Towards Understanding Classroom Culture: Students' Perceptions of Tutorials

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Abstract. Following the documentation of significant and reproducible student content learning gains through the use of the Tutorials at the University of Colorado (CU), we seek to understand the meaning that students are making of this reform. Spanning five years of Tutorials use at CU, we investigate if students' perceptions of the Tutorials shift (become more or less favorable) after the Tutorials have become fully institutionalized. We find that they do not. We observe some semesters where the majority of students perceive the Tutorials to be highly useful for their learning, but this is rarely the case. We determine that students at CU generally do not like the Tutorials. Students' perceptions of the utility and enjoyment of Tutorials do vary significantly on a semester-by-semester basis suggesting that both the lead and secondary faculty members involved in a Tutorial course may influence the students' experience in Tutorials.

Keywords: physics education research, course reform, introductory physics, educational change, student perceptions, Tutorials
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INTRODUCTION

The University of Colorado at Boulder (CU) physics department began using the University of Washington *Tutorials in Introductory Physics* [1] (Tutorials) in Fall 2003 in its calculus-based introductory physics course. Compared to traditional recitations, the use of the research-based Tutorial curriculum required significant shifts in the students' role, the educator's role, and student-educator interactions. After replicating student conceptual learning gains achieved at the University of Washington [2], the department began an effort to sustain the use of the Tutorials. Previous research at CU has shown that the sustained use of the Tutorials has resulted in significant reproducible student learning gains [3]. While research on educational transformation has traditionally focused on studying student content learning outcomes, little work has examined students' perceptions of the tools and classroom culture associated with transformed pedagogies [4].

We present analyses of students' perceptions of the Tutorials spanning five years at the University of Colorado, in order to better understand the meaning students are making of this reform. For example, we investigate whether students report usually sharing their reasoning with their peers in Tutorials and whether students perceive the Tutorials to be useful for their learning. We investigate whether there are differences in students' perceptions of the Tutorials across multiple semesters even though surface features of the implementations are similar (i.e. the same worksheet materials, equipment, classrooms, training sessions, etc.). We are particularly interested to see if students' perceptions of the Tutorials in second semester physics (Phys2) become more favorable after the Tutorials have become fully institutionalized in both semesters. Semesters of Phys2 using Tutorials are considered fully institutionalized if the majority of students used Tutorials in their prior Phys1 course and further Phys2 students the semester prior also used the Tutorials. By examining students' perceptions in Phys2 before and after full institutionalization, we hope to 1) understand the nature of student buy-in, 2) inform faculty about potential reactions from their students, and 3) identify critical parameters for researchers to focus on when studying institutional transformation.

BACKGROUND & METHODS

We investigate students' perceptions of the Tutorials and associated classroom cultures by collecting student responses to two different types of online surveys: Survey-1) data from a 'Student Assessment of their Learning Gains' (SALG) style

instrument [5], designed to identify students' broad perceptions of the utility and enjoyment of Tutorials, and Survey-2) more detailed survey data that targets students' perceptions of peer interactions and student-TA interactions in the Tutorials, as well as the coordination of the Tutorials with other course components. Each of these surveys includes both Likert-scale questions as well as long-answer open response questions. Initial information about the coarse-grained features of these environments was provided by Survey 1. Student long-answer responses from Survey 1 told us why students chose particular answer options as well as guided the design of Survey 2 to examine classroom norms of Tutorial implementation in more detail. In this paper, we present analysis of Survey 1 over multiple semesters of Tutorial use in the first semester (Phys1) and second semester (Phys2) calculus-based introductory physics courses. For all semesters of data presented, the survey response rates ranged from 50% to 80%. We also note that the student population in these courses is fairly similar from semester-to-semester.

We look to compare the overall trends across Phys1 and Phys2 courses. We then examine semester-by-semester variations separately within each course because there are significant differences between the two courses (i.e. course material, student familiarity with the material, degree of use of equipment in the Tutorial activities, etc.). For each semester of data, a letter has been assigned to each professor. Generally two professors work on a given course. The professor listed first is in charge of the lecture portion of the course. The second faculty listed is the support person who has little face time with students, and is primarily in charge of Tutorial educator training, homework, and exams.

Due to the early process of adopting the Tutorials, not all students in Phys2 have had prior experience learning physics in a Tutorial environment [6]. We will refer to Phys1 & Phys2 semesters in which the majority of students have no prior experience with physics Tutorials as Tutorial newcomer semesters. The B&C, C, and D&E semesters of Phys2 as well as all semesters of Phys1 are Tutorial newcomer semesters. In this data presentation, the earliest implementation of Tutorials is plotted to the far left of each course listed and the most recent implementation to the far right. For the last three semesters of data shown for Phys2, the Tutorials can be considered fully institutionalized (as described in the introduction) and are running simultaneously in both courses. This sustained use of Tutorials is one way to denote institutionalization.

RESULTS: PERCEIVED UTILITY & ENJOYMENT OF TUTORIALS

Students were asked to, "Please rank how much the Tutorials helped your learning in this course (1—No help, 2—A little help, 3—Moderate help, 4—Much help, 5—Very much help)." To simplify the presentation of these data, we have clustered the 1's and 2's into one group labeled 'Low' help (L). Similarly, the 4's and 5's were clustered into one group labeled 'High' help (H). The student responses for each semester of data are provided below in Figure 1.

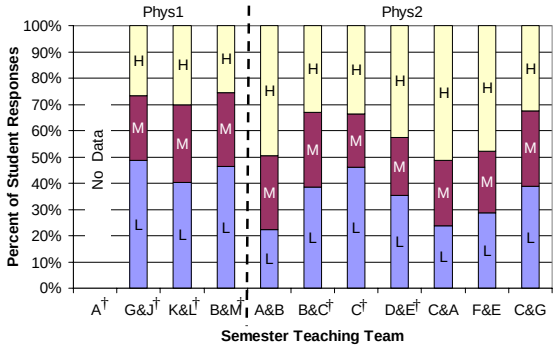

FIGURE 1. Perceived Utility of the Tutorials for Student Learning. Data labels represent L: Low help, M: Medium Help, and H: High Help. In all plots, daggers (†) represent Tutorial newcomer semesters. There is significant variation in the perceived helpfulness of the Tutorials within semesters of Phys2 as well as within semesters of Phys1.

Figure 1 shows that the perceived helpfulness of the Tutorials for student learning varies from semester to semester. At times, more than 45% of students are reporting that the Tutorials were of 'Low' helpfulness (G&J semester of Phys1) while in other semesters more that 50% of students are reporting that the Tutorials were of 'High' helpfulness (C&A semester of Phys2). Within Phys1, we see that across all three semesters, students report that the Tutorials are of low utility more than they report that the Tutorials are of high utility (%L>%H). However within Phys2, we see that across the seven semesters of data, there are some cases where %H>%L (see A&B and C&A) and others where %L>%H (see C). We can also establish that student prior experience with the Tutorials in Phys1 is not sufficient for students to perceive the Tutorials as highly helpful in the next Phys2 course (C&G semester). There appears to be some relationship or dependence between students' perceptions of utility and instructors (or instructor practices).

Despite the involvement of highly rated instructors (as evidenced by the end-of-term course questionnaire), students in Tutorial newcomer

semesters appear to be less likely to perceive the Tutorials as highly helpful (in only one of the six newcomer semesters shown do the majority of students perceive the Tutorials as highly helpful—D&E semester of Phys2). These semester-to-semester variations are statistically significant ($p<0.001$, see Ref. 7 for stat. test) within semesters of Phys2 and within semesters of Phys1 [7]. We also see that these instructor effects do not depend solely on the lead lecture professor. In the Phys2 data set, Professor C occupies the lecture role three different times and students' perceptions still vary significantly. In this way, the implementation effects due to both the primary instructor (i.e. lecture practices) and secondary instructor (i.e. the nature of the educator training meetings and design of HWs and exams) seem to matter.

Students were also asked to, "Please rank how much you enjoyed the Tutorials in this course (1—Strongly disliked it, 2—Disliked it a bit, 3—Neutral, 4—Liked it a bit, 5—Very much enjoyed it)." To simplify the presentation of these data, we have clustered the 1's and 2's into one group labeled 'negative' (-). Similarly, the 4's and 5's were clustered into one group labeled 'positive' (+). Then the 'Neutral' category label was left as 'neutral' (0). The student responses for each semester of data are provided in Figure 2.

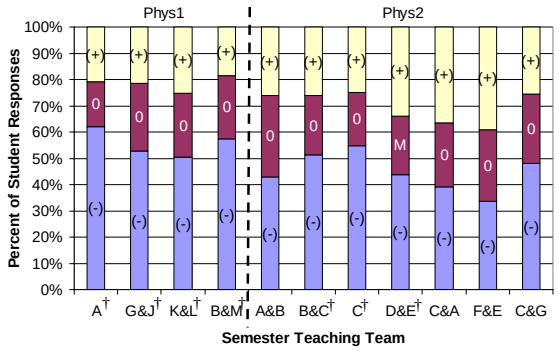

FIGURE 2. Perceived Enjoyment of the Tutorials. Data labels represent (+): Positive/Liked, (0): Neutral, and (-): Negative/Disliked. Students at CU usually report disliking the Tutorials more than they report liking the Tutorials. There is significant variation within semesters of Phys2 while Phys1 semesters are statistically indistinguishable.

We see that students generally report that they dislike the Tutorials more than they like the Tutorials (%Neg.>%Pos. in 10/11 semesters of data). There is a single case of students reporting that they like the Tutorials more than they report disliking the Tutorials (F&E), although this stands out as the only example out of eleven semesters of data. Despite the involvement of highly rated instructors, we see no case among the Tutorial newcomer semesters where the majority of students report positive enjoyment of the Tutorials (i.e. no case in which %Pos.>%Neg.). We are again led to believe that instructors or instructor practices matter, although the extent of student familiarity with Tutorial-like learning activities may also be a factor. Across all semesters of Phys1, 25% to 40% more students report disliking Tutorials than report liking them. It is also interesting to note that we see more variation by instructor on students' perception of Tutorials' utility than on students' perception of the enjoyment of Tutorials. These semester-to-semester variations are statistically significant within semesters of Phys2 [7], but not within semesters of Phys1 ($p=0.184$).

RESULTS: PERCEIVED UTILITY OF EDUCATORS IN TUTORIALS

In order to implement Tutorials with a reasonable student-to-educator ratio, Undergraduate Learning Assistants (LAs) [8] are used at CU to partner with the institutionally supported graduate teaching assistants (TAs). Students were asked two questions: "Please rank how much contact with your [graduate teaching assistant] / [undergraduate learning assistant] helped your learning in this course (1—No help, 2—A little help, 3—Moderate help, 4—Much help, 5—Very much help)." Although students were asked to respond about each educator separately, these responses have been combined into a single plot below. These answer options were collapsed consistent with the prior descriptions.

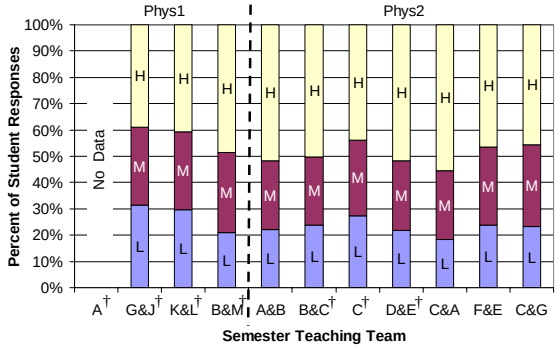

FIGURE 3. Perceived Utility of Tutorial educators for Student Learning. Data labels represent L: Low help, M: Medium Help, and H: High Help. Students generally find the educators in the Tutorials helpful.

Across all semesters, we find that students are generally positive about the educators that work with them in the Tutorials. They generally report the educators to be more helpful than the Tutorial activities as a whole. Across all semesters, between 39%-56% of students report that the educators were

of 'high' help to their learning while only 18-32% of students report that they were of low help. Students in all semesters were more likely to report that the educators were of high help than low help; In ten of the eleven semesters studied, at least 10% more students reported that the educators were of 'high' help to their learning than reported that the educators were of 'low' help. Even though we see less variation in perceived helpfulness of TAs and LAs than was present in students' perceptions of Tutorials, we still see statistically significant differences across students' perceptions of TAs and LAs in each of the Phys1 and Phys2 implementations [9].

DISCUSSION & CONCLUSIONS

At a coarse-grained scale, we find no clear shift in students' perceptions between the early, partially institutionalized Tutorial semesters and the fully institutionalized semesters. That is, students do not become successively more (or less) favorable about Tutorials. Rather, students' perceptions vary significantly on a semester-by-semester basis demonstrating that faculty members' implementation practices may matter for some aspects of the student experience in these courses. Various factors may contribute to student perceptions, including both the primary and secondary faculty members.

During some semesters the majority of students are reporting that the Tutorials were highly helpful in their learning, while in other semesters more students are reporting that the Tutorials were less helpful for their learning. There are clear semester-by-semester differences in students' perceived utility of the Tutorials. However, we do find that students at CU are generally positive about the TA and LA educators in the Tutorial environments.

Although the Tutorials do result in high student learning gains [2, 3], we find that students dislike the Tutorials fairly consistently across both Phys1 and Phys2 and we see no example where the majority of students report liking the Tutorials. Student dislike of the Tutorials is an important feature for instructors to be aware of as they begin implementing the Tutorials. Although the overall magnitude of variation in students' perceived enjoyment is smaller than the variations found in perceived utility, we do see semester-by-semester variation in students' perceived enjoyment. To better understand students' dislike of the Tutorials, we anticipate that there are two areas for further investigation: 1) how the pedagogical approach to conceptual change embedded within the curricular materials may affect students' perceived enjoyment [10] and 2) how the Tutorials are embedded within and coordinated with the rest of the course (homework, exams, lectures, etc.) and how this coordination may affect students' perceived enjoyment and utility.

Based on the compelling nature of these instructor-dependent variations, we proceeded to code student long answer responses and develop a new survey to further understand the possible instructor-dependent nature of these environments and students' experiences. The themes currently under investigation with Survey 2 include the nature of peer collaboration in the Tutorials, the nature of student-TA interactions in the Tutorials, and the degree of coordination of the Tutorials with other course components (with lecture, HW, exams, etc.).

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8. V. Otero, N.D. Finkelstein, R. McCray, and S. Pollock, *Science.* **313**(5786), p.445-446 (2006).
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