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ABSTRACT

Preservice teachers in an Educational Psychology course wrote cases about their field placements and analyzed the cases using perspectives from the learning sciences. The course helped student teachers use the learning sciences to enhance instruction. It engaged them in collaborative problem solving which required them to use theory as a tool for addressing real instructional problems. Student teachers worked in problem-based learning groups to: study cases of actual instruction and redesign instruction to enhance learning; formulate hypotheses about cases to prompt investigation into the content of the learning sciences; use a Secondary Teacher Education Project Web site to guide investigations into relevant learning sciences theories; develop instructional solutions based on their research; and develop analyses of cases from their field experiences. Results indicated that the student teachers tended to use a level 2 situation model for interpreting instruction that they observed or led, meaning that they recognized the importance of student thinking as opposed to only their own explanations and lectures. However, they did not discuss further teacher-student interactions, such as challenging students' conceptions. Results indicated that student teachers were not fully prepared to interact with students and challenge their ideas after the preservice course. (Contains 15 references.) (SM)

Models of Teacher Learning:
A Study of Case Analyses by Preservice Teachers

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Abstract

In an innovative Educational Psychology course, preservice teachers wrote cases about their field placements and analyzed the cases using perspectives from the learning sciences. We describe our approach to studying these case analyses in terms of a theory of conceptual models. Results reflect on the viability of the theory. The majority of case analyses were distinguished as level 2, meaning that student teachers recognized the importance of student thinking, but did not discuss further student-teacher interactions, such as challenging students' conceptions. Results are compared to a previous study and are explained in reference to the importance of this work for professional development efforts.

Models of Teacher Learning: A Study of Case Analyses by Preservice Teachers

Background

A common weakness of preservice teaching programs is that the courses are independent and do not build on each other. Preservice teachers experience incoherent and sometimes conflicting messages about teaching that do not help them actively build their own knowledge base for teaching (Fenstermacher, 1994). Especially problematic is that the ideas and approaches from methods class or field experience conflict with those from content courses. In our program at a large university, we have redesigned the Educational Psychology course to help preservice teachers learn in ways that will be useful to them in their classrooms. One way we attempt this is simply by integrating field experiences into the course. Teachers write cases about their field placements and analyze them using concepts and approaches from the learning sciences. The learning sciences is that branch of cognitive science, the interdisciplinary study of thinking, that relates to teaching and learning.

The course is designed to help teachers use the learning sciences to enhance instruction. Student teachers use written and video-based cases of real instructional situations as contexts for studying the learning sciences. Videos are found on the Secondary Teacher Education Project's (STEP) Web site (http://www.wcer.wisc.edu/step) and are linked to problems and content from the learning sciences. Through case-based instruction (e.g., Merseth & Lacey, 1993; Shulman, 1992), student teachers envision practical applications. The course is also designed to engage teachers in collaborative problem solving in a way that requires them to use theory as a tool for addressing real instructional problems. To solve problems associated with cases, teachers collaborate using a specific process called problem-based learning (Barrows, 1988; Siegel & STEP, 2000). This provides structure for discussion and study.

In our course, preservice teachers work in problem-based learning groups to:

1. study cases of actual instruction and redesign instruction to enhance student learning;
2. formulate hypotheses about cases that will prompt investigation into the content of the learning sciences;
3. use the STEP Web site to guide investigations into relevant learning-sciences theories;
4. develop instructional solutions based on their research; and
5. develop analyses of cases from their field experiences.

We propose an approach to assessing these case analyses from field placements based on a theory of conceptual models.

Situation Models Based on Hierarchical Schema Theory

Previous work has shown that teachers' descriptions of classroom events reveal much about their instructional strategies and beliefs. Elbaz (1991), for instance, reviewed research on teacher cases and narratives and the many ways they can be used to explicate professional knowledge and beliefs. From teachers' written analyses of classrooms, researchers have inferred teachers' (a) reasoning strategies (e.g., Moje & Wade, 1997), (b) levels of reflection (e.g., Sparks-Langer et al., 1990), (c) pedagogical beliefs (e.g., Kagan & Tippins, 1991), and (d) craft knowledge (e.g., Connelly, Clandinin & He, 1997). Our approach is based on research on mental models (e.g., Gentner & Stevens, 1983), specifically Hierarchical Schema Theory. This cognitive approach fits with the cognitive goals of our course.

According to Hierarchical Schema Theory (Derry, 1996), students (or, preservice teachers, here) can develop during a course in different ways. For example, students who activate more learning-sciences ideas in thinking about instruction have grown to some degree, but students have developed further if they more frequently activate the ideas that are appropriate in their fit to particular case contexts. In previous work, we found that preservice teachers showed both types of growth between videocase pretests and posttests (Siegel, Derry, Steinkuehler, Kim, & Seymour, 2001). In this study, we assess case analyses in terms of the latter form of growth, the most difficult form according to Hierarchical Schema Theory, the integration of course ideas to construct theoretical interpretations of situations. Such construction requires that ideas be selected, mapped, and combined to construct a situational interpretation, a conceptual "mental model" (e.g., Gentner & Stevens, 1983).

Each situation model is based on an underlying understanding of the interaction between teaching and learning, which can range from simplistic and unproductive (e.g., teaching is information transmission and learning is additive) to complex and useful (e.g., teaching is a form of assisted practice and learning is knowledge construction). We began our taxonomy using a heavily researched scheme developed by the Cognitively Guided Instruction project (e.g., Fennema, Carpenter, et al., 1996) and then adapted it for our purposes. The hierarchical coding scheme includes four situation models of instructional contexts, as well as sublevels, briefly summarized in Table 1.

As described in Siegel (et al., 2001), the teacher at **level 1** believes that for a student to learn science, a teacher has to show them or tell them (Fennema et al., 1996). A person at this level

Table 1. Summary of Situation Models

Level	Situation Model in Brief
1	Teaching is showing. Students' prior knowledge is not recognized.
2	Students bring prior knowledge, etc., to learning situations.
2a	•Only prior knowledge is mentioned.
2b	•Only the transfer of knowledge is mentioned.
2.5	•Challenging students' ideas is additionally mentioned.
3	Students' prior knowledge affects teaching.
4	Teaching is based on the students' development of knowledge within a discipline.

does not recognize the importance of students' prior knowledge or current understanding. For example, a response might include a statement such as, "Because the teacher never explained how to complete the task, the student never understood the concept."

At level 2, the teacher begins to view the student's disciplinary knowledge as important to learning (Fennema et al., 1996). The three subcategories of this level are: 2a and 2b, which are thought to be equally advanced, and 2.5 which is thought to be closer to level 3. Teachers at level **2a** describe students as users of disciplinary knowledge during learning situations. Respondents at this level recognize and minimally describe prior knowledge. For example, a respondent might write "If the teacher was able to first find out what all his students knew...," but not describe how to do this or what to do next. Level **2b** is similar, but instead of discussing prior knowledge, the teacher describes the transfer of knowledge. At level 2b, transfer is acknowledged as important to student learning; either instructors think that students have not transferred previously learned material to the new task, or they think that the activities do not facilitate transfer. We present level **2.5** as slightly more sophisticated, because teachers mention the idea of conceptual conflict. At this stage, respondents state that teachers should confront students' misconceptions, but they do not explain how to do this. They mention conceptual conflict, disequilibrium, or challenging tasks, but they do not explicate these.

At level 3, teachers believe that student thinking should determine the evolution of curriculum and the ways a teacher interacts with individuals (Fennema et al., 1996). The teacher needs to interact with students to create challenging situations and conceptual conflict. For this stage, the teacher specifically assesses students' prior knowledge and interacts with students. A level 3 response included statements, such as: "It is the teacher's job to challenge those previously held views and to engage students in an authentic process leading toward that goal and assessed in a way that tests growth in knowledge/changes in knowledge against prior misconceptions."

The most sophisticated situation model in our hierarchy is **level 4**. At this point, the teacher knows how individual knowledge fits with how understanding develops (Fennema et al., 1996). The teacher understands the disciplinary knowledge and has a sense of how to teach certain ways at certain times and why. The teacher using the fourth model is able to recognize obstacles to students' development of understanding. (No responses from our 2001 or present study were coded as level 4.)

Research Goals

A previous study using a videocase pretest and posttest (Siegel et al., 2001) showed that participants improved throughout the course in certain areas. Participants significantly improved at identifying more learning-sciences concepts within their analyses and at identifying more concepts appropriate to the given situation. However, results were marginally non-significant regarding whether participants developed more sophisticated situation models after the course. On average, they began close to a transmission model of teaching (high level 1/low level 2) and grew closer to a sociocognitive model that accounts for prior knowledge (mid level 2).

After studying teachers' analyses of classrooms shown in videocases, in the present study we further test our theory of situation models by using them to interpret teachers' case analyses of live classrooms from their field placements. We investigate if the coding scheme will work in this situation. Results will further inform our theory of developmental situation models that teachers use to interpret classrooms. The study will provide some evidence about whether the theory is reasonable or ways it needs to be modified. If the theory is applicable, will the preservice teachers use more sophisticated models of instruction applied to actual teaching and observing in the classroom after the course? Do they tend to use what they learned from the course when applying it to a real world teaching situation?

In addition, the study is designed to suggest possible reasons for differences in scores, by testing certain associations. Do the differences in situation models (1-4) relate to which class section the student teacher attended? Do they relate to the discipline and subject matter of the case? Do they correspond to the learning-sciences concept chosen to focus the analysis?

Method

Of the 56 students enrolled in our fall 2000 course, 49 students volunteered to participate in this investigation. The assignment was to analyze a case chosen from their semester-long classroom placement (called "practicum"). It was part of the regular work for the course and was due near the end of the semester. Student teachers were asked to pick one or more cognitive concepts that they learned from the course, for instance cognitive apprenticeship or procedural learning, as a focus for the analysis. They could choose to teach the lesson or observe the lesson depending on their practicum placement and preference. A short excerpt from the case analysis assignment is shown below:

- *Teaching in your practicum:* design a lesson or series of activities using this cognitive idea to help students learn. Write up how the lesson went as if it were a case: include context, grade level, school demographics, lesson plan, and a detailed story of what happened, and your post-lesson reflections as a teacher.

Note: You should try to use a lesson plan you designed in Methods class.

- *Observing in your practicum:* watch for the use or non-use of this idea during class. Write up a case of the lesson and include context, grade level, school demographics, and a detailed story of what happened. Also describe with specific examples how the instruction facilitated or impeded learning and recommend changes.

The assignment was worth 4 out of 100 course points and the recommended length was 5 pages.

Data Analysis

The 49 case analyses were coded by the author according to the levels of the situation models (1, 2, 2a, 2b, 2.5, 3, or 4). One third of the case analyses (16) were coded by another rater. The codes were the same for 87.5% of the papers, and the Cohen's Kappa measure of inter-rater reliability was .77 ($p=.00$). Excerpts from case analyses that were coded at a variety of levels are provided below in the Results section. In addition, chi-square tests of association were computed to see if the levels were associated with the course section, the subject matter of the case, and/or the concept chosen for the analysis. Classes were identified 1,2,3; each class was taught by a different teaching assistant. Class subjects were identified and grouped as: English, History, Math, Science, Geography, Social Science, and Foreign Language. Note that the subject matter (the name of the class in which the case occurred) also correspond to the disciplinary background of the case analyzer. For example, if a participant majored in English, the class subject s/he wrote about was also English. Finally, the concepts chosen for analysis were identified and grouped in three categories based on how they were framed in the preservice course (Table 2).

Table 2. Three Categories of Learning-Sciences Concepts Used in the Case Analyses

"Cognitive"	"Sociocultural"	"Cross Theory"
Information processing	Cognitive apprenticeship	Knowledge construction
Metacognition	Authentic instruction	Collaborative learning
Problem solving	Authentic assessment	Active learning
Prior knowledge	Social knowledge construction	Inquiry
Transfer	Modeling	
Representations	Scaffolding	
Higher order thinking	Discourse	
	Tools	
	Zone of proximal development	
	Prompts	

Results

The case analyses were able to be scored using the situation models scheme of levels 1-4. However, in ten analyses, there appeared to be no opportunity to achieve a high score. This was due to the discipline and/or concept chosen. For example, a foreign language teacher who focused on authentic assessment, discussed many sociocultural ideas appropriate to the case, but did not discuss how prior knowledge did/did not affect instruction because of the focus on assessment and authenticity. Cases like these were scored regardless, and marked "no opportunity".

We interpret this result as dependent on our theoretical framework. Because the hierarchy of situation models is based on math and science research, it emphasizes prior knowledge and conceptual conflict. However, these are not associated with each and every concept in the array that student teachers chose to use in their analyses (see Table 2). Having a narrow theory for analysis can be useful, and we propose that it can be useful for interpreting the case analyses. Rather than expand the situation model framework to account for the variety of cases, at this time, we will use it to interpret what is possible. Below the results for the dataset that excluded "no opportunity" cases are thus presented.

The case analyses were, on average, at level 2 (n=39, m=2.26, SD=.46). The average student teacher thus approached instruction by attending to students' prior conceptions, but did not discuss challenging misconceptions or how to interact with students. The minimum score was 1 and maximum was 3. The frequency of situation models is shown in Figure 1. Eight case analyses were coded as level 3, which is the next most frequent category after level 2. Level 1 occurred once.

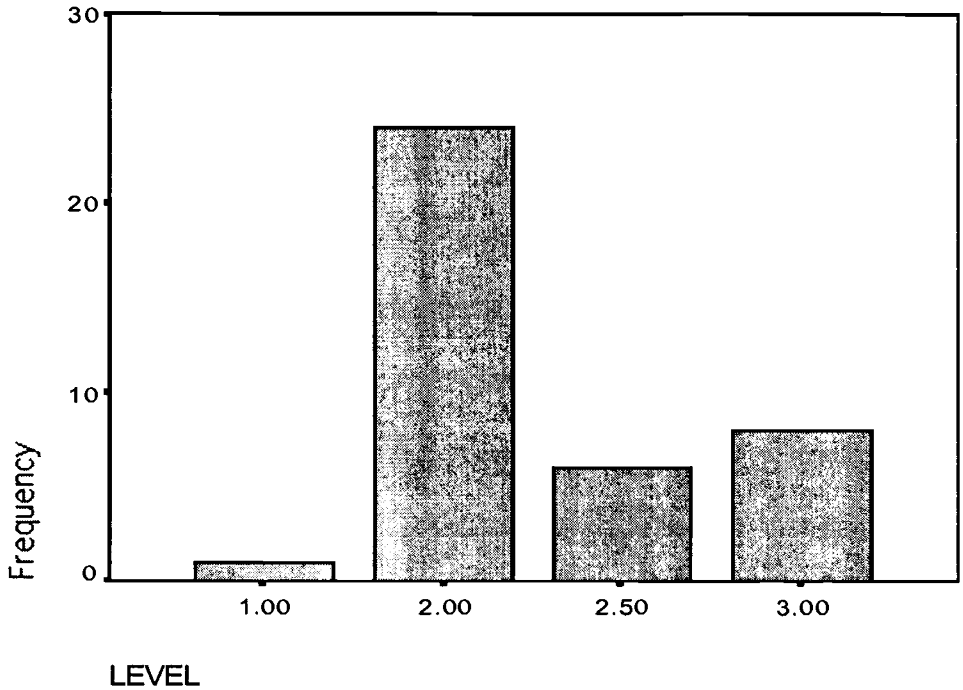

Figure 1. Frequency of main levels.

Excerpts from case analyses at each level are discussed next. Each sample represents a *very small part* of the entire case analysis. Also, note that the class analyzed does not need to be well taught for a high score, but the analysis needs to discuss learning and instruction in such a way that the analyzer reveals an understanding of the criteria for a high level. The first sample is from a third year Foreign Language class that was coded as level 1.

> When the assignment was introduced, the teacher passed out a rubric that outlined the entire assignment, clearly stating the requirements: a listing of the specific topics for research, a written report (both a rough draft and a final copy), and the specifications for the presentation including visuals and possible extra credit. By turning in the rough draft, this gives the students the opportunity to get feedback from the teacher to make sure that they are on the right track and helps to ensure better success. The students are not only producing tangible products like the report and visuals, bu also the intangible product of the oral presentation.

This excerpt reveals a positive tone toward the assessment, an assessment which does not address student thinking. Feedback from the teacher helps students keep on "the right track" rather than learn further. Prior knowledge is not accounted for at level 1.

A sample from a sixth grade English class that was scored as level 2a:

> In this particular lesson the teacher begins with a fairly formal round of IRE questioning that only involves a handful of students. She might fare better if she opened a discussion of what they have already constructed as a class about wolves and to let the comments bounce around the room rather than always coming back to her. If she wants students to work

> together to extract information and discussion from the reading then she should allow them every opportunity to practice.

This example shows that the analyzer is concerned with students' construction of knowledge. Another example from a senior science class, coded as level 2b, focuses on transfer of learning. This case involved a description of a nature of science activity and then continued:

> Conclude the activity with a discussion about what the students independently wrote down. The students can clearly see how this event relates to reconstruction of the past. But how does it relate to discovering the genetic code or discovering the key to tissue regeneration? How does it relate to their learning of science? These are essential questions for discussion that will bring everything back to biotechnology and the student's role in the classroom.

Further analysis of the case discussed how the class was designed to enhance transfer of learning. Another example from a sixth grade math class was coded as level 2.5, because the importance of students being exposed to different ideas is recognized:

> In retrospect, one aspect of modeling that I did not address was verbalizing difficulties that students may encounter. I regret this because it would have allowed students to look at different paths that people may take in encountering this problem (some bad, some good). This also would have demonstrated a decision-making process (which method is better and why?).

A preservice teacher in senior astronomy wrote the following paragraph as part of his/her case analysis:

> ...in the classroom I observed, the students had developed the naive theory that blue stars were cold and red stars were hot based on the everyday expereinces of their previous seventeen or eighteen years....simply reading that cold stars are red and hot stars are blue would likely not have reversed their misconceptions.Since Mr. A alerted students to their possible naive beliefs, hence activating their metacognition about the topic, they began to think about how their existing mental representations are inconsistent with what they are learning. By providing students with evidence (in the form of the electromagnetic spectrum) that directly contradicted their naive theories, he activated a state of disequilibrium in his students....Because Mr. A merely presented evidence, instead of allowing the students to gather evidence themselves, they may eventually revert to their own naive beleifs. Therefore, a way to improve teaching this lesson might be to conduct a lab in which students obtain temperatures for the different parts of a flame. In pairs, students would...

This level 3 sample shows more attention to the prior disciplinary knowledge of students, and goes beyond (especially in the next paragraph) a level 2.5 which would typically include a less specific statement about challenging misconceptions. However, this sample does not structure teaching based on the disciplinary knowledge of the students (level 4).

Next, we will examine factors that could indicate why people scored at different levels. Of the learning-sciences concepts that were used in the analyses (shown in Table 2), 22 fell in the "sociocultural" category, such as cognitive apprenticeship; 10 were "cross theory", such as knowledge construction which was presented in the course as related to many learning-sciences theories; and 7 were "cognitive", such as problem solving.

The subjects written about, as they were categorized for this study, are shown in Figure 2. These represent both the class taught and the background of the student teacher.

Results also reveal that these factors were not associated with the level of response. Chi-square of association tests showed that course section was not related to level; class subject was not related to level; and category of concept used was not related to level.

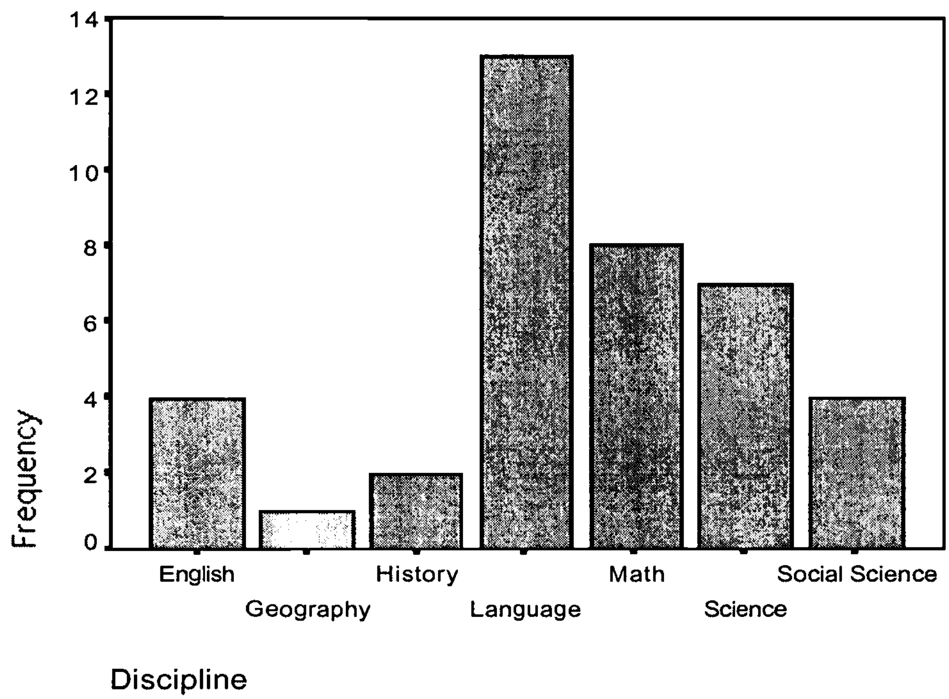

Figure 2. Frequency of subject matter, as categorized.

Discussion

Results show that the student teachers tended to use a level 2 situation model for interpreting instruction that they observed or led, after an innovative course on the learning sciences. Student teachers realized the importance of student thinking, rather than only their own explanations and lectures, but did not reach the more sophisticated level of challenging students' ideas and specifically interacting with students, or predicting student difficulties. This finding is similar to the previous videocase pretest and posttest study (Siegel et al., 2001) in which teachers began at high level 1/low level 2 and grew to a middle level 2 at the end of the course. It is notable that teachers wrote thoughtful analyses and reached a level 2 on the current task, because it demonstrates that they related (at least) some of what they learned in the course to their practical teaching experience.

We argue that even though some case analyses were excluded from the dataset because they did not appear to have an opportunity to reach a high score due to the particular subject matter and/or concept chosen, this study provides evidence to further build our theory of teacher development.

If teachers had improved too drastically, this would have indicated that the theory could not account for long-term development, because they would have reached the top of the scale too soon. Because teachers were at the same level as the previous study's posttest scores, it suggests that case analyses can also be coded in this way and that the theory deserves further exploration.

One could hypothesize that some differences exist in analyzing strangers' classrooms (as in the cases from the course and previous study's pretest/posttest videocases) versus your own or a collaborating teacher's classroom (as in the current study). This study did not detect these differences, but suggests that the theory is robust enough to explain our additional form of data. Further research could examine this hypothesis.

In addition, no factors were isolated that might suggest a cause or explanation for the difference in levels across different participants. The course section was not associated with level, nor the class subject, nor the concept chosen for analysis. Further studies could investigate other factors that might provide a reason for different levels of sophistication.

This study indicates that preservice teachers are not fully prepared to interact with students and challenge their ideas (level 3), after a preservice course near the end of their program. Further integration between the subject-specific methods courses, our new course, and practicum experiences could perhaps better prepare student teachers to foster student thinking in their subject area. Inservice programs that are tied to useful preservice programs could also prove to be necessary. The scarcity of such collaborations is shocking (for one, see Siegel & Thier, 2002).

The research outlined here is important on two levels. First, as Putnam and Borko (2000) point out, new instructional approaches such as case-based and problem-based instruction need to be more frequently tied to investigation of how teachers themselves learn in such settings. Our findings are based on only one course, but offer evidence of teacher growth in key areas. Second, while designing instruction that enables teachers to construct useful knowledge of theoretical domains such as the learning sciences is itself challenging, developing valid assessment methods can be even harder. Our models of teacher learning could be used to help teacher educators clarify their expectations for growth. The four stage model could be adapted for use as a rubric to help teachers understand long-term learning goals and monitor and stimulate their own development. Such research on models of teacher learning can inform both the design and the assessment of future professional development efforts.

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