CWSEI – PHYS & ASTRO Newsletter

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Our department has always been committed to high standards in education. Recently, with support and leadership from the CWSEI, we have made increasing progress in successfully implementing research based educational methods in our classrooms. An increasing number of our faculty are showing keen interest in these developments. In response, we distribute this newsletter to keep you up-to-date with the latest CWSEI efforts

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Many researchers and textbooks have promoted the use of rigid prescribed strategies for encouraging development of expert-like problem-solving behavior in novice students. One research question I have recently been investigating is: *Are prescribed problem-solving prompts effective at promoting student sensemaking?*

Background:

Our PHYS100 course is using a 6-step problem solving strategy in lectures and collaborative group tutorial problems. These are Context Rich, real world problems that require students to select relevant information and make estimates in support of their calculation. Students are guided in each step of the strategy by detailed prompts written on their answer sheets.

TABLE 1. The prescribed problem-solving steps provided on the small-group problem solving worksheets.

Step #	Step Name
1	Interpret the Problem
2	Identify Relevant Physics
3	Model: Identify Assumptions and Relationships
4	Model: Construct a Diagram
5	Solve the Problem
6	Error-checking and Sensemaking

We hoped that the use of a prescribed problem solving strategy would encourage students to think more deeply about the meaning of their calculations. However, a concern with this structure is that students might treat the treat the steps as a list of instructions to follow, rather than individual elements that contribute to overall understanding and a coherent problem solution.

Methodology:

In order to examine how students responded to the structured prompts, I analyzed audio recordings of groups working in tutorials. In particular, I was looking at the students' *Epistemological Framing* of their activity, which is their implicit expectations about knowledge and learning in their current activity and context. An epistemological frame comes with expectations about what kind of knowledge is relevant, what the goal of the activity is, and how progress will be made, and is usually shared by all members of the group.

In this study I coded a set of 6h-long recordings of students working on tutorials to identify students' epistemological framing according to the following coding scheme. Because the Conceptual Discussion frame is where we see students striving to express, understand, and synthesize new ideas, I operationalized the more general term "sensemaking" specifically as "engaging in Conceptual Discussion".

TABLE 2. Summary of the Epistemological Framing coding scheme.

Frame		Description
Conceptual Discussion	CD	Engaged discussion to understand meaning of physics
Procedural Discussion	PD	Engaged discussion to figure out how to proceed or what the professor expects
Worksheet Focus	W	Focus on writing on worksheet or directing others' writing
TA Focus	TA	Focus on interacting with Teaching Assistant
Other / Off-topic	O	Meta-comments, group role negotiations, off-topic discussion

Of principal interest is the students' framing after they encounter a given worksheet prompt. Because of the difficulty in ascribing straightforward causality between a prompt and subsequent conceptual discussion, I made the generous assumption that any conceptual discussion occurring during the segment after one prompt and before the next was the result of that prompt.

To give us a benchmark for comparison, a "best case" case study of another episode where a well-functioning group went through a sequence of starting a task, discussing it conceptually in an engaged collaborative fashion, and recording it, shows that a reasonable upper limit for the percentage of Conceptual Discussion in an episode is around 38%.

Results:

TABLE 3. Rates of Conceptual Discussion after structured problem-solving prompts

Prompt:	1. Interpret	2. Relevant Physics	3. Assump-tions	4. Diagram	5. Solve	6. Error-Checking
# of groups engaging in Conceptual Discussion	3	2	6	3	3	3
Average % of time spent in Conceptual Discussion	11%	2%	13%	4%	8%	5%

Even under this generous assumption the quantity and pattern of Conceptual Discussion do not suggest that the prompts had a strong effect. Compared to the best case described above, these results suggests that prescribed problem-solving strategies alone are ineffective at prompting sensemaking. The only exception seems to be the explicit requirement to state modeling assumptions, which prompted conceptual discussion from every group studied and showed a significant peak in Conceptual Disscusion nearly after the prompt.

Conclusions:

I believe that instead of treating the prompts as a license to engage in authentic sensemaking, students perceive them as a list of conditions to be satisfied for marks. This perception keeps the students' focus on what is required to earn marks rather than on making sense of their process and their answers. The Assumptions prompt is successful only because it is the only time when reconciliation between formal physics and everyday intuition is necessary, and so a certain amount of Conceptual Discussion is required. While I am unwilling to say that teaching expert problem-solving strategies is ineffective, it does seem that using prescribed prompts inhibits students' sensemaking. In order to encourage sensemaking, I suggest focusing on assessment rubrics that reward overall coherence and sensibility, perhaps even at the expense of "right answers".

If you are interested in discussing my research or results, please feel free to contact me at martinuk@physics.ubc.ca. Alternatively, you can look for the short paper I have just submitted to the Physics Education Research Conference Proceedings (AIP Conference Series) which will be published in September.