Learning Environments and Predicted Instructional Practices

Previous research (Lund, 2015) has shown that different classroom learning environments (including course level, class size, and classroom layout) will lead to different distributions of the four general COPUS instructional styles (*Lecturing, Socratic Instruction, Peer Instruction, and Collaborative Learning*). Among our classroom observations of chemistry, biology, and physics departments for this study, statistically significant differences in learning environments were present (Table 4). It was thus necessary to determine whether these differences alone were enough to produce the different COPUS profile distributions observed across the three departments in this study (Table 8).

To predict the prevalence of the COPUS instructional styles across the classroom conditions in the three departments, we first calculated the ratio of instructor-centered instructional styles *(Lecturing* and *Socratic Instruction*) to student-centered instructional styles *(Peer Instruction* and *Collaborative Learning)* found in each of the teaching conditions (see Lund et al, 2015, Fig2b-d). This ratio was combined with the actual observed distribution of each teaching condition (Table 4) to yield the predicted percentage of instructor-centered instructional styles in each department.

For example: to calculate the predicted distribution of instructional styles present in the observed biology classes due solely to differences in *class level*, we first noted that the percentage of instructor-focused instruction (*Lecture* plus *Socratic Instruction*) found in freshman/sophomore, upper undergraduate, and graduate-level classes is 56%, 84%, and 91%, respectively (Lund, 2015, Fig 2b). We then noted from Table 8 that the actual ratio of freshman/sophomore, upper undergraduate, and graduate-level classes in our observed sample of biology classes was 75%/25%/0%. Our total predicted percentage of instructor-focused instruction, then, is 56% of 75% (for the freshman/sophomore courses), plus 84% of 25% (for the upper undergraduate courses), plus 91% of 0% (for the graduate courses). This total (63%) is found in the first cell of Table SI1, and represents the percentage of instructor-focused instructional styles predicted from class level alone.

This calculation can be repeated for class size (63%) and class layout (65%) in biology. Since we do not have evidence to indicate whether any of the factors provides more weight than any other in influencing an instructor's teaching methods, we assumed the different factors were approximately equal and averaged their percentages to yield an overall average predicted percentage of *Lecturing* and *Socratic Instruction* in our biology classes (64%). This value can then be compared with the actual percentage of these instructor-focused instructional styles observed in the biology classes in this study (62%) from Table 8. In the case of the biology department, the observed distribution of COPUS instructional styles is actually very closely predicted merely by the statistically significant differences in learning environments present in the observed sample of biology classes.

When this process is repeated for the data from the chemistry and physics departments, and the predicted distribution of COPUS instructional styles is compared to the observed distribution, a different pattern emerges. In chemistry, the observed percentage of instructor-centered instruction is 20 points higher than what is predicted from the learning environment factors alone. In the physics department, in contrast, the observed percentage is 19 points lower than predicted from the learning environment. Thus, in chemistry and physics departments, the distribution of instructional styles cannot be accounted for from the variation in learning environments alone. These differences are explored further in the Discussion.

Notably, the same patterns of predicted versus observed instructional styles are found, not only when pooling all the data into instructor- and student-centered instructional styles, but also among the specific COPUS instructional styles with large numbers of observations (*Lecturing* and *Peer Instruction*). In addition, our assumption that the weighting of the learning environment factors (class level, class size, and class layout) is approximately equal should have little impact on the final results, since the predictions from these factors were within 2-6 percentage points of one another within each department.

Table SI1: Predicted vs. Observed Prevalence of Instructor-Centered Instructional Styles (*Lecturing* and *Socratic Instruction)*

	Predicted % of Instructor-Centered Instructional Styles (ICIS)			**Average Predicted % ICIS**	**Observed % ICIS [Table 8]**	**Difference**
	Class Level	Class Size	Class Layout			
Biology	63%	63%	65%	**64%**	***62%***	-2%
Chemistry	64%	68%	67%	**66%**	***86%***	20%
Physics	70%	76%	74%	**73%**	***54%***	-19%