

Science Teachers' Beliefs About the Role of Curriculum Materials in Teaching and Learning
Melissa Luna
Northwestern University

Science Teachers' Beliefs About the Role of Curriculum Materials in Teaching and Learning

Introduction

As science education undergoes change, teachers are being asked to teach science differently using new reform-based curricula. These curricula call for teachers to engage their students both in the process and content of science in deep and meaningful ways. Yet this is often challenging for teachers to do. While we know some about *how* teachers interact with these reform curricula and *how* they use such curriculum materials in their practice, we know less about *why* they interact and use (or do not use) the curricula as they do. Asking *why* brings us into the realm of teacher beliefs and offers insight into the relationship between how and why teachers use science curriculum materials as they do. Clearly, many different kinds of teacher beliefs contribute to this relationship. For example, teachers may draw on their beliefs about students, pedagogy, learning, and subject matter (Pajares, 1992) to inform their use of curriculum. This study focuses on one such area—teachers' beliefs about the role of science curriculum materials.

In particular, this study is exploratory in nature and seeks to identify two teachers' beliefs about the role of science curriculum materials in their teaching and in their students' learning. I begin this paper by describing the prior work and conceptual framework that informs this work. Then I describe my research design and methods. Next, I present cases of two middle school science teachers and discuss how their beliefs about curriculum materials lie within the conceptual framework described earlier. Finally, I conclude with a brief summary of the findings and discuss how this will inform my next steps in this larger research project.

Conceptual Framework

The question of how teacher beliefs and practice relate is certainly not new. A number of researchers have studied the relationship between teacher knowledge, beliefs, and practice (Richardson et al., 1991; Guskey, 1986; Cohen, 1990; Thompson, 1984.) More specifically, researchers have looked at

the relationship between teacher beliefs and curriculum use. Remillard & Bryans (2004), for example, describe how elementary math teachers' orientations toward curriculum influence their implementation of such curriculum. In a different subject domain, Holt-Reynolds (2000) examined how high school English teachers interpret their roles as literature teachers and how that interpretation influences their curriculum practice. Specifically, in the domain of science teaching and learning, researchers have looked at the relationship between science teachers' identity and practices (Helms, 1998; Enyedy, Goldberg, & Welsh, 2005; Sloan, 2006), between science teachers' knowledge and their enactment of curriculum (Schneider & Krajcik, 2002; Schneider, Krajcik, & Blumenfeld, 2005), and even between teachers' beliefs about features of science as subject matter and their curriculum use (Stodolsky & Grossman, 1995). However, missing in this work is research that has looked specifically at science teachers' beliefs about science curriculum materials.

Therefore, in an attempt to address this gap, this study identifies and characterizes the nature of teachers' beliefs about science curriculum materials by examining four dimensions of such beliefs. (See Table 1 below.) This conceptual framework includes beliefs about (a) science and how it is learned, (b) the role of science curriculum materials in teaching, (c) the role of science curriculum materials in student learning, and (d) the important features of science curriculum materials. Prior work informs this study and defines the first two of these dimensions.

Table 1: Dimensions of Teacher Beliefs about Science Curriculum

| Ideas about Science and how it is learned | Role of Curriculum Materials in Teaching | Role of Curriculum Materials in Student Learning | Important Features of Curriculum Materials |
|--|--|---|---|
| <i>Science is...</i> | <i>Sees curriculum for themselves as...</i> | <i>Sees curriculum for students as...</i> | <i>Pays attention to...</i> |
| <i>Inquiry, discovery of natural laws, curiosity, creativity</i> | <i>Guide (step-by-step instructions)</i> | <i>Source of science knowledge (content and/or process)</i> | <i>Activities</i> |
| <i>Scientific Method, processes of science</i> | <i>Resource (provides ideas, activities, etc.)</i> | <i>Activities to support learning science</i> | <i>Content Knowledge</i> |

| | | | |
|--|---|---------------------------------------|------------------|
| <i>Body of facts, laws, formulas established by scientists</i> | <i>Support for Teacher Learning</i> | <i>A model of scientific practice</i> | <i>Standards</i> |
| <i>Conceptual construction and evolution of theories</i> | <i>Road map (provides scope and sequence)</i> | | <i>Process</i> |
| | | | <i>Sequence</i> |

First, a number of researchers have studied the different ways teachers describe science as a discipline (Yerrick et. al., 1997; Duschl, 1983; Brickhouse, 1990). Four main ways of describing science as a discipline come out of this work. Teachers may describe science as inquiry about and discovery of natural laws, as a process of following the scientific method, as a body of known facts, or as the conceptual construction and evolution of theories. I include this dimension in this framework because I believe that the beliefs a teacher holds about science as a discipline likely inform the beliefs one holds about science curriculum materials in teaching and learning science.

Second, other researchers have examined the way teachers describe the role of curriculum materials in their teaching (Remillard & Bryans, 2004; Drake & Sherin, 2006; Remillard, 2000). In particular, four approaches have been identified. For example, teachers may describe curriculum as a guide. In this sense teachers use curriculum materials as step-by-step instructions informing them very specifically about what to teach and how to teach. Or, teachers may describe curriculum as a resource, in that they consult the curriculum materials for ideas and suggestions rather than instructions. Alternatively, teachers may describe curriculum materials as a support for their own learning. In this sense they may also consult curriculum materials but for increasing their own content knowledge rather than for ideas and suggestions about teaching. Finally, teachers may describe curriculum as a road map in that they adhere to the scope and sequence offered by the curriculum, but also supplement this with their own ideas, activities, and content. It is important to note that these ideas about the role of curriculum materials in teaching come from research with mathematics teachers. Exploring this issue with science teachers, may

reveal important differences, or confirm that these beliefs about curricula hold for science teachers as well.

The third and fourth dimensions of the framework extend prior research by exploring two aspects of teacher beliefs about curriculum materials that are primarily absent in the literature. First, the third dimension included in this study examines science teachers' beliefs about the role of curriculum materials in their students' learning. This gap in the literature seems important to consider as teachers' ideas about how curriculum helps their students learn arguably influences not only how they use the curriculum but certainly why they choose to use it as they do. If, for example, a teacher believes a curriculum should be a provider of science content knowledge for students, and nothing more, he or she may make decisions about the curriculum that support this belief but close off the potential of a curriculum (Ben-Peretz, 1990) for other purposes such as teaching scientific discovery or process. I suspect science teacher beliefs about the role of curriculum materials in their students' learning will also influence and be influenced by the other dimensions previously discussed and included in this study.

Finally, the fourth dimension I examine here concerns science teachers' beliefs about the important features of science curriculum materials. While a number of researchers have studied how teachers evaluate curriculum materials (Davis, 2006), none have looked at what science teachers perceive as important features of curriculum associated with their beliefs about science, about the role of curriculum materials in teaching, and about the role of curriculum materials in students' learning. Arguably, teachers will pay attention to the features of curriculum which support their beliefs about curriculum.

The primary value of this study is in bringing these four dimensions together in order to understand the nature of two middle school science teachers' beliefs about science curriculum materials. Each dimension tells a piece of the story, but by looking for and identifying patterns among the four dimensions, we may begin to tell more of the story about why science teachers use (or do not use) science curriculum materials as they do.

Methodology

The research for this paper has served as preliminary research for my larger second year project and has allowed me an opportunity to pilot my methods as well as inform my next steps. In order to identify and characterize the nature of science teachers' beliefs about curriculum materials, this study includes two different types of teacher interviews: a depth interview (Miller & Crabtree, 1999) and a clinical interview (Ginsberg, 1997). The depth interview's purpose is to draw out and make explicit a teacher's implicitly held beliefs about science curriculum materials related to the four dimensions discussed previously. This method of interviewing was selected because of its utilization of open, direct interview questions allowing teachers to tell their stories in non-intimidating and meaningful ways. Because this study is exploratory, and my goal is to discover evidence of teachers' beliefs about science curriculum materials, I entered the depth interviews with specific questions in mind about this particular topic of study. (See Appendix A for the depth interview protocol.)

The clinical interview's purpose is also to draw out and make explicit a teacher's implicitly held beliefs about science curriculum materials, but through a means other than posing open-ended questions. In this study, the clinical interview is intended to engage the teacher in a cognitive task while using a think-aloud protocol (Ericsson & Simon, 1984). Specifically, the teacher is presented with three different middle school science curricula consisting of a teacher's edition and a student book. The teacher is asked to focus on one topic presented in all three curricula, *how species change over time*, and choose the curricula they would use if asked to teach this topic to their students. Essentially, they are evaluating the curriculum materials, a task teachers are often faced with in their everyday teaching lives. As the teacher compares and evaluates the curricula, they are instructed to think aloud in order to make their thinking about the curriculum materials transparent. This interview ends with some follow-up questions related to the task. (See Appendix B for clinical interview protocol.)

Two middle school science teachers in a large suburban school district in northeastern Illinois participated in this study and were interviewed two times each, once using the depth interview and once using the clinical interview. The depth interview was audio taped and the clinical interview was videotaped. All interviews were transcribed and analyzed.

The Teachers

Mr. F is an eighth grade middle school science teacher. He has been teaching for 36 years, 35 of which have been at his current school. He holds a BS degree in biology and a MSED degree in administration and supervision. The eighth grade science curriculum at his current school focuses on chemistry and physical science.

Ms. K teaches sixth grade science and math in the same school district as Mr. F. but at a different middle school. She has five years of teaching experience. She holds a BS in communication and secondary teaching. The sixth grade science curriculum at her school focuses on earth science. Both teachers currently use the same science curriculum series which was adopted district wide this year.

The Science Curricula

Three different middle school science curricula were included in this study: (1) *Glencoe Science: An Introduction to the Life, Earth and Physical Sciences*, (2) *BSCS Science & Technology: Investigating Life Systems*, and (3) *IQWST: Struggle in Natural Environments, What will survive?*. *Glencoe Science* is a survey type middle school science curriculum which includes life, earth, and physical science topics. Student textbooks include a combination of illustrations, content, and hands-on activities/labs. *BSCS Science & Technology* series is an activity-based middle school science curriculum. The *BSCS* student textbooks also include a combination of illustrations, content, and activities, but with an emphasis on inquiry and collaboration. *IQWST* is a project-based middle school science curriculum with an emphasis on inquiry and technology focused by a driving question. The student reader for this curriculum is a combination of short readings and inquiry-based investigations. The first two of these curricula are published and complete, while *IQWST* is still being developed and currently has 2 complete units (one of which is included in this study).

Analysis

To analyze the transcripts, I looked for evidence of the four dimensions of curriculum beliefs present in the teachers' narratives during both the depth and the clinical interviews. Recall these dimensions are beliefs about (a) science and how it is learned, (b) the role of science curriculum materials

in teaching, (c) the role of science curriculum materials in student learning, and (d) the important features of science curriculum. I read each transcript and initially noted areas of narrative that corresponded with each dimension. This first level of analysis provided me a picture of the data and allowed me to sense whether the interviews were effective in eliciting teachers' beliefs and also whether there was evidence of these four dimensions in the teachers' beliefs about curriculum materials.

Results

First Impressions

Mr. F

I interviewed Mr. F in his classroom on two different days immediately after the last school bell rang. During both interviews, Mr. F pointed out science curriculum materials that he likes and uses as well as those that he is required to use. Prior to this school year, Mr. F used the same science curriculum for 35 years (*Introductory Physical Science or IPS*) with some piloting of various other programs throughout his career. He now teaches using the science curriculum adopted district wide this year though he expressed discontent with the choice of this curriculum:

If I were king, we wouldn't be using it [the adopted curriculum]. If I were king, I'd be using the 8th edition of Introductory Physical Science...It's horrible preparing kids for an ISAT test because it's extremely narrowly focused. But it's rich. It teaches kids how to do lab work. It teaches kids, you know, kids will understand how an atomic model is arrived at because they will have done a lot of classic experiments. They don't, nobody tells them about the philosophy and the law of conservation and mass, they do five experiments where they see mass change because they have already learned volume changes. Anyway, I'm not here to sell it, it is just that.

Ms. K

I interviewed Ms. K in her classroom during her lunch period on two different days. Ms. K does not have a lot of experience using one set of science curriculum materials consistently as she has only been teaching for 5 years. Prior to this school year, Ms. K drew from many different curricula to teach

science. She expressed favor towards a particular piece of science curriculum called *Behavior Matters* from Northwestern's *LeTUS* curriculum. In fact, throughout both interviews, Ms. K talked about this unit repeatedly and at the completion of the interview showed me all the student projects that came from it. She also expressed disappointment that she may not be able to continue using the *Behavior Matters* unit because it doesn't fit in with the newly adopted district wide curriculum.

I love LeTUS for the hands-on, it's group-based. I love the fact that the kids start to see connections, but you don't tell them outright what the connection is. Like they'll get it, it will click...I think we are the only school that did LeTUS, but I don't know if they will let us do it next year, but we might.

Dimensions of Teachers' Beliefs About Science Curriculum Materials

The First Dimension. The teachers' beliefs about science and how it is learned became apparent during both the depth interview and the clinical task interview. Interestingly, both teachers expressed ideas about science in various ways rather than a single consistently expressed idea. For example, Ms. K talked about science as inquiry but emphasized learning science as a body of facts, and Mr. F. talked about science as a process, but also described it as discovery. However, both teachers emphasized one idea more often throughout both of their interviews.

Mr. F

At the start of the depth interview when asked what science is, Mr. F simply responded, "It is the way we find the truth." From this early point and throughout both interviews Mr. F's emphasis remained on science as a process that allows us to find the truth. It was difficult to discern throughout the interviews whether Mr. F expressed more strongly the idea of science as a process to be followed or the idea of science as inquiry and discovery. Later when he talks about curriculum materials and engages in the clinical task, it becomes apparent that he believes science is a process that should be followed to find truth, this process includes discovery, but is not necessarily only about discovery. For this reason, I characterize his belief about science and how it is learned as process over discovery. Mr. F expresses this as he talks about his belief that science is a process of finding the truth:

...to me almost anything is science if you're trying to find out what things are, things are really truthful in the world...But, the fact that science is a way of really discerning the truth, is, you know, and if you discern the truth, through experiences and investigations, seeing if, hey, is this always the case, then you are doing science.

Further, he talks about how learning science is a process of induction:

Science is an inductive, is an inductive way of learning, and basically, science is induction. That means, you know, you look at individuals, events, and you try and find patterns, and then you wonder why they exist, and then you put forth ideas as to why they exist and then you test to see if you are right.

In sum, Mr. F expresses his beliefs about science and how it is learned by describing science as a process. This process involves finding knowledge by experiencing, wondering, asking questions, and investigating the world.

Ms. K

When asked what science is, Ms. K did not have a simple quick response as Mr. F did. Throughout both interviews, Ms. K oscillated between the idea of science being inquiry and making connections and between science being a body of facts. For example, we see evidence of Ms. K going back and forth as she discusses how kids should learn science:

With an inquiry base, you know, where kids are doing activities and they actually see it. They also need, they also need follow up, you know, they do need to have background information and also involved with reading it, but I think lots of kids, they remember more things by doing actually seeing it, they get more excited, whereas reading all the facts in the book, I think, it's just a bunch facts, if they don't put it to use or make a connection, they will just forget.

Ms. K did talk consistently, however, about science as inquiry in the form of asking questions and discovery as testing those questions. This is evident as she talks about science as asking and answering the *what if's* in the world:

...if you would start up with maybe a general problem, like you would think, okay, you know, what happens to this plant if we don't give it water. What ifs, in science you can actually like test out what you think, like what if I add more of this, you can actually test it, set up an experiment and see your results. So you can change a lot of things, and then, plus your answer, you can actually see the result and then you can go back and test it again...

In sum, Ms. K expresses her beliefs about science and how it is learned as both being inquisitive and learning a body of facts. She seems to place a slighter emphasis on science as inquiry, however.

The Second Dimension. The teachers' beliefs about the role of science curriculum materials in their teaching also became apparent during both the depth interview and the clinical task interview. The teachers revealed very different ways they viewed science curriculum materials in their teaching.

Mr. F

During the clinical interview, Mr. F immediately picked up the student editions rather than the teacher editions and stated he could get everything he needed from the student editions. He expressed a dislike for teacher editions in general. Though at one point he retrieved a teacher edition that he did like from his own library and discussed why he liked it, thereby revealing his ideas about the role of science curriculum materials in his teaching:

What makes this a good teacher's guide, if I want to see what the students are seeing I use the student book. This has almost nothing from the student book in it. There's some general, it starts out with some general, I mean it basically tells you what's going on, what you need to be successful...They tell you just what you need to know by section. In other words, there's no point putting in the text [from the student edition], if you want to see the text you look at the student book.

Later he said,

I mean, I look at a book that has, you know, most of the sections in the book are experiments, it's really a lab manual, and then you have your transitory passages in between that provide the content. I am pretty happy with that.

From these comments, it seems Mr. F uses science curriculum materials as a resource to support his teaching. If it tells him what he needs to be successful, whether that is a list of materials or a paragraph on background knowledge, he is satisfied. He doesn't follow the curriculum step-by-step, but he relies on it for support in the practicalities of teaching the lessons. However, Mr. F also expressed the idea that teachers may need to learn from curriculum materials,

You know most of us are only a couple of steps removed from the kids. You know we have to learn things like they do. Despite greater background knowledge, we, you know, it takes awhile to pull everything together...

and the idea that teachers need to use a curriculum sequentially because the topics build on each other:

...you see in a good program, the teaching of everything you do is gonna effect everything else later on. And it should interrelate, and it's important to understand that. For years I've had people say "Oh I don't teach all of IPS, I do parts of it". I say well that's kind of hard to do because almost everything you do relies on something that you've done earlier.

In sum, Mr. F views the role of science curriculum materials in his teaching in various ways except as a step-by-step guide. Though not emphasized throughout his interviews, he does believe science curriculum materials can support teachers' learning. However a stronger emphasis is expressed in his belief that science curriculum materials should serve as a resource and the curriculum as a whole should provide a road map telling him where to go next in order to build upon his students' knowledge.

Ms. K

Ms. K was much more clear in her ideas about the role of science curriculum materials in her teaching. She believes science curriculum materials should serve as a resource that teachers can draw from and as a support for her own learning about the science content:

Well, they give you an idea of, I would say, like important concepts, maybe how to phrase things, activities, what activities to do, I think curriculum materials, they just, they basically help you, give you ideas. Basically, also to, read the information, make sure you have a good understanding of it, and make sure that, you know, make sure that you are presenting the content correctly and also make the correct connections. So I think all around curriculum materials help you, just to give you ideas, just to verify information, and just to build on activities.

She also expressed what role she wouldn't want science curriculum materials to play:

I wouldn't like it if I was told you have to. You can't use anything else except this. Right, I wouldn't say like you need to do this activity, you have to do this, I like it where you, there is sort of leeway, it has to be flexible. Because teachers have to be flexible.

Finally, Ms. K discusses her belief about how teachers use science curriculum materials:

I think teachers all the time mix their curriculum, I mean, I am sure teachers all the time pull things from, you know, if they see, if they remember a, I don't know, a good idea from somewhere else, I think they will pull it out. Or if you have some supplemental books, you know, and they have a nice activity, you will pull it up and do it.

Like Mr. F, Ms. K rejects the idea of science curriculum materials serving as a step-by-step guide.

Different from Mr. F, however, she does not express a belief in following a curriculum sequentially as being important. Instead, she believes she can draw ideas, activities, and content from various science curriculum materials in order to build a cohesive plan for teaching.

The Third Dimension. The teachers' beliefs about the role of curriculum materials in their students' learning corresponded closely with their ideas about science and how it is learned.

Mr. F

Earlier, Mr. F described science as a process and that learning science is best achieved by engaging in this process. Similarly in terms of the role he wants curriculum materials to play in his students' learning, Mr. F expects the materials to not only focus on the process of science but to also repeatedly engage kids in that process:

I believe it's, instead of organizing a program around content, you have to run it around lab work. Science by it's nature is observing, hypothesizing, you know, devising, it's investigating, it's, you have to do that and you have to do it routinely and you have to do it enough so that kids get in the pattern of it and feeling at ease with doing it.

He again emphasizes science as process as he discusses how he would design a middle school science curriculum:

So, I would try to set it up based on what kids need to learn to do as a process and then instead of having all this content where we are scrambling to find labs to go with it, I would rather have the labs set up as the, we need to do this, we need to do this, they need to do this, science is a lab course, this is your lab, then fill in the content around that.

Finally, in learning from science curriculum materials, Mr. F expresses how he wishes his students would engage more fully with these materials:

I want them to enjoy the text. I want them to explore the text. I want them to do anything but think that reading the text is a chore, a task to be done...at some point it's got to be meaningful to them. I want them to enjoy it, I want them to go and go to classzone.com and start looking and playing with the simulations as if they were looking at videos on You-Tube. There's riches there, I show it to them, but I, I will sit down and say, here, let me show you something here, and then, there he goes again, playing with, oh, you know, that's it, I wanted you to see it and look at it, if you don't want to use it, don't use it, but it's there in case you need it, know it's there.

So, in sum, Mr. F believes the role of science curriculum materials in his students' learning is to teach students science as process through doing labs. He also believes science curriculum materials should be interesting enough to engage the students in this process willingly.

Ms. K

Like she did in her beliefs about science and how it is learned, Ms. K oscillates in her ideas about the role science curriculum materials should play in her students' learning. On the one hand, she expresses that these materials should serve as a reference for content, and on the other hand she wants the materials to engage her students in inquiry. For example, when asked how she has her students typically use science curriculum materials to help them learn, Ms. K explains,

As a reference, to read it, to get a preview of what we are talking about. Maybe I will say read section 1.1, we are going to discuss it tomorrow, as a, you know, using the reading guides to go along with the chapters, having them, how do you say it, I don't know, I guess it's probably just reading for the content. Maybe using the content and getting familiar with the terminology, with the concepts.

In addition, she discusses how, specifically, science curriculum helps her students learn:

Well, I guess maybe the first, you know, this might be a generic, but maybe how to use a text, a science textbook, which they will have to use in the future. You know, they will have to know, how to read a science textbook, you know, why is it important to check, to do the questions where it says to check your reading, why is it important to maybe do the extended questions, where they really have to think about it, learn the vocabulary, maybe it's just helping them for their future school career.

Yet when discussing which kinds of science curriculum materials helps and hinders her students' learning, Ms. K says,

Inquiry based helps them the most, straight like book and answer questions hinders them the most. You know, if you're just a science teacher, you can say, okay, we're just going to, and that's all you do, is just say read this, here it is, and no nothing else. I think that

would hinder them, that would be a turn off. I wouldn't like that, if it was just like questions, read the book, answer questions, read the book, answer questions, read the book, answer questions. They have to mix it up.

In sum, we again see Ms. K go back and forth between emphasizing science content over science process and vice versa. From these comments, however, it seems, that she believes the role of science curriculum materials in her students' learning should primarily be to provide science content knowledge.

The Fourth Dimension. The teachers' beliefs about the important features of curriculum materials remained consistent with the ways they expressed ideas about science, the role of science curriculum materials is teaching, and the role of science curriculum materials in their students' learning. Mr. F, for example, primarily paid attention to labs in the science curriculum materials, while Ms. K primarily paid attention to content first and then activities.

Mr. F

As discussed previously, Mr. F immediately turned to the student editions of the science curriculum materials and looked for labs, commenting both on the presence of lab type activities and the quality of such activities. For example, paging through the *IQWST* curriculum, he says,

Here there's a lot of data, investigating, a lot of labs. And I don't care if they're doing research out in the field or working with data sets that are provided on CD's or graphs. It's still manipulating. You know you can do science without being the one who actually goes out and collects the data. As long as you have data that you get to manipulate, you know I think that fosters higher level thinking skills.

Again, we see his emphasis on labs when he comments on the *Glencoe* curriculum:

Well, I'm looking at labs. I'm looking at labs and, you know, I was, this book is better than I thought it was at first glance. It looks like it's written simple and it's got simple illustrations, but they do have, it looks like they have a number of very nice quantitative labs written. And in life science that's not always easy. I'll assume that they have them in physical science as well.

Finally, Mr. F chooses the *IQWST* curriculum as the one he would like to teach from over the others. Evident in his characterization of this science curriculum are the ideas and beliefs about science curriculum materials he expresses throughout:

That this looks like a good, single-focus, story-line driven, program that's very inductive, and causes the kids to do high level learning at least at analysis level and higher. They've got to work with data sets, work with simulations, and spend a lot of time working in lab.

This is not a content-driven program. This is a process-driven program.

When interacting with science curriculum materials in a cognitive teaching task, Mr. F remained consistent in his expressed beliefs that science is a process that we learn inductively and that science curriculum materials should teach kids this process by repeatedly engaging them in it.

Ms. K

Ms. K's emphasis on content and inquiry is also evident as she engages in the clinical task of choosing a science curriculum to teach from. She chooses the inquiry-based science curriculum (*IQWST*) because,

I just know from what I looked at, I know this is more inquiry-based, students doing activities and finding out solutions for themselves. It's not as traditional. It's like more flexible. You can, you know, have a good outline for what, you know teacher-guided, you know, what you should do as a teacher, what questions you need to ask to get the students thinking. It's more hand-on.

But Ms. K also describe how she would redesign this curriculum by placing more emphasis on science content:

...I would almost like, you know maybe they could have some like, like more content in their books. Like more, you know, part of the book stuff [points at the Glencoe curriculum], in here [points at the IQWST curriculum]. Content wise, or even activities, you know, even of a page of just "these are the words you're going to learn", here at the

end, "these are the vocabulary words". A couple of things that are more traditional in here. Because I like, I like this.

Yet again Ms. K goes back and forth between her idea that science curriculum should help students learn science by focusing on content and her idea that it should help students learn science by focusing on inquiry. She explains the value of the *IQWST* curriculum for her students' learning:

To make them start thinking and not just say "Okay, what's the answer?" To make them start inferring and assessing, questioning, and making the connections themselves.

Verses being told, because, you know, if you do the book [turns to the BSCS curriculum], okay books, you know, okay, I like content. I can't say, I do like having that back up for content. Say "okay, kids just read. Just, just read." But you know it's almost nice where they kind of make the connection themselves, or see, or do, where they can get the answer.

Like Mr. F, when interacting with science curriculum materials in a cognitive teaching task, Ms. K remained consistent in her expressed beliefs about science curriculum materials. Ms. K consistently emphasizes science as both inquiry and as a body of facts to be learned.

Discussion

The purpose of this study was to identify and characterize two teachers' beliefs about the role of science curriculum materials in their teaching and in their students' learning. Returning to the conceptual framework of the four dimensions of beliefs about science curriculum materials, we can see that Mr. F and Ms. K's beliefs look differently and different patterns emerge within the framework. Mr. F sees science primarily as a process. As a result, his emphasis on science as process manifests itself throughout the remaining dimensions. Table 2 below shows this pattern in MR. F's beliefs. The darker shaded boxes demonstrate that Mr. F placed more emphasis on this particular belief, while the lighter shaded boxes indicate less emphasis.

Table 2: Mr. F's Beliefs about Science Curriculum Materials

| Ideas about Science and how it is learned | Role of Curriculum Materials in Teaching | Role of Curriculum Materials in Student Learning | Important Features of Curriculum Materials |
|--|--|---|---|
| <i>Science is...</i> | <i>Sees curriculum for themselves as...</i> | <i>Sees curriculum for students as...</i> | <i>Pays attention to...</i> |
| <i>Inquiry, discovery of natural laws, curiosity, creativity</i> | <i>Guide (step-by-step instructions)</i> | <i>Source of science knowledge (content and/or process)</i> | <i>Activities</i> |
| <i>Scientific Method, processes of science</i> | <i>Resource (provides ideas, activities, etc.)</i> | <i>Activities to support learning science</i> | <i>Content Knowledge</i> |
| <i>Body of facts, laws, formulas established by scientists</i> | <i>Support for Teacher Learning</i> | <i>A model of scientific practice</i> | <i>Standards</i> |
| <i>Conceptual construction and evolution of theories</i> | <i>Road map (provides scope and sequence)</i> | | <i>Process</i> |
| | | | <i>Sequence</i> |

Ms. K, on the other hand, sees science as inquiry, but continues to emphasize science as a body of facts to be learned. These beliefs may or may not be conflicting, though I suspect that they are. Further analysis of the data is necessary in order to understand whether or not Ms. K expresses these as conflicting beliefs or not. Table 3 below shows the pattern of Ms. K's beliefs. Again, the darker shaded boxes indicate greater emphasis on a particular belief.

Table 3: Ms. K's Beliefs about Science Curriculum Materials

| Ideas about Science and how it is learned | Role of Curriculum Materials in Teaching | Role of Curriculum Materials in Student Learning | Important Features of Curriculum Materials |
|--|--|---|---|
| <i>Science is...</i> | <i>Sees curriculum for themselves as...</i> | <i>Sees curriculum for students as...</i> | <i>Pays attention to...</i> |
| <i>Inquiry, discovery of natural laws, curiosity, creativity</i> | <i>Guide (step-by-step instructions)</i> | <i>Source of science knowledge (content and/or process)</i> | <i>Activities</i> |
| <i>Scientific Method, processes of science</i> | <i>Resource (provides ideas, activities, etc.)</i> | <i>Activities to support learning science</i> | <i>Content Knowledge</i> |

| | | | |
|--|---|---------------------------------------|------------------|
| <i>Body of facts, laws, formulas established by scientists</i> | <i>Support for Teacher Learning</i> | <i>A model of scientific practice</i> | <i>Standards</i> |
| <i>Conceptual construction and evolution of theories</i> | <i>Road map (provides scope and sequence)</i> | | <i>Process</i> |
| | | | <i>Sequence</i> |

Though a lot of rich data has come from these two teacher cases, I am not sure at this point what conclusions can be drawn. It is tempting to conclude that these dimensions influence and are influenced by each other, and that we can predict patterns in teachers' beliefs based on these interactions. It seems at least in the cases of Mr. F and Ms. K that this is so because the beliefs that are expressed are consistent throughout both interviews. However, this is only a preliminary analysis of the data. The next level of analysis may begin to bring clarity as to whether and how these four dimensions interact and inform our understanding of teacher's beliefs about science curriculum materials, and whether patterns emerge that are consistent with certain beliefs. Each utterance needs to be coded in order to confirm this suggested consistency and interactions of these beliefs.

Next Steps

Before I continue these teacher interviews, I need to make a few changes in the interview protocols. First, the depth interview questions can be pared down somewhat. I found that while interviewing both of these teachers, they began to repeat their answers. Though the questions were different, I was getting repetition in responses. This is okay to a point, but perhaps annoying to the teacher who feels as though she is just saying the same thing over and over again.

Second, I need to use a different set of curriculum materials other than IQWST. I feel that IQWST because it is not in a published finished format somewhat led the teachers to grant it special status over the others. The BSCS curriculum does have an emphasis on inquiry, but neither teacher picked up on this. I wonder if it is because the IQWST curriculum looked and felt much different from the other two, so the other two were characterized as content-driven and traditional, while IQWST was characterized as

inquiry-based. So I want to use the *Investigations* curriculum (Edelson, 2005) that looks and feels similar to the others because they are in a complete published format.

Finally, I want to focus the clinical interview task more than I did initially. In this pilot study, I told the teachers to evaluate the curricula as though they were going to teach their students how species change over time. I discovered that this topic was not narrow enough and has too many interpretations. I think asking teachers to think about these materials as if they were going to teach their students about food chains and food webs will help them focus on the features the materials provide, rather than on the wider curriculum.

This study was a first step in my larger second year project. In these two cases of middle school science teachers, the four dimensions seem to make sense in characterizing the nature of science teacher's beliefs about curriculum materials. Further, it seems plausible that with more teacher participants, patterns will begin to emerge that can inform our understanding of teacher thinking and learning. If in the larger study, patterns are identified across teachers, this work will have both theoretical and practical importance. By exploring teacher beliefs about science curriculum materials, I will contribute to our understanding of science teacher thinking and learning. In addition, this research can inform the design of science curriculum materials so that they become more useful for teachers.

Finally, this work has implications for professional development around the use of curricula. For example, if we can describe certain patterns in teachers' beliefs about science curriculum, we may be able to design materials and teacher learning experiences that speak to those patterns. If my research can uncover specific patterns of teachers' beliefs about science curriculum materials, then curriculum designers as well as teacher educators can use this framework to inform their work. If we can plan for effective teacher learning when implementing a new science curriculum, then the actual enactment of the curriculum (the everyday decisions and practices using the curriculum) may more closely align with the curriculum's goals for science learning. Science teachers then may be better prepared to face the challenges of teaching science in new ways as called for by the new reform-based science curricula.

References

- Ben-Peretz, M. (1990). *The teacher-curriculum encounter: Freeing teachers from the tyranny of texts*. Albany, NY: State University New York Press.
- Brickhouse, N. (1990). Teachers' beliefs about the nature of science and their relationship to classroom practice. *Journal of Research and Development in Education*, 15(4), 13–18.
- Bruozas, M., Finn, L.-E., Tzou, C., Hug, B., Kuhn, L., & Reiser, B. J. (2004). Struggle in natural environments: What will survive? In J. Krajcik & B. J. Reiser (Eds.), *IQWST: Investigating and questioning our world through science and technology*. Evanston, IL: Northwestern University.
- BSCS Science & Technology: Investigating Life Systems (3rd ed.)*. (2005). Dubuque, IA: Kendall/Hunt.
- Cohen, D. K. (1990). A revolution in one classroom: The case of Mrs. Oublier. *Educational Evaluation and Policy Analysis*, 12(3): 311-329.
- Davis, E. A. (2006). Preservice elementary teachers' critique of instructional materials for science. *Science Education*, 90(2), 348-375.
- Drake, C., & Sherin, M. G. (2006). Practicing change: Curriculum adaptation and teacher narrative in the context of mathematics education reform. *Curriculum Inquiry*, 36(2), 153-187.
- Duschl, R. (1983). The elementary level science methods course: Breeding ground of an apprehension toward science? *Journal of Science Teaching*, 20, 745–754.
- Edelson, D. C. (Ed.). (2005). *Investigations in environmental science: A case-based approach to the study of environmental systems*. Armonk, NY: It's About Time.
- Enyedy, N., Goldberg, J. & Welsh, K. (2006). Complex dilemmas of identity and practice. *Science Education*, 90, 68-93.
- Ericsson, K. A., & Simon, H. A. (1984). *Protocol analysis: Verbal reports as data*. Cambridge, MA: The MIT Press.
- Ginsberg, H. P. (1997). *Entering the child's mind: The clinical interview in psychological research and practice*. New York: Cambridge University Press.
- Glencoe Science: An Introduction to the Life, Earth, & Physical Sciences*. (1999). Blacklick, OH: McGraw-Hill/Glencoe.
- Guskey, T. R. (1986). Staff development and the process of teacher change. *Educational Researcher*, 15(5): 5-12.
- Helms, J. V. (1998). Science—and me: Subject matter and identity in secondary school science teachers. *Journal of Research in Science Teaching*, 35(7), 811-834.
- Holt-Reynolds, D. (2000). What does the teacher do? Constructivist pedagogies and prospective teachers' beliefs about the role of a teacher. *Teaching and Teacher Education*, 16, 21-32.

- Miller, W. & Crabtree, B. (1999). Depth interviewing. In B. Crabtree & William Miller (Eds.), *Doing qualitative research* (pp. 89-108). Thousand Oaks, CS: SAGE.
- Pajares, M. (1992). Teachers' beliefs and educational research: Cleaning up a messy construct. *Review of Educational Research*, 62(3), 307-332.
- Remillard, J. T. (2000). Can curriculum materials support teachers' learning? Two fourth-grade teachers' use of a new mathematics text. *The Elementary School Journal*, 100(4), 331-350.
- Remillard, J.T. & Bryans, M.B. (2004). Teachers' orientations toward mathematics curriculum materials: Implications for teacher learning. *Journal for Research in Mathematics Education* 35(5): 352-388.
- Richardson, V., Anders, P., Tidwell, D., & Lloyd, C. (1991). The relationship between teachers' beliefs and practices in reading comprehension instruction. *American Educational Research Journal*, 28(3): 559-586.
- Schneider, R. M., & Krajcik, J. (2002). Supporting science teacher learning: The role of educative curriculum materials. *Journal of Science Teacher Education*, 13(3), 221-245.
- Schneider, R. M., Krajcik, J., & Blumenfeld, P. (2005). Enacting reform-based science materials: The range of teacher enactments in reform classrooms. *Journal of Research in Science Teaching*, 42(3): 283-312.
- Sloan, K. (2006). Teacher identity and agency in school worlds: Beyond the all-good/all-bad discourse on accountability-explicit curriculum policies. *Curriculum Inquiry*, 36(2), 119-152.
- Stodolsky, S., & Grossman, P. (1995). The impact of subject matter on curricular activity: An analysis of five academic subjects. *American Educational Research Journal*, 32(2), 227-249.
- Thompson, A. (1984). The relationship of teachers' conceptions of mathematics teaching to instructional practice. *Educational Studies in Mathematics*, 15: 105-127.
- Yerrick, R., Parke, H., & Nugent, J. (1997). Struggling to promote deeply rooted change: The "filtering effect" of teachers' beliefs on understanding transformational views of teaching science. *Science Education*, 81, 137-159.

Appendix A

Interview #1 Protocol: Depth Interview

Introduction:

First, I am interested in your ideas about science: What science is, how it is learned, how it is taught...so I am going to ask you questions that will get at your ideas about science. Any questions before we begin?

1. In a general sense, what is science?
2. Can you describe a time of you doing science? What do you do when you “do science”? What makes this science?
3. Can you describe what scientists do? What kinds of things do scientists do?
4. How would you describe science in the everyday world?
5. How is science that kids do in school different from or the same as science that scientists do? Different from or the same as everyday science in the world?
6. What’s the best way to learn science? For you? For your students?
7. What is the best way to teach science?

Okay, now I am interested in understanding your ideas about science curriculum and curriculum materials and how these relate to your teaching and your students learning.

1. How do you decide what to teach in science? How do you decide how to teach these things?
2. If you were asked to choose a science curriculum for your school, what kinds of things would you look for? What kinds of things would cause you to not consider the curriculum?
3. Let’s say you are planning your lessons for the week. Describe how you typically use your science curriculum materials.
4. Now let’s say you are teaching these lessons. Describe how you use your science curriculum materials while teaching.
5. Do you typically use your curriculum materials in any other ways you haven’t already described?
6. Describe the curriculum and/or the curriculum materials you currently use in teaching science. How long have you been using this curriculum/these materials?
7. Have you used other curricula or curriculum materials in teaching science? When? Describe.
8. How are these different curricula/curriculum materials similar? How are they different?
9. What has been your favorite science curriculum to use? Why?
10. Least favorite? Why?
11. Easiest? Hardest?
12. How do curriculum materials help you? What do you find useful?
13. How do curriculum materials hinder you? What do you find not useful/waste of time?
14. How do curriculum materials support you in your teaching?
15. How should science curriculum be designed so it is helpful for teachers?

16. Think back when you were a student, do you remember using science curriculum materials in class? Can you describe how you learned from these materials?
17. Now, as a teacher describe how you have your students typically use science curriculum materials to help them learn?
18. How do you think these materials help them learn?
19. Of all the science curriculum materials you use or have used, which are/were best in terms of student learning? Why? Which helped students learn most? Which hindered students most?
20. Again, if you were asked to choose a science curriculum for your school, what things are you looking for that will help students learn science? What things would cause you to not consider the curriculum in terms of helping/not helping students learn?

Appendix B

Interview #2 Protocol: Clinical Interview

Evaluating Different Curricula Task

In this task I will ask the teacher to spend some time looking over three different middle science curricula to determine which one he/she would choose to use in his/her classroom. In order to focus the task, I will ask him/her to focus his/her exploration of the materials on a specific topic/unit that is present in all three curricula. (change in species over time). As the teacher looks them over I will ask him/her to think aloud about the things he/she is noticing and the things that are influencing his/her choice. Throughout the task, I will prompt the teacher with questions such as *Why is that important?* or *What are you thinking about when you look at that?* in order to make his/her thinking and decision making process more transparent. After the teacher has indicated which curricula he/she would use, I will end the task with some follow-up questions.

- Why did you choose this curriculum over the other two?
- What were the selling points for you? (What are the greatest strengths of this curriculum?)
- Any concerns?
- How would this curriculum support you in your teaching?
- How would this curriculum support your students' learning?
- What are the pros and cons of the two you did not choose?
- How would you characterize each of these curricula?
- Any features of these curricula that you didn't care about or didn't consider in your decision? Why?
- Of the two you did not choose, which one would you rank as the least desirable for use in your classroom? Why?
- If you could use all three of these in your teaching which features would you take from each?