

# Exploring the Intersections of Personal Epistemology, Public Epistemology, and Affect

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**Abstract.** This paper discusses an approach to exploring the divide between students' stances toward their own learning and their perceptions of what is productive for the scientific community (sometimes called "personal epistemology" and "public epistemology"). The possible relationship between this divide and students' science- and course-related affect (e.g. preferences, motivation, emotions) will also be discussed. Previous research and theory indicate certain methodological considerations in study design and analysis, particularly attention to survey context, both with respect to attempting to tease apart epistemology from course expectations, and in considering differences between stated and enacted epistemologies and, similarly, beliefs vs. resources. A survey instrument designed to explore personal/public epistemology splits and affective variables will be described and preliminary results will be presented.

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## INTRODUCTION

In recent years, science education researchers have paid increasing attention to understanding the nature, influences, and impact of students' approaches to learning science and their ideas about the nature of science (NOS),<sup>1-2</sup> with more and more evidence pointing to the complexity of these ideas and approaches.<sup>2-9</sup> One important complexity is the sometimes vast difference between what students think is productive for their own learning (their "personal epistemologies") and what they feel they need to do in a particular course (their "expectations").<sup>3-4</sup> Another divide is between students' personal epistemologies and their "public epistemologies" (perceptions of NOS, or stances on knowledge that a student perceives as appropriate for the scientific community.)<sup>5-6</sup> Students' epistemologies also vary widely across different scientific domains.<sup>7</sup> Clearly these are cognitive constructs that are highly sensitive to context.

The richest and clearest data on these complexities come from observational studies where students' epistemological stances can be inferred from their actual learning behavior. This methodology allows researchers to determine epistemology and context simultaneously, and also look for other influencing factors. Survey methods can be useful but must be very carefully devised and analyzed.

## PREVIOUS RESEARCH

One of the earliest relevant qualitative studies is Hammer's<sup>3</sup> case study from introductory physics in which a student describes having to curtail her learning to survive the course. This is an example of the personal epistemology/expectations divide.

Other qualitative studies bear on the personal/public epistemology divide and the possible link to affect. Hogan<sup>5</sup> analyzed interviews and classroom discourse to study children's "personal frameworks" for science learning, finding that students' "learning-referenced" frameworks (similar to personal epistemology) had a much larger impact on their learning behavior than their "discipline-referenced" frameworks (similar to public epistemology). The affective variables she measured ("self-referenced" frameworks) such as interest in science, success attribution, etc., correlated less directly with observed learning behaviors, but Hogan suggests that future research look at the inter-relationships among the three constructs. In Lising and Elby's<sup>6</sup> observational case study of an undergraduate physics student, the subject displayed a sophisticated understanding of how scientists learn despite her often unproductive practices in her own learning. There were indications that for this student, the divide had something to do with affect. She did not identify with physics, stating that she was not "a physics person." She expressed low confidence in her ability to use

common sense and everyday experiences in reasoning about physics problems, claiming that it seemed there was always “something that I’ve overlooked.”

Other studies have also shown relations between affective and similar variables and students’ learning approaches.<sup>8-9</sup> Of particular interest is the belief in “natural talent,” which can be considered to lie in both the affective and epistemological domain and can have a huge negative impact on learning behaviors.<sup>10</sup> Although motivation and other emotional factors have been studied extensively in the science education literature, to date no targeted work has looked at the intersections of these factors and the divide between a students’ personal and public epistemological stances. The present study attempts to make a start at this.

Survey methods have proved to be an interesting way to collect a broader set of data. Building on Hammer’s<sup>3</sup> qualitative study, Elby<sup>4</sup> surveyed students about their actions and attitudes towards their physics course, and then asked what advice they would give a hypothetical student who only wanted to learn the material well and not worry about grades. He found that students’ advice indicated a much more sophisticated understanding of productive learning behaviors than their own actions would seem to indicate (personal epistemology vs. expectations). The Colorado Learning about Science Survey (CLASS)<sup>10</sup> was used by Gray et al.<sup>11</sup> by having students mark both their responses and the responses a physicist would give.<sup>9</sup> They found that students often chose the more productive response in the “physicist” case, and that splits were larger for women than men. In preliminary follow-up interviews, asking subjects about the reasons for their disparate responses, these authors found some indications of epistemological, expectational, and affective factors. For example, students explained that physicists like physics more and may have different learning styles. These data are useful for understanding how students interpret the CLASS survey and provide more insight into how interwoven are these various factors.

## METHODOLOGICAL CONSIDERATIONS

Elby’s result makes it clear that, in looking at the personal/public epistemology divide, effort must be made to avoid measuring expectations in lieu of personal epistemology. Although with a survey it is not possible to manipulate context precisely in order to absolutely isolate different epistemological constructs, careful attention to teasing apart these different issues could make the data easier to interpret and use.

For instance, some of the personal/public epistemology splits suggested by the Gray et al. survey

data are difficult to discern due to the fact that most of the individual CLASS items as well as the survey as a whole do not specify a context, so responses are likely to reflect a mix of personal epistemology and expectations from students’ varied classroom experiences. Gray et al. measured the largest splits on an affective item (“I enjoy solving physics problems”) and two items that were statements about what the students actually do, which tends to probe expectations more strongly than epistemology. It can be expected that students split heavily on expectations vs. public epistemology since physics courses tend to stand in such contrast to scientific research environments.

It is also important to have a theoretical viewpoint with which to approach the analysis, even with primarily quantitative survey data. A resource view of epistemology<sup>12</sup> predicts the observed context- and domain-sensitivity of personal epistemologies, describing this as a natural outcome of a cognitive structure whereby, rather than stable, unitary constructs (stable “beliefs”), epistemologies are a collection of resources for knowing and learning that are activated by internal and external factors. This implies that surveys and interviews can best characterize students’ epistemologies when they vary the context so the analysis can look for patterns of both consistencies and inconsistencies in students’ responses and behavior.

A resource-type cognitive structure also accounts for differences between students’ stated epistemological stances and those that they display in action, even when the statements are made in a seemingly identical context (since statement and action are inherently different contexts.) Thus a survey only can measure students’ stated stances, and raise questions about their stances in practice.

## PRELIMINARY SURVEY

The survey developed for this study contains three sections: a section with 10 items set in a personal epistemology context; a second section with 10 parallel items set in a public epistemology context; and a third section with an array of affective items. Most of the epistemological items were adapted from the widely-used surveys.<sup>11,13,14</sup> A sample of instructions and items from the survey illustrates the different contexts and items.

**Question Set 1.** Suppose you were taking a physics class and your goal was to learn the material well and didn’t have to worry about grades. That may or may not seem far-fetched to you, but please do your best to answer the following questions as if you were in this situation.

Item 2. Remembering lots of facts and formulas would be the most important thing for you in understanding physics.

**Question Set 2.** Now think about what scientists do. Please answer the following questions with scientists in mind. (You'll notice they are almost the same set of questions as above, but about what scientists do.)

Item 12. Remembering lots of facts and formulas is the most important thing for scientists in understanding physics.

**Question Set 3.** Now forget about the hypothetical situation in Question Set 1 and the scientists in Question Set 2. Please answer the following questions about yourself.

Item 22. If there is such a thing as natural talent in physics, I am not one of those people.

Because the first context is rather contrived, the survey also contained an item to provide some indication as to whether or not students were able to successfully consider that scenario. There was also an item to probe domain-sensitivity and several items to collect demographic information.

The survey was administered in an algebra-based introductory physics course. Forty-six surveys were returned completed. Some preliminary results from this small sample are described below. Interviews, refinement of the survey, collection of a larger sample, and further interviews and/or observations are planned for the future.

During the analysis the raw data were collapsed from a 5-point to a 3-point agree/neutral/disagree scale (i.e. "agree" includes "agree" and "strongly agree" responses.)

## Differences Between Stated Personal and Public Epistemologies

*Splits in one direction.* There were two item pairs where the means for the class showed statistically significant differences between the students' stated

public and personal epistemologies. Item Pair 5/15 (see Table 1) showed the largest split ( $p=0.01$  from a  $\chi^2$  analysis). For this item, one would expect some difference due to the fact that scientists have more knowledge and resources with which to evaluate controversies. However, it is not productive for students to think that they have "no way to evaluate." For this item, a full 12 of the 46 students (26%) made the full split, choosing disagree for the scientists (the productive response), while choosing agree for themselves.

The other large split was with Item Pair 6/16 ( $p=0.03$ ), concerning alternate ideas (see Table 1.). Almost all of the students (45 of 46) chose agree for the "scientist" item, suggesting a sophisticated understanding of this aspect of scientific knowledge, yet 14 of 46 students chose neutral or disagree for their own learning (although it is still impressive that 32 students chose agree for themselves.)

*Bimodal Splits.* Several item pair responses showed high degrees of splitting with bimodal splitting patterns. On Item Pairs 1/11, 2/12, and 4/14, over 40% of the students split (see Table 1.) Students who split were almost equally likely to split in either direction and were more likely than not to split drastically (from agree to disagree or vice-versa rather than to or from the neutral position.) Two of these item pairs involve real-life experiences and the third involves facts and formulas, which might be counterposed in some students' minds with common-sense conceptual resources like their real-life experiences. These data suggest that some students might perceive that, in understanding physics, real-life experiences are only necessary for students, who perhaps don't think like real scientists. Conversely, other students might perceive that real-world experiences are only useful for scientists, whereas students can only hope to learn the simplified or abstracted material. This possible dichotomy merits further exploration.

**TABLE 1.** Notable splits between personal and public epistemology (statistically significant mean differences or splitting percentages over 40%)

Item Pair	Item in Personal Epistemology Form	Percentage Splitting	Splitting Pattern	p-value for $\chi^2$ analysis
1/11	1. Physics is related to the real world, but you could understand physics without thinking about that connection.	48%	bidirectional	
2/12	2. Remembering lots of facts and formulas would be the most important thing for you in understanding physics.	43%	bidirectional	
4/14	4. Suppose you read something in your physics textbook that seemed to disagree with your own experiences. But to understand physics well, you shouldn't think about your own experiences; you should just focus on what the book says.	48%	bidirectional	
5/15	5. When it comes to controversial topics in physics, there would be no way for you to evaluate which scientific studies are the best.	59%	unidirectional	0.01
6/16	6. To understand physics, it would be important for you to be able to understand and explain not only what I think is the right answer, but also what other answers my peers might have.	30%	unidirectional	0.03

## Affect Results

On all but three of the ten affect items, over 50% of the students responded with negative affect. The two items with the strongest negative response (both over 80%) concerned the existence of natural talent and if the student felt lacking in that type of talent. On only one item was there an average positive affective response.

To study correlations between the personal/public splits and affect, affective responses were compared for negative splitters (who expect scientists' learning to be more sophisticated than theirs), non-splitters, and positive splitters. These data suffer most from the small statistics and the lack of range in affective response, and almost no differences were noticeable with  $p$  less than 0.1. Further data collection should allow the analysis to capture subtleties that are only accessible with larger statistics and qualitative data.

The only statistically significant affect correlation measured was with Item Pair 8/18 (splitting at 33%):

Item 8: If you were working in a group and got the right answer to a problem, convincing your peers should be easy. The correct answer would sort of "speak for itself."

This item was correlated with affect Item 22 (student's identification of self as one with natural talent.) Perhaps feeling lacking in "natural talent" could impact students' confidence in convincing their peers compared to scientists' ability to do the same.

## Other Data

Item 31 was designed to probe the difference between personal epistemology and course expectations, although it also is an indirect indicator of the success of the contextualization of Question Set 1.

Item 31: If I were to go through and redo Question Set 1 but instead of thinking about how I might go about learning physics just for the sake of learning, I thought about how I actually go about learning physics these days, my answers would probably be significantly different.

Twelve of the 46 students agreed with this item, indicating that the contextualization was at least partially successful.

## CONCLUSIONS

Including NOS instruction in courses has been shown to impact stated public epistemologies, but the assumption that this will translate into more sophisticated personal epistemologies is problematic.

To understand this better we must look more closely at the divide between personal and public epistemology and try to tease it apart from the more externally-driven splits between expectations and epistemology, and also explore what other factors might influence this complex landscape. If we discover there are affective issues influencing some of these splits, there may be targeted interventions that are beneficial. In addition to overall course reform, we might, for example, we might make effective use of free writes, learning reflections, stories about students and scientists, and readings about the malleability of intelligence. These might help students bridge the gap between what they think can be productive for others into what can be productive for their own learning in science.

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