CLASS Shifts in Modeling Instruction

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Abstract. Among the most surprising findings in Physics Education Research is the lack of positive results on attitudinal measures, such as Colorado Learning Attitudes about Science Survey (CLASS) and Maryland Physics Expectations Survey (MPEX). The uniformity with which physics teaching manages to negatively shift attitudes toward physics learning is striking. Strategies which have been shown to improve learning, such as interactive engagement and studio format classes, provide more authentic science experiences for students, yet do not produce positive attitudinal results. Florida International University's Physics Education Research Group has implemented Modeling Instruction in University Physics classes. Using the CLASS as a pre/post measure has shown attitudinal improvements through both semesters of the introductory physics sequence. In this paper, we report positive shifts on the CLASS in two sections of Modeling Physics, one in Mechanics (N=30) and one in Electricity and Magnetism, (N=31) and examine how these results reflect on Modeling Instruction.

Keywords: Modeling Instruction, CLASS, Attitudinal Survey PACS: 01.40.Fk, 01.40.gb

INTRODUCTION

Recently, significant attention has been paid to assessing students' attitudes, expectations, views and epistemological beliefs because all of these are believed to play important roles in learning and distinguish experts in a field from novices. [1-4] A striking outcome from the development of such attitudinal surveys is the consistent negative shifts shown by students in introductory physics. [1,2] The overall negative shifts seem independent of instructional approach even when other measures such as normalized gain on FMCE indicate the course has successfully addressed conceptual learning. [1]

Conceptual understanding is one of many characteristics that distinguish experts from novices, other attitudinal characteristics discriminate novice and experts as well. Reformed teaching seeks to enhance the development of expert-like characteristics in students. [5,6] Reform based strategies such as active engagement, and studio format classes, have been shown to improve conceptual learning. [7,8] It is not unreasonable to suppose that simply improving conceptual learning is sufficient to develop expert-like characteristics in students, however the overall negative shifts on attitudinal surveys would indicate the contrary. National science standards have also placed a value on classes that provide students with authentic science experiences, in order that students gain an appreciation for the Nature of Science. [9] Common instructional approaches to addressing the Nature of Science include using inquiry-based methods and encouraging hands-on, minds-on teaching. Otero and Gray have published positive results on the CLASS from courses with pre-service teachers utilizing the Physics and Everyday Thinking (PET) curriculum which includes an explicit Nature of Science theme. [10]

Florida International University's Physics Education Research Group has implemented Modeling Instruction in selected sections of introductory calculus-based physics as the central educational reform effort associated with the Center for High Energy Physics Research and Education Outreach (CHEPREO). CHEPREO is one of several coordinated efforts (PhysTEC, SEAMS) at FIU with intention of improving participation the by underrepresented students. The ongoing assessment of Modeling Instruction sections includes the administration of the CLASS as a pre/post diagnostic each semester. Among the results we present in this paper are the positive overall shifts as measured by the CLASS and the progression of CLASS scores for students enrolled in sequential semesters of one section of introductory physics.

MODELING INSTRUCTION AT FIU

FIU is the largest source of Bachelors degrees for Hispanic students in the United States. It is a large (38,290 students) urban research university with a Hispanic enrollment of nearly 60%, which reflects the demographics of South Florida. The student population at FIU make it an ideal setting for increasing participation of Hispanic students in physics.

FIU began implementing Modeling Instruction in Fall 2004. Initial implementations were based on the high school Modeling curriculum and included up to 30 students in a studio format class with integrated lab and lecture. The class included real time data acquisition hardware and software and focused on problem solving and conceptual understanding. Over time, the instruction became more student-centered through the use of Modeling Discourse Management, [11] which features students working in small groups on portable whiteboards and subsequently presenting the whiteboards to the entire class, with the teacher acting as discussion moderator.

Modeling sections of introductory physics are quite popular, requests for enrollment outpacing available space by a factor of four. As a result students who enroll in Mechanics tend to continue directly into Electricity and Magnetism. The contiguity of the students provides us with a representative pool of matched students in each semester which allows us to examine not only the gains during each semester, but the progression of CLASS scores over an entire school year.

METHODS

The particular Modeling physics course we examine ran during the 07/08 school year and followed the standard sequence of Mechanics during fall and E&M during spring. During the Fall, 30 students were enrolled, and during the Spring 31 students were enrolled, 26 of whom were continuing from the Fall. The class met 3 days a week, and each meeting lasted 2 hrs. The CLASS was administered on the first day of each semester and again during the last week of the semester. During each semester, the response rate on both the pre and post tests was high (22/30 during Fall, 24/31 during Spring, 16/26 over full year.) Only results from students who completed both the pre and the post survey are included. Also, the CLASS includes one unscored item (#31) to identify students who are not reading carefully, data

from students who answered this question incorrectly were not included. For the full year analysis, only students who completed all four surveys (Fall pre/post and Spring pre/post) and who did not answer #31 incorrectly were included in the analysis.

The CLASS is an attitudinal survey, developed and validated at University of Colorado. It includes 42 statements which students respond that they disagree or agree to on a 5 point Likert scale. Scores from 8 categories (in Table 1) overall are reported.

Data were analyzed using the analysis template provided on the CLASS website. The template provides overall results as well as category by category results and then calculates shifts from pre to post. Shifts of pre to post scores were calculated for each combination of pre and post data, we will focus on four combinations, pre/post within each semester, Fall pre to Spring post and Fall post to Spring pre. Significant shifts are identified as shifts which are greater than 2x the standard error of the shift in accordance with established practice. [12]

RESULTS AND ANALYSIS

Looking first at results from the Fall and Spring semesters individually (Figures 1) which show that during the Fall semester, the class had significant positive shifts toward more favorable responses overall as well as in 5 categories. During the spring semester, the class had significant positive shifts toward favorable responses in 2 categories and the overall shift was positive but not significant.



Figure 1. CLASS Average Scores in Modeling Instruction Fall Pre and Post (N=22), and Spring Pre and Post (N=24).

Column Header		Fall Pre to Fall Post			Spring Pre to Spring			Fall Pre to Spring			Fall Post to Spring		
Goes Here		(N=24)			Post (N=24)			Post (N=18)			Pre (N=21)		
	Pre	Post	Shift	Pre	Post	Shift	Pre	Post	Shift	Post	Pre	Shift	
Fav.	68.4	77.1	8.6	78.2	80.4	2.2	71.5	83.5	12.0	77.8	78.6	0.8	
Unfav.	10	7.3	-2.7	5.9	6.3	0.3	5.9	3.7	-6.0	6.1	5.6	-0.5	
Fav.	69.9	78.0	8.2	78.7	83.8	5.1	73.3	87.8	14.5	78.8	80.2	1.4	
Unfav.	7.9	5.6	-2.2	5.6	5.3	-0.3	8.5	2.6	-6.0	4.8	4.8	0.0	
Fav.	71.5	75.0	3.5	75.0	88.9	13.9	76.9	92.6	15.7	75.4	77.8	2.4	
Unfav.	4.2	2.8	-1.4	3.5	3.5	0.0	3.7	0.9	-2.8	2.4	2.4	0.0	
Fav.	82.3	83.3	1.0	82.3	87.5	5.2	86.1	93.1	6.9	82.1	84.5	2.4	
Unfav.	1.0	4.2	3.1	2.1	3.1	1.0	1.4	0.0	-1.4	3.6	2.4	-1.2	
Fav.	77.1	84.9	7.8	82.2	87.0	4.8	81.3	92.4	11.1	86.3	82.7	-3.7	
Unfav.	2.6	3.6	1.0	4.7	2.6	-2.1	3.5	0.0	-3.5	3.0	4.2	1.2	
Fav.	77.1	87.5	10.4	84.4	86.5	2.1	80.6	93.1	12.5	89.3	85.7	-3.6	
Unfav.	1.0	2.1	1.0	2.1	2.1	0.0	1.4	0.0	-1.4	1.2	1.2	0.0	
Fav.	56.9	72.9	16.0	74.3	73.6	-0.7	62.0	82.4	20.4	75.4	77.8	2.4	
Unfav.	11.1	8.3	-2.8	6.3	7.6	1.4	12.0	2.8	-9.3	7.1	6.3	-0.8	
Fav.	82.1	78.6	-3.6	87.5	91.7	4.2	84.1	93.7	9.5	78.9	88.4	9.5	
Unfav.	1.8	3.0	1.2	3.6	2.4	-1.2	1.6	1.6	0.0	2.0	2.7	0.7	
Fav.	65.3	79.2	13.9	73.6	81.3	7.6	68.5	83.3	14.8	78.6	73.8	-4.8	
Unfav.	11.1	9.0	-2.1	11.1	7.6	-3.5	13.9	4.6	-9.3	8.7	11.1	2.4	
Fav.	51.8	73.2	21.4	72.6	72.6	0.0	55.6	77.8	22.2	74.1	73.5	-0.7	
Unfav.	20.2	10.1	-10.1	9.5	10.7	1.2	22.2	7.1	-15.1	9.5	8.8	-0.7	
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 TABLE 1. Summary of Pre and Post CLASS Scores for Each Combination of Matched Data (Large Shifts in Bold)

Focusing on the overall shifts from the beginning of instruction to the end, the class has significant shifts in favorable responses in 7 of the 8 categories (Real World Connections was positive but not significant.) Additionally, the overall shift in favorable responses is significant and positive.

An interesting additional outcome is that students tend not to shift during the winter break, using the Fall Post and Spring Pre, we see only one significant shift, a positive shift in Sense Making/Effort. The interpretation of Effort categories has been challenging with other attitudinal measures, often students are overly optimistic about the effort they anticipate expending prior to the semester and more realistic about the amount of effort expended after the semester. [2] The significant positive shift seen over winter break is consistent with students being optimistic at the beginning of a semester and realistic at the end of a semester.

These data, which are summarized in Table 1, indicate that during each of the two semesters, students' attitudes about learning science progressively shift toward more expert-like. Further, the shifts seem to rise continually over the duration of the instruction, with little change during the winter break.

The basic interpretation of these CLASS data indicate that for one stable, albeit small, population of students in Modeling Instruction physics shift toward more expert attitudes toward science. The shifts seem to be linked to the instructional approach, as the class profile starts on par with published data and increases during both semesters.

DISCUSSION AND CONCLUSIONS

The data presented in this paper are preliminary and the authors acknowledge that the sample size is too small to serve as the basis for substantial conclusions. Further it can not be ruled out that the shifts are the result of the instructor rather than the instructional approach. However the existence of the positive shifts on the CLASS and the nature of these shifts, indicate that Modeling Instruction is impacting students in a positive manner.

Two interesting aspects of the data deserve further discussion. First is that the initial averages are somewhat higher than published results. [1] This is noteworthy because the student population at FIU is unique. The prevalence of Hispanic students at FIU indicates that perhaps attitudes about science at the onset of physics classes do not differ significantly. The authors acknowledge the speculative nature of this observation, but substantiating this similarity would provide insight into the nature of achievement gaps.

A second aspect of the data shows students in a single course over an entire year. The class starts with slightly more positive initial attitudes, and then after a single semester show a significant shift. This indicates that a single semester is sufficient to shift attitudes of students. Then, students do not shift during winter break, which is not particularly interesting, but it means that they begin the second semester with similar attitudes they held at the end of the first semester. This indicates the attitudes measured by the CLASS are stable over extended periods of time.

Initial CLASS scores in the Modeling Instruction course are slightly higher than published results. This leads to a reasonable that the students are initially predisposed to positive attitudes and that the results are due to a selection effect. While future research efforts will attempt to address this question, the results remain compelling, due to the positive shifts.

Clearly the compelling nature of these results merit further study. Additional data, including data from other instructors, will allow us to evaluate the claims that Modeling Instruction improves student attitudes. As we extend the scope of this investigation, we will be collecting data from comparable student groups to further substantiate the claims made in this preliminary study. Already we have interviewed students from the Modeling class which will validate and extend the findings presented in this paper.

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