

FRESHMEN AND PHYSICS TEACHER EXPECTATIONS IN LEARNING PHYSICS

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ABSTRACT

Students' beliefs in the nature of science and expectations when learning science can affect their learning behaviours. In this study, we investigated the expectations of freshmen taking an introductory physics course (with calculus) at Chiang Mai University in Thailand during the 2010 academic year. The instrument used was the Maryland Physics Expectations survey (MPEX), a 34-item Likert-scale (agree/disagree) survey that probes student attitudes, beliefs and assumptions about physics. Here, we report on the results of the MPEX survey taken before (pre, $N = 227$) and after (post, $N = 181$) physics instruction was given to first year medical students, plus for those students taking other courses, including associated medical sciences ($N = 206$), engineering ($N = 60$) and agro-industry ($N = 93$), after the instruction was given. The MPEX survey was also administered to high school physics teachers attending a summer workshop at Chiang Mai University. In terms of the results, a large gap was found between the expectations of the experts and the students, with a tendency for the medical students' expectations to deteriorate as a result of taking the introductory physics course.

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INTRODUCTION

Students' beliefs and expectations play an important role in their learning. When coming to the physics classroom, students bring their attitudes, beliefs and assumptions about what will be taught, what skills will be required and what they will be expected to do (Redish, Saul, & Steinberg, 1998). Most physics instructors found physics to be interesting after taking it for the first time; however, students in the first year of physics at college have a different mind-set than their physics instructors. The different expectations of the instructors and students can lead to both ineffective teaching and learning; therefore, physics education researchers have developed surveys to investigate student attitudes, beliefs and assumptions about the discipline.

Four well-known surveys for probing student beliefs about the physical sciences are the Maryland Physics Expectation survey (MPEX) (Redish, Saul, & Steinberg, 1998), the Views About Science Survey (VASS) (Halloun & Hestenes, 1998), the Epistemological Beliefs Assessment about Physical Science (EBAPS) (Elby, 2001), and the Colorado Learning Attitudes about Science Survey (CLASS) (Adams, Perkins, Podolefsky, Subson, Finkelstein, & Wieman, 2006). Both VASS and EBAPS have similar aims – to probe personal beliefs about nature of science and learning science, whereas MPEX and CLASS focus specifically on student beliefs regarding physics and learning physics.

Students studying different majors may have different beliefs and expectations in terms of learning physics and its teaching. Using MPEX, Kortemeyer (2007) found that pre-medical students have unfavourable beliefs and expectations in terms of learning physics when compared to engineering students and physics instructors. Kortemeyer claimed that pre-medical students are motivated by their need to perform well on standardized tests (mostly formula-driven numerical problems) and to get a good grade on their course, but that the physics learned in class is irrelevant and not useful to their professional life.

Over the past two years, health science faculties at Chiang Mai University have reformed their curriculums according to new regulations introduced by the Higher Education Commission, the aim being to reduce the overall credit hours. Physics courses are compulsory for health science freshmen; however, many faculties view physics as not important to their students' professions and receive negative feedback from them, so have decided to either reduce the number of credit hours or eliminate introductory physics courses from their curriculums altogether. For example, physics for medical students has been reduced from 3 credits to 2 credits, and laboratory work has been

eliminated, and this change may have been caused by students' negative attitudes towards learning the physics. In light of this, the aim of this study was to investigate the beliefs and expectations of freshmen when learning physics and we focused on medical students because we have another research project ongoing which is looking at reforms to the introductory physics course for medical students.

METHOD

SUBJECTS AND SETTING

There were two groups used as subjects for this study; first year students and physics teachers, and the study was carried out during the 2010 academic year. The first subject group was made up of first year Thai students taking four introductory physics courses (with calculus) at Chiang Mai University in Thailand. For the first year medical students, we administered the MPEX survey both before (pre, $N = 227$) and after (post, $N = 181$) they had received physics instruction, and they received a small number of course credits for completing the survey. Students studying other courses, including associated medical sciences ($N = 206$), engineering ($N = 60$) and agro-industry ($N = 93$), were asked to complete the survey voluntarily only once, after the instruction had been given.

The second group of subjects consisted of in-service physics teachers attending a summer teaching workshop during May 2011 at Chiang Mai University. The teachers were experienced and were known to have sufficient physics knowledge because they had had to pass a comprehensive exam to qualify for the workshop. We asked the teachers to respond to the survey using "the answer they would prefer their students to give". They were informed about the objectives of the survey and asked to complete the survey voluntarily. In total, 27 out of 67 teachers completed the MPEX surveys.

INSTRUMENT

We used the MPEX (Redish, Saul, & Steinberg, 1998), which consists of 34 statements, and the respondents were asked to rate their answers on a five-point Likert scale (agree-disagree). As shown in Table 1, most MPEX statements can be divided into six dimensions, and there are seven statements that cannot be classified into any dimensions (as listed in the last row of Table 1).

RESULTS AND DISCUSSION

In order to analyze the responses to our own MPEX survey, we used the responses given by physics instructors or experts in a previous study (Redish, Saul, & Steinberg, 1998), one in which the instructors or experts ($N = 101$) were asked to complete the survey by giving the responses that they would prefer their students to give. Thus, for us a response was considered *favourable* if it corresponded to the experts and *unfavourable* if it stated the opposite, as shown in Table 1. A neutral answer was considered to be neither favourable nor unfavourable.

OVERALL RESPONSES TO THE MPEX SURVEYS

The overall survey results, both for the students on the four courses and the physics teachers, are presented in Figure 1. For the medical students the pre-instruction results show that they only agreed with the experts' (favourable) responses on 26 to 54% of occasions, and the results after instruction show a decrease in the number of favourable responses. The results from the students taking other courses were slightly different from the medical students (after the instruction), except for the engineering students in the effort dimension. This suggests that the instruction given caused an average deterioration in students' positive attitudes and expectations (Redish, Saul, & Steinberg, 1998; Kortemeyer, 2007).

THE INDEPENDENCE DIMENSION

For independence, the students' views were least aligned (favourable) with the experts', and surprisingly teachers' views were also the least favourable. The study by Redish, Saul, and Steinberg (1998) found the same results, and they claimed that there are two extreme views on the development of knowledge – that it is gained "by authority" and that it is "independent". The low percentages given on this dimension indicate that most students and physics teachers believe physics knowledge comes from authoritative sources such as physics instructors and textbooks; however, the experts believe that students have to construct their own physics knowledge.

Table 1: MPEX dimensions and corresponding statements showing favourable and unfavourable views as given by the experts*

Dimensions	Expert View*	Descriptions	MPEX Statements
Independence	Favourable	Takes responsibility for constructing their own understanding	1, 8, 13, 14, 17, 27
	Unfavourable	Takes what is given by the teacher or textbook without evaluation	
Coherence	Favourable	Believes physics needs to be considered as a connected, consistent framework	12, 15, 16, 21, 29
	Unfavourable	Believes physics can be treated as unrelated facts or "pieces"	
Concepts	Favourable	Stresses an understanding of the underlying ideas and concepts	4, 19, 26, 27, 32
	Unfavourable	Focuses on memorizing and using formulas	
Reality link	Favourable	Believes ideas learned in physics are relevant and useful in a wide variety of real-world contexts	10, 18, 22, 25
	Unfavourable	Believes ideas learned in physics bear little relation to experiences outside the classroom	
Math link	Favourable	Considers mathematics as a convenient way to represent physical phenomena	2, 6, 8, 16, 20
	Unfavourable	Views physics and maths as independent; there is little relationship between them	
Effort	Favourable	Makes the effort to use information available and tries to make sense of it	3, 6, 7, 24, 31
	Unfavourable	Does not attempt to use available information effectively	
Unclassified			5, 9, 11, 23, 28, 33, 34

* The 'expert view' is based on a previous study (Redish, Saul, & Steinberg, 1998), in which the experts were experienced physics instructors interested in teaching and learning physics and who attended a teaching physics workshop in the US. The researchers asked the experts to answer the MPEX as they would prefer their students to answer.

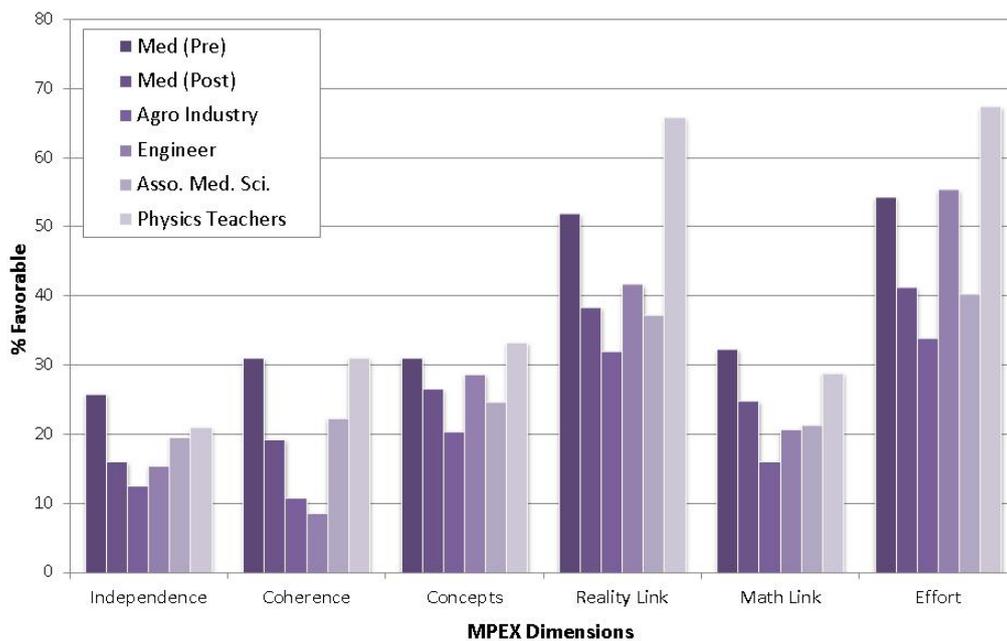


Figure 1: Percentage of 'favourable' student and teacher responses from the MPEX survey

THE COHERENCE DIMENSION

Most physics experts expect students to see physics knowledge as a coherent and consistent body. In our study, the views of both students and teachers were only favorable between 9% and 31% of the time, and the medical students' views deteriorated significantly after instruction. Redish, Saul, and Steinberg (1998) claimed that students' lack of a coherent view can cause them to fail to notice errors in their reasoning, and that they rely on memorizing facts rather than rebuilding their physics knowledge structure.

THE CONCEPT DIMENSION

For this dimension, students and teachers' views were only favorable between 20% and 33% of the time, suggesting that students and even teachers view physics problems as basically the mathematical manipulation of an equation (Redish, Saul, & Steinberg, 1998). When they solve physics problems, they therefore tend to use the "plug-and-chug" method.

THE REALITY LINK DIMENSION

For this dimension, teachers' views were significantly more favourable than the students', and the medical students' views showed substantial deterioration after their instruction. This suggests that the physics instruction did not help the medical students realize the connection between physics principles and their profession, and that the form of the instruction has to be reformed to make that connection more obvious and significant.

THE MATH LINK DIMENSION

The percentage of favourable views from the teachers was very low in this dimension, and this may have been due to the fact high school physics courses include less mathematics than university physics courses, such that teachers do not expect their students to develop an ability to use abstract and mathematical reasoning when making predictions of real physical systems (Redish, Saul, & Steinberg, 1998).

THE EFFORT DIMENSION

This dimension provided the highest number of favourable scores across the subject groups. Both students and high school teachers expected that their efforts would help in terms of learning physics; however, the medical students' views showed a substantial deterioration after instruction – they perceived that their efforts were not relevant to their level of understanding during the course.

THE MEDICAL STUDENTS' VIEWS

Figure 2 compares the percentage of favourable responses given by the medical students (Med) in our study - both pre- and post-instruction, with those given in a previous study (Kortemeyer, 2007), one that investigated pre-medical students' (Premed) attitudes, beliefs and expectations pre- and post-instruction. In our study, medical students' views on physics in each dimension were the least expert-like to begin with, becoming even less so across all dimensions after the physics instruction. These results show the negative effects physics instruction can have on students' expectations and attitudes.

In Figure 2, the reality link dimension shows the largest difference in terms of favourable responses pre- and post-instruction; therefore, we carried out further analysis on this dimension, as shown in Figure 3. From Figure 3, it can be seen that the medical students' views showed the greatest change, with favourable responses falling from 39% to 13% for statement 22. Thus, after physics instruction, more of the medical students felt that physics is not related to the real world.

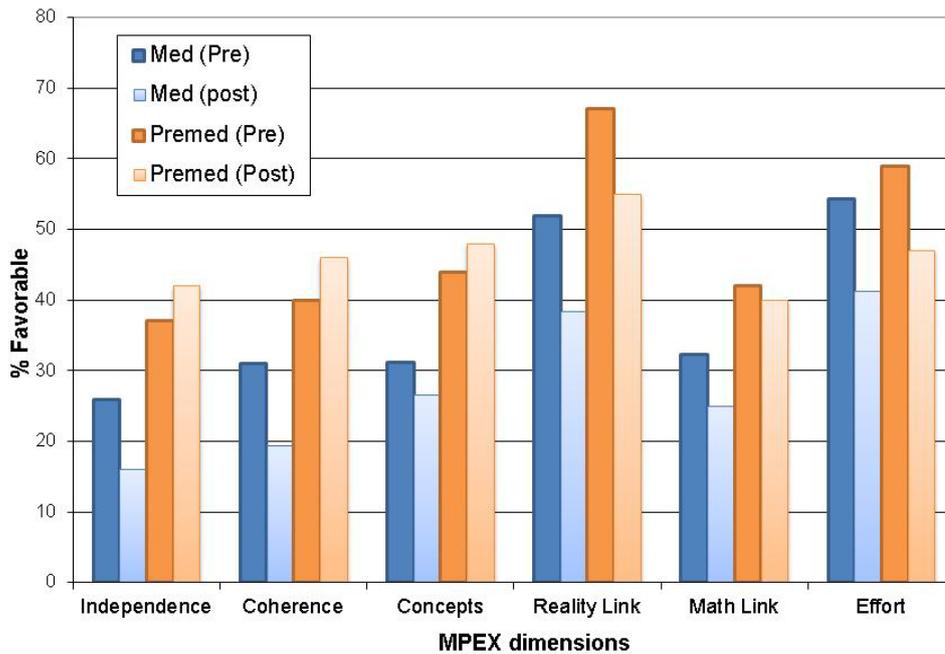


Figure 2: Percentage of favourable responses given by medical students, when compared with pre-medical students (Kortemeyer, 2007)

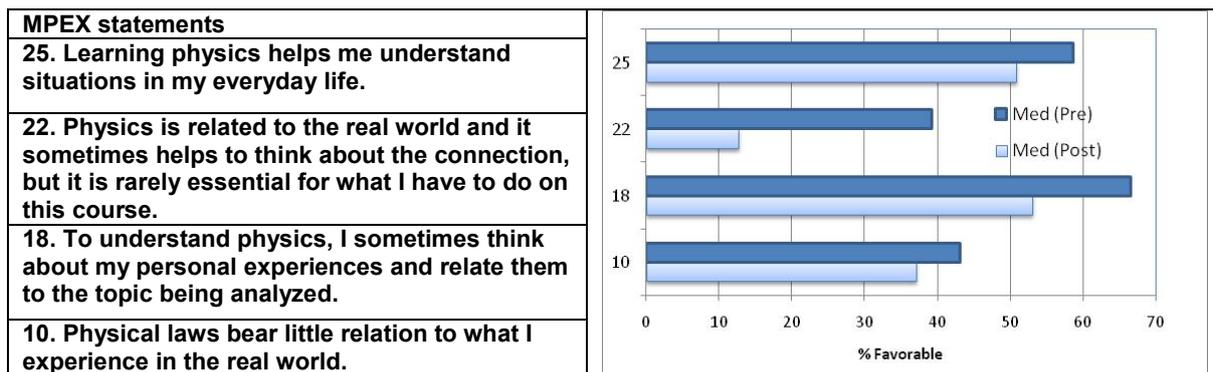


Figure 3: Medical student responses for the reality link dimension

IMPLICATIONS FOR PRACTICE

The results of this study suggest that much of what we do in the physics classes not only does not improve students' beliefs and expectations, but actually reduces them. Therefore, physics instructors have to make more of an effort to make an explicit connection between the physics learned in class and its real world application in terms of the students' professions. In the case of the medical students, a previous study suggests that a visible connection should be made between physics and medicine by using medical examples on the course (Kortemeyer, 2007).

CONCLUSIONS

The results from the MPEX survey presented here represent a first step in terms of investigating students' expectations. Surprisingly, after instruction most students, even high achievers like medical students, felt that their learning efforts were not related to their potential success in the classroom. As a result, they were somewhat reluctant to put in the time and effort needed to understand the topic in detail, and simply ended up memorizing sufficient detail to pass the exam. Moreover, the results from the high school teachers are also troublesome, because their unfavourable views might affect how their students view the learning of physics. In light of this, future work should investigate the attitudes and expectations of high school physics teachers in more detail as well.

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REFERENCES

- Adams, W. K., Perkins, K. K., Podolefsky, N. S., Dubson, M., Finkelstein, N. D., & Wieman, C. E. (2006). New instrument for measuring student beliefs about physics and learning physics: The Colorado Learning Attitudes about Science Survey, *Physical Review Special Topics—Physics Education Research*, 2, 010101-1-14.
- Elby, A. (2001). Helping physics students learn how to learn, *American Journal of Physics*, 69(7), S54-S64.
- Halloun, I. & Hestenes, D. (1998). Interpreting VASS dimensions and profiles for physics students, *Science & Education*, 7, 553-577.
- Kortemeyer, G. (2007). The challenge of teaching introductory physics to premedical students, *The Physics Teacher*, 45, 552-557.
- Redish, E. F., Saul, J. M., & Steinberg, R. N. (1998). Student expectations in introductory physics, *American Journal of Physics*, 66(3), 212-224.