



Student Expectations in University Physics: *Using The Maryland Physics Expectations Survey*

Overview

Student understanding of what science is about and how it is done, and their expectations as to what goes on in a science course play a powerful role in what they can get out of an introductory calculus-based university physics course. This is particularly true when there is a large gap between what the students expect to do and what the professor expects them to do. In the Maryland Physics Expectations (MPEX) project*, the Physics Education Research Group at the University of Maryland has been investigating the distribution of student expectations at the beginning of the course, the effect of their expectations on their behavior during the course, and the effect of the course on changing their expectations.

1. Students' expectations are important.

What students expect will happen in their introductory calculus-based (university) physics course plays a critical role in what they will learn during the course. It affects what they listen to and what they ignore in the firehose of information provided during a typical course by professor, teaching assistant, laboratory, and text. It affects what activities students select in constructing their own knowledge base and in building their own understanding of the course material.

Note: We limit our use of the phrase *student expectations* to the meaning: "what students expect will happen in the class, what they expect to do, and what they believe is the nature of science and scientific learning". It can also be used to mean "what the student expects will happen in a physical experiment". These latter are content expectations; in this proposal we are focusing on what might be called context expectations.

2. Students often have incorrect expectations that professors aren't aware of or don't deal with.

Studies at the pre-college level by Carey [1], Linn [2], and others have demonstrated that students have misconceptions about science and about what they should be doing in a science class. Hammer [3] has demonstrated similar problems in college students in a small number of detailed interviews. When students' expectations are distorted by misconceptions about the nature of science, the nature of scientific knowledge, and the nature of what they can learn and how to learn it, what the students extract from the course may be very different from what the professor expects. This is particularly true when the professor's goals for the students' learning are a "hidden agenda" -- neither articulated explicitly during the course nor enforced through appropriate testing. Students' expectations can have both broad, general implications for how they study and detailed implications for how they interpret or use particular activities.

3. Many students enter university physics with misconceptions as to the nature of the subject and their role in learning it. The typical introductory course does not improve this situation.

We have studied the expectations of university physics students using the MPEX Survey at more than a dozen colleges and universities to more than 3000 students. The results of our study indicate that there is a significant gap between expert responses to this survey and that of novice students. The impact of one semester of mechanics instruction tends to be an

increase in the discrepancy between expert and student attitudes rather than an improvement. Particular problems lie in the areas of

- relation of physics to reality
- understanding of the role of mathematics in physics and
- applying appropriate effort.

In our study, the least overall damage was done by innovative courses designed by workers relying on the results of physics education research, delivered at the institution where the course was developed.

4. Analyzing the MPEX Results

We have given our survey to a group of experienced university faculty committed to reforming their teaching to increase its effectiveness and have used this group's response as our definition of "expert". This group shows a strong consistency (>90%) on most of our survey items. We hypothesize that students who become effective scientists and life-long learners either have or will develop these attitudes.

The survey was constructed to illuminate student attitudes along five specific dimensions. These are described briefly in Table 1 below.

	Favorable	Unfavorable	MPEX Items
independence	learns independently, takes responsibility for constructing own understanding	takes what is given by authorities (teacher, text) without evaluation	1, 8, 13, 14, 17, 27
coherence	believes physics needs to be considered as a connected, consistent framework	believes physics can be treated as separated facts or "pieces"	12, 15, 16, 21, 29
concepts	stresses understanding of the underlying ideas and concepts	focuses on memorizing and using formulas	4, 19, 26, 27, 32
reality link	believes ideas learned in physics are relevant and useful in a wide variety of real contexts	believes ideas learned in physics are unrelated to experiences outside the classroom	10, 18, 22, 25
math link	considers mathematics as a convenient way of representing physical phenomena	views the physics and the math independently with no relationship between them	2, 6, 8, 16, 20

Table 1: Clusters for dimensions probed by the MPEX Survey.

We call the responses that are preferred by our experts and which are most commonly found in the dedicated, self-motivated learner as *favorable*. We call those responses that disagree with our experts and are often found in students more concerned with grades than with learning as *unfavorable*. We hypothesize that favorable attitudes are more likely to yield effective, life-long learners, and believe that it is part of the goal of a good introductory physics course to help students begin to develop these attitudes. The expert responses to our survey items are given in Table 2 below.

Expert Responses									
1	D	8	D	15	D	22	D	29	D
2	D	9	(D)	16	D	23	D	30	A
3	A	10	D	17	D	24	D	31	A
4	D	11	A	18	A	25	A	32	A
5	A	12	D	19	D	26	A	33	D
6	A	13	D	20	D	27	D	34	(A)
7	(A)	14	D	21	D	28	D		

Table 2: Prevalent responses of our expert group. Where the respondents did not agree at the 85% level, the item is shown in parentheses and the majority response is shown. Even in those cases, there was a strong plurality in favor of the answer indicated. The response "A" indicates agree or strongly agree -- a choice of numbers 4 or 5. The response "D" indicates disagree or strongly disagree -- a choice of numbers 1 or 2.

Product Warning Label:

Note that individual items from this survey should not be used to evaluate individual students. On any single item, students may have atypical interpretations or special circumstances which make the "non-expert" answer the best answer for that student. Furthermore, students often think that they function in one fashion and actually behave differently. For the diagnosis of the difficulties of individual students more detailed observation is required. This survey is primarily intended to evaluate the impact of one or more semesters of instruction on an overall class. It can be used to illuminate some of the student reactions to instruction of a class that are not observable using traditional evaluations. In this context, it, together with evaluations of student learning of content, can be used as a guide for improving instruction.

References

1. Carey, Susan, Rita Evans, Maya Honda, Eileen Jay, and Christopher Unger, " 'An experiment is when you try it and see if it works': a study of grade 7 students' understanding of the construction of scientific knowledge", *Int. J. Sci. Ed.* **11** (1989) 514-529.
2. Linn, Marcia C., and N. B. Songer, "Cognitive and conceptual change in adolescence", *Am. J. of Educ.* (August, 1991) 379-417.
3. Hammer, David, "Defying common sense: Epistemological beliefs in an introductory physics course" (1991), Ph.D. Thesis, U. of California, Berkeley.

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