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ABSTRACT

While college faculty are experts in their disciplines, teaching expertise is less understood. This paper explores one aspect of the pedagogical content knowledge of faculty new to teaching, specifically, knowledge of student difficulties. The project, conducted at three different institutions, used a case method, employing interviews and observations. Novices (N=11) were interviewed about the common difficulties students encountered in a specified introductory college course. Synthesis of data from the cases resulted in a working model of new faculty members' knowledge of student difficulties, including how difficulties are discerned, the actual content and processes of student difficulties, principles of action for overcoming difficulties, what faculty do in response to student difficulties, and how faculty know what they know about student difficulties. Results suggest that the core of what faculty know about student difficulties is represented by problems with specific content, problems with academic processes, and variables that affect students' understanding. Implications for faculty development and agendas for future research on this and other aspects of pedagogical content knowledge are included. (Contains 22 references.) (LL)

EXAMINING PEDAGOGICAL CONTENT KNOWLEDGE OF COLLEGE FACULTY NEW TO TEACHING

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Title

Examining Pedagogical Content Knowledge of College Faculty New to Teaching

Abstract

This paper examines one aspect of Shulman's notion of pedagogical content knowledge: knowledge of student difficulties. At three different types of institutions, the authors interviewed eleven faculty members, new to teaching, about the common difficulties students encountered in a specified introductory college course. Results took the form of a working model of novice faculty members' knowledge of student difficulties, including how they learn about student difficulties, the actual content and processes with which students have difficulties, principles of action for overcoming difficulties, what faculty do in response to difficulties, and how faculty know what they know about difficulties. Implications for faculty development and agendas for future research on this and other aspects of pedagogical content knowledge are included.

Keywords (in order of importance)

Pedagogical-Content-Knowledge, Teacher-Knowledge, Novice-Teacher, College-Faculty, University-Faculty, Higher-Education

Chart 1

PROBLEM STATEMENT

While college faculty are experts in their disciplines, their expertise as teachers is less understood. This study explores the teacher knowledge of faculty new to teaching.

New Faculty as Teachers

- New college faculty desire to succeed as teachers (Baldwin & Blackburn, 1981) and spend a great deal of time preparing for teaching (Sorcinelli, 1988; Turner & Boice, 1987).
- However, they arrive at their first academic position with little or no *formal* knowledge of teaching (van der Bogert, 1991).
- Still, new faculty carry heavy teaching loads (Finkelstein & LaCelle-Peterson, 1992; Trautvetter, 1992) in the midst of highly stressful first years of professional work (Dinham, 1992) in which they demonstrate *informal* understandings about teaching (Fink, 1984).

Call for Research on Teacher Knowledge in Higher Education

- Contemporary researchers agree that understanding teacher knowledge and thinking is critical to understanding teaching (Clark & Dunn, 1991; Clark & Peterson, 1986; Fenstermacher, 1994). Yet, research on teaching in higher education has historically focused on teacher behaviors (Dunkin & Barnes, 1986).
- New directions for research on college teaching include research on teacher knowledge, beliefs, and decisions (Dunkin & Barnes, 1986) and on teachers' thinking and planning (Dinham & Blake, 1991).

Research Questions

- Using conceptualizations of teacher knowledge from secondary education (Shulman, 1986, 1987), this study focuses on a specific area of teachers' practical knowledge referred to as pedagogical content knowledge.
- In the larger investigation from which this report is the first, we ask:

  "What pedagogical content knowledge do college faculty new to teaching possess?"

Chart 2

RESEARCH ABOUT TEACHER KNOWLEDGE

Research on teacher knowledge has recently expanded from investigations of teachers' formal knowledge to include practical knowledge. One conception of practical knowledge--pedagogical content knowledge--frames this study of the knowledge held by college faculty new to teaching.

Teacher Knowledge in Secondary Education

- Virtually all the research on teacher knowledge has concerned elementary and secondary education teachers. Of the two, subject-based secondary-level teaching provides the greater relevance for college teaching of academic subjects.
- Research on teacher knowledge rests in either of two conceptions of teacher knowledge (Fenstermacher, 1994):
  - formal knowledge (largely, that derived from educational science)
  - practical knowledge (also called craft knowledge or the "wisdom of practice")

Pedagogical Content Knowledge

- Of the several research programs addressing practical knowledge, one of the most useful for informing thought about college teachers' knowledge is that of Shulman (1986, 1987) and his associates (e.g., Grossman, 1990, 1991), who use the term "pedagogical content knowledge" to describe how knowledge about teaching is tied to, influenced by, and part of the content being taught.

  > Within the category of pedagogical content knowledge I include, for the most regularly taught topics in one's subject area, the most useful forms of representations of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations--in a word, ways of representing and formulating the subject that make it comprehensible to others.... Pedagogical content knowledge also includes an understanding of what makes the learning of specific topics easy or difficult; the conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning of those most frequently taught topics and lessons (Shulman, 1986, 9-10).

- Grossman's (1991) more recent definition categorizes four aspects of pedagogical content knowledge: 1) what content is most important to know (focus on the subject matter), 2) students' prior knowledge and misunderstandings (focus on students), 3) the order in which subject matter should be presented (focus on curriculum), and 4) the instructional strategies useful for teaching a given subject (focus on pedagogy).

Chart 2

RESEARCH ABOUT TEACHER KNOWLEDGE (continued)

Investigating Pedagogical Content Knowledge of College Teachers

- Our ongoing research on college faculty new to teaching investigates pedagogical content knowledge through several approaches, one being the framework suggested by Grossman's conceptualization:
  - knowledge of purposes and goals for the subject area
  - curricular knowledge, both intra- and inter-course, within the discipline
  - knowledge of student attitudes, prior knowledge, misconceptions, and difficulties with the subject
  - knowledge of instructional strategies for the subject area
- This paper begins the process of unfolding teacher knowledge for college faculty new to teaching by addressing the question:

  "How are student difficulties with course content understood and dealt with by faculty members new to teaching?"

Chart 3

RESEARCH PROCEDURES

Part of the New Faculty Project, this study of teacher knowledge held by faculty members new to college teaching used a case method, employing interviews and observations. The data were coded and classified to yield a map displaying the complexity of new teachers' practical knowledge.

Participants

- Twelve[1] faculty members (4 from each of three types of colleges/universities) were chosen for inclusion, based on their minimal teaching experience, from a pool of 88 newly hired tenure-track faculty participating in the New Faculty Project interviews.
- Participant demographics and teaching experience appear in Tables 1 and 2 on the next page.

Design

- This study is designed as a longitudinal, three-year case study. This report spans the first two years of the study.
- We use a single case method (Yin, 1989)--a case of pedagogical content knowledge in higher education.
- A focused approach (Yin, 1989) allowed us to examine one aspect of pedagogical content knowledge--understandings about student difficulties--from faculty members' perspective.

Data Collection

- Interviews and observations were the main methods of data collection. Three researchers (one assigned to each institution) underwent extensive interview training to ensure like goals and methods.
- Researchers interviewed participants four times (once in fall, 1991 and three times in fall, 1992) and observed their teaching (in fall, 1992). Observed classes and interviews about observed classes were tape recorded.

[1] One faculty member from the research university withdrew when researchers arrived on campus, yielding a total of eleven participants.

Chart 3

RESEARCH PROCEDURES (Continued)

Table 1

Demographics of New Faculty Members

	Gender	Field	Institution
Bob	Male	Political Science	Research University
Maxene	Female	Linguistics	Research University
Robert	Male	Statistics	Research University
David	Male	Computer Science	Liberal Arts College
Keith	Male	Geology	Liberal Arts College
Margaret	Female	Linguistics	Liberal Arts College
Rachael	Female	Spanish	Liberal Arts College
Carl	Male	Math	Community College
Harvey	Male	Math	Community College
Rhonda	Female	Math	Community College
Juanita	Female	Spanish	Community College

Chart 3

RESEARCH PROCEDURES (Continued)

Table 2

Number of Years Teaching Experience of New Faculty Members upon Hiring

	As Instructor at 4-yr Institution	As Instructor at 2-yr Institution	As Teaching Assistant	As 1^0 or 2^0 Teacher
Bob	-----	-----	1.0	-----
Maxene	-----	-----	2.5	3.5
Robert	-----	-----	3.0	-----
David	1.0	-----	3.0	-----
Keith	-----	-----	4.0	-----
Margaret	-----	-----	1.0	-----
Rachael	-----	-----	4.0	0.5
Carl	-----	-----	5.0	-----
Harvey	-----	-----	6.0	-----
Rhonda	-----	-----	4.0	-----
Juanita	-----	1.0	3.0	-----

[0] 1^0 refers to elementary school, and 2^0 refers to secondary school.

Chart 3

RESEARCH PROCEDURES (Continued)

Data Analysis

In the analytic induction (Jacobs & Jackson, 1982) process, coding categories emerged from the data. Four tiers of analysis occurred:

- In an open round of coding, we read three data sets to generate a coding scheme.
- Subsequent readings of eight data sets established concurrence and informed our grouping and refinements of codes.
- We expanded the coding groups to determine dimensions, relationships, and axes of codes and their categories.
- The coding scheme was subjected to concept mapping to develop core concepts and themes and to establish an overarching conceptual scheme.

Chart 4

FINDINGS: WORKING MODEL OF TEACHER KNOWLEDGE

Synthesis of the data from this case study resulted in a working model of teacher knowledge in higher education, depicted in Diagram 1 at the bottom of the page.

Description of Working Model Parts

- Part L represents how faculty learned about student difficulties in specific classes they have taught.
- Part K represents what faculty know about student difficulties in specific classes they have taught. This part of the model includes knowledge of the difficulties themselves and of the constraints that affect students' overcoming these difficulties.
- Part R represents what faculty understand, in general, about the relationship between student action and overcoming difficulties.
- Part D represents how faculty dealt with student difficulties in specific classes they have taught. This part of the model addresses Shulman's (1986) conception of instructional representations and Grossman's (1991) conception of instructional strategies.
- Part H represents faculty's understandings about how they know what they know about student difficulties and how they know what to do about student difficulties.

Diagram 1: Working Model of Teacher Knowledge in Higher Education

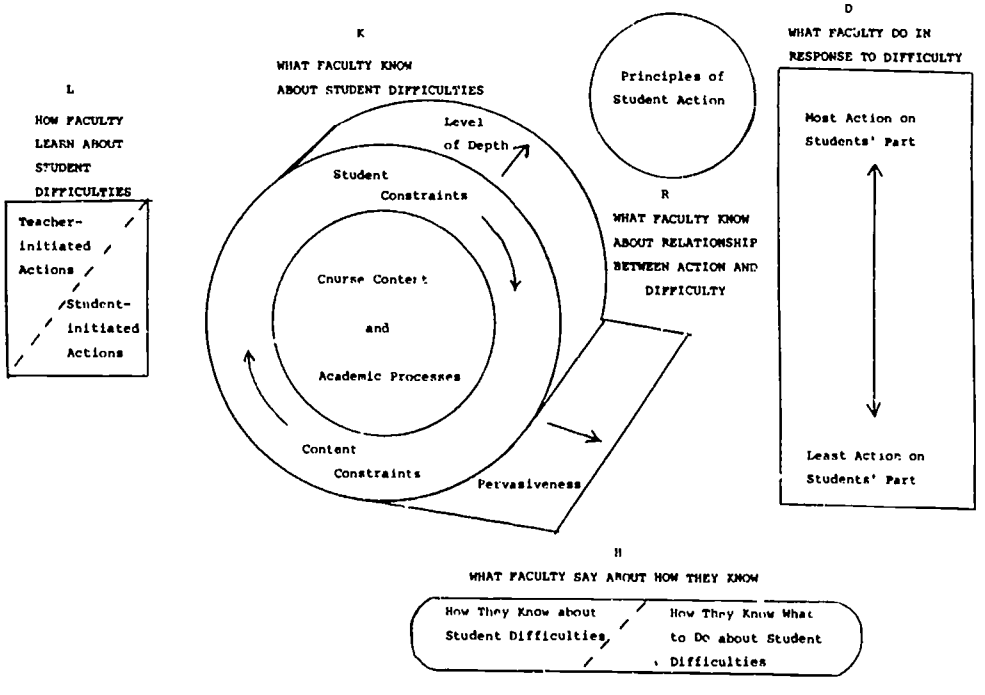

Chart 6

Part K:
WHAT FACULTY KNOW ABOUT STUDENT DIFFICULTIES

Descriptions of student difficulties centered on problems with specific content, problems with academic processes, and variables that affect students' understanding. This knowledge represents the core of what faculty know about student difficulties.

Knowledge about Difficulties with Specific Course Content

- When pressed, faculty expressed knowledge of difficulties with specific course content. They mentioned difficulty with rules, technical terminology, concepts, formal theories, and organizing frameworks.

- For example, Rhonda said, "They get to where they can do problems, but they don't get concepts. I've started noticing that" (Case Study Data Set, 1992, Rhonda--p. 8).

Knowledge about Difficulties with the Academic Processes Necessary for Understanding Course Content

- Faculty were more fluent in their accounts of difficulties with academic processes. They described difficulties with recognizing patterns in linguistic pronunciations or mathematical procedures, thinking in Spanish, constructing arguments to support hypotheses, or judging the value of political perspectives.

- For example, Maxene said, "These problems [with recognizing patterns] go across all students. Students want to study language without linguistics. They want to look at phenomena like babies' language development at six months, nine months, and so on. They just want to get lists of information about each stage. That's all descriptive work. But I want them to see patterns, and they need linguistics for that.... For example, today we talked about 'zots' and 'kutches,' and I made them say the words. They are afraid to experiment, to say the words out loud, to speak and explore. So, I stand up there and contort my face so that they will at least try to verbalize it. But only by saying it will they hear the patterns (Case Study Data Set, 1992, Maxene--p. 6).

Knowledge about Constraints and Dimensions

- Two categories of constraints emerged: student constraints and content constraints. Student constraints, the most frequently mentioned constraints, include lack of prerequisite course work and affective aspects of content difficulty. By content constraints, we mean characteristics of course material that make it hard for anyone to learn that material. Common content constraints include ill defined concepts, complex material, abstract notions, and artificially constructed categories of information.

- Two dimensions further describe faculty knowledge of student difficulties: pervasiveness and level of difficulty. Some faculty described the pervasiveness of specific difficulties for students in their courses and throughout the field. Fewer faculty talked about the level of student difficulty; that is, the "depth" of the misconception, misunderstanding, or lack of understanding.

Chart 5

Part L:
HOW FACULTY LEARN ABOUT STUDENT DIFFICULTIES

Faculty gave many strategies for learning about student difficulties. We describe these strategies using four conceptual dimensions, of which we regard the first as the most useful in conveying how faculty say they learn about student difficulties.

Source of Initiation

- Faculty learned about student difficulties either because they initiated action that provided information about students' difficulties (e.g., faculty member asks students a question) or because students initiated action from which faculty learned about difficulties (e.g., responding to in-class events, or groaning audibly).
- Ashford and Cummings' (1983) terminology for feedback activities elaborates on the meaning of teacher-initiated and student-initiated actions. They refer to the former as "feedback seeking activities" (i.e., teacher requests information) and the latter as "feedback monitoring activities" (i.e., although students initiate actions, teachers must pay attention to students' actions in order to receive feedback about students' progress).

Level of Inference

- What faculty learned about student difficulties varied according to the required level of inference.
- For example, learning about difficulties from students' body language is high-inference; learning about difficulties from students' questions is low-inference.

Frequency of Checking for Understanding

- Faculty varied the frequency with which they used certain strategies (e.g., continuous checking occurred as faculty attended to students' responses in class; discrete checking occurred when faculty relied on tests or term papers).
- Sometimes, faculty did not control frequency; that is, the strategies, themselves, precluded more frequent use (e.g., end-of-course evaluations occur only once).

Purpose of Checking

- The reasons for gathering information, applicable only to teacher-initiated actions, varied from formative to summative.
- For example, faculty learned about difficulties from in-class student questions (formative purpose) and from exams (summative purpose).

Chart 7

Part R:
WHAT FACULTY UNDERSTAND ABOUT THE RELATIONSHIP BETWEEN STUDENT ACTION AND OVERCOMING DIFFICULTIES

Some faculty made general statements about the relationship between student action and overcoming difficulties and about the type of actions students engage in.

Principles of Student Action

- Faculty mentioned that student action is necessary for overcoming difficulties. Keith explained:

  > I really think the only way to get through this is through iteration.... Because every time you go through this, you get a little more. You know, it's like Thermo--Physical Chemistry, you know? About the third time you take it, you understand it. And this is conceptually on a similar scale (Case Study Data Set, 1992, Keith--p. 26).

- Faculty talked about a variety of student actions that they believed would help students overcome difficulties. Most commonly, they mentioned practicing. For instance, Rachael and Margaret said, respectively:

  > If you would ask me what is the tense they have more trouble with, I would say it's the subjunctive.... I guess it's just a matter of practice. I think they need a lot of input. And one hour three times a week is not enough. If they would get a lot of input, like a lot of the students that go and study abroad and come back, that problem almost disappears. So, it's a matter of practicing, of using it. Until you get the difference" (Case Study Data Set, 1992, Rachael--p. 18-19).

  > One of the things they are supposed to be learning, according to me, is syntactic argumentation. How you argue for a particular position. And they're weak at that whole idea... [What helps is] just, just practice. You know, just exercises either in class or on homework where they're forced to argue for a position...You have to learn syntax by doing (Case Study Data Set, 1992, Margaret--p. 8-10).

- Other actions that faculty believed would help students overcome difficulties include repeating efforts; reading materials before and after class; coming up with examples; listening, rather than taking notes; and doing homework problems.

Chart 8

Part D:
WHAT FACULTY DO IN RESPONSE TO STUDENT DIFFICULTIES

Five categories describe how faculty deal with student difficulties. These categories range from most to least action on the student's part. Two categories predominate.

Faculty Have Students Do Something

- Often, faculty had students do something to help students overcome the difficulty. For example, faculty had students do exercises, give each other feedback, or work through problems by writing, talking, or otherwise making explicit their thinking.

- David said that doing a particular type of exercise--coming up with algorithms--is a common way to help students overcome their difficulty with developing algorithms: "I have them do--come up with algorithms, either informal (a pseudo code kind of thing) or, typically, more formal Pascal to solve the particular kind of problem. So, I mean, that's in a sense what the course is about. Let's practice lots and lots of these" (Case Study Data Set, 1992, David--p. 29).

- Bob explained that in order to help his students analyze texts and political theory, he has his students give each other feedback: "In discussion sections, what I do is have them criticize each other, because that's just what happens naturally in discussions--one person says something and soon enough people disagree and learn from this" (Case Study Data Set, 1992, Bob--Q 23).

Faculty Do Something

- Most often, faculty themselves took action to help students overcome the difficulty. The activities they mentioned ranged from most action with the material and most interaction between faculty and students (e.g., prodding students, with questions, to work through a difficulty or modeling how to think) to least action with the material and least interaction (e.g., stating a rule or correcting an answer).

- David said that modeling his thinking helps students understand the idea of abstraction in computer programming: "A technique that I like using in courses...[is] trying to lead them through my thought processes...you know, obviously we're going to need a loop here as part of our algorithm. You know, what kind of a loop should we use? What needs to be done before the loop? What steps need to be inside of here? And let's look for patterns" (Case Study Data Set, 1992, David--p. 27-28).

- Juanita explained that giving students the rules for the imperfect tense in Spanish helps them overcome the difficulty of knowing when to use the imperfect tense: "Well, I just go through the rules, and then I drill.... Like for example, I would say that you use the imperfect when you are reminiscing in the past. Anytime that you can substitute 'used to,' like, 'I used to like to go to my grandma's house,' or, 'I used to eat berries when I was ten,' anything that you can substitute 'used to,' you can use the imperfect" (Case Study Data Set, 1992, Juanita--p. 7).

Chart 8

Part D: WHAT FACULTY DO (Continued)

Faculty Ask for Further Information

- Some faculty asked for further information, either about the difficulty or about how to solve the difficulty.
- For example, Rhonda said, "Sometimes I'll ask, 'Does it help to draw pictures or to talk?' Nine out of ten say pictures" (Case Study Data Set, 1991, Rhonda--Q23).

Faculty Defer the Problem

- Faculty also deferred certain difficulties. This was a common strategy if a question was far above the level of the class or if only one student did not understand.
- For example, Harvey told us, "If they try the exercises, if they are trying and not getting through it all the time, once they've made an effort, I suggest they come in and talk to me and ask some questions" (Case Study Data Set, 1992, Harvey--p. 1).

Faculty Dismiss the Problem

- One faculty member admitted to dismissing some difficulties.
- She said, "This class, it's so huge.... This makes it difficult to teach--they all understand different things. Sometimes I have to say, 'That's above this level'" (Case Study Data Set, 1991, Maxene--Q23).

Chart 9

Part H:
WHAT FACULTY SAY ABOUT HOW THEY KNOW

While this phase of the project did not focus on how faculty know what they know about student difficulties with course content[2], our faculty offered information on sources of their pedagogical content knowledge.

How They Know about Student Difficulties

- Most commonly, faculty said they know about student difficulties from their own personal experience--either as a teacher or as a student. Keith explained, "I can remember, still, very vividly how difficult it was for me to understand this" (Case Study Data Set, 1992, Keith--p. 38).

- Some faculty said they gained knowledge of student difficulties from colleagues. For example, Robert said, "I was warned, by someone who taught the course before, of the difficulties I'd run into" (Case Study Data Set, 1992, Robert--p. 4).

How They Know What to Do about Student Difficulties

- Almost all faculty offered information on how they know what to do, most often crediting personal experience, either as a student or as a teacher. Carl shared a particularly vivid memory of what helped him learn about mathematical functions when he was a student:

> When I first learned functions, I liked The Who--the rock group, The Who. And "Magic Bus" was a fairly common, frequently played song on the radio. And I remember having the same struggle with functions, and I was listening to the radio, doing my math homework...and "The Magic Bus" came on. And for some reason, I visualized, at the time, that the magic bus--the inside of the bus was my function. And a number would come on the bus and leave a different number. And it just--[worked]" (Case Study Data Set, 1992, Carl--p. 8-9).

- Many faculty also alluded to tacit principles that told them a particular strategy would work (e.g., saying they realize that student work is better than teacher talk).

- Other sources of knowledge included colleagues who shared their knowledge, students who told faculty that certain strategies work, and disciplinary norms for dealing with particular difficulties.

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[2] Third year data, exploring the issue of how faculty know what they know, will be incorporated into future papers.

Chart 10

CONCLUSIONS

From our analysis of the recurrence of issues for each faculty member and our analysis of the variability across the eleven faculty members, we discerned four conclusions.

What this Study Tells Us about Faculty Members' Pedagogical Contents Knowledge

- Faculty new to teaching vary substantially in their understandings of course content and in their strategies for helping students overcome difficulties with course content. This variation is not attributable to experience, as these faculty members are relatively new to college teaching.
- In describing student difficulties, faculty mentioned substantive course content less readily than they mentioned the academic processes necessary for understanding course content. This salience of academic processes could reveal the neophyte's tendency to blame the student or could signal that faculty understand the particular academic processes required for particular content.
- The role of student action and its relationship with student difficulty emerged throughout the data. Faculty were quick to acknowledge the centrality of student action in student learning. Furthermore, some faculty believe they play a part in bringing about student action.
- For most faculty, knowledge of student difficulty was inextricably linked to the content area.

Chart 11

IMPLICATIONS

A constructivist perspective suggests that for instructional developers to be successful agents of change, they must work from faculty members' prior knowledge about teaching. This study of teacher knowledge suggests several actions for consideration.

Implications for Faculty Development

- For many faculty, this study was an intervention. They had never reflected on how they deal with student difficulties. Instructional developers might help faculty reflect on and diagnose student difficulties.
- While our detailed picture of teacher knowledge of student difficulties comes from eleven faculty members, any one faculty member's knowledge is less substantial than this overall picture implies. This suggests that when dealing with the topic of student difficulty, instructional developers should approach the topic cautiously, anticipating variance from faculty member to faculty member.
- Although our working model suggests two clear categories of content and process difficulties, faculty did not express this distinction readily. Instructional developers could help faculty distinguish between these difficulties and reflect on the strategies useful for helping students overcome the two types of difficulties.
- Instructional developers might consider developing faculty members' knowledge of the relationship between student action and student difficulties. Although almost all faculty acknowledged the importance of students "doing" or "practicing," few could explain why this was important.
- In order to best connect with faculty members' understandings, instructional developers should consider planning discipline-specific, decentralized activities. Or if resources do not permit, in centralized sessions, instructional developers should at least acknowledge and foster discussion about the link between content, student difficulty, and teaching.

Chart 12

FUTURE RESEARCH

This paper reviews preliminary findings from the first in a series of studies within a larger research program exploring the pedagogical content knowledge of faculty new to teaching. Here, we present the research agenda for the larger program and directions for future research to be undertaken by others.

Research Agenda for this Program of Research

- We expect to address other aspects of teachers' knowledge of student knowledge through observational data (from faculty members' classrooms) and written data (from faculty members' students) we collected.
- We will also examine other aspects of pedagogical content knowledge: knowledge of goals and purposes, curricular knowledge, and knowledge of instructional strategies.
- Simultaneously, we will explore pedagogical content knowledge as revealed in the design and management of students' academic work for the courses we observed.

Directions for Future Research

- This study leaves unexplored many intriguing questions about new faculty members' pedagogical content knowledge. For example, how do faculty understandings of student difficulties vary across disciplines?
- Do faculty describe student difficulties in the context of substantive content because that content is the only context in which they have seen student difficulty, or because student difficulty is truly content-bound?
- What is the linkage between deeply understanding students' difficulties and effectively helping students overcome them?
- One faculty member explicitly stated the importance of studying teachers' knowledge of difficulties and how to deal with them:

> It [Systematic Mineralogy] is a challenge to teach it... It's not my area of expertise, though my area does use mineralogy. But it's probably my favorite course to teach now... I think I come closer probably to teaching it well than any of my other courses, which are maybe near and dear to my heart.... I'm probably not as sensitive to the battles with understanding [for my area of expertise] as I am with mineralogy. Because it's [mineralogy] not first nature to me... I have to battle with it. I have to read every time before lecture. Re-read the text, and several of them, to refresh my memory how all of this works... And I can remember still very vividly how difficult it was for me to understand this. And I know that I never really did until I had to teach it. So, I think that helps with the teaching (Case Study Data Set, 1992, Keith--p. 37-38.)

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