Student goals and expectations in a large-enrollment physical science class

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Abstract: What are the goals of non-science students taking a lecture-based physical science course? Do students' goals and expectations change as they progress through the class? We surveyed students on the first day of class about their goals as well as what they, their instructor and their classmates could do to help them achieve these goals. The same questions were asked at the end of the semester. A comparison of students' pre- vs. post-course responses reveals that students change what they believe to be key to meeting their goals for the class. After the class they are more likely to believe that they and their peers rather than the instructor have a larger role in achieving their goals.

Introduction

Instructors in science courses often have implicit expectations about what students should learn. [1] In his recent book, Redish [2] refers to these goals as the "hidden curriculum." However, instructors are not the only ones that have goals and expectations about a course. Often students have goals beyond getting a good grade. In the present study we attempt to understand and measure students' goals in a conceptual physics course as well as their expectations of themselves, their peers and their instructors in helping them achieve these goals.

We believe it is important for educators to understand students' motivations and goals and what students believe can help them achieve these goals. We hope that students would begin to see learning as a shared responsibility by themselves and their peers and believe that classroom interaction can positively contribute toward their goals. The results of this study demonstrate, albeit in the context of a single class, that it is possible to achieve these desired shifts.

Relevant Literature

It has been recognized that students' goals and expectations affect the way in which they react to instruction. Researchers [3-5] have found that students often have misconceptions about what they should expect from a science class. At least three instruments have been used to measure students' views, expectations and beliefs about physics and science in general.

Redish and co-workers [6] developed the Maryland Physics Expectations Survey (MPEX) to measure students' expectations about what they needed to do to succeed in their physics course. Students' results are often presented as either favorable or unfavorable compared to those of experts. The instrument was originally designed for an introductory calculus-based class. The Views About Sciences Survey (VASS), developed by Halloun and Hestenes [7] probes students' views about the nature of science and about what it takes to learn science. Students are categorized as having either expert, folk or transitive views. Elby and co-workers [8] have developed the Epistemological Beliefs Assessment in the Physical Sciences (EBAPS) which measures how students function in a real science class rather than what they *think* about how they *should* function in an idealized situation.

Motivation & Research Goals

Each of the instruments above and several other instruments similar to these represent years of research and measure attributes along multiple dimensions. However, we felt that none of them completely met our needs, i.e. measuring students' goals in our particular class and what students felt they, their classmates and their instructor could do to help them achieve these goals. Our research questions were:

- What are the goals of students entering a conceptual physics class?
- What they expect they, their instructor and their classmates should do to help them achieve their goals?
- What major obstacles do they perceive in achieving these goals?
- Do their answers to the above questions change at the end of the semester?

Research Methodology

We adapted a survey used previously by an earlier researcher [9] in our group, which contained the following open-ended questions:

Q1: In addition to a good grade what are the most important goals that you wish to attain?

Q2: What are the most important actions *you* can take to help attain your goals?

Q3: What are the most important actions *your instructor* can take to help attain your goals?

Q4: What are the most important actions *other students* can take to help attain your goals?

Q5: What are the biggest obstacles or barriers that you will need to overcome to reach your goals?

In Phase I of the study in fall 2001, students were given the survey on the first day of class. On the last day of class one-half of the class was given a copy of their responses to the first-day survey and asked to what extent they had achieved the goals mentioned by them in the first-day survey and the extent to which they, their instructor, and classmates helped achieve their goals. The other half of the class was *not* shown their responses to the first-day survey; rather they were given a survey with the same questions as the pre-instruction survey, but phrased in past tense (e.g. …what *were* the most important goals…, or what *were* the most important actions you/instructor/classmates took to help…).

The open-ended responses to each question on both pre- and post-surveys were categorized for each using phenomenographic [10] analysis. In this qualitative analysis technique, the researcher categorizes students' open-ended responses on the survey. The researcher does not decide *a priori* what the categories should be but rather the categories emerge from the responses.

Phase II of the study was conducted one year later, in fall 2002, in the same course taught by the same instructor (author). Students were presented with a survey having the same questions, but this time the students were asked to rank order a set of statements for each question. These statements were based on the categories extracted from students' open-ended responses in Phase I. We acknowledge that the labels for these categories may be ambiguous. For instance, "studying hard" in Q2 was a category that arose from student responses, but we cannot be sure what students mean by "studying."

Based on the pre- vs. post- comparisons for Phase I we decided not to split the post-instruction survey into the two formats, rather all of the students in the post-instruction survey were given the pre-instruction survey with rephrased questions in the past tense as described above.

Context of Study

This study was conducted in a conceptual physics class for non-science majors. The largest single group of majors was business majors (35%). A vast majority were either sophomores (45%) or first-year students (36%). The gender ratio was nearly 50:50.

The textbook for the class is *Conceptual Physics* by Hewitt. [11] Most of the students were non-science majors who had not taken physics in high school. The course met three times a week for a 50-minute lecture in large lecture hall. There was no laboratory component in this course.

This course was chosen for two reasons. First, anecdotal evidence indicates that students in this course typically do not see themselves as "science people" and are taking the course merely to fulfill a requirement. They are also usually very apprehensive of this course and for the most part are satisfied with merely passing it. Therefore, we wondered how these students would respond if asked their goals and expectations for this course. Second the course was taught in a traditional format. Research [12] has shown that such courses tend to be ineffective in promoting student conceptual learning. Student attitudes and beliefs are also typically harder to change, even with targeted interventions in calculus-based physics courses. [6] Given this background this course provided a challenging opportunity to test whether any attitudinal change at all could be affected.

At least two strategies to increase student participation in class were used. The first is an adaptation of Peer Instruction [13] using an infrared Personal Response System (PRS). The second is an adaptation of Interactive Lecture Demonstrations. [14] Students were asked to predict the outcome of the demos by voting on the PRS system. They then observed the demo and often voted again to explain their observations. Therefore, we integrated a predict-observe-explain sequence with these demos using the PRS.

We hypothesized that we would see a shift toward students' believing that classroom interaction between themselves and their peers had a positive role to play in helping them achieve their goals.

Results & Discussion

Phase I (N=176) was primarily used to construct the categories from students' open-ended responses to the questions. The results have been reported previously. [15] Half of the post-instruction surveys were used to gauge the extent to which students felt that their goals had been met and that they and others (peers and instructor) did what they had expected them to do to help them achieve these goals.

Results of this half of the post-instruction survey indicated that almost all (>95%) students felt that they had met their goals and expectations for the course. The results for the second half of the post-instruction survey (when students were not shown their pre-instruction responses) showed significant shifts (similar to Phase II) in students' perceptions of the role of themselves, their instructor and other students in the class.

Phase II (N=124) Students were asked to rank order statements from most likely (Rank=1) to least likely (Rank=5). Similar wording was used for all questions (pertaining to expectations of themselves, their instructor, their classmates and obstacles faced). The results reported below indicate the percent of respondents who ranked the corresponding statement toward the "top." The functional definition of "top" is responses in which the statement was ranked either '1' or '2.' We used the z-test of proportions to compare the pre-instruction vs. post-instruction top ranking for each statement. A z-value $\geq$ 1.96 corresponds to p-value $\leq$ 0.05.

There is no significant change in the top goals identified by students at the beginning of the semester to those identified at the end. "Increasing general knowledge" (~75%) followed by "Understanding Physics" (~50%) were cited as students' top goals before and after the class.

We focus on responses to Q2, Q4 and Q5. The first two of these pertain to what the students and their classmates did to help them achieve their goals. Q5 focuses on obstacles faced by the students.

In Q2 (Fig. 1) students rank ordered statements pertaining to what *they* did to achieve their goals for the course. The only statistically significant (z=2.38, p=0.017) increase is for "interacting with others in class." After completing the class students appear to have recognized that in-class participation helped them achieve their goals much more than they predicted at the beginning of the class.

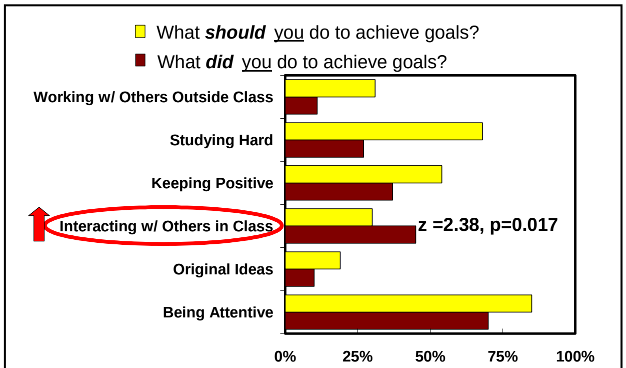

Fig. 1: Responses to Q2 for pre vs. post

In Q4 (Fig. 2) the percentage of students who ranked class participation as one of the top actions *their classmates* could take significantly increased (z=4.20). Correspondingly the percent of students who at the beginning of the course ranked being quiet as the top action their classmates could take to help them achieve their goals declined significantly (z=7.90). Students appear to have realized that their classmates can help them achieve their goals by participating in class rather than by being quiet.

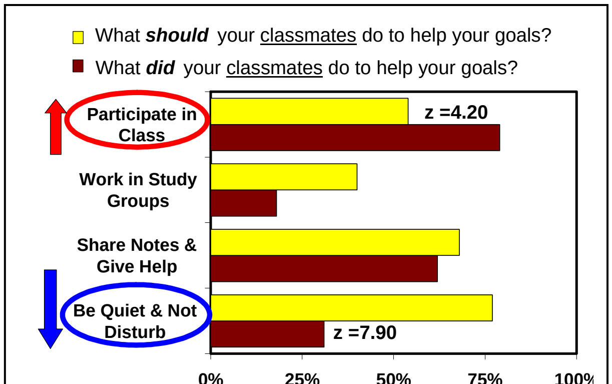

Fig. 2: Responses to Q4 for pre vs. post

In Q5 (Fig. 3) students rank ordered statements pertaining to the main obstacles and barriers they expected to face or did face as they tried to achieve their goals. The only significant (z=3.67, p=0.0024) increase occurs in those students who cited "lack of motivation" as a barrier. Again students appear to believe their own attitude was an obstacle to the course rather than external factors.

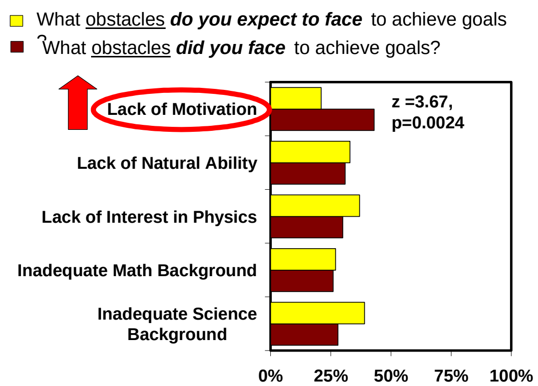

Fig. 3: Responses to Q5 for pre vs. post

Conclusions

We have demonstrated that students' expectations of the role of themselves, their peers and their instructors in helping them achieve their goals can change significantly in a course. Although students at the beginning of the course do not cite classroom participation or peer interaction as a factor contributing toward their goal, at the end of the semester both of these factors increase significantly in their importance toward contributing to students achieving their goals in the class. Also, at the end of the class students are more likely to cite their own lack of motivation as an obstacle, rather than their prior knowledge or external factors.

These changes are all desirable because students appear to recognize their own and their peers' role in contributing toward their goal. We speculate that these changes were due to the focus on interactive engagement in class. Further research comparing this class with a more traditionally taught class would be needed to substantiate this claim.

Acknowledgements

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