Instructional Changes Based on Cogenerative Physics Reform

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Abstract. We describe changes in a physics teacher's pedagogy and cultural awareness that resulted from her students' involvement in reforming their classroom. For this case study, we examined a veteran high school teacher's semester-long use of CMPLE (the Cogenerative Mediation Process for Learning Environments) in her Modeling Instruction classroom. CMPLE is a formative intervention designed to help students and instructors collaborate to change classroom dynamics, based on how closely the environment matches their learning preferences. Analysis of classroom videos, interviews, and other artifacts indicates that adapting the environment to align with the preferences of that shared culture affected the instructor in complex ways. We will trace her teaching practices and her self-described awareness of the culture of learning, to highlight notable changes. The teacher espoused deeper understanding of her students' physics learning experience, which she gained from including students in responding to their own individual and collective learning preferences.

INTRODUCTION

We present data on a high school physics teacher's pedagogical changes, with regards to helping her students improve their white board presentations and adding hints to worksheets. What is notable about those changes is that her students took part in developing and implementing those changes. This paper functions as a preliminary overview and analysis of our recently-collected data set.

LOCALIZED REFORM

Research-based physics reforms, such as the "Modeling Instruction in High School Physics[4]" curriculum, understandably are written by multiple authors, tested with a large number of participating students and teachers, and are disseminated on national (and international) scales. Yet when teachers use such a curriculum to undergo "local" reform efforts in their own classrooms, they must manage the "systematic change of the many complex and interconnected factors" associated with their particular experiences and contexts[1]. Cogenerative dialogues (cogens) have been shown to be a useful tool in science learning environments for mediating such factors[2]. A cogen is a whole-class discussion between instructors and students in which "the goal is to reach agreement on changes to improve the learning environment"[2]. Using cogens, teachers have managed their change efforts by sharing the responsibility with their students, while in the process gaining a deeper understanding of their classroom culture.

CMPLE

We have designed a framework for change that nests cogens in the context of an overarching localized reform effort by instructors. This framework is called the Cogenerative Mediation Process for Learning Environments (CMPLE – pronounced "simple"). CMPLE is a three-step formative intervention designed to help teachers and students change their learning environment to become more representative of their collective learning preferences[3]. In three general steps, participants 1) reflect on their own learning preferences, 2) set classroom goals through cogens, and 3) work towards their goals over a longer period of time. We suggest the cycle be repeated, after being initiated by the teacher. What follows is a more detailed description of CMPLE, and a high school physics teacher's ("Lana") changes in pedagogy and classroom awareness as a result of enacting CMPLE with her students.

DATA

For this case study, we observed Lana's classroom from January to June of 2012, once a week (on

average). Aside from observation notes, video footage was recorded during each visit with two simultaneous cameras, so that more interactions could be analyzed later. Five audio interviews with Lana were also recorded over that time period, and one interview was recorded with "Sasha", a peer teacher from Lana's school. Furthermore, we obtained scanned copies of students' CMPLE written learning preferences.

In June and July, complete transcripts were made from the videos of the two cogens, the five audio interviews with Lana, the interview with Sasha (the peer teacher), as well as short selections of classroom video. Those transcripts were coded using the open-source TAMS Analyzer software[5].

RESEARCH CONTEXT

This study took place within a high school honors physics course in which the teacher, "Lana", used "Modeling Instruction in High School Physics[4]" as her curriculum. Lana had eleven years of previous teaching experience, and had attended Florida International University's Summer Physics Modeling Workshop from 2009-2011. She was her school's science department chair, and holds a PhD in biophysics. In her teaching style, Lana emphasized a large amount of student participation, group work, and authentic science experiences. Her lessons typically contained dynamic classroom interactions, which resulted in a moderate-to-high degree of volume produced by students talking to each other (and with Lana). We contacted Lana about participating in our study because we were familiar with her personality, teaching philosophy, and two years worth of her students' FCI data. She told us that she agreed to participate because she was interested in developing new ways of listening to her students' voices and concerns in her classroom.

Lana enacted CMPLE during the Spring 2012 semester with her 5th period class, which was comprised of twelve students. By gender, half of her students were female, and by grade levels students were evenly divided between the 11th and 12th grades. In her opinion, her students were relatively homogenous with regard to certain demographic and affective areas, such as socio-economic status and their dedication to learning. She explained to us that she chose this particular course section due to her apprehension concerning enacting CMPLE with a larger number of students, and a non-homogenous group.

ENACTING CMPLE – REFLECTING

In Lana's class, the students were assigned a homework reflection, in preparation for having a class cogen later. The reflection question was, "What helps you to learn best?" Students were prompted to consider how they became proficient in their outside interests and hobbies, physical objects they like to have around them while they learn, and to consider how their five senses are conducive to learning. A variety of answers were given in response to this open-ended question.

Typical responses included preferences such as, "Hands-on interaction with the lesson learned", "Involvement with other students during practice", "I learn better when the teacher shows and writes down the steps", "I like to work alone", and "Quiet."

ENACTING CMPLE – COGEN

The purpose of the cogen is for participants to collectively set classroom goals. To scaffold the goal-setting outcome, CMPLE cogens are comprised of a process of discussing everyone's reflection responses and preferences, grouping their preferences into categories, comparing their current learning environment to the categorized preferences (by rating them on a Likert scale of 1-5), and then finally setting goals. The cogen associated with the following description lasted slightly longer than 43 minutes.

Discussing, Categorizing, and Rating Preferences

Lana initiated her cogen at the beginning of the class period by asking each student to describe her/his most important learning preferences, as listed on their aforementioned reflection handout. All students had the opportunity to relate their own preferences, and ask clarifying questions about others' preferences. While Lana moderated the discussion, a student volunteer "scribe" wrote everyone's preferences on the front white board, as can be seen below in Image 1.

IMAGE 1. Lana moderating the 1st CMPLE cogen, with a student "scribe" assisting.

As the front white board filled with preferences, Lana asked students to group preferences into logical categories. This categorization functioned to organize and reduce the overall number of preferences in preparation for the goal-setting activity. The four categories of preferences that emerged were "Hands-on [learning]", "Seeing steps [while presenting white boards]", "[teacher-led] Examples then practice [with worksheets]", and "Quiet [during class work time]".

Students were then arranged into their smaller lab groups, in order to discuss and rate (on a 1-5 Likert scale) each of the categories, with respect to how well they matched to their current classroom learning environment. These lab-group conversations went on simultaneously all around the classroom for approximately 5 minutes.

The following excerpt represents a typical conversation being carried out in the room at the time. The transcript shows three students, Chantelle, Robert, and Shawn, discussing the "Examples, then practice" category:

Chantelle:	You know like, in math when you have like one lesson you have like, five examples.
Robert:	Oh yeah.
Shawn:	Yeah, but she does give us worksheets. Like, she gives us worksheets for the things that we're on -
Chantelle:	Yeah, but she doesn't do the worksheet with you.
Shawn:	Yeah, that's true. But she does go around helping us [at our tables].
Chantelle:	Yeah, but if she did it in front of the class more, I would know it so much better…

In the above excerpt, Chantelle made an analogy to mathematics teachers who more typically (than Lana) work out several problems for their students. Shawn counters by reminding Robert and Chantelle that Lana goes "around" to the various groups and helps them if they are having problems. Chantelle agreed with Shawn, but asserted that she would understand the material "so much better" if Lana worked out problems at the front of the class.

Eventually this lab group assigned that category a Likert rating of "3". That rating represented their opinion that Lana occasionally engaged in working out (or leading) problems on the front board before students worked on their own (or in small groups).

Goal-Setting

In the final portion of the cogen, Lana and her students negotiated to produce goals, in order to provide clear paths to improving the ratings of categories. Two of the produced goals are listed below in Table 1. Lana posted a printed document of these cogenerative goals on the south wall of her classroom, where they remained for the duration of the school year. In so doing, she divided the goals into "Learning Strategies" and "Group Dynamics", delineations she came up with on her own.

TABLE 1. Two Goals Produced from Cogen #1.
Learning Strategies
• Teacher led examples of problems before students attempt to work problems on their own
• Show all steps when explaining solutions on white boards
o Write equation with variables before substituting in numbers
o Explain steps slowly

For analysis purposes, we divided goals into teacher-oriented goals (i.e. "teacher led examples…") and student-oriented goals (i.e. "show all steps…"). In the next section we will briefly highlight Lana's curricular changes with regards to those two goals.

ENACTING CMPLE – WORKING TOWARDS GOALS

The class spent approximately 12 weeks in between their two cogens (the first was held in January, and the second in April). In that time, they engaged in the teaching and learning of physics, which was mediated by their use of CMPLE.

"Show all steps…"

Lana informed us that at the beginning of the school year, "showing all steps" was actually a rule for her classroom. However, the issue of students presenting incomplete and/or incomprehensible white boards had become worse in the couple of months before the first CMPLE cogen. In the nearly all of the interview transcripts, she explained that although she was aware of the problem, she "never really verbalized or formalized my thinking about" how to improve the issue. Although she would occasionally tell students that, "Nobody can understand what you just wrote because it's just a bunch of numbers," she tended to wait for other students to ask clarification questions.

In an interview conducted directly after the first cogen, Lana expressed hope that her students will improve because, "I think as a student they're much more likely to help their peers, than they are to comply with some rule that the teacher's making them do."

Throughout the rest of the year she described the situation steadily improving. In explaining how she gained her ability to help the students become more prone to correct their white boards, she described pointing to the goals on the wall and reminding students that, "you told me this was really helpful [to you]," instead of "harping on them". Her sense that there was a positive change was reinforced later in the year by the 2nd cogen, in which all of the students agreed that they had improved. Sasha, who frequently observed Lana's classes, corroborated their steady improvement as well.

"Teacher led examples…"

After the first cogen, Lana began leading the first problems from assigned worksheets. Because she had changed her instruction, she assumed she was accomplishing this teacher-oriented goal.

A few days before the second cogen, Lana decided to administer the CLASS[6]. She recalled having taken the CLASS during her first Modeling workshop, and thought her students' responses might provide further insight into the classroom environment, as well as into hew CMPLE process. Lana told us she was going to use this data more as a "snapshot", rather than to examine "shifts" in students' CLASS scores.

After analyzing her data, she decided that her students scored comparatively lower in the CLASS "Sense Making/Effort" category in their survey results. Then, during the 2nd cogen, students informed her that she wasn't leading enough examples, and that she wasn't "doing the harder ones." Lana was troubled by their new request, because she felt that by working more (and more difficult) examples on the board for students, she would be limiting their problem solving skills. She immediately connected their request with her CLASS analysis and said, "That actually is in line with some of the, with one of the CLASS [categories]"

After voicing her concerns about the CLASS analysis, she continued, "I just thought that it was really interesting that you brought up that I should give you the harder examples in class, [and] that I should do them with you, as opposed to you making the connection yourself when the worksheets get a little bit harder."

Lana then asked students for their ideas. One student, "Rachel", responded with, "what helps me is if you make little hint-offs…and instead of like, an abrupt change it's more like a gradual getting into the problem." Other students joined in the discussion, and eventually they and Lana negotiated that she would start adding hints to the worksheets, in placed where she predicted students might "get stuck".

Because the second cogen was so close to the end of her school year, Lana told us she did not have many opportunities to implement that change. She did, however, add a hint to students about "drawing field lines" to a difficult worksheet problem in the unit on electric potentials. She reflected in a later interview that, "All they had to do was think about fields, and they got the right answer. As opposed to, "Oh I had to wait for the teacher to come tell me the answer." If they can feel they figured it out on their own, it's so good for their confidence." In considering next year's teaching, she added, "So I'll try to add those [hints] in [to more worksheets]. That's what summers are for, right?"

SUMMARY

The pedagogical changes described in this paper occurred in the context of a teacher attempting localized reform. As theorized earlier, Lana's process of change was complex and rooted in issues surrounding her students' culture of learning, as well as her own experiences. In using CMPLE to bring her students' voice into her reform efforts, she was encouraged "look at my class and … reflect back on what we're doing and what we should do differently." As we further analyze this data, we will explore how she used CMPLE to mediate her past, present, and future.

ACKNOWLEDGMENTS

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