

Comparison of Student Outcomes and Evaluations in Hybrid Versus Face-to-Face Anatomy and Physiology I Courses

By Sanjeeda Jafar and Viji Sittler

In this study, two sections of undergraduate Introductory Anatomy and Physiology taught in the traditional face-to-face format ($n = 58$) was compared to two hybrid classes ($n = 38$) using the flipped-classroom model taught by the same instructor. Formative and summative examination scores were compared to determine the effect of the different learning methods. Our results revealed no significant difference between the mean scores of summative examinations and between the traditional and hybrid classes ($p > 0.05$). Of five quizzes administered, students taught in the traditional format scored significantly higher in only one of five quizzes. In addition, comparison of in-class laboratory examination scores showed no difference ($P > 0.05$) in three out of four. However, student evaluations of the hybrid classes were more positive as determined by end-of-course evaluations (4.54 versus 2.9 on a 1–5 Likert scale). This is the first study that compares a hybrid versus a traditional science course at a historically black college or university. We conclude that comparison of student outcomes in traditional versus hybrid Anatomy and Physiology I classes were similar. At a time when all institutions of higher learning have adopted online learning and distance learning due to the COVID-19 pandemic, this is a timely comparison.

Traditional class formats in colleges and universities typically involve the instructor and students meeting face-to-face (f-2-f) in the classroom. Distance education courses include both fully online as well as hybrid formats that are a blend of f-2-f and online materials. In recent years, online and hybrid classes have become more common due to advances in technology and student demand (Nguyen, 2015). According to the National Center for Education Statistics, in the United States,

753,640 students were enrolled in distance learning classes in 1994–1995 (USDE, 1997). This number increased to 5,750,417 by 2014, a 783% increase (USDE, 2015). By fall 2016, the number had increased to 6,294,801 (USDE, 2018). The Babson Report (Seaman et al., 2018) reported that enrollment in distance education courses showed 14 consecutive years of increase. However, from fall 2012 to fall 2016, the total number of students enrolled at colleges and universities decreased by 3.8%; yet, the number of students

taking at least one distance education course increased by 3.4%. Unfortunately, breakdown of the data indicating how many of these courses were fully online and how many were hybrid is unavailable.

While student enrollment in online courses has exponentially increased, they often leave some students feeling isolated (Ali & Smith, 2015). Hybrid courses attempt to reduce this feeling of isolation, as they involve both online and f-2-f components, and combine the best of both online and f-2-f teaching (Lindsay, 2004). Some benefits of hybrid classes include flexibility, opportunity for f-2-f time, and increased interaction and feeling of community (Tayebinik & Puteh, 2012). A major concern is that less than 20% of Historically Black Colleges and Universities (HBCUs) offer online degree programs (Beasley, 2012). Less than 10% of the HBCU online programs are in STEM disciplines (Flowers et al., 2012). In this study, we compared a traditional versus hybrid class in a STEM discipline at an HBCU. This is particularly important as there is a gap in the availability of data in evaluating hybrid versus traditional learning of science courses in an HBCU setting.

Anatomy and Physiology I (A&PI) is an introductory course

that covers topics such as anatomical terms; cells; chemistry; tissues; and the integumentary, skeletal, muscular, and nervous systems. The traditional A&PI course evaluated in this study met two times per week for three-hour sessions each time (3-3 format) for 16 weeks during which students attended lecture classes and conducted their laboratory exercises. There is increasing demand for A&PI classes by nursing, biology, and physical education majors. In response to this great demand, we redesigned a traditional A&PI course into a hybrid format to offer greater flexibility for students and to experiment with a flipped-classroom model. This would allow students to master knowledge and gain comprehension outside of class and focus on application and synthesis in class (Brame, 2013). Because the hybrid course met f-2-f only once a week, it would also free up the laboratory for additional sections, if required. The homework was tailored so that students would be prepared for f-2-f activities as suggested by Freeman & Schiller (2013). Asynchronous class discussion is a key component of online and hybrid teaching (Rossman, 1999) and was used in the redesigned hybrid course. Both the traditional and hybrid courses in this study used tools from the publisher's website (discussed in Methods).

Common assessment tools were used in both courses. We evaluated in-class examinations and quizzes. The in-class exams and quizzes used a multiple-choice format with an added constructed response question. In-class laboratory examinations consisted of identifying tissues from microscopic slides, identifying anatomical structures from models, and

answering questions on the function of those structures.

Methods

The new hybrid course was offered for the first time in the spring and fall semesters of 2015–2016 and administered online through Blackboard, our Learning Management System. Table 1 explains the years and sessions of the sections evaluated. The flipped-classroom model was used whereby students had access to all information via Blackboard and the textbook publisher's website. Online activities included students interacting with each other through the discussion board on Blackboard and completion of assignments at the textbook publisher's website. During f-2-f meetings, students performed laboratory exercises.

Both the hybrid and traditional courses were 16 weeks long. Each week, the traditional class met on site twice a week for three hours (3-3 format). One of these meetings was for laboratory exercises and the other for lecture. The hybrid class met on site for f-2-f meetings once a week. Therefore, there were 16 f-2-f meetings. Of these, there were 11 laboratory days and five lab examination days, similar to the traditional course laboratory and examination days.

Both courses used Interactive

Physiology (IP), Practice Anatomy Labs (PAL), and Homework (HW) from the publisher's website. IP consisted of interactive animations from different systems highlighting the function (physiology) of a body system. Students interacted and received immediate feedback. Students were assigned IP on the muscular system and the nervous system. Similarly, PAL allowed students to view images of models, cadavers, and photomicrographs of tissue sections. They identified and named body parts and tissues. Common assessment tools were used in both the traditional and hybrid courses. We evaluated in-class examinations and quizzes. The in-class exams and quizzes used a multiple-choice format with an added constructed response question. In-class laboratory examinations consisted of identifying tissues from microscopic slides, identifying anatomical structures from models, and answering questions on the functions of those structures. Student examination scores were compared using the Analysis ToolPack in Microsoft Excel. *P* values for statistical significance were determined by the *t*-test.

All examinations (laboratory and summative) and some quizzes were administered during f-2-f meetings in class. The in-class examinations and quizzes were identical for the hybrid

TABLE 1

Sections of hybrid and traditional Anatomy and Physiology I evaluated in this study.

Type	Traditional		Hybrid	
	Spring 2015	Fall 2015	Spring 2016	Fall 2016
Session				
Number of students	32	24	16	22
Total number of students for each type	56		38	

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and traditional courses. These included five laboratory examinations, three summative examinations, and three quizzes. Two quizzes (quizzes 2 and 3) were offered online via Blackboard and were identical for the traditional and hybrid courses. Students who took hybrid or traditional A&PI with the same instructor were evaluated.

The instructor is the lead author in this paper as well as the hybrid course designer.

The student demographics are summarized in Table 2. Both the hybrid and traditional sections had very similar ethnicity, female: male ratios, majors, classification, and incoming grade point averages (GPAs).

Our university is an HBCU, where the majority of our students are African American. This was reflected in the demographics of the hybrid and traditional A&PI courses, showing more than 80% of students were African American. Female students made up two-thirds to three-fourths of each type of class.

Students taking the A&PI courses included physical education (PHEC), nursing (NURS), biology (BIOL), nutritional science (NUSC), food and nutrition (FONT), and health education (HEED) majors. PHEC, NURS, and BIOL majors made up 70–80% of either type of class. A&PI is a 200-level course and therefore, the student classifications were mainly junior (JR), senior (SR), and sophomore (SO). Juniors and seniors made up about 70% of either type of class. About one-third of students had GPAs of 3+ on a scale of 0–4 and about two-fifths of either type of class had incoming GPAs of between 2 and 3.

Results *Comparisons of summative examinations*

Students in all four classes received identical questions in their summative examinations. Performance of students in the hybrid classes were compared to students in the traditional classes by comparing examination scores (Figure 1). The mean grade in the skeletal system examination (“bones”) was 58.37% for the hybrid and 54.7% for the traditional classes. For the muscle examination, students in the hybrid classes and traditional classes had comparable mean scores. The mean grade in the final exam for the traditional classes was 57.79% and 55.15% for the hybrid classes. There was no significant difference ($P > 0.05$) between

TABLE 2
Demographics of students in evaluated Sections of Anatomy and Physiology I.

		Hybrid (%)	Traditional (%)
Gender	Female	74	67
	Male	26	33
Diversity	Black/African American	84	85
	Hispanic	5	3
	White	3	5
	Multiracial	5	3
	International	3	0
	Unknown	0	3
Major	Physical education (PHEC)	36	33
	Nursing (NURS)	31	29
	Biology (BIOL)	13	9
	Nutrition science (NUSC)	8	8
	Food and nutrition (FONT)	5	3
	Chemistry (CHEM)	5	2
	Medical technology (MEDTECH)	2	2
	Health (HEED)	0	10
	Sociology (SOC)	0	2
	Undeclared (GENL)	0	2
Classification	Freshman (FR)	0	2
	Sophomore (SO)	34	21
	Junior (JR)	40	48
	Senior (SR)	26	29
GPA	0–1	19	10
	1–2	5	14
	2–3	42	43
	3–4	34	33

the hybrid and traditional classes for any of these examinations.

Comparison of summative quizzes

For quizzes 2, 3, 4, and 5, there was no significant difference between the mean scores of the hybrid versus traditional courses (Figure 2). Quiz 1 did show a significant difference ($p < 0.05$) between the means of the hybrid (59.73%) and the traditional (75.07%).

Online formative assessments at publisher's website: Homework and practice anatomy labs

Students for both the traditional and hybrid courses were required to complete assessments at the textbook publisher's website, "mastering A&P" (MAP). These included HW on each chapter. The HW questions consisted of multiple-choice questions and matching labels to diagrams. Another assignment was online PALs where students completed virtual labs using photomicrographs, three-dimensional models and cadaver images. Students identified structures and answered questions on those structures. The PAL exercises students were assigned were on histology, the skeletal system, and the nervous system. Students received instant feedback on these exercises. There was no significant difference between the hybrid and traditional mean scores in either the HW or PAL (Figure 3).

Comparison of in-class summative lab examinations

For in-class laboratory examinations, stations were set up. Each station consisted of an anatomical model with a question. During the lab examinations, students moved from station to station identifying struc-

FIGURE 1

Summative examination scores.

Students in both the hybrid and traditional sections took identical examinations on the skeletal system, muscular system, and a final. The mean score percentages were compared using the Analysis ToolPack in Microsoft Excel. Hyb = hybrid; trad = traditional.

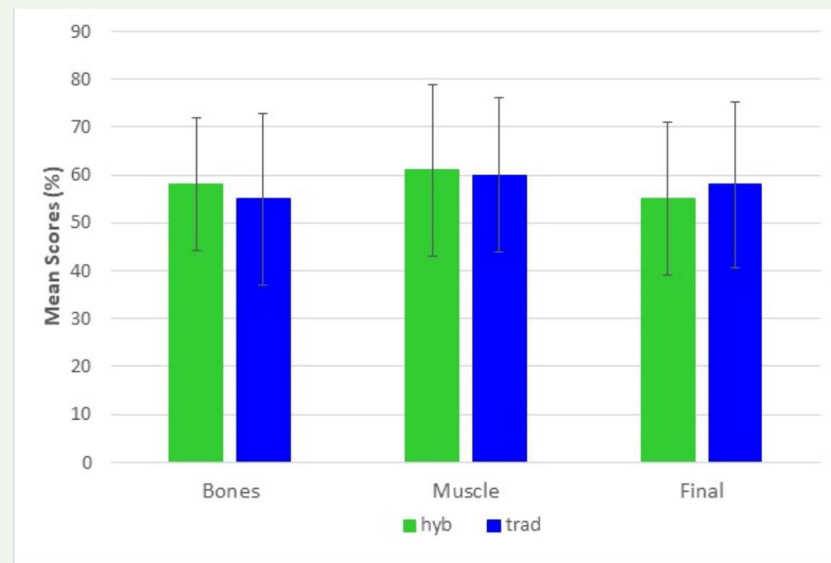


FIGURE 2

Comparison of quiz scores between the traditional (trad) and hybrid (hyb) courses.

Students in both the hybrid and traditional sections took identical quizzes on chapters 1–5. Quizzes 2 and 3 were online. Quizzes 1, 4, and 5 were taken during the f-2-f meetings. The mean score percentages were compared using the Analysis ToolPack in Microsoft Excel. The P values for statistical significance were determined by the t -test. Quiz 1 $P = 0.00022$.

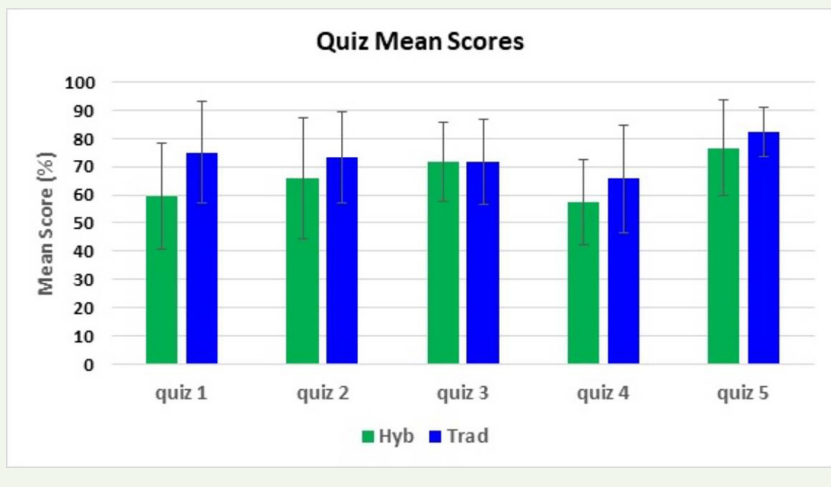


FIGURE 3

Online formative assignments mean scores at the textbook publisher's website.

Students in both the hybrid and traditional sections completed formative assessments online. The mean score percentages were compared using the Analysis ToolPack in Microsoft Excel. HW = homework; PAL = Practice Anatomy Lab.

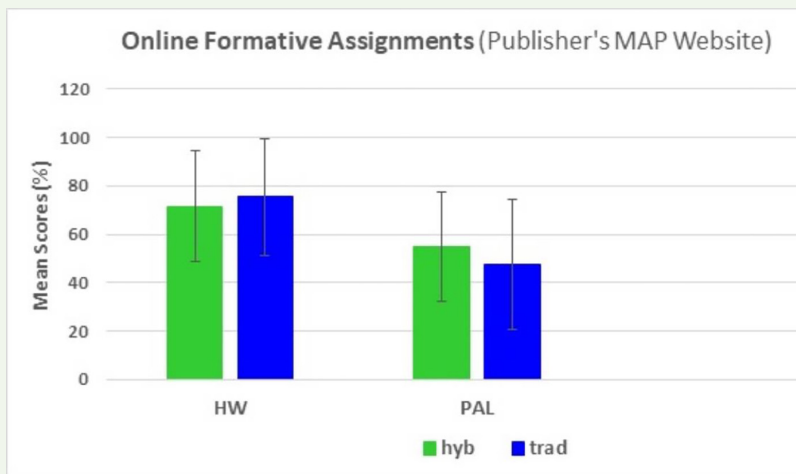
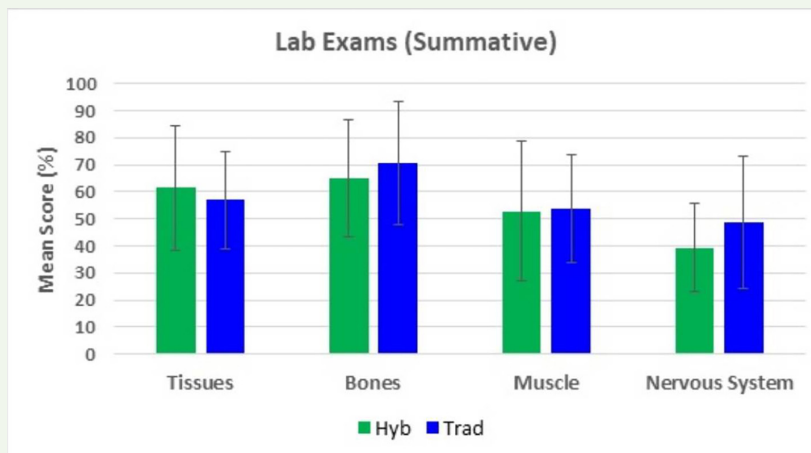


FIGURE 4

Comparison on in-class examinations.

Students in both traditional and hybrid sections took identical laboratory examinations on tissues, skeletal system (bones), muscular system (muscles), and the nervous system. The mean score percentages were compared using the Analysis ToolPack in Microsoft Excel. The *P* values for statistical significance were determined by the *t*-test. Nervous system exam *P* = 0.045.



tures from the models and answering short questions. For histology, each station had a microscope with an unknown slide of a tissue specimen, which the student had to correctly identify.

There was no significant difference between the lab exams for tissues, the skeletal system (“bones”) and the muscular system (Figure 4). The exception was the lab exam on the nervous system: traditional sections mean score was 10 points higher ($p < 0.05$). The nervous system exam was the last laboratory examination. It is to be noted that seven students in the traditional sections who were not doing well did not show up for the nervous system laboratory exam. Similarly, nine students who were not doing well in the hybrid sections did not show up for the nervous system examination.

Learning outcomes summary

The publisher’s website provided a learning outcomes summary (LOS). This was based on learning outcomes such as “explain the principle of complementarity,” and “name the major parts of the axial and appendicular skeleton.” Comparing the grades on the learning outcomes, the means of the hybrid (89.08%) and the traditional course (89.36%) were very similar (Table 3).

Course passing rate

As stated earlier, a hybrid class is not a traditional class offered partly online. Our hybrid A&P I used a flipped-classroom model. The hybrid classes had a different grade distribution as it incorporated online discussions in addition to common features of both hybrid and traditional classes: in-class examinations, in-class laboratory, and online homework. In addition, the traditional course had lower percentage of grades from online activities such

as IP, PAL, and online HW (MAP HW) at the publisher's website (Table 4).

Therefore, comparing final grades may not reflect an apples-to-apples comparison. However, we noted that the pass rate (with grades of A, B, or C) was higher in the hybrid sections (Table 5). Twenty-seven out of 38 students passed the hybrid A&PI class with a pass rate of 71%. In the traditional class, 30 of 58 students passed, reflecting a pass rate of 52%.

Student evaluations

Online student evaluations were completed by students in Searchlight from the fall of 2015. There were 25 questions regarding the syllabus, assignments, grading, and instructor interaction with students. Of the few students who completed the course evaluations in each class ($n = 3$ per class), evaluations for the A&P I hybrid was higher than those for the traditional class (Table 6). Although the same instructor taught both the hybrid and the traditional courses, students perceived the hybrid classes to be more organized with better communication with the instructor and better and prompt feedback. This may be a reflection of the online graded discussion that the hybrid class students participated in. Every student posted a question and answered another student's question. The instructor provided feedback on both the question and the answer. In traditional classes, not all students get to ask questions.

Discussion

While the number of African-American students enrolled in distance learning has increased significantly in recent years, HBCUs have struggled to accommodate this growing need (Williams, 2015). Most of the distance education courses for African-

American students have been offered by for-profit institutions (ISU, 2013). The percentage of African-American students enrolled in distance education was only 9% at public institutions while it was 18% at private and 24% at for-profit institutions (Howarth & Stifler, 2019). It was also found that African Americans, women, and adult students are targeted by primarily online for-profit institutions in their

marketing and recruiting efforts. With many HBCUs working to bridge the gap between supply and demand for online learning, the detailed analysis comparing hybrid and traditional A&PI course at Morgan State University, and the conclusions drawn from it, are essential in our effort to gauge effectiveness of hybrid science courses in an HBCU setting.

The hybrid and traditional A&PI

TABLE 3

Summary of student learning outcomes in traditional and hybrid sections of Anatomy and Physiology I.

	Hybrid	Traditional
Mean score (%)	89.08	89.36
SD	8.88	8.13
Count* (of learning outcomes)	315	332
P value	0.678	

TABLE 4

Grade distribution of students in hybrid and traditional sections of Anatomy and Physiology I.

Points		Hybrid		Traditional	
		%	Points	%	Points
Lecture	Quizzes 1–5	100	10	100	10
	Quiz 6			20	2
	Exams	75	7.5	150	15
	Final	200	20	200	20
	Discussion (OL)	140	14		
	Class participation (CP)			16	1.6
	Professionalism	44	4.4	40	4
	MAP HW (OL)	91	9.1	40	4
	IP (OL)	50	5	34	3.4
Lab	f-2-f lab work	100	10	150	15
	Lab tests	100	10	200	20
	PAL (OL)	100	10	50	5

OL= online activity; MAP HW =mastering anatomy and physiology homework
IP = interactive physiology; PAL = practice anatomy labs

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courses evaluated in this study were taught by the same instructor. Comparisons between the hybrid and traditional A&P I included three examinations, five quizzes, four laboratory examinations, formative assessments on each chapter (HW), as well as formative PALs. The comparison was made possible by the fact that both groups received identical assessments.

We found a significant difference in mean scores only in one quiz (quiz 1) and one lab exam (nervous system) where the traditional sections scored higher. Quiz 1 was the first in-class lab exam given in week 2. It is certainly possible that the traditional class was more effective in students' learning anatomical terms, body planes, introduction to anatomy and physiology, and the material for quiz 1 than the hybrid class. We also need to consider the fact that most students in the hybrid section were taking a flipped-classroom, hybrid class for the first time. It may have taken students time to adjust to the hybrid class. The

nervous system lab examination was the last lab examination given during the last week of classes. The overall findings suggest that hybrid courses are as effective as traditional courses in learning a STEM subject in an HBCU setting.

Previous studies that compared hybrid versus traditional found conflicting results (Corgan Monto, 2016). In a study performed to evaluate the effectiveness of a hybrid versus a traditional lecture in Microbiology, Adams et al. (2015) reported that students in a traditional section performed significantly better than students in a hybrid section. In other studies, no difference was observed (Dell et al., 2010; Ernst, 2008, Stack, 2015). Yet, other studies demonstrated better results in online compared to traditional learning (Flowers et al., 2012; Gratton-Lavoie & Stanley, 2009) and hybrid learning was found to be effective (Chen & Chiou, 2014; McGee & Reis, 2012; Shachar & Neumann, 2003; Vignare, 2007; Es-

telami, 2012). Results of our study indicated that traditional and hybrid A&P I classes were comparable in the majority (12/14 = 86%) of formative and summative evaluations, which is in agreement to those summarized by Dell et al. (2010).

The effectiveness of a hybrid A&P I course very likely depends on the exercises designed for the class. Students using the flipped classroom complete the homework and other online activities and know immediately what concepts they have mastered. While the sheer volume of work is quite extensive, it is interesting to note that students in the traditional classes deemed they were given too much work, but students in the hybrid class deemed it appropriate. Student evaluations reflected that the hybrid course was perceived to be better. However, only a handful of students completed the evaluations.

Even as more online and hybrid courses show growth in student enrollment, many faculty still consider the traditional model of teaching better than hybrid or online classes. Especially in HBCUs, many educators are biased against distance education without supporting data (Jones & Davenport, 2018). Findings demonstrating that there is no difference in an HBCU will serve to alleviate these biases. There is also the opinion that HBCUs are introducing online education at a modest pace as part of a strategy to address the unique needs of their students (Evans-Bell, 2015). Of course, with the Coronavirus (COVID-19) outbreak, more than 1,100 institutions of higher learning across the United States have transitioned to online and distance learning since March 2020 to prevent academic disruption (Smalley, 2020). The results of this study provides valuable insight into resolving this crisis.

TABLE 5

Comparison of passing rate of students in traditional and hybrid sections of Anatomy and Physiology I.

	Hybrid	Traditional
Number of students passing with an A, B, or C	27	30
Total number of students	38	58
Pass %	71%	52%

TABLE 6

Student evaluations of Anatomy and Physiology I on a Likert scale of 1–5.

Traditional		Hybrid	
Spring 2015	Fall 2015	Spring 2016	Fall 2016
Not available	2.93	3.6	4.54

Conclusions

This study clearly shows that a hybrid A&PI course is as effective as a traditional course. Some students may do better in hybrid classes while others may do better in traditional classes. In our opinion, both types of classes should be offered to students at HBCUs so that they have a choice from a broader menu and select the offering that best suits them. Besides the convenience of taking distance education courses, African-American students will have the benefit of achieving their goals without incurring too much debt. HBCUs will also benefit by attracting more students who are enrolling in for-profit institutions as they offer more online courses and degrees.

Acknowledgments

This study was supported by the National Institute of General Medical Sciences award RL5GM118972 for course redesign to Dr. Jafar. Support by the National Science Foundation's Division of Engineering award CBET-1900966 to Dr. Sitther is gratefully acknowledged.

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