FRAMING OUR WORK

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The theme of this conference, "Frameworks that Support Research and Learning," invites us to take stock of where we are as a field with respect to frameworks, which are a critical element of scholarly inquiry. In an effort to take stock, I briefly review the purpose of frameworks, make the case for why we need more robust frameworks, and suggest approaches that might lead us to more robust frameworks.

Model. Construct. Theory. Paradigm. Framework. To some, these words have vastly distinct meanings, while to others they are separated by shades of grey. Dictionary definitions (Houghton-Mifflin, 2004) of these terms would favor the shades-of-grey school of thought:

Model: A schematic description of a system, theory, or phenomenon that accounts for its known or inferred properties and may be used for further study of its characteristics.
Construct: an abstract or general idea inferred or derived from specific instances.
Theory: The branch of a science or art consisting of its explanatory statements, accepted principles, and methods of analysis, as opposed to practice: a fine musician who had never studied theory.
Paradigm: A set of assumptions, concepts, values, and practices that constitutes a way of viewing reality for the community that shares them, especially in an intellectual discipline.
Framework: A set of assumptions, concepts, values, and practices that constitutes a way of viewing reality.

Given the relative cohesiveness of these terms as defined above and the fact that some of them can be combined (e.g., theoretical framework), I am going to use the term *framework* throughout this paper to be consistent with the conference theme. However, I do want to identify some terms that I am deliberately omitting from this paper. I make a distinction between a theoretical *perspective/orientation/viewpoint* and a theoretical *framework*. A theoretical perspective is a world-view that influences one's approach to professional life, in general. Wikipedia defines a perspective as "the choice of a single point of view from which to sense, categorize, measure or codify experience, typically for comparing with another. Viewpoint is another word for this principle - with a similarly broad interpretation. It may be visual and/or mental, related to cognition." Examples of theoretical orientations include radical constructivism, postmodernism, and interpretivism. While reports of research are certainly strengthened by revelation of the authors' theoretical stance, most people do not find this difficult to do. Thus, I am confining my remarks to what I see as the area in which our field needs more work–both in

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explicitness and robustness–that of theoretical frameworks.[1] I am by no means the first person to suggest that we need to grow as a field in this arena. Indeed, several plenary speakers at the 1991 PME-NA conference addressed this topic (viz., diSessa, 1991; Eisenhart, 1991).

Roles and Purposes of Frameworks

Consider the every day uses of a frame–a picture frame, a bed frame, or the frame for a house under construction. These frames serve various purposes that parallel the use of frameworks in mathematics education research. A picture frame serves to demarcate an image and set it off so that it will be noticed by others and can be easily distinguished from the wall on which it is hung. The material from which the frame is made, the size of the frame, and the placement of the frame in relation to the image all influence how an observer processes the image. A bed frame serves as a base upon which a mattress can be placed without fear of the mattress warping or sagging with time. A house frame provides an underlying structure to support the sheetrock, floor joists, and roof that make up the house. Without the framing, the house would collapse upon itself. The purposes of a theoretical framework are similar. A theoretical framework can help "set off" ideas from other data to draw attention to them, giving them names and robust definitions. It can support the building up and deepening of an idea, or it can provide a structure on which to hang new ideas.

Thus, a framework can serve multiple purposes. In a particular study a framework may serve only one of these purposes, or it may serve several of them. Further, a framework can be somewhat minimalist, as in the case of a picture frame, or it can be quite robust and well-tested, as in the case of a house frame. As with everyday frames, frameworks are not right or wrong. They must fit the researcher and the data; some are a better fit than others, but they are not inherently right or wrong.

As a graduate student, I struggled with the notion of a theoretical framework. I really thought it was something I had to put in Chapter 2 to satisfy my dissertation committee; I did not see its relevance and usefulness as a research tool. The most common and biggest flaw I see in manuscripts that I review for journals is that authors go to some trouble to describe a theoretical basis for their work, but these ideas never appear again later in the paper. They seem to be parading their theory before the reviewers but not actually *using* it. Ideally, theory ought to be the element that undergirds an entire research project from the research questions to the conclusions. In the papers written from that research project, theory should wind and weave throughout a paper and be used to "tie it all up" in a neat package at the end. As a manuscript reviewer, I want to see how the theory relates to the research questions, the data collection methods, and the analysis of results. A framework is what moves a manuscript from an anecdotal account to a scholarly piece of literature. Ideally, I also want to see the author tie the results to the literature, pressing on points of cohesion and divergence, which may help other researchers refine the framework. In the next two sections I provide arguments for why we need frameworks to undergird our research–both as individual researchers and as a field.

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[1] I acknowledge that others offer additional types of frameworks and names for frameworks, such as conceptual frameworks (e.g., Eisenhart, 1991), but I am not going to enter the semantic fray of defining each of these terms.

The Value of Frameworks for Individual Researchers

There are several ways that frameworks are useful to individual researchers. First, a framework serves as a sort of binocular that allows one to narrow down the scope of the research site to focus on particular aspects of the situation. They help us notice things and help us cut out "noise" in our data. Importantly, they also help us know when we have found what we are seeking.

Let me share an example from a study that is currently underway. One of the doctoral students with whom I work, Andrew Tyminski, is studying a phenomenon first labeled by Mary Boole in the early 1900s (Boole, 1931) as "teacher lust." Teacher lust occurs when a teacher acts in a manner counter to his/her intentions by assuming an authoritative stance in the classroom and telling students something about mathematics. As we have read in the literature (e.g., Chazan & Ball, 1999; Lobato, Clarke, & Ellis, 2005), not all telling is inherently bad; some judicious telling is necessary to good instruction. So Tyminski was faced with the challenge of deciding how he was going to recognize instances of telling that qualified as teacher lust. He used Smith's definition of traditional telling (Smith 1996) to describe telling actions that did exhibit teacher lust, but he needed an alternate description of telling actions that did not. This involved getting beyond the trap of labeling all teaching as either "reform-oriented" or "traditional" by conceptualizing various ways that teachers interact with students and mathematics content. To do so, he used Mason's six of modes of interaction (Mason, 1998)–expounding, explaining, examining, exploring, exercising, and expressing. The basis for Mason's modes of interaction is the relationship among teacher, students, and content with regard who/what is affirming, responding, and mediating. Figure 1 depicts the three modes of interaction that Tyminski classified as examples of what judicious telling could look like. As Mason describes these relationships, the teacher's role in these three instances is that of facilitator of knowledge, not as a keeper or provider of it.

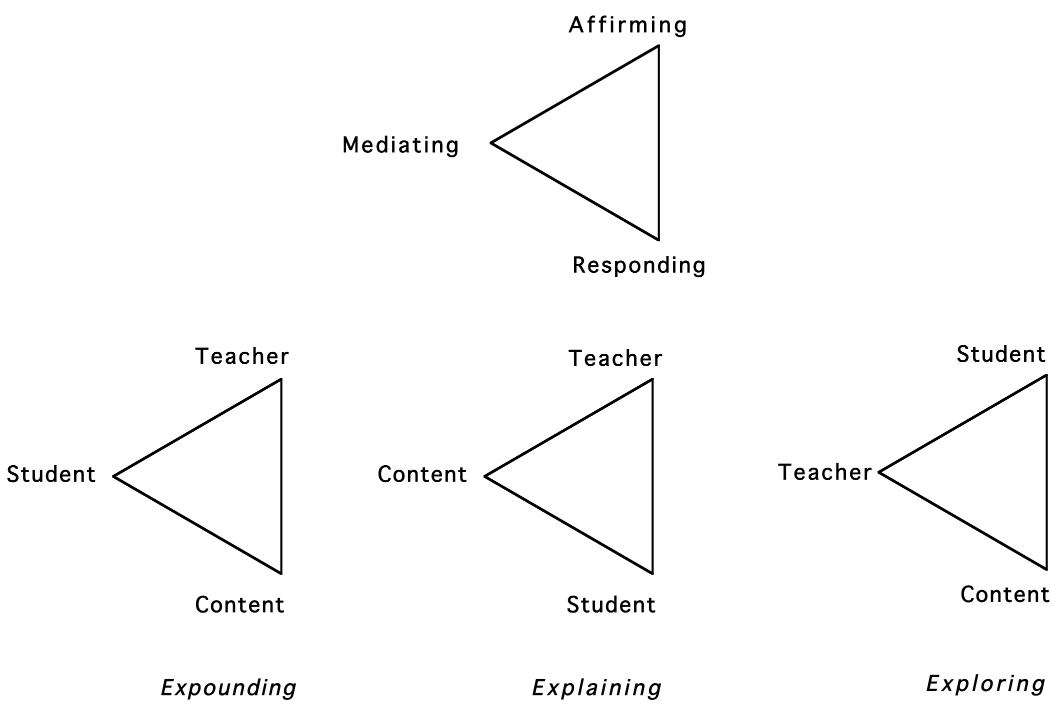

Figure 1: Mason's modes of interaction

Tyminski plans to look for instances where classroom interaction is in the expounding, explaining, or exploring mode and then slips into one of the other modes because such shifts will signal a switch from judicious telling to teacher lust. By analyzing antecedents (from his perspective and the teachers' perspectives) to these shifts, he will be able to enrich the construct of teacher lust by explaining when and why it occurs in mathematics classrooms.

By developing a framework for the notion of teacher lust prior to data collection, Tyminski has positioned himself to better notice instances of the phenomenon and ignore the many things that happen in a classroom that are not related to the phenomenon under study. Further, he will use this framework to analyze data during data collection in order to select instances of teacher lust for stimulated recall interviews with teachers. The framework will also be useful as he conducts a retrospective analysis of his data after it has all been collected because the framework will provide a structure for looking across teachers to offer more general comments about teacher lust. Finally, the framework will be useful in writing up his study as it will provide a structure for reporting his findings. The framework will enable him to communicate his findings in a more general way that transcends the particular teachers and contexts that he studied.

A second purpose for the use of frameworks by individual researchers is what Eisenhart (1991) and others have called sensitizing. Eisenhart noted that frameworks cause the researcher to "tack between the concepts advanced or assumed and the meanings given or enacted in context" (p. 211). Thus, a framework forces a researcher to constantly compare and contrast what the data are saying with what the framework is saying. This notion is commonly referred to as the constant comparative method of data analysis (Glaser, 1965). Eisenhart suggested that this tacking between the framework and data helps guard against poorly warranted conclusions. Note, however, that in order for a framework to serve the purpose of sensitizing the researcher, it must be actively used as a research tool throughout the study. The researcher must be tacking back and forth between the framework and the data during data collection and analysis. The framework cannot be a well-written piece of prose or a pretty diagram that sits on a page; it must be actively used.

As a related side note, I would like to suggest that we make a conscious effort in our field to "clean up our language," with regard to the constant comparison method and building grounded theory (Strauss & Corbin, 1990). Saying that one is using the constant comparison method or that one is building grounded theory has become immensely popular these days, but I question how many of us are really being faithful to these methods. I have already commented above on what it means to use the constant comparative method, and much more can be found in the writings of Glaser. Grounded theory implies that one is doing analysis as the data are being collected so that emerging hypotheses can be tested in subsequent data collection sessions. This is akin to what Steffe (Steffe & Thompson, 2000) strives to do in teaching experiments when he is building second-order models of children's mathematics. He develops a hypothetical learning trajectory for a particular child and poses tasks that will test the path of the trajectory across the course of the teaching experiment. What happens one day is shaped by what happened on the previous days. I think that many of us use the notion of grounded theory to mean that we are building new ideas, but we are not necessarily adhering to the methodological implications of grounded theory where analysis is on-going throughout the data collection process. I think we would be doing a service to the field if we–both writers and reviewers–revisited the original writings on which these methods are based and interrogated our own methods to see if they can legitimately be labeled as constant comparison or grounded theory. Reviewers should expect to see some evidence beyond a mere statement that these methods were used and should push authors to provide evidence if none if given.

A common concern about frameworks is that they can be confining and restrictive. A framework is often not a perfect fit; not every person or instance will map directly onto the framework. In some cases, these misfits provide us with an opportunity to refine the framework. However, in general, frameworks are not meant to be pigeonholes into which we cram data. Rather, frameworks are meant to guide data collection, analysis, and reporting. Frameworks help us move one level beyond the particulars of the study at hand to the more general ideas at play. For example, much research has been done using Perry's scheme for intellectual development (Perry, 1970). While an individual researcher may struggle to classify a study participant as dualistic or multiplistic, it is really not terribly important to the rest of the mathematics education community which classification is a better description of this particular person. What is more important is for the researcher to illuminate the ways in which the intellectual development of college students interfaces with their learning to teach mathematics. Where do preservice teachers who exhibit dualistic tendencies tend to struggle with the ideas presented in mathematics classes? How do preservice teachers who exhibit multiplistic tendencies interpret the messages of the current reform movement? It is in thinking through these kinds of larger questions that frameworks help us progress; the power of a framework is not in labeling John Q. Preservice Teacher as dualistic. I would like to note, however, that frameworks can be confining when used inappropriately. The mindless application of an a priori framework can blind us to certain elements of our data. This is where notions of triangulation, disconfirming evidence, and member checking play a role.

Making the Case for Frameworks at the Level of the Field

In addition to the strength that frameworks lend to individual studies, they also serve a purpose at the level of the field. When frameworks span a number of studies they begin to have a cumulative effect (diSessa, 1991) that leads to predictive power. Frameworks with predictive power transcend the particulars of time, place, context, and participants. When frameworks have predictive power, they also afford us greater credibility for making links to practice.

As we open new areas of research, we generally start with a collection of anecdotal stories that often lack theoretical coherence. Analyzing this collection of stories or anecdotes leads to frameworks that have explanatory power to help us make sense of a particular situation. Continued analysis of these explanatory frameworks and the studies from which they came leads to frameworks that have predictive power. Moving toward predictive frameworks is not going to come from doing more studies alone; it will come from thoughtful analysis of a large collection of existing studies.

I see striking difference in our field between frameworks used by those who study the learning of mathematics and those who study the teaching of mathematics.[2] I will assert that we have predictive frameworks in the area of student learning, but we are still at the stage of explanatory frameworks in the area of teaching. I suspect that if I challenged you to think of a framework in the arena of learning, most readers could produce an example. I suspect the same request for teaching, however, would produce less robust results.

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[2] For simplicity's sake, I am going to stick to these two large arenas of research, although I acknowledge that there are subfields within each and that there are areas of study, such as equity, that cross these boundaries or do not fit neatly into one of them.

Frameworks in the area of learning seem to come in two types–more general frameworks about how learning occurs, and frameworks that are specific to a particular piece of content. For example, Steffe (1988, 1994) and diSessa (1988, 1993) take different approaches to a theoretical basis for learning. Steffe relies on schemes, while diSessa relies on a knowledge in pieces epistemology. Either of these frames is transportable across different content domains and different student populations. In a different vein, there are frameworks that are specific to counting, fractions, geometry, and algebra, among other topics. Perhaps the most widely known of these is the van Hiele levels of geometric thought (van Hiele, 1986) and the corresponding phases of learning (which seem to be largely forgotten!). Such frameworks have been used by multiple researchers across various contexts over time, leading to their predictive power. While there are many idiosyncrasies to student learning, we can make reasonable predictions about how new groups of students will respond to particular kinds of tasks. Thus, we are not surprised when kindergarten students identify a square that has been rotated 45 degrees as a diamond because the van Hiele levels allow us to predict that this will be so. The phases of learning also give us some direction for shaping experiences that will help the child come to see the figure as a square.

In contrast, research on mathematics teacher education was described as a collection of interesting stories (Cooney, 1994) a little over a decade ago. Cooney suggested that we had a lot of local theories that explained the behavior of a particular teacher in a particular classroom, but we lacked more general theories that would "allow us to see how those stories begin to tell a larger story" (p. 627). We have made some progress toward more general frameworks since Cooney wrote those words. For example, as noted above, Perry's stages of intellectual development (1970) have been used by many to describe the growth of preservice teachers. Thus, we are not surprised when preservice teachers come to us wanting to know *the* right way to teach decimals because Perry's scheme suggests that many college students hold dualistic views of knowledge. We are subsequently not surprised when these same preservice teachers later assert that mathematics teaching is simply a matter of finding your own individual style because nothing is clearly right or wrong about teaching. Perry's scheme predicts that as college students mature, they will adopt a more multiplistic view of knowledge. Perry's scheme also gives us some guidance in thinking about experiences that we might provide for teacher education students.

By and large, I do not yet see robust frameworks in the areas of mathematics teaching and teacher education that would parallel the frameworks in the area of learning.[3] One could speculate many reasons for this, but that leads easily into the trap of making excuses for why such frameworks are not possible in the complicated venue of teaching and teacher education–a trap diSessa urged us to avoid (1991). diSessa also noted that there is no shame in the fact that we do not yet have robust frameworks. We were in 1991 and still are today a relatively young field, especially when compared to many scientific fields. Thus, we need not be alarmed by the lack of frameworks, but it is certainly appropriate to work toward their development.

Moving Forward

In this section of the paper I offer some possible avenues for generating predictive frameworks in mathematics education. I first suggest a few places where we need more frameworks and then offer ways that we might develop them.

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[3] I would note, however, that Andrew Izsák is preparing to conduct a study to determine whether diSessa's knowledge in pieces perspective is useful for studying teacher cognition.

As a field we have developed a body of vocabulary that is taken-as-shared within the mathematics education community, but we lack conceptual definitions of these terms. For example, many of us glibly use terms such as "traditional," "reform-oriented," "standards-based," and the like without much behind them. We also tend to set up false dichotomies using these and other terms.

In a related vein, there is little in the way of a theoretical framework behind long-used ideas in the field, such as Lortie's apprentice of observation (Lortie, 1975). Many of us have read and taken for granted Lortie's ideas, but in the 30 years since *Schoolteacher* was published we have not come terribly far in theorizing about apprenticeship of observation.

Another place where we might strive to develop frameworks is in the arena of linking teaching to learning. In this age where there is such a push for highly qualified teachers and for raising student achievement on standardized tests, it is painfully obvious that we have not come far as a field (nor has the more general education field) in theorizing about the links between teacher knowledge and practice and student learning.

As for where to turn to build new frameworks, I see a number of potentially promising directions. One starting place would be to conduct theoretical meta-analyses of studies in a particular subfield. Authors of handbook chapters typically do a sort of meta-analysis of the findings of studies in a subfield, but this same type of analysis of frameworks could be quite instructive.

We might revisit some of the scholars of yesteryear and see what they have to offer the twenty-first century researcher. In addition to people like John Dewey, we might reconsider the work of earlier scholars in mathematics education. For example, Kenneth Henderson's work on discourse moves (Henderson, 1965) has largely disappeared from the contemporary research scene. While we might be able to improve upon his methods, and we might even be interested in different questions, it is worth revisiting his framework. So often these days I see literature reviews that contain nothing earlier than 1989 as if the birth of the National Council of Teachers of Mathematics *Standards* obliterated the value of all that came before them. While the field has changed rapidly in the last decade or so, there are perennial issues that date to the earliest beginnings of the field, and the work of earlier scholars may illuminate some of the questions we have now.

There is value in following in the footsteps of others and transporting an existing framework to another setting. For example, Izsák used diSessa's knowledge-in-pieces framework (diSessa, 1988) to study elementary school students' understanding of whole-number multiplication in the context of area (Izsák, 2005). Not only was Izsák able to use the knowledge-in-pieces idea to make sense of his data, he was also able to add a layer of robustness to diSessa's framework because he showed that it is useful beyond the domain of physics and with younger students. There is particularly fertile ground here in looking at frameworks that have been used to study mathematical understanding (such as the one by Pirie and Kieran, 1989) to see if they can be transported to the teacher cognition.

Because mathematics education as a discipline is grounded in so many other disciplines (e.g., mathematics, sociology, psychology, anthropology), we might turn more deliberately to those fields in search of fresh directions. Indeed, many of us have turned to these fields for methodologies, so it makes sense to look there for frameworks as well. However, I offer a point of caution here. I urge us to retain a central place for mathematics in our frameworks. This is obvious in the case of frameworks for learning because the content is critical to what is being studied. However, in studies of teaching, teacher education, and equity, in particular, I often find myself reading studies in these areas where I am left wondering what is so special about mathematics. There is most definitely a place for studies of these topics without regard to content, but I also believe there is a place for studies where the content is a prominent element.

Conclusion

Consider one more real-world use of frames–a series of still pictures that make up a moving picture. In our writing and our presentations, we tend to show the moving picture version of our frameworks. As I have noted earlier in this paper, authors often go to great lengths to describe their frameworks in detail, but they rarely provide a glimpse of how the framework was actually used. Thus, we need to slow down the moving picture and show the individual frames that allow others to see the details of how our frameworks were used in data collection and analysis. As we move toward developing more robust frameworks, our field would benefit from more explicit descriptions of the development and implementation of frameworks. If we take the same care in sharing our frameworks with readers as we do with our data, we will provide fodder for others to consider as they develop their own frameworks.

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