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.
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

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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.
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.
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).

<table>
<thead>
<tr>
<th>Better understanding of subject matter</th>
<th>Educational activities to use with students</th>
<th>More comfort with subject matter</th>
<th>Learning opportunity to meet with other teachers/collaboration</th>
<th>More comfort with teaching subject matter</th>
<th>Learning to use inquiry-based methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Better understanding of subject matter</td>
<td></td>
<td>-5.05964</td>
<td>-2.45967</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Educational activities to use with students</td>
<td></td>
<td>-6.66795</td>
<td>-2.9542</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More comfort with subject matter</td>
<td></td>
<td>-5.3033</td>
<td>3.299832</td>
<td>-2.35702</td>
<td></td>
</tr>
<tr>
<td>Learning opportunity to meet with other teachers (collaboration)</td>
<td>3.299832</td>
<td></td>
<td>-5.05964</td>
<td>-2.45967</td>
<td></td>
</tr>
<tr>
<td>More comfort with teaching subject matter</td>
<td></td>
<td></td>
<td>-6.66795</td>
<td>-2.9542</td>
<td></td>
</tr>
<tr>
<td>Learning to use inquiry-based methods</td>
<td></td>
<td></td>
<td>-5.3033</td>
<td>3.299832</td>
<td></td>
</tr>
</tbody>
</table>
Table 1B  

<table>
<thead>
<tr>
<th>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)”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Better understanding of subject matter</td>
</tr>
<tr>
<td>Educational activities to use with students</td>
</tr>
<tr>
<td>More comfort with subject matter</td>
</tr>
<tr>
<td>Learning opportunity to meet with other teachers/collaboration</td>
</tr>
<tr>
<td>More comfort with teaching subject matter</td>
</tr>
<tr>
<td>Learning to use inquiry-based methods</td>
</tr>
</tbody>
</table>

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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)”

<table>
<thead>
<tr>
<th>Better understanding of subject matter</th>
<th>Educational activities to use with students</th>
<th>More comfort with subject matter</th>
<th>Learning opportunity to meet with other teachers/collaboration</th>
<th>More comfort with teaching subject matter</th>
<th>Learning to use inquiry-based methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Better understanding of subject matter</td>
<td></td>
<td>-1.64317</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Educational activities to use with students</td>
<td>-2.54</td>
<td></td>
<td>-4.42719</td>
<td>-2.7735</td>
<td>-2.54</td>
</tr>
<tr>
<td>More comfort with subject matter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning opportunity to meet with other teachers (collaboration)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More comfort with teaching subject matter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning to use inquiry-based methods</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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)”

<table>
<thead>
<tr>
<th>Better understanding of subject matter</th>
<th>Educational activities to use with students</th>
<th>More comfort with subject matter</th>
<th>Learning opportunity to meet with other teachers/collaboration</th>
<th>More comfort with teaching subject matter</th>
<th>Learning to use inquiry-based methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Educational activities to use with students</td>
<td>-5.17549</td>
<td></td>
<td></td>
<td></td>
<td>-4.24264</td>
</tr>
<tr>
<td>More comfort with subject matter</td>
<td></td>
<td>-5.17549</td>
<td></td>
<td></td>
<td>-4.24264</td>
</tr>
<tr>
<td>Learning opportunity to meet with other teachers (collaboration)</td>
<td></td>
<td></td>
<td>2.826505</td>
<td></td>
<td>-2.79078</td>
</tr>
<tr>
<td>More comfort with teaching subject matter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning to use inquiry-based methods</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**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).
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.

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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.
REFERENCES


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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)
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.
Teacher Learning

______ 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.

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