Teacher Learning – Content Knowledge, Practical Knowledge and Professional Development

Abstract – The No Child Left Behind (NCLB) Act (2002) requires that teachers achieve the designation of "Highly Qualified" within a certain time frame. If they are teaching out of their field, or without certification, they may participate in intensive, long-term professional development programs to become highly qualified. One such program was funded by the Collaborative Grant Program, and piloted at the University of Texas at Dallas during the school year 2003-4. Its aim was to provide long-term professional development in teaching physical sciences for teachers who are teaching out of their subject area.

What features of professional development do teachers find enhances their teaching? How do these features relate to research in design of professional development? The formulaic NCLB mandates particular landmarks that teachers must pass in order to considered "Highly Qualified" but how are these landmarks (degrees, etc.) connected with teacher learning? This preliminary study explores long-term professional development in terms of teacher learning and will discuss future work to corroborate how the involvement of teachers in their own learning can maximize the benefits of professional development.

Kendra Bober
SCE 5308
2004

INTRODUCTION

"Teaching and becoming a teacher is a process" – van Driel, et al. (2001)

One assertion in the professional development literature is that teacher learning should parallel the experiences that reformers want students to receive from these teachers. (Borko & Putnam, 1996, as cited in Davis 2003; Loucks-Horsley, Love, Stiles, Mundry, and Hewson, 2003). Teacher learning is important to reform, because how teachers learn will be reflected in how they teach their students. Specifically, "teachers as well as students must: be challenged to become skillful thinkers and problem solvers", as well as "be flexible and adaptable to changes and discoveries" Davis, 2003. A handbook by Loucks-Horsley et al., (2003) discusses four aspects of constructive teacher learning that are important for professional development:

1. "What learners already know influences their learning.
2. Learners acquire new knowledge by constructing it for themselves.
3. The construction of knowledge is a process of change that includes addition, creation, modification, refinement, restructuring and rejection.
4. Learning happens through diverse experience."

The first of these four points will be used to discuss teacher beliefs and attitudes about teaching, and why it is important to address these beliefs and attitudes. The remaining three points emphasize learning as a process, and will be used to consider aspects of teacher professional development that help teachers become learners.

Teacher Education and Knowledge

Teacher education is a highly conservative process, owing to the fact that teachers, having been students themselves, are continually influenced by the teaching styles and methods they have been exposed to throughout their education (Lortie, 1975, as cited in Windschitl, 2003). As such, there is a high degree of retention of teaching

methods of those teachers who had a primary and sustained influence on the proceeding generation. Specifically, as students in science classes, teachers may not have experienced science in a dynamic sense (Songer & Linn, 1991), but rather have "constructed an empiricistic representation of teaching and learning" (Désautels, 2000). This exposure to science teaching and learning shapes and gels the beliefs and attitudes of prospective teachers even before they begin teacher training (Bryan, 2003). Windschitl (2001) asserts that "teachers are less likely to be guided by instructional theories than by familiar images of what is 'proper and possible' in classroom settings." Thus beliefs about inquiry and the nature of science are well formed. Despite the introduction to instructional theories they may encounter in teacher training programs, pre-service teachers are still very much influenced by their cooperating teachers, who also help to perpetuate classroom practices that discourage the student teacher from such methods as inquiry-based teaching (Bryan, 2003). This influence may also discourage experimentation by pre-service teachers that would otherwise be beneficial to helping them construct their own teaching style and probe their students' learning styles.

In addition to what teachers have learned by being students, teachers also have knowledge and opinions derived from their experience as teachers. Continual practice and experimentation is a promising point of departure for teachers to begin to incorporate their own learning into their classroom and teaching methods. It is important for those in educational research and reform to be aware of this. Teacher questions and concerns are often quite different than those of educational researchers (Gabel, Samuel, Helgeson, Novak, and Butzow, 1986). For example, teachers tend to be interested in educational research that has been "shown to work", rather than with research that discusses how

their students learn (Gabel et al., 1986). Another study tells us that teachers are concerned with what motivates students, rather than theories about how or what students learn (Brophy, 1986). Overall, the concerns of teachers show that they value applied research, but it is shown that their professional curriculum does not emphasize "reflection and analysis" (Lanier, 1984). Additionally, the expectations of teachers and what they actually get out of professional development are often dissimilar. This may occur because the challenge to change seems too high (Davis 2003), or teachers become uncomfortable taking the risks involved in pushing beyond their understanding of content knowledge (Loucks-Horsley, Continuing to learn). Both of these studies and a great deal of previous research explains that teacher learning depends on the ability of teachers to continue to refine and revise their knowledge and pedagogy.

Teacher Learning

Continual construction of knowledge by teachers (teacher learning) in their subject areas and in professional development programs determines, in part, what happens in the classroom. Studies by Hashweh (1986), and van Driel, Beijaard and Verloop (2001) relate that the degree of subject knowledge that a teacher has correlates directly with the number of teaching strategies that are employed by the teacher. The study by van Driel et al., (2001) goes on to describe the teacher's asset as "a transformation of subject matter knowledge, used by teachers in the communication process with learners." What this suggests is that teachers are continually assessing and reassessing what they are teaching to adjust for the myriad of learning styles and backgrounds of their students – in this way, the teachers' construction of their teaching methods employ constructivist views of the learner, whether the teacher is aware of it or

not. A study by Osborne (1998) asserts that in this way, teachers are always learning. This reflects point two of Loucks-Horsley, et al. (2003) that "learners acquire new knowledge by constructing it for themselves."

One way that teachers can become aware of their own learning and incorporate it into their teaching is through professional development and collaborative action research (van Driel et al., 2001). Despite the fact that in-service programs are rated low as a source of learning by teachers (Supovitz & Turner, 2000), these authors tell us there is also a strong link between the quantity of professional development and the amount of inquiry in the activities of the classroom. While reform generally values methods described as "inquiry-based" and "hands-on", the important point in this study is that professional development successfully encourages teachers to try new methods. Implementation by teachers of different methods is indicative of teacher learning. Even though "change is hard" (Davis, 2003), teachers are willing.

Several studies list common qualities of effective professional development and teacher learning: emphasis on content or practical knowledge (Supovitz & Turner, 2000; van Driel et al., 2001; Davis, 2003), collaboration with and feedback from educators and/or peers (Supovitz & Turner, 2000; van Driel et al., 2001; Davis, 2003), and an element of time, sustained as a program (Supovitz & Turner, 2000), as well as for reflection. (Davis, 2003). Sustained professional development can be a way for teachers to become aware of their learning and can provide a situation in which teachers can cultivate this learning as a process, whereby they can assess and improve their own methods, knowledge and skills. While the mandate "No Child Left Behind" (2002) has designated certain landmarks such as certification and achievement of a higher degree in

one's are of study in an attempt to reform the state of teaching, Peacock & Rawson (2001) suggest that sustainable professional development and reform occurs when the teachers are able to identify their own set of competencies for effectiveness on the job, and work toward these self-defined goals.

The teacher as a learner, engaged in the process of learning, is an important status. It is important for teacher learning to parallel the concept of constructive student learning (Davis, 2003), by continually building and reflecting on what has been learned (Osborne, 1998), in what van Driel et al. (2001) calls "practical knowledge", through professional development involving both content knowledge (Supovitz & Turner, 2000;) and constructivist teaching (Loucks-Horsley et al., 2003), and by collaborating and/or action research with peers and educators (van Driel et al., 2001; Davis, 2003). Teacher quality and quality of the school system should reflect this.

RESEARCH

This initial study focuses on participants in the 2003-4 Physical Sciences Collaborative Grant Program at the University of Texas at Dallas. The program is intended to improve the physical science backgrounds of teachers who are teaching out of their area of training. This research attempted to discover what types of professional development teachers participate in, and to gain insight regarding what effects different types of professional development have on teaching. Future work will focus on finding a relationship between teacher learning and the self-perceived quality of their teaching. Of particular interest is whether teachers involved in long-term professional development exhibit higher feelings of efficacy concurrent with their continued learning.

Kendra Bober
SCE 5308
2004

METHODS

A survey (Appendix 1) was made of teachers participating in the Physical Sciences Collaborative Grant Program at the University of Texas at Dallas. Demographic questions were meant to summarize the backgrounds of the teachers, including areas of certification, current areas of teaching, how certified, and number of years teaching.

Survey questions asked teachers to address particular professional development (PD) opportunities in which they have participated, and to rank the following in terms of how the PD affected/enhanced their teaching in the following categories:

- Better understanding of subject matter.
- Educational activities to use with students.
- More comfort with subject matter
- Learning opportunity to meet with other teachers/collaboration.
- More comfort with teaching subject matter.
- Learning to use inquiry-based methods.

Statistical analyses compared the ratings within questions and between questions for these categories using a non-pooled, small sample hypothesis t-test (see Table 1A-E). Open ended questions and limited follow-up interviews were conducted to get a better sense of how teachers view and change their teaching, how they learn and how they adapt to mandates regarding their teaching materials and how they teach it.

Kendra Bober
SCE 5308
2004

Table 1A	Question 6 – "Think back to when you signed up for the CPO class. Please rank the following in order of how well they agree with what you expected or wished to receive from the program. (1=agrees most with what I expected, 6=agrees least).					
	Better understanding of subject matter	Educational activities to use with students	More comfort with subject matter	Learning opportunity to meet with other teachers/collaboration	More comfort with teaching subject matter	Learning to use inquiry-based methods
Better understanding of subject matter				-5.05964		-2.45967
Educational activities to use with students				-6.66795		-2.9542
More comfort with subject matter				-5.3033		-2.35702
Learning opportunity to meet with other teachers (collaboration)		3.299832				
More comfort with teaching subject matter						
Learning to use inquiry-based methods						

Kendra Bober
SCE 5308
2004

Table 1B	Question 7 – "With regard to the actual utility of the CPO program as it affects your teaching, please rank the following (1=has most effect on my teaching, 6=has least effect on my teaching)"					
	Better understanding of subject matter	Educational activities to use with students	More comfort with subject matter	Learning opportunity to meet with other teachers/collaboration	More comfort with teaching subject matter	Learning to use inquiry-based methods
Better understanding of subject matter		-2.26274				-3.81
Educational activities to use with students						-2.21359
More comfort with subject matter						-2.32379
Learning opportunity to meet with other teachers (collaboration)						
More comfort with teaching subject matter						
Learning to use inquiry-based methods						

Kendra Bober
SCE 5308
2004

Table 1C	Question 9 – "For all inservices attended (if applicable), please rank the following with regard to how they have enhanced/affected your teaching (1=had greatest effect on my teaching, 6=had least effect on my teaching)"					
	Better understanding of subject matter	Educational activities to use with students	More comfort with subject matter	Learning opportunity to meet with other teachers/collaboration	More comfort with teaching subject matter	Learning to use inquiry-based methods
Better understanding of subject matter				-1.64317		
Educational activities to use with students			-2.54	-4.42719	-2.7735	-2.54
More comfort with subject matter						
Learning opportunity to meet with other teachers (collaboration)						
More comfort with teaching subject matter						
Learning to use inquiry-based methods						

Kendra Bober
SCE 5308
2004

Table 1D	Question 10 – "For all graduate level classes attended (if applicable, not including CPO), please rank the following with regard to how they have enhanced/affected your teaching (1=had the greatest effect on my teaching, 6=had least effect on my teaching)"					
	Better understanding of subject matter	Educational activities to use with students	More comfort with subject matter	Learning opportunity to meet with other teachers/collaboration	More comfort with teaching subject matter	Learning to use inquiry-based methods
Better understanding of subject matter		-4.08712	-4.08712	-19.0066	-4.33013	-8.44097
Educational activities to use with students			-5.17549			-4.24264
More comfort with subject matter				-5.17549		-4.24264
Learning opportunity to meet with other teachers (collaboration)					2.826505	-2.79078
More comfort with teaching subject matter						
Learning to use inquiry-based methods						

Kendra Bober
SCE 5308
2004

Table 1E	Question 11 – "For all workshops at science conferences (if applicable), please rank the following with regard to how they have enhanced/affected your teaching. (1=had most effect on my teaching, 6=had least effect on my teaching)."					
	Better understanding of subject matter	Educational activities to use with students	More comfort with subject matter	Learning opportunity to meet with other teachers/collaboration	More comfort with teaching subject matter	Learning to use inquiry-based methods
Better understanding of subject matter						
Educational activities to use with students						
More comfort with subject matter						
Learning opportunity to meet with other teachers (collaboration)						
More comfort with teaching subject matter						
Learning to use inquiry-based methods						

FINDINGS AND DISCUSSION

Six teachers from the grant program returned the survey. Of these teachers, three were elementary school teachers, two were middle school teachers and one taught in high school. Inservice professional development comprised the bulk of the participants' professional development experience, followed by workshops at science conferences (see Table 2).

Table 2	Number of Professional Development programs attended by participants in the Physical Sciences Collaborative Grant Program					
Participant	**1 hour to 1/2 day inservices**	**1 day inservices**	**Multi-day inservices**	**One semester graduate course**	**Peer coaching meetings**	**State/National Conference Workshops**
1	15	20	5	5	1	5
2	2	12	6	3	6	15
3	6	24	6	5	4	6
4	10	15	1	2	0	12
5	2	2	1	3	10	2
Total	35	73	19	18	21	40

Five questions on the survey asked participants to consider how they expected the Physical Sciences Collaborative Grant Program (IPC) to affect their teaching, as well as how the IPC, inservices, graduate level science courses and conference workshops affected their teaching in the 6 categories, listed in the Methods section. Table 1 summarizes the significant comparisons between questions. Comparisons within survey questions were examined to determine whether teachers found each type of professional development more or less helpful with different aspects of their teaching. Listed below are the questions from the survey that pertained to different types of professional development. Significant differences between the different effects on teaching are listed ($p=0.05$). A positive number means that the teachers found the effect listed in the column more important than that in the row, a negative number means that the teachers found the effect listed in the row more important than that in the column.

Different professional development programs seem to have different effects on teaching. For example, “Better understanding of subject matter” ranked significantly higher than any other category as an effect of *graduate level science courses* on teaching (Table 1d), while “Educational activities to use with students” ranked significantly higher than most other categories as an effect of inservices on teaching. This is interesting,

because participants were generally critical of the content and presentation of inservices. While they answered that they use Educational Activities in the form of "every day practical ideas with easily obtainable materials, because these are more easily transferable to the actual classroom," it was also stated that, "very little obtained at school sponsored inservice helps me to do an effective job at teaching science," and, "typically, inservice sessions reinforce and adapt existing curriculum and add further instruction in areas required by the district to meet state goals." Indeed, teachers will use educational activities and "plug and play" products from inservices, when they are mandated, or have been shown to work. This is consistent with Gabel et al. (1986).

When comparing what teachers *expected* from IPC to what they gained from other types of professional development, there was no clear pattern (Table 1a). It is unclear whether participants just did not know what to expect from IPC. Overall, the participants did not rank "Learning opportunity to meet with other teachers/collaboration" or "Learning to use inquiry-based methods" very high as effects from any professional development, nor did they expect this to be a result of the IPC course.

Interestingly, "Better understanding of subject matter" which was ranked highly as a teaching effect of graduate level science courses was ranked significantly higher as an *outcome* of the IPC course over "Educational activities to use with students", showing that the clear result of the program was a gain in understanding of content knowledge, which is consistent with the goals of the grant. Moreover, participants were pleased with this learning. One participant wrote, "I feel my knowledge base has expanded through the [IPC] course," while another said, "[the IPC course] has totally changed my approach to the force and motion unit and Newton's laws, because I now understand the 'why' of the

concepts. My students are now performing more hands-on, minds-on labs with the force and motion unit." Indeed, the participants see the value of persevering, even though "change is hard" (Davis, 2003), and this is reflected by another participant's comment, "I am more aware of the potential of hands-on inquiry. By doing things myself, I learned a good deal."

CONCLUSIONS AND FUTURE WORK

In what ways can teachers' interactions with profession development help them to see themselves as learners? It is clear by the comments of the participants that they at once recognize their learning, as well as see how that learning translates positively in the classroom. This is perhaps what Thompson & Zeuli (1999) meant when they said that reform is "a process of learning rather than design and engineering." Teachers involved in this process will be utilizing for their own benefit the very inquiry methods that those in educational research and reform believe they should be teaching. It is important that professional development programs help teachers see themselves as learners, and see their own teaching and learning as a process. By doing so, teachers will be enabled to address the questions most relevant to their own teaching.

It has been shown that sustained professional development that allows time for collaboration and reflection leads to an increase in the number of methods used by teachers in the classroom (Hashweh 1986; van Driel, Beijaard, and Verloop, 2001). Engaging teachers actively in the learning process during professional development programs can help teachers more effectively translate their learning to the classroom. Future work will focus on ways to engage teachers in the learning process. In addition to a sustained time frame, teachers will be given the opportunity to develop some of their

own goals, such as the self-defined competencies of Peacock & Rawson (2001), consistent with their strengths, but also to identify areas in which they wish to improve. Pre and post-assessment of content knowledge in the physical sciences will be compared with results from a modified version of the Science Teaching Efficacy Beliefs Instrument (STEBI) (For a modified example, see Enochs, 2000) to determine whether, by focusing on their own self-defined competencies, and being aware of their learning, teachers feel more effective in the classroom.

Kendra Bober
SCE 5308
2004

REFERENCES

Bryan, L. A. (2003). Nestedness of beliefs: Examining a prospective elementary teacher's belief system about science teaching and learning. Journal of Research in Science Teaching 40(9), 835-868.

Davis, K. S. (2003). "Change is hard": What science teachers are telling us about reform and teacher learning of innovative practices. Science Education 87, 3-30.

Désautels, J. (2000). Science teacher preparation: an attempt at breaking the re-production cycle of the tradition model of teaching. In L. P. Steffe and P.W. Thompson (Eds.), Radical constructivism in action Buildignin g on the pioneering work of Ernst von Glasersfeld (pp. 195-212). Routledge Falmer, London, UK.

Enochs, L. G. (2000). Establishing factorial validity of the Mathematics Teaching Efficacy Beliefs Instrument. School Science and Mathematics 100(4), 194.

Gabel, D. L., Samuel, K. V., Helgeson, S., Novak, J., & Butzow, J. (1986). Research interests of secondaray science teachers. Journal of Research in Science Teaching, 23, 145-163.

Hashweh, M. Z. (1986). An exploratory study of teacher knowledge and teaching: The effects of science teachers' knowledge of subject matter and their conceptions of learning on their teaching (Doctoral dissertation, Stanford University, 1985). Dissertation Abstracts International, 46(12), 3672A.

Institute for Research on Teaching, Michigan State University. (1986). On motivating students. (ERIC Document No. 2:276724). East Lansing, MI: Brophy, J.

Kendra Bober
SCE 5308
2004

Institute for Research on Teaching, Michigan State University. (1986). Research on teacher education. (ERIC Document No. 2:251450). East Lansing, MI: Lanier, J. E. & Little, J. W.

Loucks-Horsley, S., Love, N., Stiles, K. E., Mundry, S., Hewson, P. W. (2003). Designing professional development for teachers of science and mathematics. (2nd ed.). Corwin Press, Inc., Thousand Oaks, CA.

Loucks-Horsley, S., Harding, C. K., Arbuckle, M. A., Murray, L. B., Dubea, C., Williams, M. K. (1987) Continuing to Learn: A Guidebook for Teacher Development. Copublished by The Regional Laboratory for Educational Improvement of the Northeast and Islands, Andover MA and National Staff Development Council, Oxford OH.

NCLB (2002) www.nochildleftbehind.gov

Osborne, M. D. (1998). Teacher as knower and learner: Reflections on situated knowledge in science teaching. Journal of Research in Science Teaching 35, 427-439.

Peackock, A., Rawson, B. (2001). Helping teachers to develop competence criteria for evaluating their professional development. International Journal of Educational Development 21, 79-92.

Piaget, J. (1971). Science of education and the psychology of the child. Viking Press, New York, NY.

Kendra Bober
SCE 5308
2004

Songer, N. B., & Linn, M. C. (1991). How do students' views of science influence knowledge integration? Journal of Research in Science Teaching, 28(9), 761-784.

Supovitz, J. A., Turner, H. M. (2000). The effects of professional development on science teaching practices and classroom culture. Journal of Research in Science Teaching 37, 963-980.

Thompson, C. L., & Zeuli, J. S. (1999). The frame and the tapestry: Standards based reform and professional development. In L. Darling-Hammond & G. Sykes (Eds.), Teaching as the learning profession. Handbook of policy and practice. (pp 341-375). Jossey-Bass, San Francisco, CA.

van Driel, J. H., Beijaard, D., Verloop, N. (2001). Professional development and reform in science education: The role of teacher's practical knowledge. Journal of Research in Science Teaching 38, 137-158.

Windschitl, M. (2003). Inquiry projects in science teacher education: What can investigative experiences reveal about teacher thinking and eventual classroom practice? Science Education 87,112-143.

Kendra Bober
SCE 5308
2004

Survey for CPO Participants – 2003-2004 – UT Dallas – Science Education

Instructions: Please save this document to your hard drive. Answer questions by typing your response next to or underneath the question. Use the carriage return if you need more space. Save the document and then return it by attaching it to an email to Barbara Curry (barbc@utdallas.edu)

Thank you in advance for your input.

1. What level/grade do you teach?
2. What is your certification? (Please indicate the grade you teach and the subject you teach)
3. How long have you been certified (Number of Years)?
4. How many years total have you taught at your current level/grade?
5. How were you certified?
6. Think back to when you signed up for the CPO class. Please rank the following in order of how well they agree with what you expected or wished to receive from the program (1=agrees most with what I expected, 8= agrees least):

   _____ Better understanding of subject matter (physics)

   _____ Educational activities to use with students.

   _____ More comfort with subject matter (physics)

   _____ Learning opportunity to meet with other teachers/collaboration

   _____ More comfort with teaching subject matter (physics).

   _____ Learning to use inquiry-based methods.

   _____ Other (Please Specify: _____)
7. With regard to the actual utility of the CPO program as it affects your teaching, please rank the following (1=has most effect on my teaching, 8=has least effect on my teaching):

   _____ Better understanding of subject matter (physics)

   _____ Educational activities to use with students.

   _____ More comfort with subject matter (physics)

Kendra Bober
SCE 5308
2004

_____ Learning opportunity to meet with other teachers/collaboration

_____ More comfort with teaching subject matter (physics).

_____ Learning to use inquiry-based methods.

_____ Other (Please specify_____)

8. What kind of professional development have you attended in the past 3 years? Indicate number of sessions next to all applicable categories:
    a. 1 hour to ½ day in services_____
    b. Full day in service _____
    c. Multi-day in service _____
    d. One semester graduate level science class (not including CPO workshop)_____
    e. Peer coaching meetings _____
    f. Workshops at state or national teacher conferences _____
    g. Other (Specify: _____ # Sessions _____)
9. For all in services attended (if applicable), please rank the following with regard to how they have enhanced/affected your teaching (1=had greatest effect on my teaching, 8= had least effect on my teaching)

    _____ Better understanding of subject matter.

    _____ Educational activities to use with students.

    _____ More comfort with subject matter.

    _____ Learning opportunity to meet with other teachers/collaboration.

    _____ More comfort with teaching subject matter.

    _____ Learning to use inquiry-based methods.

    _____ Other (Please specify_____)
10. For all graduate level classes attended (if applicable, not including CPO), please rank the following with regard to how they have enhanced/affected your teaching (1= had greatest effect on my teaching, 8= had least effect on my teaching)

    _____ Better understanding of subject matter.

    _____ Educational activities to use with students.

    _____ More comfort with subject matter.

    _____ Learning opportunity to meet with other teachers/collaboration.

_____ More comfort with teaching subject matter.

_____ Learning to use inquiry-based methods.

_____ Other (Please specify_____)

11. For all workshops at science conferences (if applicable), please rank the following with regard to how they have enhanced/affected your teaching (1= had most effect on my teaching, 8= had least effect on my teaching):

    _____ Better understanding of subject matter.

    _____ Educational activities to use with students.

    _____ More comfort with subject matter.

    _____ Learning opportunity to meet with other teachers/collaboration.

    _____ More comfort with teaching subject matter.

    _____ Learning to use inquiry-based methods.

    _____ Other (Please specify_____)

12. What types of information from an inservice do you use in your classroom (and why)?

13. What types of information from an inservice don't you use in your classroom (and why not)?

14. Please make a statement of how what you have learned in the CPO course has changed *one thing* you do in your classroom.

Thank you for participating and returning this survey. Your input is important and is highly appreciated.

Kendra Bober
SCE 5308
2004