ABSTRACT
Many studies support the shift to interactive biology classrooms. Implementing these pedagogical changes can be particularly challenging for educators who must balance class preparation time with student engagement and course content. One approach to finding this balance is the use of complex classes with many components that continually redirect student focus. This study aimed to determine which components of a complex lecture were most engaging to senior-level college students in an animal behavior course. For this study, I presented students in two animal behavior classes with a PowerPoint presentation, an activity, group work, class discussion, and a PowerPoint presentation with videos. Students responded to Likert items on a survey to rate their interest in lecture activities, the extent to which the activities encouraged thinking, and to identify their favorite component of the class. Students agreed that the activity encouraged thinking. The two classes varied in preferred components, with the first class leaning toward the activity, whereas the second class preferred the videos, but these differences were not statistically significant. Overall, most students identified components of the traditional lecture as their favorites. These results suggest that moderately interactive approaches, such as videos, can engage students.

Key Words: behavior simulation; engagement; student preference; traditional lecture.

Introduction
There is a growing shift away from unidirectional, lecture-style education to more interactive teaching strategies to improve learning across all educational levels (AAAS, 2011). An interactive approach may range from questions during lecture and group work up to more complex activities that involve hands-on experience with material. These strategies are consistently linked to improved measures of learning (e.g., Connell et al., 2015; Anderson et al., 2011; Armbruster et al., 2009), and it is widely acknowledged that active learning strategies will better serve the diverse learning patterns of the student population. The difficulty lies in the implementation of these strategies, which can require extensive planning and training for educators in faculty development programs (D’Avanzo, 2013; Rogan & Anderson, 2011). Although examples of research-based teaching strategies date back to the 1950s (Pelaez et al., 2015) and databases of activities and lesson plans have been available for educators (e.g., the EcoEd Digital Library through the Ecological Society of America), adapting these items to particular courses can still be a challenge. With ever-increasing demands on educators’ time, it is important to know which teaching strategies have the most impact with students. This information would guide the efficient use of classroom time.

The average attention span of a young adult is reported to range from a mere 8 seconds (Microsoft Corp., 2015) up to 20 minutes (Johnstone & Percival, 1976); therefore, it may be necessary to vary the teaching style several times during a class period. Moreover, the variety of learning styles and temperaments of students (i.e., introverts and extroverts) suggests that an assortment of interactive learning strategies must be employed to effectively reach all students (Murphy et al., 2004). For example, one class period may include a video, discussion, a lecture, and group work. For courses that do not have a laboratory component, it may also be useful to incorporate hands-on activities, such as games or simulations, into the weekly class meetings. It is important to mention here that there is debate regarding the existence of student learning styles, or the validity of learning style theories. Although it is generally accepted among educators that some individuals prefer visual, auditory, or tactile learning (Howard-Jones, 2014), there is little to no scientific evidence to support these claims (Willingham et al., 2015). The use of several teaching styles in complex lectures can be a “bet-hedging” measure, allowing the educator to engage students in a variety of ways.
just in case they do have different learning styles. Such a complex lecture can address concerns about both attention span and varied learning styles.

This complex lecture strategy, sometimes referred to as “chunking” (Zilora & Beaton, 2006), can be particularly challenging when balancing the need for student engagement with student exposure to fundamental biological concepts. The solution to this problem of interaction vs. content is often met by increasing student learning responsibilities outside of the classroom (e.g., “flipped” classes; Mok, 2014, and references within); however, students are often resistant to course changes that require additional work, as evidenced by lower course ratings (Persky & Dupuis, 2014; Ferreni & O’Connor, 2013), and preparation of the material for outside-of-class work can be time-consuming. For larger classes, one solution to improve interaction among students is to assign groups for discussions. This approach can have mixed success, and largely depends on the students’ receptiveness to group work (e.g., Knight & Wood, 2005). There needs to be a balanced, time-efficient approach to presenting fundamental content and interactive teaching during class meetings.

An interactive lecture period using a moderate combination of traditional and modern delivery methods may achieve this balance. Addressing the issue of efficient use of interactive teaching lies not only in analysis of learning outcomes through assessments, but also in feedback provided by students. Decades of research have indicated a strong role of student emotions (also known as affect) in development and maintenance of student interest in particular topics (Hidi, 2006; Ainley et al., 2005). Indeed, Sengupta-Irving and Enyedy (2014) demonstrated that students gave higher ratings to student-driven learning opportunities than more guided learning approaches even when learning gains were equal across both strategies. Thus, it would not be surprising for students to generally prefer a more interactive approach to teaching since the students will have a greater role or emotional investment in their own education. When people laugh or are entertained, they actually learn more as a result of reduced anxiety and greater attention to the subject (Cueva et al., 2006; Walker, 2006; Berk, 2002; Berk & Nanda, 1988); therefore, student enjoyment of class activities can be a valid measure for assessing the effectiveness of interactive classes in student engagement.

This study investigated the usefulness of interactive and traditional lecture components in a senior, college-level animal behavior class through anonymous student feedback. The class period consisted of PowerPoint lecturing with graphics and videos, a simulation of fish schooling behavior, group discussions, and a concluding lecture. A student survey with a Likert scale and open-ended questions was used to identify student interest in class components.

**Methods**

To determine student receptiveness to a highly interactive lecture, I used a complex lesson plan to teach antipredator behavior to senior-level college students in the animal behavior course at Pennsylvania State University, University Park, PA, in 2011 (n = 38) and 2012 (n = 40). Although an ideal study would compare multiple sections of the course within each year to account for annual variation in my teaching, there is only one section of this course each year. Consequently this study will only be able to address variation between class years. For this study, “lecture” will refer to an educator standing at the front of the classroom and presenting information to the students in a PowerPoint format with blanks on slides to facilitate note-taking.

**Lesson Plan**

I began each class with an introductory PowerPoint lecture on antipredator behavior using an image of a colorful timeline to illustrate a continuum of antipredator responses. This introductory lecture was immediately followed by a simulation of fish schooling behavior (Rosier, 2015). The purpose of the simulation was twofold: it served as an ice-breaker to encourage interaction among students, and it illustrated antipredator and predator strategies. During the simulation, most students pretended to be fish, while a few of the students were either predators or refuges. Most of the students formed the school of fish, and had to pick up on cues to identify predators.

Following three repetitions of the simulation, the students returned to the classroom and worked in small groups to answer questions following the activity. Following group work, I asked for groups to volunteer their responses to the questions as part of a full-class discussion. I used these responses to return to the continuum of antipredator behavior and a second, more interactive PowerPoint lecture using videos from the Internet and examples from my and my colleague’s own research.

The class concluded with an anonymous survey to determine student interest in the class components (both years), student interest in having more simulations (both years), and the appropriateness of the simulation for a senior-level course (2012 only). Students indicated their level of agreement with statements using a Likert scale, with a score of 5 as complete agreement. Students indicated what they liked most and least about the class through open-ended questions at the end of the survey. Since these surveys were conducted in class and had no association with student grading or annual faculty reviews, they are unlikely to be affected by many of the biases linked with student course evaluations at the end of the semester (i.e., Spooren et al., 2013; but see Gigliotti & Buchtel, 1990, which supports the validity of student evaluations when “properly obtained”).

**Data Analysis**

Values of 4 or higher were considered agreement, values between 3 and 4 were considered neutral, and values less than 3 were interpreted as disagreement. To determine if student survey responses differed significantly between the two years, Likert items were analyzed using separate t-tests. Although these data violate the assumptions of non-parametric tests, comparisons of the Mann-Whitney U and regular t-test revealed little difference in power or Type I error in analysis of Likert data, indicating that t-tests may be applied to Likert score data (de Winter & Dodou, 2012). These t-tests were conducted using Microsoft Excel 2010.

In addition to the Likert items, students also identified their preferred components in an open-ended survey question. Student responses to this question were grouped into the following categories: PowerPoint lecture, activity, research examples, videos, or both activity and lecture. I tested for differences in preferred components between classes using a generalized linear model.
(GLiM with Poisson distribution and Log link function) with the number of responses as the response variable, and the class year and component category as factors. I used JMP Pro 12 statistical software to produce and test this statistical model.

○ Results
On average, the Likert scale questions revealed that the students from both classes agreed that the fish schooling simulation encouraged them to think and weakly agreed overall that there should be more interactive activities incorporated into lectures (Table 1). The 2012 class also indicated that they felt the fish-schooling activity was appropriate for a senior-level college course.

Analysis of the open-ended questions revealed statistically significant differences in student preferences for components ($\chi^2 = 19.022, df = 1$ and 4, $p = 0.0008$). When the two classes are considered together, the fish schooling activity was identified as the most favorite component (33% of respondents), which was closely followed by the videos used in the second half of the lecture (29%; Figure 1). Although there was no significant effect of the class year on student preferences overall ($\chi^2 = 0.288, df = 1$ and 4, $p = 0.592$), there was a statistically significant interaction between the class year and the preferred components (year + component interaction: $\chi^2 = 10.181, df = 1$ and 4, $p = 0.038$). This significant interaction results from the relatively high preference for the activity in 2011 that was absent in 2012. In 2011, 42 percent of the students identified the schooling activity as their favorite, and 26 percent enjoyed the videos the most (Figure 2). By contrast, only 25 percent of the 2012 class preferred the activity, and 33 percent preferred the videos. When components of the PowerPoint lecture are considered together (PowerPoint lecture, research examples, and videos), this portion of the class was strongly preferred by the 2012 class (70% of students) but less preferred by students in 2011 (31% of students).

○ Discussion and Conclusions
The results of the Likert question portion of this study suggest that students typically do perceive interactive teaching to be engaging, which is an unsurprising result given the growing body of research demonstrating that student-driven activities increase student engagement (Sengupta-Irving & Enyedy, 2014). This result supports the shift toward active-learning strategies; not only do they improve learning, but students also tend to enjoy them. Interestingly, the open-ended question on the survey revealed that brief video examples of animal antipredator behaviors were just as interesting to the students as a hands-on behavior simulation in the 2012 class. The videos were the second favorite for the class in 2011. Although the majority of the students reacted positively to the fish-schooling activity, it seems that student engagement can be achieved by incorporating videos with brief follow-up discussions into a traditional lecture rather than a full behavior simulation. Thus, elaborate activities need more planning and class time, but may not be required to achieve student engagement. I do not mean to imply that highly interactive activities are not useful, but rather that they are not always required to engaged students. Further measures of student engagement using an ethology approach, such as an ethogram to quantify time spent taking

Table 1. Likert scores (mean ± SD) to measure agreement with statements from student surveys in 2011 and 2012, which were compared for statistical differences.

<table>
<thead>
<tr>
<th>Statement</th>
<th>2011</th>
<th>2012</th>
<th>t-test</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>The class activity encouraged me to think.</td>
<td>4.24 ± 0.79</td>
<td>4.08 ± 0.86</td>
<td>$p = 0.39$</td>
<td></td>
</tr>
<tr>
<td>I would like to have more in-class activities.</td>
<td>4.18 ± 0.95</td>
<td>3.83 ± 1.26</td>
<td>$p = 0.16$</td>
<td></td>
</tr>
<tr>
<td>The class was appropriate for a 400-level course.</td>
<td>N/A</td>
<td>4.44 ± 0.91</td>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>

Figure 1. Student preferences for particular class components identified in the open-ended survey for both classes combined.

Figure 2. Comparison of student preferences identified in the open-ended survey question for classes in 2011 (shaded bars) and 2012 (open bars).
notes or observing the instructor, could provide an even more precise estimate of the effectiveness of these educational tools.

Even though the difference between the two classes was not statistically significant, the variation between the two classes in their preferred components warrants discussion. Several factors could contribute to this variation. First, changes in my teaching style with increased experience can affect the results. For example, for the first year I gave the instructions for the activity while the class was outside, which made it difficult for students to hear the rules of the fish schooling exercise. In the second year I gave the instructions in the classroom first and then repeated them while the class was outside. Any changes in my enthusiasm for particular components could also affect student responses. A larger sample size or measures of my teaching style in each class could have potentially addressed these sources of variation. Second, it is important to note that guest-lecturing in itself may have influenced student responsiveness to the interactive activities in this study, in response to the novelty of a different lecturer. The novelty of a guest-lecturer can inflate the Likert scores overall.

Most obviously, the many differences among the students within and between classes can lead to marked variation in survey responses. For instance, these students were seniors accustomed to and comfortable with a traditional PowerPoint lecture format. Although these students are considered members of the Millennial Generation (i.e., were raised with technology; Considine et al., 2009), students often prefer this traditional form of pedagogy because it is familiar and predictable (DiLullo et al., 2011; Knight & Wood, 2005), which could affect their perceived enjoyment of less traditional learning tools, such as the behavior simulation in this study. This lecture format is also preferable for shy or introverted students who are stressed by active learning strategies, such as group discussions. These factors together could explain why students frequently identified components of the interactive PowerPoint lecture as their preferred delivery methods, and not the behavior simulation or group work. Students more accustomed to games, simulations, and videos during classroom meetings may respond differently to the complex class presented in this study. Since there are tests to measure cognitive styles (i.e., Myers-Briggs Type Indicator for educators; McCutcheon et al., 1991), future studies should investigate the relationship between introversion/ extroversion and learning preferences in the biology classroom.

Overall, the results of this study indicate that students tend to enjoy interactive approaches to teaching when they are used in moderation. This result is helpful for educators who are striving to find balance between course content and student engagement with limited time in and out of the classroom. Occasional use of interactive activities can boost engagement, but these time-intensive teaching approaches may not be needed with every class meeting. The continued assessment of these strategies for learning and retention, together with student preferences, will serve to inform pedagogical changes in the college classroom.

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**References**


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