

Tyro Teacher Talk: Pedagogical Content Knowledge

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Pedagogical content knowledge (PCK) as described by Shulman (1986, 1987) indicates a variety of interactions or relationships among five knowledge domains that experienced teachers use in the classroom. Studies indicate that PCK does not appear in novice teachers (Lederman & Latz, 1993; Dickman, Van Sickle & Bogan, 1994). This study was designed to identify key relationships that novice teachers make and the labels they place on the categories they name. The study was a longitudinal qualitative research study. The case study method was used to follow a total of eight teachers from practicum experiences through a second year of teaching. The science teachers in this study had completed one to two years of teaching. They continued to name and further conceptualized the nature of science, ethics, psychology, and social issues as the important knowledge domains when they described their teaching. Teachers who had completed two years of teaching began to develop additional categories related to school administration and local culture as important to their teaching.

Introduction

Typically beginning teachers' thoughts about teaching follow two distinct lines, content and pedagogy (Lederman, Gess-Newsome & Latz, 1992; Shulman, 1987). Some current educational research indicates a new domain called pedagogical content knowledge (PCK) (Shulman, 1986 & 1987). Shulman (1987) describes PCK as the intersection of several knowledge domains. The interaction of the content and pedagogy remains an enigma among first year teachers, and PCK examples as described by Shulman typically do not occur. Current studies suggest some first year secondary science teachers understand and can describe some relationships between content and pedagogy and use the overlap in teaching their courses, while others maintain separate categories (Bogan, Van Sickle & Dickman, 1994; Lederman & Latz, 1993; Van Sickle, 1992;). To date tyro teachers do not label the connections that they are making in the same way researchers do (Van Sickle, Dickman & Bogan, 1994). In fact, the evidence to date suggests that novice teachers (as defined by Spector, 1989) with up to five years of teaching practice do not have the

experience to make the connections necessary to meet the criteria of PCK that Shulman describes (Lederman, 1995).

To address the issue, a qualitative longitudinal study was designed to determine what connections first year teachers make in the knowledge areas of content, pedagogy, and pedagogical content knowledge. The purpose of this longitudinal study was to assess the development of new teachers' conceptions of the relationships (if any) between content and pedagogy and knowledge structures during their first years of teaching. These tyro professionals graduated from education programs in three southeastern universities: College and University of Charleston, SC; Radford University, VA; and Jacksonville State University, AL. (See Bogan, Van Sickle & Dickman, 1994, for program descriptions.) Questions were used to guide the identification of pedagogy and content structures that the teachers built between content and pedagogy. The same questions were used and data were gathered as these teachers were finishing their professional development through the education programs at the above universities.

Background

The data for this study were generated by pre-service secondary science teachers. These teachers were followed for one to two-and-a-half years. They were asked the same set of questions several times during this time span. The questions were asked several times during the students' methods course, the student teaching experience, and the first year-and-a-half of public school teaching. The original four questions adopted from Lederman, Gess-Newsome, and Latz (1992) were:

(1) What topics make up your primary teaching content? What would it look like to use these topics to diagram your content area?

(2) Have you ever thought about your content area in the way you have been asked to do in question one?

(3) What topics make up important elements/concerns of teaching? What would it look like to use these to diagram the important elements/concerns of teaching?

(4) Does your content area and teaching practice overlap? If so, how; if not, why not?

After the third collection of answers to these questions, the three investigators noted a pattern among the pre-service teachers' responses. The students repeatedly used words like *linked*, *bridged*, *connected*, and *related* in their descriptions of content and pedagogy. At this point the investigators developed a fifth question that was used during subsequent interviews. This question was:

(5) What relationship(s), if any, do you see among content, pedagogy, and teaching objectives?

Research Techniques and Data Sources

Teachers develop pedagogical content knowledge in the same way that they truly come to comprehend anything, i.e., through experience. However, just surviving the teaching experience is insufficient. Teachers must reflect on and analyze the parts of PCK and make connections among these parts (Draft of the National Science Education Standards, 1994). In order to facilitate the formation of these connections, we as teacher educators should understand the processes by which new teachers begin to make these connections, when they start this process, and what vocabulary they use to describe this process.

A basic assumption of this research was that the underlying content and pedagogy structures were changing constantly and thus a descriptive longitudinal study would best inform the researchers. A multiple case study method (Bogden & Bicklen, 1982) was considered the most appropriate design for this longitudinal study. Data were collected and analyzed in several phases, beginning with entrance knowledge structures on content and pedagogy, followed by conceptions on these same structures several times during student teaching and the first year(s) of public school teaching. Teachers were also interviewed after each formal

data collection was completed and after each phase of writing the final documents. To ensure that the teachers' perspective was heard, each interview and written document was reviewed by the teachers (Douglas, 1976).

When this group of teachers began working in the public school system, they were asked the same set of questions once a year. To assist their memory, the last paper written about their experiences was mailed to them along with the questions. Included with the original questions was a new set of questions. Additionally, field notes and artifacts such as lesson plans were collected from each teacher. Interviews were conducted at each data collection point. The following questions were developed by the researchers as a secondary interview protocol. These questions were:

(1) Do you still think you are making the connections named in the paper? If so which ones?

(2) Do you think you are now making other connections not named in the paper? If so name them and give an example?

(3) What factors help you/allow you to make the connections you named in (1) and (2) more often?

(4) What factors hinder/stop you from making the connections you named in (1) and (2)?

Results

The pre-service categories for study emerged and were reported (Bogan, Van Sickle & Dickman; 1994 and Dickman, Van Sickle & Bogan, 1994) during a previous study. It is worthy of note that the pre-service teachers did not perform nor express vocabulary consistent with the PCK literature. The categories that they defined at the conclusion of student teaching were nature of science, ethics, psychology, and sociology. This is in direct contrast to Shulman's (1986) categories of content knowledge: curriculum, knowledge of educational context, learners and their characteristics, and pedagogical knowledge. While some parallels, after two years of teaching, may be drawn between the two sources, such as psychology and learners and their characteristics, the researcher and early practitioner vocabulary is not congruous. The apparent incongruity between the researchers' vocabulary and the teachers' words may be part of the education faculty's' dismay at pre- and in-service teachers' failure to understand the research literature.

Subsequently, several of the original cohort of pre-service teachers have become in-service teachers, and have agreed to answer the questionnaires and interview questions to continue a longitudinal study of PCK. It appears that the linkages, using the categories defined by Dickman, Van Sickle & Bogan (1994), may be necessary for PCK development and probably follows an undulating path. Data generated from the initial survey (data were gathered upon entrance to the practical course work) suggested that no linkages were apparent and thus no linkages were possible.

After course work and practicum work, data indicated that categories had begun to form in the pre-service teachers' minds. During student teaching the categories seemed to submerge at first. Later, after school rules, discipline, and lesson planning became more routine, the initial category linkages began to emerge again in a clearer form. This same, on-again—off-again, pattern seemed to present itself during the first year of teaching. Some typical statements from some first year teachers were: "I'm still making those connections a little." "I was in shock after my first year of teaching." All indicated that during their first year of teaching they had fallen back, to some degree, into the lecture mode as a survival mechanism. For example, one first year teacher said,

I have many of the same feelings outlined in the paper such as the need to correlate subject and pedagogy. I'm having a difficult time linking the two. As I feel I'm in survival mode, I fall back on lecture much too often to get content out to students.

One first year teacher appears to have regressed to a pre-practical experience position. His comment is that he feels dumb with regard to his content. He is coaching and teaching four different courses, for which he feels he had received limited or no content preparation. During his student teaching, he was observed implementing creative and effective inquiry lessons. At this point in the school year, he is relying exclusively on lecture from the text and worksheets. At the opposite extreme, another first year teacher commented that "...I went through a major paradigm shift about science and science education during my science methods class." Since that time, this teacher has moved from science as facts to understanding and delivering science using interactive pedagogy. His experiences during his first year of teaching have not dampened his interactive approach. "I now realize that I will have to be asking myself questions about the connections between content and pedagogy as long as I teach." The on-again—off-again pattern of making linkages among the categories seemed to be reduced in most cases as teachers moved from mentor supported practica to first year teaching.

Current interviews suggest that this pattern was maintained through a second year of teaching. However, the amplitude and the frequency of category linkages increased. Here are some comments by second year teachers:

Inquiry is part of the nature of science, but you can only go so deep because first you have to learn what they actually believe. I still won't let them get away with all lecture, you can't learn it all by lecture. This way they have to apply and use it and think.

Another teacher perceived herself as making more connections in the areas of nature of science, psychology, and ethics. An example about ethics was "...discussing evolution, environmental issues and genetic engineering many of these

(ethical) concerns arose." A third teacher talked about psychology as "...some kids have good hearts. They act bad sometimes, but it's just because they don't know any better. I can't work with kids who have bad hearts. They just want to hurt and cause pain."

All of the participating teachers except one, perceived themselves as making new connections. One first year teacher was struggling to connect social issues into her existing framework. "I can't teach enough about responsibility. I know the science I need to know and I learned a lot about science teaching, but not about teaching kids social skills, resourcefulness, and responsibility." A second year teacher had begun to make administrative and parental types of connections. "In order to make students independent thinkers there is a perception by parents and administrators that you are being too hard on them and they pressure you to ease up." Another second year teacher had begun to connect into the impact of culture (sociology) on learning. "I have to deal with what Grandma believes—because they (students) believe that most." A first year seventh grade life science teacher walked into the classroom and noted that there were no computers available for his students. He spoke with several "old-timers" and another first year teacher, asking about grants and fund-raisers to get computers in the classrooms. The old-timers were not interested in pursuing any such avenues. The two first year teachers teamed up on a fund-raising venture and raised \$6,200. The new teacher found this scenario incredulous.

Initially, first year teachers didn't see anything as helping them to make connections. "I have many of the same feelings outlined in the paper, such as the need to correlate subject and pedagogy. I'm having a difficult time linking the two as I feel I'm in survival mode." About half way through their first year, teachers began to see some things as helping them make connections. "When I am completely prepared and have preguessed how my students may approach the subject matter, I have much better results." A second year teacher saw herself as regrouping/resetting her teaching methods on where her students actually were. "My connections are more reality-based now and I'm making more connections because I'm in the classroom." A second teacher described her development:

I feel strong feelings that these things are what's best for the students and I get positive feedback from the students. That's what keeps me going. The students eventually get better grades because of studying this way—they having to think—they get better test scores.

One teacher listed a plethora of problems hindering her development of connections. Among these were a lack of laboratory equipment, student behavior problems, drugs, student apathy and poor preparation in how to deal with students with learning disabilities. She felt that the students "...especially don't like me because I'm white and they tell me so. The school is 95% black and 95% of the teachers are black." Other external factors described by

teachers were parental, administrative, and student expectations, lack of safety features that prevented hands-on interactive activities, and inadequate content preparations in some programs. Two of the teachers experienced natural disasters during their first year of teaching. One teacher's classroom was intentionally burned down. A tornado destroyed much of the service community of another teacher. One teacher very clearly expressed awareness of internal factors hindering her formation of connections. "...I want to go back to the old model of teaching which hurts them (students) because they do not have to think. That just makes them dependent on me which doesn't help them in the long run." Cases where school/parent politics and discipline problems were most severe indicated a lower frequency of linkages accompanied by reduced opportunities to develop PCK.

Comparison to Previous Pre-service Study

These teachers continued to describe the same categories (e.g. nature of science, psychology, ethics, and social concerns) and to utilize the same descriptors they used during the pre-service studies. The social concerns category seems to be taking on more definition than the earlier study. For example, the new teachers have discovered that family and religion play an important part in what students will learn. The myths and legends that the family tells are more believable and seem more rational to the secondary science student than the scientific evidence that the teacher presents. Secondly, the new teachers found that teaching students "responsibility" was important. The students did not seem to want to behave in the school setting in ways that the teachers considered a socially responsible way. The students were stealing and fighting.

The tyro teachers also seem to be forming a new category related to school administration. The administration of the schools seemed either to support the new teachers' decisions or apply pressure so that the new teachers would change teaching strategies. The new teachers in this study, predominately, retained their beliefs about student learning and science and thus continued using pedagogy that focused on critical thinking, hands-on/minds-on laboratory activities, and higher-order thinking skills. The teachers who maintained such teaching strategies found that their students eventually scored better on classroom and standardized tests. The teachers who reverted to a higher percentage of lecture in their instruction found that their students did not score higher on either classroom or standardized tests. This is a phenomenon that needs further study and clarification.

It seems likely that first year teachers can maintain some of the bridges between content and pedagogy when required to be self-reflective. These teachers continued to believe that pedagogy and the nature of science were intimately linked. The evidence gathered in this study seems to support the stance that PCK may have environmental

controls. These new teachers should have been reminded about what they had learned in their course work and practice.

These data agree with the draft of the National Research Council's (NRC, 1994) position that experience is essential to PCK's development if, in fact, PCK is a separate knowledge domain. While some researchers seem to be claiming that PCK is indeed a separate knowledge domain, the evidence may be pointing in the direction of experiences that do not overwhelm the teacher. For example, misbehavior on the part of students may cause the teacher to be constantly disciplining students rather than teaching. Teachers may have to respond to demands made by the school administration such as paperwork requirements that also divert attention from teaching content, and parents may insist that "school is school" and perceive that what the teacher is doing is not "school."

Conclusions

While past studies have suggested that expert teachers develop pedagogical content knowledge, the structure changes that would occur over time were not known. Some things teachers believed would facilitate their formation of more complex connections were: inservice training in areas such as teaching responsibility, teaching social skills, an experiential component incorporated into more education courses, parental and administrative support for inquiry-based learning, more opportunities to experience different teaching strategies, adequate content preparation, and ways of obtaining funds for the supplies and equipment needed to implement interactional pedagogy.

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