. Prabhu, Pai, Pranbhu, and Shrilatha (2014) mention that teaching with the chalkboard engages learners actively and the learner is more attentive to what the instructor is discussing, writing and illustrating on the board. On the other hand, PowerPoint is useful in larger groups (50 to 100) and is often used to enhance visual quality of text and figures. Ultimately, the choice to use the chalkboard or PowerPoint lies with the instructor and should be chosen to enhance learning (Prabhu et al., 2014).

Comparing different media used to deliver content and the subsequent effects on student learning, Prabhu et al. (2014) found no significant difference in pre and post- multiple choice test scores for students in one section of the same course taught using PowerPoint and another section taught using a chalkboard. Authors concluded that both media chosen to deliver the content have their respective benefits in the college classroom. Another study comparing PowerPoint with chalkboard found that the integrated use of both PowerPoint and chalkboard media, rather than each medium used alone, was more suitable (i.e., more knowledge gain) for teaching undergraduate medical students (Meo et al., 2013). In another study, students who attended a class using chalkboard obtained significantly higher test scores compared to those who attended the same content-based lecture using PowerPoint, suggesting that chalkboard teaching has the advantage of better recall for medical students (deSa & Keny, 2014). While comparing three different delivery methods (lecture, hybrid, and online), results of Gonzalez's (2014) six year study indicated that the highest student success rates were achieved for those taught using blended media to deliver content, followed by hybrid, then lecture. Traditional lecturing without the use of chalkboard or PowerPoint has been found to be a less effective method for delivering content to students (Gonzalez, 2014); however, empirical evidence that indicates the extent to which different media improves student performance is still lacking (Bartsch & Cobern, 2003). While any instructional aid has the potential to be effective, the instructor must reflect on their current practice and choose the appropriate medium to influence and positively impact their students' learning experience (Aranha, Shettigar, & Varghese, 2013; Lane & Harris, 2015).

To gather more objective information about effective teaching and levels of student engagement, research in the field has shifted to increased observations within the college classrooms and is focused more on the collection of systematic data. In his article discussing the state of college teaching, Berrett (2014) points out how critics view the teaching as "insufficiently interactive" and indicates that the knowledge we do have on teaching is based primarily on self-report data from student evaluations or from the instructors themselves. To increase the knowledge base in this area, Berrett (2014) communicates the need for, and the value of, direct observation to find out what exactly is happening in the classroom. To gain a more accurate picture of teaching practices, observation tools and protocols should be developed from a more scientific lens and "broken into its atoms, categorized, and analyzed" (Berrett, 2014). Observations should not be limited to only the behavior of the instructor, the methods of teaching, or the media chosen to deliver instruction, they should also capture the use of instructional technology and more subtle pedagogical strategies, such as the nature of questions, humor, illustrations, and anecdotes, which all play a critical role in instruction (Hora & Ferrare, 2014). A narrow focus on only the instructor will prevent the observer from gathering valuable data on one of the most critical determinants of learning - that of student engagement with the course content (Hora & Ferrare, 2014). Despite the continued challenged to conceptualize and measure the construct of student engagement (Sinatra, Heddy, & Lombardi, 2015), there is a paucity of research and a lack of authentic observational data related to student behavior as the unit of measurement (Lane & Harris, 2015) and the associated learning outcomes in higher education. Therefore, the purpose of this study was to systematically analyze the effect of content delivery media on student engagement, learning outcomes, and instructor behavior in two sections of the same lecture-based college Biomechanics course.

Method

Setting

The study took place at an urban university in the Southeastern United States. The setting for the study included two sections of the same introductory undergraduate Biomechanics course during the fall of 2014. Biomechanics is required for all Exercise Science majors at the university. Each section met for a 50-minute lecture twice a week, and a lab section once a week. Each section had a total of 41 and 36 students, respectively. The lab classes were taught by teaching assistants and therefore were not included as part of the study due to the intended focus on only the primary course instructor. Each section of the course was taught using a different medium to deliver content to students during lectures. The same instructor implemented instruction using each medium. Content in one section was delivered primarily via electronic PowerPoint-based media presentations (referred to as the "PowerPoint" [PPT] section). Content in the other section was delivered primarily with the use of a whiteboard (referred to as the "Whiteboard" [WB] section). Live demonstrations, interactions, and the use of video were also deployed in each section; however, sections were labeled according to the primary method used to deliver content to the students in each section.

Participants

Participants in the study included the instructor of the Biomechanics course and the students in the two sections who consented to participate. The instructor for the study was self-recruited, having approached the senior investigator with the intention to conduct the study in the fall of 2014. Following approval from the institution's IRB, consent for instructor and student participation was obtained prior to the start of the semester. The instructor has taught Biomechanics every semester for 11 years at this university. Students were recruited in the first class meeting of each section. Initially, 49 students within both course sections consented to participate in the study. After one student withdrew, a total of 48 students participated in the study (*N* [PPT] = 22; *N* [WB] = 26). Only students enrolled in the course were included in the recruitment process.

Data Collection

Student Engagement

A customized observation instrument was developed to observe and code student behaviors in person during classes. Prior to the start of data collection four graduate students on the research team were trained to observe students with an acceptable level of interobserver agreement at or above 80% on each defined category. Observer reliability was checked again three additional times during the data collection period; all observers remained above the 80% criterion on all categories throughout the study. The observation-coding instrument consisted of both duration and frequency recorded categories of behaviors. Researchers observed eight randomly selected students in two-minute rotational sequences in each class meeting. The lecture room was divided into four quadrants, with two students selected from each quadrant in each class. The live observations of students took place twice a week for the 50-minute class throughout the entire semester, excluding non-content delivery days (e.g., course introduction, reviews, tests). This resulted in approximately half of all class meetings (*N* = 18) being observed for each section. See Table 1 for the specific categories of student behaviors included in the observation instrument.

Student Learning Outcomes

Additional sources of data included learning outcomes from a variety of sources including three exams and final course grade. The instructor provided the researchers with exam and final grades for each consenting student in the sample.

Instructor Behavior

A customized observation instrument was developed to observe instructor behaviors during lecture classes. See Table 2 for the specific categories of instructor behaviors included in the observation instrument. Four graduate students on the research team were trained to observe the instructor with an acceptable level of interobserver agreement at or above 80% on all categories. Observer reliability was checked again three additional

Table 1. Student Behavior Categories.

Duration Recording Categories		Descriptor	Code	Definition/Example
1	Task (in class)	Individual	TI	Student is participating in content-related task assigned only to them.
		Group	TG	Student is participating in content-related task assigned to a group.
		Class	TC	Student is participating in content-related task assigned to entire class.
2	Listening		L	Student is actively listening to instructor.
3	Reading or Taking Notes		RTN	Student is reading content-related material or actively taking writing (or typing) class notes. *Make note if reading. If reading is assigned it is considered a 'task'.
4	Content Interaction		CI	Student is interacting with instructor.
5	Off Task	Sleeping	OTS	Student is sleeping/eyes closed/head on desk.
		Talking	OTT	Student is talking to peer student.
		Absent	OTA	Student leaves room.
		Media	OTM	Student is using technology (phone, computer) for non-content purposes.
		Other	OTO	Student is engaged in off-task behavior other than categories defined above.
6	Management		MG	Student is engaged in management task such as attendance, receiving graded papers or administration of materials for class.
7	Other		O	Student is engaged in behavior other than categories defined above.
Frequency/Event Categories			Code	Definition/Example
1	Questioning - open ended		QO	Student asks a type of question (content-related only) that requires explanation.
2	Questioning - closed		QC	Student asks the type of question (content-related only) that has only one answer.
3	Raising Hand - called on		RHC	Student raises hand and is called on by instructor.
4	Raising Hand - not called on		RHN	Student raises hand and is not called on by instructor.
5	Call Out		CO	Student answers question without being called upon by instructor.
6	Reply - correct		RC	Student answer is correct.
7	Reply - incorrect		RI	Student answer is incorrect.
8	Reply - redirected		RR	Student has been redirected, and the interaction chain continues.
9	No Reply		NR	Student is not acknowledged by the instructor.

Table 2. Instructor Behavior Categories.

Group	Duration Recording Category	Code	Definition/Example
Episode (Duration)	Management	M	Instructor is discussing assignments with students, setting up technology, etc.
	Review	R	Instructor is reviewing previous class content.
	New Content	NC	Instructor is presenting new content. Does not include problem solving.
	Other	O	Anything not described above.
Delivery (Duration)	Instruction-Whiteboard	IW	Instructor is writing on and/or referring to content (texts or images) on whiteboard while lecturing and/or problem solving.
	Instruction-Media	IM	Instructor is lecturing and/or referring to content on any technology that is NOT the whiteboard and/or problem solving.
	Instruction-Modeling	IMO	Instructor is modeling while lecturing and/or problem solving.
	Instruction Only	IO	Instructor is lecturing without the use of ANY visual aid or technology (i.e. white board is blank).
	Non-Verbal- Media	NVM	Instructor is not speaking while playing a video or audio clip.
	Non-Verbal- White Board	NVW	Instructor is NOT speaking while writing on whiteboard.
	Wait Time	W	Instructor waits for student responses to questions or task/problem solving completion.
	Anecdote	A	Instructor tells a story about his personal life (self, family).
	Other	O	Instructor is presenting content in a way not described above.
Teacher Behavior (Frequency)	Modeling- Self	MS	Instructor is using his own body to demonstrate a concept or content.
	Modeling- Other	MO	Instructor is using a prop or artifact to demonstrate a concept or content.
	Anecdote- Relevant	AR	Instructor tells a story about him-

			self that is used to expand upon or act as an example of class content.
	Anecdote- Non-relevant	ANR	Instructor tells a story about himself that does not relate to class content.
	Teacher Question/Task to Class	QC	Instructor asks question to class or gives class task/problem to solve.
	Teacher Question Individual	QI	Instructor asks question to individual student.
	Student Initiates Question	SQ	Student asks question to instructor.
	Other	O	Instructor is engaged in behavior other than described in categories above.
Interactions (Frequency)	Rhetorical	R	Question that does not require a response.
	Open	OP	Question that requires explanation but does not have one specific answer sought by the instructor.
	Closed	CL	Question that has one specific answer sought by the instructor. Answer choices can include yes/no, one word answer, definitions, brief explanations, and/or checking for understanding.
	Correct Answer	CA	Instructor informs student or class that answer is correct.
	Incorrect Answer	IA	Instructor informs student or class that answer is incorrect.
	Teacher Self Answers	TSA	Instructor responds to student question or his own question (could happen if no one speaks up to answer a question, or if instructor does not hear the correct answer from the class, and then answers the question himself).
	Teacher No Reply	TNR	Instructor does not respond directly to student.
	Teacher Re-Direct	TRE	Instructor re-directs the question to either an individual or the class.

times during the data collection period; all observers remained above the 80% criterion on all categories throughout the study. The instructor was videotaped during each section twice per week, resulting in recordings of approximately half of total semester classes, minus one for technical difficulties (N = 17). The trained observers used the video recordings for systematic observation and coding of instructor behaviors. The observation coding instrument consisted of both duration and frequency recorded categories of behaviors.

PowerPoint Usage and Content

A customized analytic instrument was developed to collect frequency data on PowerPoint slide usage per class in each of the two sections to verify the difference between the two sections on the medium used to deliver content. A graduate student on the research team utilized the video recordings of instructor behaviors to systematically code frequency of content per section, resulting in content collection from approximately half of all class meetings (N = 17). See Table 3 for the specific categories included in the observation instrument.

Table 3. PowerPoint Slide Categories.

Frequency/Event Categories		Code	Example
1	Text	T	PowerPoint slide consisted of text only (i.e. words, numbers, definitions, equations).
2	Picture	P	PowerPoint slide consisted of pictures only (i.e. images, graphics).
3	Video	V	PowerPoint slide consisted of video only (i.e. link to video).
4	Text & Picture	TP	PowerPoint slide consisted of combination of text and pictures.

Data Analysis

Data were analyzed using SPSS and descriptive statistics were reported for student engagement, instructor behavior, and PowerPoint content. Independent *t*-tests were used to compare instructor behaviors, student engagement, and student learning outcomes (grades) between the two course sections.

Results

Student Engagement

Descriptive statistics and independent sample *t*-tests were conducted to analyze differences between sections on four main student engagement categories: Listening, Reading/taking notes, Content interaction, and Off-task (See Figure 1). Results revealed the student engagement behaviors between the two classes were not statistically significantly different on the four main student engagement: listening [$t(15) = -.08$, $p. = 0.94$], reading

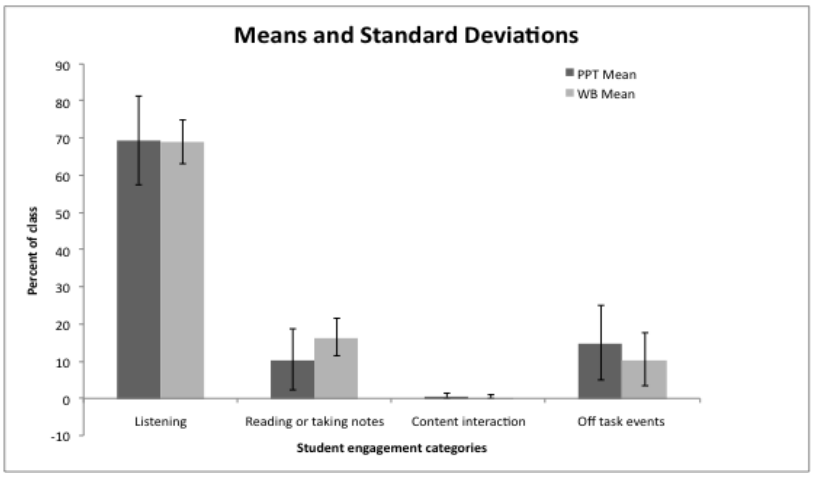

Figure 1. Student engagement means and standard deviations.

or taking notes [$t(15) = 1.85$, $p. = .09$], content interaction [$t(15) = -.52$, $p. = .61$], and off-task behavior [$t(15) = -1.068$, $p. = .30$].

Student Learning Outcomes

A comparison of group mean GPA scores between the PPT section ($N = 14$) and the WB section ($N = 21$) revealed no difference between course sections at the start of the fall semester (PPT M = 3.31, SD = .42; WB M = 3.35, SD = .37). A comparison of final course grades and final exam grades for each section are illustrated in Figure 2. Independent sample *t*-tests were conducted to analyze differences between sections regarding the final exam grades, final course grades, and overall GPA. These tests revealed no significant difference in grades across course sections: final exam [$t(44) = -.51$, $p = .61$], final course

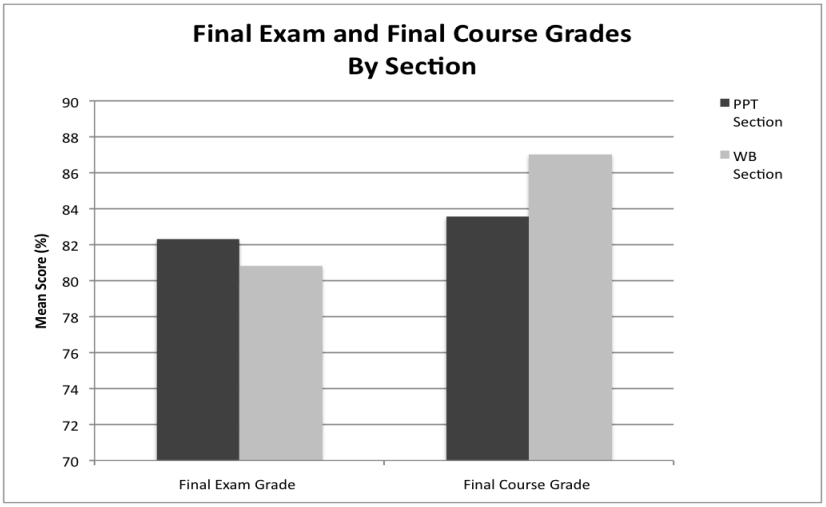

Figure 2. Comparison of final exam grades and final course grades by section.

grade [$t(46) = 1.19$, $p = .24$], and overall GPA [$t(33) = .28$, $p = .78$].

Instructor Behavior

Descriptive statistics were performed to analyze the percent of class time the instructor used the whiteboard to deliver content in the WB section and the percent of class time that the instructor used PowerPoint slides to deliver content in the PPT section. Examination of the data confirmed the use of the two different media for delivering content as intended. The instructor spent relatively the same amount of total class time teaching content in the WB section compared to the PPT section. Similarly, the overall behavior of the instructor was very similar in each section. Refer to Figure 3 for a graphical representation of the descriptive statistics for all instructor behaviors. Independent sample *t*-tests were conducted to analyze differences between sections on percentage of class time spent in individual categories and combined categories. These tests revealed a significant difference in two categories: the percent of class time spent instructing using the WB [$t(14) = 9.38$, $p = .00$] and the percent of class time spent instructing using PPT [$t(14) = 10.89$, $p = .00$]. These results confirm that the two sections were taught using two different methods of content delivery. Additionally, descriptive statistics and independent sample *t*-tests were conducted to compare percent of class time spent in various instructor behavior categories between the two sections (See Figure 3 for descriptive statistics). Results revealed no significant differences in instructor behaviors categories across the two sections: instruction modeling [$t(14) = -.35$, $p = .73$], instruction only [$t(14) = 2.18$, $p = .05$], nonverbal instruction using the whiteboard [$t(14) = 2.05$, $p = .06$], percent of class time waiting [$t(14) = .25$, $p = .81$], percent of class time telling anecdotes[$t(14) = -.66$, $p = .52$], percent of class time spent reviewing [$t(14) = -1.72$, $p = .11$], percent of class time introducing new content [$t(14) = 1.77$, $p = .10$], total amount of instructional time [$t(14) =$

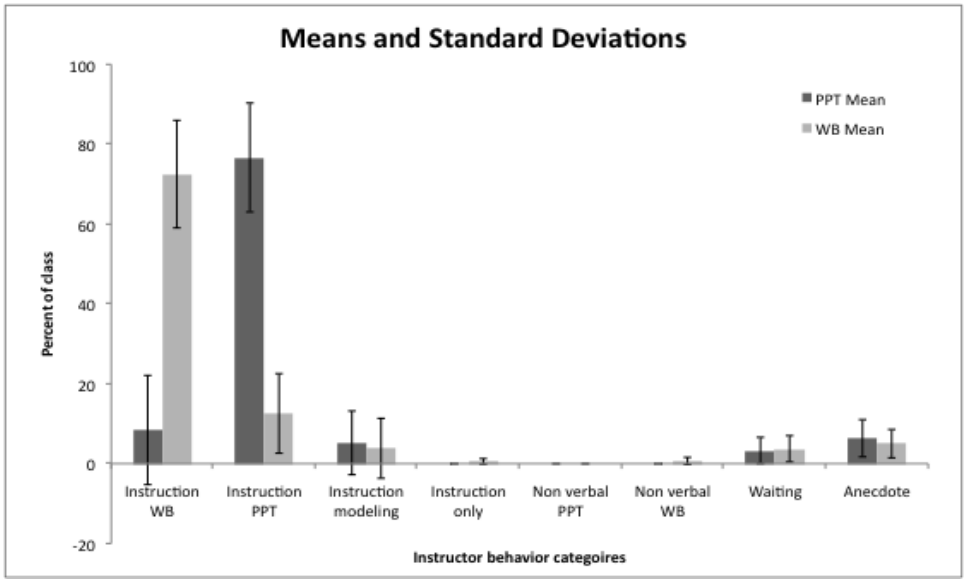

Figure 3. Instructor behavior means and standard deviations.

-.26, p = .8], total percent of class time in instructional categories [t(14) = -.91, p = .38], total percent of class time in episode categories [t(14) = 1.17, p = .26], total percent of class time in content categories [t(14) = .33, p = .74], anecdotes rate per class [t(14) = -.97, p = .35], total rate of teacher questions per class [t(14) = .06, p = .96], and total rate of open and closed content questions per class [t(14) = .42, p = .68].

PowerPoint Usage and Content

Descriptive statistics revealed total PowerPoint slide usage (per class) in the WB section (M = 3.22, SD = 4.63) to be lower than the total PowerPoint slide usage (per class) in the PPT section (M = 31.00, SD = 18.92). Additionally, independent *t*-tests were used to compare PowerPoint usage and PowerPoint slide content between the two sample sections. These tests revealed a significant difference between the two sample sections in amount of text per slide [t(14) = -4.08, p = .001] and text and picture per slide[t(14) = -4.73, p = .00], confirming the method of content delivery was different between the two sections. No significant difference was found in the amount of pictures per slide [t(14) = -1.23, p = .24], or video per slide [t(14) = -.18, p = .86]. This was because the instructor showed the same pictures and videos in each section of the class.

Discussion

There is an increasing interest in collecting information regarding instructional practices and student engagement in college courses (Smith et al., 2013), as well as an investment to increase overall student success in postsecondary education (Kuh et al., 2006). Upon analyzing the effect of different content delivery media on student engagement, student outcomes, and instructor behavior, it was found that there were no significant differences between the two sections of a Biomechanics course in this study. Overall, the results illustrate that even though different media can be used to deliver the same content, the different instructional approach does not necessarily result in a change in interaction between the instructor and student, or between the student and the content, or differences in student learning.

Student Engagement

The students exhibited similar behavior in both of the sections of the course and maintained engagement in relatively similar ways. The different instructional media did not translate to a significant difference in student behaviors representative of engagement (i.e. content interaction) or in behaviors representative of student disengagement (i.e. off-task).

Student Learning Outcomes

While small differences exist between sections regarding student grades on exams, homework, quizzes, and GPA, *t*-tests showed that these variables were not statistically significant. Therefore, regardless of section, students performed similarly on course assignments and had similar GPAs at both the start and end of the course. Using a different

medium to present content did not affect student outcomes differently in the PPT section compared to the WB section.

Instructor Behavior

Observation of the instructor behaviors indicate that the instructional medium used to deliver content did not lead to differences in overall instructor behavior. Essentially, using the whiteboard or PowerPoint to deliver content represented two ways to present content and did not affect how the instructor behaved or interacted in each section. Regardless of the delivery, no significant difference in teacher behavior exists regarding time spent instructing in each section, the amount of questions asked per section, type of question asked per section, amount and type of modeling per section, amount and type of anecdotes per section, etc. This illustrates that changing the media to deliver content does not change instructor behavior between sections of this specific course.

PowerPoint Usage and Content

As intended, the PPT section was taught predominantly with the use of technology (PowerPoint presentation and slides) as the main medium for delivering content. Although the WB section did include occasional complementary PowerPoint slides, it was taught using minimal technology, with the content delivered to students predominantly through a traditional whiteboard medium. The data support a difference in the delivery and usage of media by the instructor; however, the insignificant differences in student engagement and student learning outcomes indicate the students received the content of the course in the same manner across both sections.

Limitations

The data in this study were collected only during the lecture section of the Biomechanics course. In addition to attending the lecture sections twice a week, students also attended a one-hour lab section once a week. The intent of lab was to apply content learned in the lecture classes in a smaller setting through active learning. No observations or data were collected from this lab section. Different instructional strategies and/or methods of content delivery may have been implemented in this lab section, which could have influenced the engagement of students in the lecture sections. Students engage more in learning when they are able to make a connection between the content learned in the classroom and real life (Lukowiak & Hunzicker, 2013). It is unknown whether this connection occurred more extensively during the lab section and subsequently, if this had any effect on engagement, learning, outcomes, and/or instructor behavior in the lecture sections.

Implications

Observational data alone should not be used as a measure of teaching quality or efficacy and "any attempt to assess instructional quality should be based on a variety of measures and data sources, including student outcomes" (Hora & Ferrare, 2014, p. 40). According-

ly, this study was not intended to measure the teaching effectiveness of the instructor, but rather was intended to compare the effectiveness of one instructional medium with another. The objective data and results are meant to help inform teaching practices and provide a comparative glance into the effect of two mediums for delivering content on various constructs of student learning.

As indicated in the results of this study, changing the media in which an instructor delivers content does not necessarily translate to greater student learning outcomes. The focus needs to shift more towards how the students are engaged in the content, which in turn will provide more information on the extent to which learning is potentially taking place. The results of this study do not place one medium as more or less effective than the other, which reinforces the concept that content can be presented through different media and achieve the same outcomes in terms of behavior, engagement, and learning outcomes.

The findings from this study can also be used to inform professional development opportunities. Educating and encouraging instructors to implement more interactive and active teaching methods will assist them in fostering student engagement and lead to student achievement in the college setting (Lane & Harris, 2015; Smith et al., 2013; Wieman & Gilbert, 2014). Additionally, PowerPoint dependent instructors may find comfort in branching out to explore other delivery methods, even more interactive ones, if they know that they can present the same content with a different media and have students achieve the same outcome. In their comprehensive literature review, Kuh et al. (2006) highlight a number of pedagogical approaches that are known to be effective in promoting student success: active and collaborative learning, classroom-based problem solving, peer teaching, instructional technology, service-learning, reciprocal teaching, and concept-knowledge mapping (p. 67). If student engagement is known to be one of the most important factors in student learning during college (Hu & Kuh, 2002; Smith et al., 2013), it is vital for instructors to look beyond their own behaviors in the classroom and evaluate the impact that their practice has on the students, not only in terms of how content is being received, but also in terms of how students are engaged with the material. Instructors that are committed to creating a student-centered learning environment and developing an engaging pedagogical practice can play a critical role in improving student learning in college courses (Kuh et al., 2006; Lane & Harris, 2015; Smith et al., 2013).

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