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Research

First-Year and Non-First-Year Student Expectations Regarding In-Class and Out-of-Class Learning Activities in Introductory Biology †

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National calls for teaching transformation build on a constructivist learning theory and propose that students learn by actively engaging in course activities and interacting with other students. While interactive pedagogies can improve learning, they also have the potential to challenge traditional norms regarding class participation and learning strategies. To better understand the potential openness of students to interactive teaching practices, we administered a survey during the first week of two sections of an introductory biology course to characterize how students envisioned spending time during class as well as what activities they expected to complete outside of class during non-exam weeks and in preparation for exams. Additionally, we sought to test the hypothesis that the expectations of first-year students differed from those of non-first-year students. Analyses of closed-ended and open-ended questions revealed that students held a wide range of expectations and that most students expressed expectations consistent with some degree of transformed teaching. Furthermore, first-year students expected more active learning in class, more out-of-class coursework during non-exam weeks, and more social learning strategies than non-first-year students. We discuss how instructor awareness of incoming student expectations might be used to promote success in introductory science courses.

INTRODUCTION

Several key issues have emerged within undergraduate STEM education. These challenges include high drop-out rates among introductory students, disproportionate achievement for particular demographic groups, and an anticipated shortage of qualified STEM majors (1–3). In response to these deficits, national agencies have called for transformations to undergraduate education, and many instructors have altered their pedagogical approaches to better reflect how students learn (4, 5). These changes build on constructivist learning theory, which stipulates that students learn by developing, revising, and augmenting their knowledge structures (6, 7). To support these cognitive processes, instructors have incorporated more active learning during class to enable students to engage with course concepts and work with their peers as well as structured homework assignments to help students prepare for in-class activities, assess their own understanding, and prepare for exams (8). These in-class and out-of-class activities combine to form learning cycles that help students iteratively build and revise their understanding.

Numerous studies have demonstrated the positive impacts of these course transformations on student outcomes. A meta-analysis of previous studies revealed that students in active learning courses achieve significantly higher scores on exams and concept assessments and experience reduced course failure rates compared with students in courses that use traditional lecturing strategies (9). Furthermore, the addition of highly structured in-class and out-of-class course activities can improve the performance of all students, with the highest gains appearing for students from traditionally underserved groups (10–12). Course "flipping" represents another strategy that has emerged to boost student engagement. In a flipped course, students prepare for class by reading passages or watching videos that include the material traditionally covered during lecture, allowing them to spend more class time working together to complete activities, answer questions, and solve problems. Compared with students in a standard course, students in a flipped course engage more with course material, prepare for class earlier and more frequently, and perform better on exams (13). Taken together, these results provide justification for the continued implementation and exploration of instructional strategies that actively engage students.

While active learning holds promise for addressing certain shortcomings in STEM education, this instructional

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change represents a divergence from the traditional conception of a college course, where students spend the majority of class time listening to a lecture and prepare for class and exams without the benefit of highly structured assignments. Importantly, this shift may contradict expectations and values that students hold about college classroom environments and effective learning strategies. Originally developed to understand how people interact with their personal space, expectancy violation theory (EVT) broadly addresses how people respond to violations of social norms (14). This theory provides an additional lens through which to interpret the interplay between student expectations, course practices, and student satisfaction. Within this framework, instructors who make changes to their courses may introduce activities and structures that are unfamiliar or unexpected to students. As a result, students may not fully understand the purpose of the activities or how to best utilize them to improve their learning. While many students can buy into interactive teaching practices, some students may resist instructional innovations, threatening the long-term sustainability of these promising practices (15–18).

Previous research on student expectations has focused on incoming student expectations about overall first-year experiences and differences between high school and college. This emphasis on first-year students stems from the importance of the first year for dictating academic persistence as well as a student's social, emotional, and intellectual development (19). Incoming students expect college to differ from high school, and while they may not understand how college will be different, they do expect to work with other students (20). Students often retain high expectations regarding instructor availability and opportunities to receive personalized feedback (20, 21), although these expectations may be considered impractical to course instructors (21). Furthermore, students who enter college with unrealistic academic expectations are more likely to achieve lower grades than students with more realistic expectations (22). These studies highlight the potential disconnect between student and instructor expectations, the association between student expectations and student success, and the need for further research characterizing student expectations regarding course activities, particularly among students entering their first year of college.

Understanding student expectations regarding in-class activities and out-of-class coursework represents a key starting point for optimizing the implementation of transformed teaching practices. Knowing how students expect to spend class time and engage with a course outside of the classroom will help instructors 1) address discrepancies in student and instructor expectations, 2) coach students on how to best make use of instructional activities to advance their learning, 3) mitigate potential student resistance, and 4) guide students toward effective learning strategies. In this study, we used a mixed-methods approach to uncover initial student expectations for an introductory biology course. We used closed-ended questions to probe student expectations regarding how they expected class time to be partitioned between lecture and active learning and the amount of time they expected to spend on the course outside of class time. We used open-ended questions to solicit student expectations about the degree to which they saw active and passive strategies as key to their learning and what types of activities they expected to complete outside of class. In collecting this data, we sought to characterize the extent to which student expectations aligned with transformed teaching practices, test the specific hypothesis that first-year students had different course expectations than non-first-year students, and understand how these incoming expectations related to course achievement.

METHODS

Study context and survey administration

This study took place in two sections of an introductory biology course for life science majors at the University of Nebraska-Lincoln during the fall 2014 semester. The two sections were taught by different instructors, both with some level of educational training. During the first week of class, students completed an online survey outside of class through Qualtrics. The instructors spent some time on the first day of class introducing the course structure and activities, but they did not explicitly align their explanations with the survey content. Survey responses were combined with student demographics from the institutional research office and course scores from the instructors. In total, 394 students completed the survey and consented to have their responses released, representing 77% of total enrollment. Complete demographic information was available for 288 students, who were included in the statistical models (Table 1). This research was classified as exempt from IRB review (Project 14314).

Survey content

Survey questions probed how students expected to engage with the course during and outside of class time, using language appropriate for undergraduate students. The survey included five closed-ended and three open-ended questions (Appendix 1). Closed-ended questions addressed the percent of class time that students expected to spend participating in active learning activities or listening to lecture as well as how much time students expected to spend outside of class on required homework, non-required activities, and exam preparations. Open-ended questions allowed students to express in their own words how they thought class time could be best structured to support their learning as well as what activities they expected to complete outside of class during non-exam weeks and in preparation for exams.

TABLE 1.
Student demographics.

Categorical variable	%	*n*
Class status		
First-year	55%	158
Non-first-year	45%	130
Gender		
Male	38%	109
Female	62%	179
URM status		
Non-URM/international	89%	256
URM	11%	32
Generation status		
Continuing generation	69%	199
First-generation	31%	89
Major		
Life sciences	69%	199
Other STEM	9%	27
Non-STEM	16%	47
Undeclared	5%	15
High school location		
Urban/other	73%	210
Rural	27%	78
Course section		
1	53%	153
2	47%	135

URM = underrepresented minority.

Statistical modeling

We generated univariate linear models in SPSS to analyze student responses to the closed-ended expectations questions. To test whether first-year student expectations differed from non-first-year students, we developed four models, with each model having first-year status as a dichotomous predictor variable and one closed-ended question as the outcome variable. First-year students were those who had not previously attended college, while non-first-year students had attended college for at least one semester. To test whether student expectations predicted exam scores or grades, we developed eight models, with each model having one of the closed-ended questions as a predictor variable and exam grade z-score or course grade as the outcome variable. For all models, we accounted for additional sources of variation by adding other predictor variables, including gender, underrepresented minority (URM) status, first-generation status, rural/urban high school location, college major, ACT (or converted SAT) score, GPA, and course section. Variable descriptions, assumption checking, and full model results can be found in Appendices 2–5.

Open-ended response coding

We developed a coding rubric for each open-ended question and applied this rubric to categorize student responses. For each open-ended survey question, 50 random responses were initially analyzed from each course section, and unique responses were identified to capture the variety of student answers. Unique responses were grouped into general themes and further sorted into specific response categories, which were further delineated by articulating descriptions and example responses for each category (Table 2). Across open-ended questions, we identified a broad distinction with respect to whether an activity would be performed individually versus in an explicitly social context. For individual activities, some responses made only generic reference to learning or studying, whereas other responses specifically mentioned behaviors that could be classified as active or passive. Active behaviors were those where students used information, constructed explanations, or answered questions. Passive behaviors were those where the most immediate purpose pertained to information exposure, although this did not preclude the notion that students could have been processing the information in active ways. For social activities, some responses made only generic reference to working with other people, while other responses distinguished between seeking help from someone with more expertise versus collaborating with peers. Most categories applied across all three open-ended questions, while some categories were unique to a specific question. All three authors were involved in the initial development and iterative refinement of the coding rubric.

For the coding process, student responses were first separated into their distinct ideas, which were coded separately. Response categories were all mutually exclusive, meaning that a single idea was coded under only one category, but students could have listed more than one idea in a given response. Coding reliability was established through two-rater coding, where at least 20% of survey responses were co-coded with at least 90% agreement. Any disagreements were discussed and brought to consensus, and the remaining responses were coded by a single rater. Open-ended responses for first-year and non-first-year students were analyzed using Fisher's exact test in GraphPad Prism.

RESULTS

Student expectations regarding in-class activities

To determine how students expected to spend class time, we asked one question about what percentage of class time students expected to spend completing activities and working in small groups and another question about what percentage of class time students expected to spend listening to lecture and taking notes (Fig. 1). Student responses to the two questions were required to total 100 percent. Students expected to spend a median of 27% of class in an active learning modality and 73% in a passive mode. Holding other demographic variables constant, first-year students anticipated a significantly more active class experience,

TABLE 2.
Coding rubric used to categorize open-ended responses.[a]

	Category[b]	In	Out	Ex	Definition	Examples
Individual	General	•	•	•	An activity typically completed alone that could be either active or passive. It is undefined whether the activity is active or passive. There is no indication that the student completes the activity with other people.	learning, study
	Active	•	•	•	An activity typically completed alone that requires students to use information, construct explanations, or self-assess. There is no indication that the student completes the activity with other people.	hands-on activities, practice problems, taking notes while reading, drawing diagrams, clicker questions
	Passive	•	•	•	An activity typically completed alone where students are exposed to information and course content but do not explicitly use information, construct explanations, or self-assess. There is no indication that the student completes the activity with other people.	lecture, listening, reading book, copying notes, watching videos, highlighting material
Social	General	•	•	•	An activity that involves a student seeking interaction (correspondence, collaboration, or contact) with another person. It is not specified with whom the student may interact.	asking questions, going to study sessions, review session
	Expert	•	•	•	An activity that involves a student seeking interaction (correspondence, collaboration, or contact) with an authority figure.	working with tutor, studying with tutor, asking professor, asking learning assistant for help, talking to instructor
	Peer	•	•	•	An activity that involves a student seeking interaction (correspondence, collaboration, or contact) with a peer for learning-related purposes.	group discussion, group study, homework with other students, studying with partner
Other	Experiential	•	•		Students are able to observe science in an applied context.	demonstrations, doing research, job shadow,
	Pre-class prep	•	•		An activity explicitly completed before the topic is covered in class.	previewing material for next week, reading prior to lecture
	Providing resources	•			Students are provided with resources or tools for learning.	providing PowerPoint slides, post lecture notes
	Engaging environment	•			Student mentions a classroom environment that is engaging, interesting, or conducive to learning.	engaging students, class is interactive
	Test prep	•			Students are provided with information, practice, or resources specifically to help prepare for tests.	covering test materials
	Attending lab		•		Student mentions attending the lab section accompanying the course.	attending lab
	Study with frequency			•	Student mentions studying or preparing for the exam with regularity or consistent frequency.	studying throughout the semester
	No activities[c]	•	•	•	Student indicates that no activities are completed for this class.	none
	Off-topic[c]	•	•	•	Answer is unrelated to the question asked.	joining a sorority or fraternity

[a]Response categories are grouped under the themes of individual, social, or other.
[b]Dots represent that a given response category was coded for the indicated question:
In = What are the best ways that class time can be used to help you learn in this course?
Out = What activities do you expect to do for this course outside of class time?
Exam = How do you expect to prepare for exams in this course?
[c]These two categories were not included in graphs for simplicity. For each question, less than 1% of students listed no activities and less than 7% of students gave off-topic remarks.

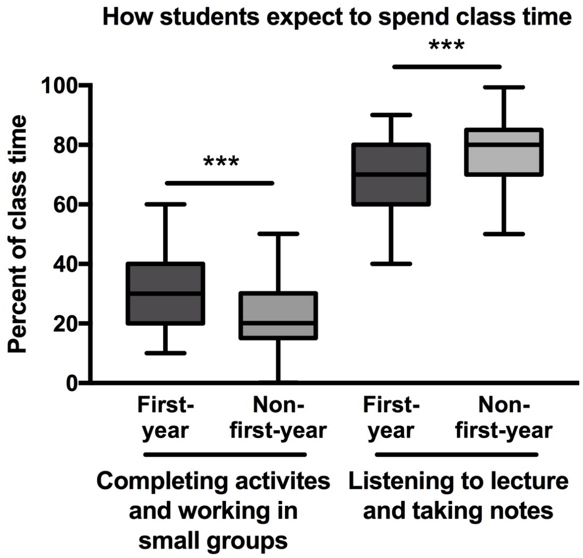

FIGURE 1. Student expectations regarding the percentage of class time they expect to spend completing activities and working in small groups or listening to lecture and taking notes. Student responses to both questions were required to total 100%. Response distributions are shown for first-year and non-first-year students. Central bars represent medians, boxes represent inner quartiles, and whiskers represent the 5th and 95th percentiles. General linear model, $***p < 0.001$, see Appendix 4.

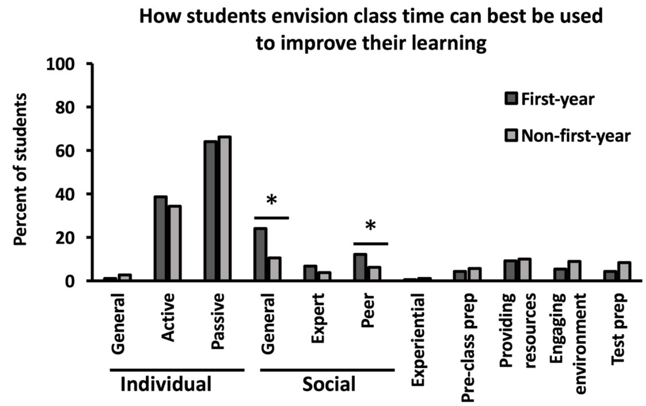

FIGURE 2. Open-ended student perceptions regarding the best use of class time. Bars represent the percentage of first-year and non-first-year students who indicated each category at least once in their response. Fisher's exact test, $*p < 0.05$.

expecting roughly 8% more time to be devoted to active learning than non-first-year students (Appendix 4; B = 8.09 ± 1.72, $p < 0.001$).

To further understand incoming student perspectives, we asked an open-ended question about the best ways that class time could be used to help students learn (Fig. 2). Across the whole sample, 37% of students indicated that active behaviors were a beneficial use of class time, and 66% listed passive behaviors as being useful. Students additionally cited the utility of social interactions, with 28% listing at least one social activity. Finally, a number of other activities were acknowledged by students, including experiential learning, the need to prepare before class, the ability of class meetings to provide learning resources, the benefits of an engaging classroom environment, and the use of class time to prepare for exams. On the whole, these open-ended responses indicated that the majority of students perceived passive modalities as useful to their learning, while a substantial number of students expressed value in active and social behaviors. Interestingly, a significantly higher percentage of first-year students mentioned general and peer social behaviors compared with non-first-year students (Fig. 2).

Student expectations regarding out-of-class activities

To determine how many hours students planned to devote to the course outside of class time, we separately asked students to report the number of hours per week they expected to spend completing required homework assignments and other non-required preparations during typical weeks without exams (Fig. 3). Students expected to spend a median of six hours on required assignments and five hours on other preparations. Holding other demographic variables constant, first-year students expected to devote significantly more time to coursework outside of class than non-first-year students (Appendix 4; required assignments: B = 2.3 ± 0.64, $p < 0.001$; other preparations: B = 1.36 ± 0.64, $p = 0.03$).

To characterize student out-of-class expectations, we asked students to describe the activities they expected to complete for the course outside of class time during typical weeks without exams (Fig. 4). Interestingly, 69% of students listed at least one behavior classified as active, while 61% included at least one passive behavior. Students also reported social interactions as part of their out-of-class work. In particular, 23% of students mentioned working with their classmates or peers, and 7% of students discussed seeking help from the instructor, a teaching assistant, or another person with biology expertise. Other anticipated activities included experiential learning, specific plans to prepare prior to class, and attending the associated lab course. These responses demonstrated that students expected to engage in a wide range of activities outside of class and envisioned completing active and passive activities to similar extents. Furthermore, first-year students reported significantly fewer active behaviors, but more social peer interactions, than non-first-year students (Fig. 4).

Student expectations regarding exam preparations

Recognizing that students adopt specific study habits for exams, we asked students to report the number of hours they expected to spend preparing during the week prior to an exam (Fig. 5). Students anticipated a median of eight hours of exam preparation. Holding other demographic variables constant, first-year students expected to spend significantly fewer hours preparing for exams than non-first-year students (Appendix 4; B = -1.51 ± 0.74, $p = 0.04$).

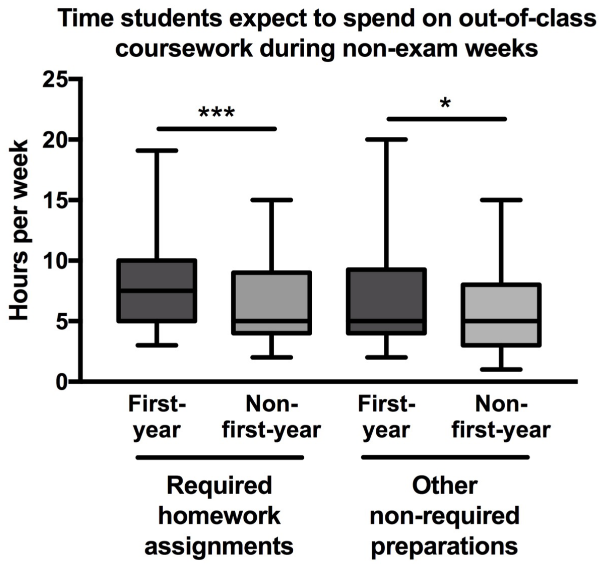

FIGURE 3. Student expectations regarding the amount of time they expect to spend on required and non-required work outside of class time. Response distributions are shown for first-year and non-first-year students. Central bars represent medians, boxes represent inner quartiles, and whiskers represent the 5th and 95th percentiles. General linear models, *$p < 0.05$, ***$p < 0.001$, see Appendix 4.

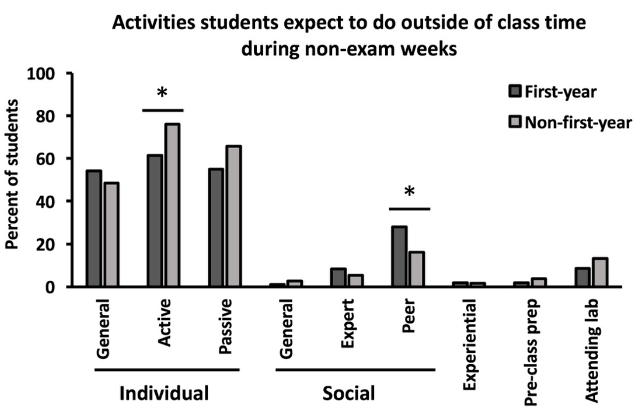

FIGURE 4. Open-ended student expectations regarding out-of-class activities during non-exam weeks. Bars represent the percentage of first-year and non-first-year students who indicated each category at least once in their response. Fisher's exact test, *$p < 0.05$.

We also asked students how they planned to prepare for course exams (Fig. 6). Similar to other out-of-class activities, students predominantly listed individual activities, with 48% of students listing at least one activity classified as active and 73% listing at least one passive strategy. With respect to social behaviors, 27% of students expressed plans to study with their peers, while 9% listed study activities that involved someone with greater expertise. Students additionally mentioned the spacing and consistency of exam preparations. First-year students included significantly more references to generic studying, working with peers, and working with an expert than non-first-year students (Fig. 6).

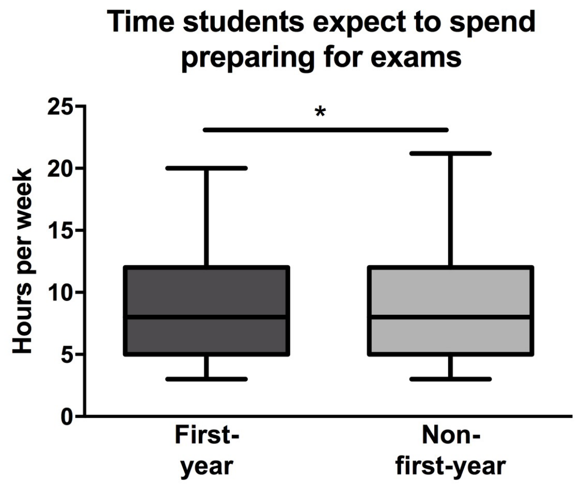

FIGURE 5. Student expectations regarding the amount of time they expect to spend preparing for exams. Response distributions are shown for first-year and non-first-year students. Central bars represent medians, boxes represent inner quartiles, and whiskers represent the 5th and 95th percentiles. General linear model, *$p < 0.05$, see Appendix 4.

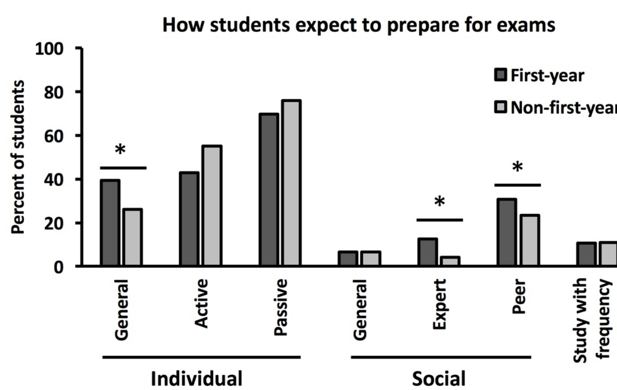

FIGURE 6. Open-ended student expectations regarding exam preparation. Bars represent the percentage of first-year and non-first-year students who indicated each category at least once in their response. Fisher's exact test, *$p < 0.05$.

Student expectations and course success

To determine whether student expectations related to course achievement, we developed general linear models separately, including each of the closed-ended questions as independent variables predicting either exam scores or course grades. Holding other demographic variables constant, student expectations regarding these quantitative measures did not significantly predict either of these course outcomes (Appendix 5).

DISCUSSION

We sought to understand the extent to which student expectations aligned with a course structure that incorporated active learning, social interactions, and out-of-class

assignments. In general, we found that students anticipated some degree of interactive teaching practices and that their expectations met or exceeded traditional perceptions of college workloads.

In-class expectations

With respect to in-class learning, our results revealed that many students recognized active and passive strategies as part of the learning process, while a relative minority of students explicitly cited social interactions. The amount of time students expected to spend in class completing activities and working in small groups mirrors the average percentage of time that observation-based studies have found college instructors devote to active learning (23, 24). These results also parallel previous survey-based studies, which found that incoming students in a variety of disciplines ranked formal lecture as the most expected teaching modality, with active and social activities being expected, but to a lesser extent (25).

Student expectations are significant because they may alter the classroom learning environment and dictate an instructor's willingness to implement active techniques, even though the expectations measured in this study did not directly predict course outcomes. The finding that most students expected some degree of active learning suggests that implementation of a moderate amount of active learning during class likely would not have violated student expectations. We note, however, that a small fraction of students still expected nearly all of class time to be spent in a lecture mode, and the majority of students expected less than 50% of class time to be spent in active learning (see Fig. 1). Thus, a few students may have found even a moderate amount of active learning to violate their expectations, and most students would likely have been surprised by substantial levels of active learning. The low rate at which students explicitly listed peer interactions could have stemmed from students expecting a fairly individual learning experience, discussion not forming a salient part of their conception of the learning process, or social interactions being implicit within responses coded as individual and active (e.g., clicker questions or practice problems). This social dimension of constructive learning represents an area in which students may require specific explanation and justification, as group dynamics can be a source of potential resistance to transformed teaching (17, 26, 27).

Out-of-class expectations

We asked students about their anticipated time commitment as a starting point for contextualizing their out-of-class expectations. Previous research on study time has yielded mixed results, with different studies finding positive (28), negative (29), or no correlation (30, 31) between study volume and course performance. While we recognized that student reporting of their predicted time allocations could not be taken as accurate estimations of their actual practices, we reasoned that their expectations would serve as a proxy for what they considered to be normative for a course. The students sampled generally expected substantial time commitments that exceeded the two to three hours per credit-hour traditionally cited in college guidebooks. These results suggest that a class with significant out-of-class course work does not contradict incoming student expectations, although this workload may later prove to be undesirable or difficult to manage.

While study volume reflects a student's anticipated time allocation for out-of-class activities, our finding that out-of-class study time did not predict student outcomes agrees with previous reports suggesting that the way students use this time and structure their study environment may be more important for their academic success (31, 32). Indeed, one meta-analysis found that study skills exhibit strong relationships with individual course performance and overall grade point average (33). Interestingly, more students expected to engage in active behaviors outside of class than in-class (compare Figs. 2 and 4), suggesting that students perceive homework as a key place for active engagement. Furthermore, more students cited active course-related behaviors for normal weeks than for exam weeks (compare Figs. 4 and 6), implying that some students viewed normal weeks as the time to actively engage with material but did not expect to use these same activities for exam preparation. These practices may not represent an optimal approach, however, as active study behaviors (e.g., answering questions on a study guide, using practice exams, or explaining phenomena) have been found to positively correlate with exam scores, while in general, certain passive behaviors (e.g., looking over notes after class, highlighting materials, or reviewing chapters) negatively correlated with exam performance (34). This same report found that social behaviors (e.g., asking a classmate for help or requesting additional materials from the instructor) also negatively correlated with exam scores, which may be related to the tendency of low-performing students to engage in help-seeking behaviors (35). Thus, while student expectations encompassed the range of activities that might be asked of students in a transformed course, students may still benefit from guidance and reflection on the efficacy of different study strategies.

First-year and non-first-year student expectations

We detected consistent differences in responses between first-year and non-first-year students. First-year students expected to spend more class time doing active learning, and they more often cited social behaviors as useful ways to spend class time. This resonates with previous findings that lower-division students have more positive attitudes toward in-class active learning techniques than more advanced students (36–39). First-year student expectations of more social interactions also extended to their open-ended responses regarding out-of-class behaviors. Furthermore, first-year students expected to spend more time outside of

class preparing during normal weeks and less time studying during exam weeks than non-first-year students, suggesting that first-year students may be expecting a more even distribution of studying, while non-first-year students may be expecting more studying immediately before an exam. The increased expectation of first-year students for in-class active learning, social interactions, and distributed practice suggests that incoming students may have a greater receptivity toward transformed teaching practices than their more experienced peers. Conversely, first-year students less frequently listed active out-of-class behaviors for non-exam weeks and more often expressed their exam study plans in a general manner (e.g., I will study), implying that these students may not have had a full toolkit of active strategies to use outside of class. Thus, while incoming students may have expectations that align with a slightly more active and social learning experience, instructors should recognize that some students may need help identifying and adopting effective study strategies early in their careers. Finally, whether the differences between first-year and non-first-year students represent changes in student expectations over time (i.e., development) versus differential retention of students with particular expectations (i.e., selection) remains an important area for further investigation.

Implications

Bearing in mind that student expectations may differ in other courses or at other institutions, this study has direct implications for efforts to implement transformed teaching. First, our results suggest that students in our study did not expect a college course to be devoid of activity, interaction, or structured assignments, and caricatures of "traditional" college courses in these terms may lack relevance in the modern teaching environment (40). Student expectations generally aligned with a moderately active class experience accompanied by assignments that involve both information exposure and processing (10). Second, instructors should recognize that students exhibit a wide variety of expectations and help students properly engage with a course by making the form and substance of course activities transparent. Finally, our finding that student expectations did not predict course achievement suggests that students may adapt to teaching practices and course demands as the semester progresses. While the course sections investigated used teaching practices consistent with student expectations, other courses with more unexpected teaching practices (e.g., very high active learning) may produce stronger relationships between student expectations and performance outcomes. Understanding how student expectations relate to course engagement, satisfaction, and achievement represents an important area for future studies, particularly given the discrepancies between first-year and non-first-year students.

SUPPLEMENTAL MATERIALS

Appendix 1: Complete list of survey questions
Appendix 2: Description of criteria for demographic variables
Appendix 3: Accounting for model assumptions
Appendix 4: Results of general linear models predicting student expectations about time spent on in-class and out-of-class activities
Appendix 5: Summarized results of general linear models predicting student exam and course grades

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