Expectancy Violation in Traditional and Studio-mode Introductory Physics Courses

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Abstract: Instructors of reformed courses face many potential barriers to change. One possible barrier is students' reactions to differences between reformed and traditional courses. We used an "expectancy violation" framework to explore students' experiences in second semester calculus-based introductory physics courses, taught either in a traditional lecture and laboratory mode or in a studio mode that closely modeled SCALE-UP. In this pilot study, we adapted the Pedagogical Expectancy Violation Assessment (PEVA) to include questions about course satisfaction. At the end of the semester, students were asked to report on their initial expectations for the course and what they experienced in the course, as well as their satisfaction with specific experiences and the course overall. We investigated differences between the courses, as well as the effect of the format of students' first semester introductory physics course, gender and race/ethnicity. Although preliminary, our results suggest that students in the SCALE-UP course experienced more expectancy violations and more frequently had a negative opinion about those expectancy violations. Our analysis also revealed differences between the types of questions that exhibited expectancy violations in each course and a difference in interpretation of the traditional course for students with prior experience in a SCALE-UP course.

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INTRODUCTION

While student-centered and active learning methodologies are becoming more common, instructors face many potential barriers to the use of these and other research-based instructional strategies.[1] One possible barrier is student resistance to strategies that require them to interact with each other or think independently,[1] which are hallmarks of course reforms such as SCALE-UP.[2] Such resistance may arise from "expectancy violations", or differences between students' expectations for a course and their experiences in that course. For example, one study of a SCALE-UP implementation found that students felt they had to work harder to earn the same grade that they could have earned in a traditional course.[3] To further explore students' expectations and experiences, Gaffney, Housley Gaffney and Beichner developed the Pedagogical Expectancy Violation Assessment (PEVA), which showed that students' expectations for certain activities, like lecture, were violated in a SCALE-UP course.[4]

We are in the process of improving the PEVA to include a measure of students' satisfaction. This additional information would allow instructors to change the framing of their course to target significant and damaging expectancy violations. In this pilot study, we used a modified version of the PEVA, which included a course satisfaction sub-scale, to explore students' expectations and experiences in three second-semester introductory physics courses: one traditional lecture and laboratory course and two SCALE-UP style courses. In particular, we looked for differences between the traditional and SCALE-UP courses. Within a course, we also looked for differences based on the type of first semester physics course students had taken, gender and race/ethnicity. We will use these results to inform future modifications to the PEVA.

METHODOLOGY

Survey Design

The modified version of the PEVA[4] used in this study included 20 items representative of the activities students may have engaged in during or outside of class in a traditional or SCALE-UP style physics course. Students reported on a seven-point Likert scale the frequency with which they expected to engage in or experienced each activity, from 0 (almost never) to 6 (very often). Students also expressed "valence", or their opinions of the amount of time spent engaged in each activity, on a scale from -3 (very displeased) to +3 (very pleased). So, for each of the twenty items, students expressed their expectation of how often they

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would engage in the activity, how often they experienced the activity, and their opinions about the amount of time spent on the activity. Finally, students responded to an eight item course satisfaction questionnaire, which was found to be reliable with a Cronbach's alpha above 0.9.

Data Collection

The data sample included 179/293 students from the traditional course and 88/174 students from the SCALE-UP courses. Students responded to the modified PEVA during the last two weeks of the semester. Thus, their reported expectations were based on their recollections from the beginning of the semester, and it is possible that students did not accurately recall their initial expectations. However, this modified implementation of the PEVA did allow students to more conscientiously point out expectancy violations.[1]

RESULTS

SCALE-UP Students Experience More Expectancy Violations

The Mann-Whitney test was used to explore differences between course satisfaction in the two course formats. Students in the traditional course (Trad) reported statistically significantly higher satisfaction with the course than did students in the SCALE-UP (SU) class (m_T = -0.1 vs. m_S = 8.8, Z = -5.7, p < 0.001). This supports the claim that students may resist certain research-based instructional strategies.

To explore the possible sources of this difference in course satisfaction, we compared the total number of expectancy violations (EVs) experienced by students in the Trad course with students in the SU course. Students in the Trad course experienced statistically significantly fewer EVs that did students in the SU course (m_T = 11.2 vs. m_S =12.9, Z =- 3.3, p = 0.001). By this measure, students in both courses tended to experience EVs on more than half of the items.

To determine which features of the course yielded the most EV, we calculated Cliff's δ for each of the 20 items in the PEVA. (Cliff's δ is like an effect size, and ranges from –1, indicating less experience than expectation, to +1, indicating more experience than expectation. See Ref. 5 for details of how δ is used to analyze EV.) When analyzed in this way, six questions showed EV for the SU course and nine questions for the Trad course. On the surface, the Mann-Whitney analysis seemed to predict that more items should have EVs. In that analysis we counted each time a student reported a different value for expectation and experience, which may over-emphasize small differences. To explore further, we counted the total number of questions for each student where there was at least a two point difference between expectations and experiences. With this new tally, students in the Trad course still reported significantly fewer EVs than did students in the SU course, although we find a total number of EVs closer to the number predicted by δ, (m_T = 4.7 vs. m_S = 6.2, Z = -3.3, p = 0.001). Thus, it appears that students experience more EVs in a SU course than a Trad course.

SCALE-UP Students Experience More Negatively Valenced Expectancy Violations

Since students reported their satisfaction with the amount of time spent on each activity, we explored whether there was a difference in how students felt about the items where their expectations were violated by looking for differences between the numbers of positively, negatively, or neutrally valenced EVs. We claim that an EV is positively (negatively) valenced when a student reported positive (negative) satisfaction with the amount of time spent on that activity. There was no significant difference between the number of positively (m_T = 6.2 vs. m_S = 7.1, Z = -1.6, p = 0.113) or neutrally valenced (m_T = 3.1 vs. m_S = 2.8, Z = -0.945, p = 0.345) EVs experienced by students in the Trad and SU courses. However, students in the Trad course experienced significantly fewer negatively valenced EVs than did students in the SU course (m_T = 1.9 vs. m_S = 3.0, Z = -2.4, p = 0.016). All individual items were, on average, neutrally to positively valenced for both courses, so we could not identify particular items that were causing this difference between the courses. The lack of overall negatively valenced items is likely because individual students have different opinions about specific activities. However, the overall tendency toward more negatively valenced items in the SU course may explain the lower course satisfaction, and suggests a potential relationship between course satisfaction and EV, which has previously been predicted.[4] We are exploring this relationship in our present work.

[1] For example, if a student knew that she paid attention to lecture more than she expected even though she expected to experience it very often, she could choose "5" for expectation and "6" for experience. In a traditional implementation of the PEVA, such a student may have marked "6" for expectation and would not be able to indicate that she experienced more lecture than she expected.

TABLE 1. Average reported expectations, experiences and valence for PEVA items with expectancy violations

Item	Expectations		Experiences		Valence	
(IN or OUT of class)	**Trad**	**SU**	**Trad**	**SU**	**Trad**	**SU**
A. Expectancy violation in both courses						
Pay attention to lecture (IN)	4.8#	5.3#	4.0*	4.7*	1.1	1.2
Solve physics probs., individually (IN)	4.4#	3.9#	3.9+	3.2+	1.3*	0.4*
Work on ungraded book probs. (OUT)	3.1#	2.6#	2.3	1.9	0.5	0.3
Review notes from class (OUT)	4.0	4.2	3.6	3.7	1.1#	0.7#
B. Expectancy violation in SCALE-UP Only						
Solve physics problems, in a group (IN)	3.7+	4.3+	3.4*	5.3*	1.1	1.3
Engage in off-topic activities (IN)	2.4#	1.9#	2.4	2.4	0.6	0.4
C. Expectancy violating in Traditional Only						
Ask questions of instructors (IN)	2.85*	4.0*	1.9*	3.7*	0.5	0.8
Answer questions from instructors (IN)	2.8+	3.4+	2.3*	3.3*	0.7	0.6
Discuss coursework w/ instructor (OUT)	2.4	2.8	3.03	3.35	0.55	0.6
Work on ungraded worksheets probs. (OUT)	2.9	2.9	2.1#	2.7#	0.5	0.4
Read the textbook (OUT)	3.4+	4.0+	2.7*	3.9*	0.6	0.6

[1]Significant difference between Traditional and SCALE-UP courses indicated by * for $p < 0.001$, + for $p < 0.01$ and # for $p < 0.05$

Trends in Expectancy Violations

Items with Expectancy Violation in Both Courses

Four items exhibited EV within both courses; the average expectation, experience and valence for each course are reported in Table 1. We used the Mann-Whitney test to make comparisons between responses. On all four items, students in both courses reported higher expectations of the amount of time spent on each task than they experienced. On the Lecture and Ungraded Textbook Problem items, both groups reported similar, slightly positive feelings about the amount of time spent on the task. On the Individual Problem Solving and Notes items, students in the SU course reported significantly less satisfaction with the amount of time spent than did students in the Trad course.

Interestingly, students in the SU course reported significantly higher expectations and experiences for time spent paying attention to lecture than did students in the Trad course. This may be due to interpretation of the item, with students emphasizing "pay attention" and reporting paying more attention to the short bursts of lecture in the SU course, or may indicate that lecture is more common than expected in the SU course. This item will be revised in future versions of the PEVA to tease apart different things the instructor might do, such as introduce new material or demonstrate how to solve a problem. Additionally, students in the SU course experienced less time on individual problem solving during class time than did students in the Trad course. Combined with lower valence in the SU course, this may indicate that students would like to spend more class time on individual problem solving. We will further explore this trend in future studies.

Expectancy Violations in SCALE-UP Course Only

Two items exhibited EV only for students in the SU course, as shown in Table 1. For both items, students in the SU course reported spending significantly more time on the task than expected. On the Group Problem Solving item, students in the SU course reported higher expectations and experiences for the amount of time spent than did students in the Trad course. Here, the PEVA is likely detecting a true difference between the two courses since SCALE-UP classes typically emphasize group work. Students in both courses reported similar satisfaction with the amount of time spent on group problem solving. On the Off-topic Activities item, students in the SU course reported expecting to spend significantly less time than did students in the Trad course, and students in both courses reported spending about the same amount of time and having similar satisfaction with that time. This is surprising and difficult to interpret. It seems to suggest that students in the SU course expected their time in class would be used in a focused manner, and while they experienced less focus than they expected, it did not exceed the level experienced in lecture.

Expectancy Violations in Traditional Course Only

Five items exhibited EV only for students in the traditional course, as shown in Table 1. For four of these items, students in the Trad course reported spending significantly less time on the task than they expected, and on all five items, students in both courses reported similar satisfaction with the amount of time spent. These questions are related to two possible themes: relationships with course instructors and personal effort.

The data suggest that the SU course is helping students experience a closer relationship with the course instructors. Students in the SU course reported expecting and experiencing significantly more time asking questions of and answering questions from course instructors. A similar trend is observed for the Discuss Coursework item, although the difference was not statistically significant. Thus, the SU course appears to offer students more interaction with course instructors.

Students in both courses expected to spend the same amount of time working on ungraded problems from worksheets outside of class time, but students in the Trad course reported significantly less time spent on this task. The students in the Trad class reported expecting and experiencing less time spent reading the textbook than did students in the SU course. These items may indicate that students in the Trad course found that less personal effort was required in the course than they expected, which may be related to their more positive course satisfaction.

Previous Course Affects Present Course

We explored several factors that may affect students' experiences within a given course, including the format of their first semester physics course (Trad or SU), gender and race/ethnicity. Across the same measures described above (course satisfaction, total number of EVs and number of positively, negatively, or neutrally valenced EVs), we found no significant differences based on gender or race/ethnicity. However, among students who were currently enrolled in the Trad course, those who had previously taken an SU course (N=37) experienced significantly more negatively valenced EVs than did students who had previously taken a Trad course (N=132) ($m_{Pre\text{-}T}$ = 1.76 vs. $m_{Pre\text{-}S}$ =2.8, Z = -2.1, p = 0.035). This may indicate that students value some features of the SU course or had unrealistic expectations of the Trad course.

Due to this initial finding, we explored EV differences within each course based on prior course. No such differences emerged in the Trad course. However, in the SU course, students who had previously taken a Trad course experienced EVs for the items related to discussion with classmates ($\delta_{Pre\text{-}T}$ = 0.334 vs. $\delta_{Pre\text{-}SU}$ = -0.169), individual problem solving ($\delta_{Pre\text{-}T}$ = -0.444 vs. $\delta_{Pre\text{-}SU}$ = 0.123) and group problem-solving ($\delta_{Pre\text{-}T}$ =0.590 vs. $\delta_{Pre\text{-}SU}$ = -0.116), while students who had previous experience with an SU course did not. The signs of δ indicate that students who had previously taken a traditional physics course experienced classmate discussion and group problem solving more than they expected, and individual problem solving less than they expected. These results lend support to the claim that students in the SU course were experiencing more interactions with their peers and suggest this as a factor to further explore in future versions of the PEVA. On the other hand, students who had previously taken the SU course worked on ungraded worksheets outside of class less than they expected ($\delta_{Pre\text{-}T}$ = 0.100 vs. $\delta_{Pre\text{-}SU}$ = -0.376). This result is likely due to differences in instructional style between instructors who teach the SCALE-UP courses, as some instructors may assign more worksheets or not formally grade all assignments.

DISCUSSION & FUTURE WORK

The modified version of the PEVA detected that students enrolled in a SCALE-UP course experienced expectancy violation (EV) about more course activities than did students in a traditional course, and the students in the SCALE-UP course were more likely to have a negative reaction to those EVs. Since students in the SCALE-UP course also had lower course satisfaction, there may be a relationship between EV and course satisfaction or valenced EV and course satisfaction, which suggests that if instructors could shift students' expectations early in the semester, students may feel more satisfied with the course. Differences within each course support this claim, since students who had previously taken a SCALE-UP course had more negatively valenced EVs in the traditional course and EVs on fewer items in the SCALE-UP course. Additionally, several themes emerged related to differences in EVs between the two courses, such as relationships with instructors, personal effort and group work. We will expand on these themes further in future versions of the PEVA.

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