

Creative Ways Students Interpret Experiences as Physics Majors

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1. Abstract

Performance feedback offers a valuable opportunity to guide students' development of knowledge and skills. Undergraduate physics majors in upper division classes dedicate many hours to coursework, yet the feedback for their effort often takes the form of numeric scores with uncertain meaning, especially for students who recently transferred to the university from a community college. This year-long study focuses on the experiences of transfer students within a large cohort of physics majors and reveals the creative work that students do to fill in the gaps in the assessment of their performance. Findings from observations, interviews, and participation in the student community indicate that students use many indirect means to guess how they're really doing in their major, such as informal conversations with classmates and instructors, and time spent solving problems. These findings have useful implications for instructors working towards creating an inclusive physics classroom by centering students' perspectives.

2. Transfer Students in Physics

An increasing number of students take physics classes at two-year colleges in the US, making these pathways an important area for physics education research. Transitions from community colleges to four-year schools are not thoroughly investigated in the literature, yet impact many first generation college students and students of races and ethnicities that are underrepresented in physics. Further, math and science students often experience "transfer shock" and take a hit to their GPA upon moving into a four-year institution from a community college.

This study centralizes student perspectives while contributing to a greater understanding of how transfer students experience physics culture.

Description of the Setting

Sun University (pseudonyms are used throughout) is a large R1 research university in California where roughly half of the upper division physics majors are transfer students (29% of students in the major overall). Community college students from all over the state (shown in the map below) transfer to Sun University each year.





Above: The graph illustrates the percentages of each student group belonging to different categories. PHY represents physics majors. MAT/CHE represents combined math and chemistry majors. Transfer students and students admitted as freshmen are distinguished

Among physics majors between transfers and freshman admits, there is a similar percentage of women (24.8% freshman admit compared to 22.4% transfer) and low income (21.6% freshman admit compared to 21.8% transfer), but larger percentages of both groups among math and chemistry majors. In physics there is a higher percentage of students of races or ethnicities that are underrepresented in STEM among transfer students (24.7%) than freshman admits (14.9%). In physics there is also a higher percentage of first generation college students among transfer students (44.3%) than , freshman admits (26.6%).



3. Ethnographic Data Collection & Analysis

Ethnographers aim to study culture by focusing on everyday behaviors, collecting multiple forms of data, and engaging actively with the community of interest. Data were collected over the course of fifteen months at Sun University through interactions with 35 participants, including undergraduate students and instructional staff.

Type of Data Collection	Date Range	Total Number of Participants	Total Duration (in hours)	Data Format
Interview	Dec '16, Jun & Dec '17	20	32	Audio recordings
Observe Lecture	Oct '16 - May '17	29	37.2	Field notes & Audio recordings
Observe Office Hours	Feb - May '17	13	3.5	Field notes & Audio recordings
Participate in Help Sessions	Oct '16 - May '17	22	21.2	Audio recordings
Observe Outside of Class	Nov '16 - Dec '17	21	21.1	Field notes & Audio recordings
Grades	Jan – Jun '17	NA	NA	Numeric & Categorical
Total:	15 months	35 participants	115 hours	

Above: The table describes data collection, which was carried out between Oct. 2016 and Dec. 2017. Undergraduate student participants included 14 transfer students and 15 students admitted as freshmen. Six instructional staff members also participated.

The constant comparative method was used, where researchers analyze data in cycles with continued data collection so that preliminary results guide deeper investigation. Qualitative coding of data involved reviewing the body of data for patterns or themes, then systematically marking instances related to the themes. The result is a description and explanation of the culture from the perspectives of the participants.

NVivo, a qualitative data analysis software package, was used in support of this project.

4. Grading Policies and Distributions

20

15

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One of the major themes discovered from this study was the strength of the influence of grading practices on student thinking and behavior. During unstructured interviews, students frequently raised concerns about low exam scores.



Histograms to the right illustrate the score distributions

division physics classes. Scores below 60% are

common, which has typically corresponded to failing grades in students' prior academic experiences,

> 57 77.8

57

especially at community colleges.

Classical Mechanics 2 32

Exam

F&M 1

F&M 2

Math Methods

E&M 1 Midterm 2

E&M 2 Midterm 2

on six midterm exams administered during four upper 15

91.1 9.1 70 100 10

Count Mean St. Dev. Min Max

74 77.3 18.6 12 100

47 58.6 22.1 26 99

47 67.2 18.2 25 100

65.8 18.9 21 100

16.4 30 99

Students typically take six required physics classes during their junior year. Instructors in all six classes explicitly placed significantly more value on work carried out in timed. closed-book testing conditions than any other form of assessment. One class offered participation credit worth 10% of the final grade. One class had quizzes worth 20% of the final grade.

Class syllabil were used to create the nie chart to the left

NVIVO

Students interpret their exam scores in relation to their classmates using the mean and standard deviation, obscuring the intended link between scores and physics knowledge and creating a sense of competition.



Classical Mechanics 2 is a notable exception to the pattern of wide exam score distributions and low averages. This midterm exam has the smallest standard deviation and highest average among this sample of exams. Students identify Professor Wheat as someone who gives "fair" exams and cares about students. Professor Wheat has also identified and reached out to students with test anxiety as a result of this practice.

To the left: Students work silently on individual written exams during a 90-minute lecture period. Professor Almond sits at the front of the room





6. Implications for Physics Educators

The following recommendations emerge

relative

performance

knowledge and skills.

- Spend time listening to all students while they work on problem-solving and conceptual explanation. This may help align expectations and provide important, informal feedback to students throughout the duration of the class.
- 2. Use a variety of strategies to engage students and assess their understanding. Over-emphasis on timed. closed-book, individual written exams fails to capture the diversity of student knowledge and skills.
- Grade exams using rubrics according to learning outcomes. This may help to reduce competition and give meaning to scores.

notable themes emerging from this work include:

Above: Students take turns working at the board during office hours while a teaching assistant (circled) observes from the back of the room. Students discussed the problem as a cooperative group



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 Student responses to the environment of unstructured, independent learning. - Impressions of faculty unavailability to support students, and

7. Future Work

This significant body of data lends itself to many avenues for further investigation. Other

The ways students position themselves with respect to stereotypes about physicists