Strauss, S. (2001). Folk psychology, folk pedagogy and their relations to subject matter knowledge. In B. Torff and R. J. Sternberg (Eds.), Understanding and teaching the intuitive mind. (pp. 217-242). Mahwah, NJ: Erlbaum.

RUNNING HEAD: Folk Psychology and Subject Matter Knowledge

Folk Psychology, Folk Pedagogy and Their Relations to Subject Matter Knowledge

Sidney Strauss

Tel Aviv University

Some of the research reported in this chapter was supported by the Binational Science Foundation (Grant Number 92-00286) which was awarded to the present author and David C. Berliner. I would like to thank Eva Brand, Adee Matan, Miriam Mevorach, Gadi Rauner, Judy Steiner, Niva Walenstein, and Gila Zimet for helpful discussions about this chapter and to Michal Avivi and Nili Laor Blasbalg for their help in various aspects of my work.

As I write this chapter, controversy swirls in the state of Massachusetts. The topic of oftentimes acrimonious and sanctimonious debate concerns how well teacher education departments prepare teachers for their profession. The debate has been used as a stick to beat the drums of a gubernatorial race. The head of the education division in the State of Massachusetts resigned purportedly out of indignation that a topic of such importance was getting used for political purposes. (So what's new?) Boston newspapers were filled with op-ed articles and letters to the editor for and against college departments of education, teachers, and the ways departments of education prepare future teachers.

Bad news travels fast. The New York Times picked up on the topic and published an opinion piece praising a decision by the New York State legislature allowing the possibility of certifying teachers without their having studied in departments of education in universities and colleges. The program "All Things Considered" of National Public Radio had programs on the topic. And late night television comedians have been having a heyday skewering everyone in sight involved in these matters. Much ink has been spilled. Many words have been uttered. Education has been in the headlines.

However, unlike the adage of advertising people, not all publicity is good publicity, even if your name is spelled correctly. What prompted the rush to judgment were some worrisome findings. A teacher certification exam, new in Massachusetts, was failed by close to 60% of those graduating students who are prospective teachers. The examination tested teachers' general cultural knowledge (basic arithmetic skills and their knowledge about grammar) and the knowledge they have about the subject matter they are going to teach.

This not very encouraging finding was seized by many as an indication of what they always knew: teachers are not a very bright lot and teacher education departments fail in their mission to improve teachers to an even minimal level. Others rushed to defend both the future teachers and their college teachers. Few were apathetic to the issues that were part of the maelstrom.

In the vortex of debate was what certification tests should include, which is another way of asking what should be in an examination that purports to predict teacher effectiveness. Debate also centered on whether or not the particular test used this time was adequate. Surprisingly few questioned whether or not teachers should be examined to be licensed, even though they received their BA degrees from accredited colleges and universities. Perhaps this is because professions such as medicine and law have licensing examinations after applicants have completed their university studies. If that holds for medicine and law, why shouldn't it for education?

There was also some discussion about whether or not licensed teachers who are currently teaching should be examined, with their teaching licenses being renewed if they passed the examination or revoked were they to fail it, a practice that holds for continuing certification in the medical field. There have been objections to this possibility. No surprises there. Some protested the threat to job security. Others questioned whether or not a test of the sort used to license new teachers in the state of Massachusetts captures the knowledge and skills teachers have and use as effective practicing teachers. So here we are back again to the enormously complex question: What does an effective teacher know and know how to do that an examination can capture?

One of the problems about certification examinations for licensing teachers is that there is no consensus about how to answer that question. Should one know contemporary theories of learning? Of classroom management? Should one have considerable and deeply organized subject matter knowledge? Should one demonstrate actual teaching, especially when children are having difficulties with material so that the examiners can evaluate how a teacher analyzes the nature of these difficulties and addresses them in classroom instruction? Should “classroom presence”, a close relative to leadership and charisma, be a feature of such an examination?

In the debate about the certification examination, the unanswered question was and remains one of anatomy: what is at the heart of teaching? Nobody has an agreed-upon answer to that question, no matter how complex that answer is. I won’t disappoint you later by building false expectations now. I do not have a comprehensive answer to this question, either. But I do pose here one part of an answer to the anatomy query. The partial answer is that adults, teachers in the case at hand, have folk psychology conceptions of the mind, psychological causality, and learning. These conceptions are reflected in the ways teachers speak about their teaching and in the ways they teach. The first purpose of this chapter is to address the nature of this folk psychology as it applies to teachers.

Among the content tested in the licensing examination was teachers’ subject matter knowledge (SMK). Conventional wisdom holds that the deeper the teachers’ SMK, the better a teacher of that subject matter they should be. My second purpose in writing this chapter is to question the conventional wisdom.

To recap, this chapter is divided into two parts. In the first, I describe what I believe is at the heart of adult cognition that concerns teaching: teachers' folk psychology of the mind and learning and folk pedagogy. The second part gets at how a part of teachers' folk psychology, the part that relates to learning, is related to their SMK.

FOLK PSYCHOLOGY AND FOLK PEDAGOGY

Folk psychology deals with the ways laypersons represent the psychological world. These laypersons have not studied the cognitive sciences, psychology, and related fields that deal directly with the human psyche. In contrast, psychologists of various stripes are experts in the area of the human psyche.

One part of the psychological world is the domain of cognition. And part of human cognition touches on the nature of the human mind, psychological causality, and how learning takes place in the mind. Adult laypersons, as you can imagine, although they have not formally studied psychology or allied fields, have notions about the nature of human being's psychological world.

Work by Rips and Conrad (1989) was among the first to test not psychologists' ideas about human cognition, but instead to test layperson's notions of human cognition. Work in this area has come to be termed theories of mind. This quite young area of theory-building and research has four principal foci. One concerns young children's language. Research has shown that young children use words that indicate an understanding of mind, e.g., think, believe, etc. (Astington & Pelletier, 1997; Bartsch & Wellman, 1995). The second focus is on children's ability to solve false belief tasks (Perner, 1991; Wellman, 1990). The third focus concerns the use of metaphors in language as expressions of our understandings of the mind (Reddy, 1978; Sfard, 1998).

The fourth focus is the concern of this chapter: how adults conceive of the mind and its functioning (Strauss, 1993, 1996, 1997).

I once assumed that the folk psychology of laypersons was completely different than the folk psychology of experts who conduct research in domains such as cognitive aspects of psychology, the cognitive sciences as practiced in laboratories that test the wet mind (the brain sciences), laboratories that deal with artificial intelligence, philosophy of the mind, etc. After all, cognitive scientists spend much of their lives constructing theoretical models that describe the mind and how it works and conducting research to test those models. Laypersons do none of the above. We should expect, then, that the folk psychology views about the mind, learning, etc. held by cognitive scientists and laypersons are different.

For me, this assumption about the nature of the differences between cognitive scientists and laypersons lasted until I attended a colloquium arranged for a potential donor for the establishment of a Center for the Study of Learning at Tel Aviv University. It was there that I realized that scientists and laypersons may have the same implicit, intuitive folk psychology notions about the mind and learning. But that gets me ahead of my story.

The meeting was intended to show the donor various aspects of learning that are being explored these days, and the format of the colloquium was that several faculty members from the learning sciences presented their work with discussions afterwards, a sort of tutorial about the areas they were investigating.

The first speaker, a biochemist working on learning at the level of the neuron, spoke about how proteins are produced when an impulse passes through a neuron and

how these proteins go to a particular site in the cell. Once at the site, the protein breaks up in a matter of milliseconds; however, if another impulse passes through the cell, the protein is once again synthesized and sent to the same site. This can happen repeatedly. After many impulses have passed through the neuron, part of the cell sends information to the nucleus which, in turn, sends information to a relevant part of the cell to constantly produce that protein and to send it to the same site. This description was how learning of the short term and long term types can be described at the biochemical level of a single neuron. It was a bottom-up model of learning.

The second speaker was an artificial intelligence expert and he spoke about how expert systems learn. They can seek solutions in a problem space, and when the solution does not work, they seek other solutions. Expert systems are able to modify their behavior when presented with problems. In short, expert systems are adaptive and learn. This speaker's model, different from that of the biochemist, was a top-down model of learning.

A third speaker, a philosopher, encouraged the audience to consider different kinds of learning, e.g., learning how to ride a bike, to make a friend, to keep a friend, to solve a linear algebra problem, to take apart a carburetor, clean it and reassemble it, to understand why a colleague behaved badly, to understand how large bureaucracies work (and don't work), etc. He suggested that these different kinds of learning, not being identical, need different models to describe them.

Others spoke at the same meeting. It struck me during the presentations that each speaker had developed a model of learning in the areas of their expertise. And each of the models was different from the others. In fact, there didn't seem to be any overlap between the models they had constructed, which is quite expected.

Yet despite these differences, there was one area of commonality among these scientists. They all taught the audience in the same manner. And because people teach to cause learning in others (more about that later), these scientists had the same implicit, intuitive folk psychology understandings of learning. Not surprisingly, these understandings were quite unrelated to their scientific models of learning.

Given this and similar experiences and some reflection about them, I believe that even experts in the area of learning hold folk psychology views of learning when they teach others. To be sure, scientists hold explicit views that are strikingly different from that of laypersons about the mind and learning. However, when they teach and speak about teaching, their intuitive understandings of learning come into play. And they are indistinguishable from those of the layperson. The line separating cognitive scientists and laypersons concerning their folk psychology understandings about the mind and learning, then, are blurred beyond recognition when they teach and speak about teaching.

My work has carried me to investigate teachers' folk psychology notions of the mind since 1989, and I do so out of the conviction that they are at the heart of teachers' teaching. Put strongly, the idea is that the ways teachers understand children's minds and learning (that part of their folk psychology) guides their actual teaching and the ways they speak about their teaching. So if I am interested in teacher preparation and inservice teacher education, I ought to know what that understanding looks like. For if I don't, I will be in the position of preparing teachers for teaching without understanding what I believe to be fundamental to their understanding of teaching. I now turn to the first part of this chapter: teachers' folk psychology.

TEACHERS' FOLK PSYCHOLOGY ABOUT CHILDREN'S MINDS AND LEARNING

The study of teachers' folk psychology involves determining the nature of the psychological entities that guide the ways teachers' teach and interpret the world of children's learning. These psychological entities have been described in various ways: theories (Schon, 1983), knowledge (Shulman, 1986), and mental models (Johnson-Laird, 1983; Norman, 1983). I use the mental models (MMs) construct as an heuristic. I tested neither Johnson-Laird's nor Norman's version of MMs. Instead, I used their notions of MMs as a means to test teachers' mental representations of children's minds and learning.

The claim here is that mental models are powerful organizers of people's understandings of aspects of their world (Gentner & Stevens, 1983; Johnson-Laird, 1983). In the same vein, Norman (1983) claimed that a major purpose of a mental model is to enable a user of that model to predict the operation of a target system that has operations. An example he offered concerned people's mental models of the operation of a calculating machine. In research I have conducted with my colleagues and students, the target system is children's minds and learning. Norman proposed that mental models have three functional factors of importance, which I summarize in terms of children's minds and learning: (1) people's mental models reflect their beliefs about children's minds and learning; (2) there is a correspondence between parameters and states of the mental model and the aspects and states of children's minds and learning; and (3) the mental model has predictive power in that it allows people to understand and anticipate the behavior of children's minds and how learning takes place in them.

In addition to the above, mental models are implicit in that they are hidden, internal, and inaccessible by direct observation. They are inferred from what is observable, external, and explicit. Implicit mental models cannot be seen directly; instead, they are inferred from explicit, observable behaviors. The relations between implicit mental models and explicit behaviors are that the former organizes the latter, and through the latter, we come to know the former.

Teachers' implicit MMs of children's minds and learning, then, are the psychological entities I describe in this chapter.

Types of Mental Models

The nature of professionals' beliefs and theories has occupied the concerns of Schon (1983) and his co-workers who, among other ideas, devised a classification system of kinds of theories professionals have. Although Schon claims that teachers have theories, I believe the psychological entity we should be addressing is mental models (MMs). But to stay true to Schon's terminology, I write about theories when discussing his work.

Among the theories he suggested are part of professionals' repertoire, my students and I have addressed two in my research: teachers' espoused and in-action mental models. Espoused theories are those theories professionals display when they speak about how they practice their profession. In-action theories are those theories professionals show when they practice their profession. Both kinds of theories are implicit. They are between the lines of what people do and say. We studied teachers' implicit espoused and in-action MMs (not theories).

Schon's taxonomy of professional knowledge is intended to describe professionals' theories. But the theories of professionals who practice different professions do not have the same content; e.g., there is no reason to expect that the content of, say, an architect's in-action theory of design will be the same as a teacher's in-action theory of children's learning. As a consequence, we must look elsewhere for those aspects of professionals' theories that are central to teachers. Shulman (1986) provides us with those aspects, and it is to his work that I now turn.

Teachers' Cognition

Shulman and his co-workers (Shulman, 1986; Wilson, Shulman, & Richert, 1987) proposed a taxonomy of kinds of knowledge teachers employ. Among the kinds of teacher knowledge Shulman proposes are pedagogical content knowledge (PCK) and subject matter knowledge (more about that later).

In broad strokes, PCK refers to teachers' professional knowledge about how to make subject matter understandable to children. PCK includes teachers' knowledge of students' preconceptions about subject matter, which concepts and skills are particularly difficult for children to learn, what makes them difficult, ways to make these difficult concepts and skills easier, and how these are different at different ages. In shorthand form, it is the knowledge teachers have about children's minds (folk psychology), how their minds work when learning takes place (folk psychology), and the roles of instruction in fostering learning (folk pedagogy).

Let us now look at the two kinds of MMs about learning held by teachers: espoused and in-action MMs.

Teachers' Espoused Mental Models. We tapped teachers' implicit espoused MMs by interviewing novice and experienced high school teachers who teach the sciences and the humanities (Strauss & Shilony, 1994). A semi-structured clinical interview format was used where we posed the same initial question to teachers and then followed up their answers with other questions. The initial question we posed asked how they teach material that is difficult for children to learn. Because teachers teach for learning to take place, we could infer their MM of children's minds and learning from their statements. Teachers' statements were classified and organized, and it is that organization which constituted our description of teachers' espoused MM of children's minds and learning.

The espoused MM found among the teachers by Strauss & Shilony (1994) and subsequently replicated by Polansky (1996), Strauss, Ravid, Magen, & Berliner (1998), Strauss, Ravid, Zelcer, & Berliner (1999), and Strauss & Rosenberg-Meltser (1996) bears a family resemblance to 1960's information processing models such as that of Atkinson and Shiffrin (1968). This model has been presented elsewhere (Strauss, 1993, 1996, 1997; Strauss, Ravid, Magen, & Berliner, 1998) so I will not elaborate on it here. Suffice it to say that it is based on a view that knowledge is outside children's minds and the task of the teacher is to get it inside the mind so that it will eventually arrive at a location where it will stick. That's the place where the glue is.

In order for learning to occur, the content must first enter children's minds, and teachers conceive of children as having openings of a certain size that allow information to enter. Teachers believe that good pedagogy involves serving up knowledge in chunk sizes that can "get through" the openings. For example, teachers said that what makes some subject matter difficult is that it is complex and, as a result, it may not be able to get

"into" the mind. Here teachers see their task as reducing this complexity by breaking the material into component parts so that it will be able to enter the mind's openings. I have more to say about this later on. However, even were the material to be of the right complexity, it may never enter the mind if the child's affective states are not primed to receive the content.

Teachers believe that once content gets through, it must somehow connect up with already-existing knowledge by means of analogies, associations, familiar examples, and so on. Accordingly, teachers believe they should facilitate connection-making between new and old knowledge. If there is no existing knowledge to get connected to, the new knowledge can get driven into memory through repetition, rehearsal, and practice. This new knowledge now becomes part of already-learned knowledge. How does the new knowledge affect the prior knowledge? Teachers believe that there are changes in the amount and organization of prior knowledge, the prior knowledge gets broadened and generalized, it is at higher levels of abstraction that what was in previous knowledge, and more.

Figure 1 illustrates this remarkable rich and structured espoused MM. It contains 11 general categories of knowledge teachers hold about children's minds, learning, and instruction. Notice that the category “Characteristics of Subject Matter Content” has levels of complexity as one of its components. Each category has a number of components, only some of which appear in the Figure. Table 1 describes the espoused MM.

Insert Figure 1 and Table 1 here

Teachers' in-action mental models. Work initiated by Mevorach (1994) and subsequently replicated and extended by Mevorach and Strauss (under revision), Strauss, Mevorach, & Greenberg (1998), and Strauss, Mevorach, & Litman (1998), has investigated teachers' in-action mental models of children's learning. This mental model is gleaned from the ways teachers actually teach.

Participants in the Mevorach & Strauss (under revision) study were 24 first grade teachers of varying teaching experience. We videotaped an arithmetic lesson given by each teacher, where the teacher taught new material on the process of adding two numbers that generate a third number. We developed a category system that enabled us to analyze the videotaped data and to describe the MM. I now present the general description of the categorization system.

Categorization System. We devised a two-tier category system that allows a classification of teachers' instruction and enables us to infer the MMs teachers hold about children's minds.

In the first tier we classified teachers' explicit teaching behaviors, and found that they were organized into units that bear a resemblance to those described by both Flanders (1970) and Cazden (1988). The first tier has four units: (1) the teachers' and pupils' behaviors; e.g., the teacher asks a question. (2) An event is the combination of several behaviors on the part of the teacher and pupils; e.g., the teacher asks a question, a pupil answers the question, and the teacher remarks about the answer. Behaviors from the first unit gain meaning in the events. (3) An episode includes several events; e.g., there are several events of the teacher asks - pupil answers - teacher responds type, where the aim of the episode is to, say, define the subject being presented. (4) A lesson is comprised

of a number of events, where the lesson has a particular purpose; e.g., introducing the subject matter: addition.

The second tier is more inferential than the first, and is based on the teachers' explicit behaviors we observed in the first tier. This tier is our addition to previous work on teachers' teaching. Others have documented the first tier's behaviors (Cazden, 1988; Flanders, 1970), but we are the first to suggest that an implicit mental model organizes them. This is our contribution, and I believe it points to a way that the cognitive sciences can be put to use to describe teachers' cognition.

The units of the second tier comprise teachers' in-action MM. These units are: (1) cognitive goals teachers want their pupils to achieve; e.g., connecting the new material being taught to what the pupils already know. (2) cognitive processes teachers think lead to these cognitive goals; e.g., retrieval of already-learned material from memory. (3) assumptions about how teaching in a particular way leads to these cognitive processes that, in turn, lead to the cognitive goals; e.g., mentioning a prior lesson leads to the retrieval of already-learned material from memory. And (4) the mother of all assumptions (meta-assumptions) about learning and teaching; e.g., knowledge is stored; knowledge can be retrieved.

I now illustrate some aspects of these units. Teachers occasionally say something like this to their class: "We are now going to begin our history lesson. Where did we leave off last time"? On the surface, this familiar way of opening a lesson seems to be a rather meager beginning, but it actually has a quite deep and rich MM underlying it. Let's see how it works.

The teacher, by asking the children this seemingly trifling question, believes that children remember where the last history class ended, which is to say that that knowledge is stored somewhere in their minds. This is a meta-assumption. She also believes that that knowledge can be located and retrieved. This, too, is a meta-assumption. She is interested in the children searching for, locating, and retrieving that knowledge, which are cognitive processes. The cognitive goal she wants her students to achieve is retrieving the knowledge of their last math lesson. And she believes that her teaching, which begins by asking about the last lesson, can cause the cognitive processes of searching, locating, and retrieving that knowledge. This is what we have termed an assumption.

So what appears on the surface to be a rather innocent and insignificant question has considerable power packed into it. That power is the in-action MM which gives rise to such a question.

The point here is that teachers have a folk psychology MM of children's minds and learning which is inferred from their folk pedagogy. This is the case for both espoused and in-action MMs. For the espoused MM, teachers speak about how they teach (folk pedagogy) for learning to take place (folk psychology). We infer their espoused MM of children's minds and learning (folk psychology) from the ways they speak about their teaching (folk pedagogy). For the in-action MM, teachers teach for learning to take place, and we interpret the ways they teach (folk pedagogy) to see what their MMs of learning are (folk psychology). The espoused and in-action MMs are quite different from each other epistemologically. They are as different from each other as declarative and procedural knowledge are.

Part of teachers' in-action MM is a notion of psychological causality, the next topic of my presentation.

Psychological Causality

What are hallmarks of folk psychology? At the heart of any model of the mind and its workings, especially when learning takes place, is a notion of causation. Philosophers have wrestled with this particularly prickly area and have written about three aspects of causation. The first is its ontology, where one tries to account for the nature of causality, the kinds of causality, what is and what is not a causal relation, and more. The second deals with epistemological considerations. Here philosophers describe how causal relations are discovered, how they can be tested and confirmed, when we can assert a causal claim, and what kinds of causal inferences may be valid. The third deals with conceptual analyses. This area concerns itself with the meaning of the term "cause". How shall one define it? How is it different from other, but related, terms? What is their use in our language, and more.

Discussions of psychological causality generally include the notion of intentionality, which sets psychological causality apart from physical causality. I believe that intentionality has two important facets: physical impermeability and psychological action at a distance.

The physical impermeability of the mind is central to psychological causality. We believe that we cannot literally enter children's minds or mix our minds with theirs in ways that physical objects can penetrate other physical objects, as in when we put our finger in clay or place a rock in water, or in ways that physical objects can mix, as when a soluble powder mixes in water or when cold and hot water mix.

That leads to the second facet, psychological action at a distance. This means, in the case of the psychological realm, that although teachers stand outside of children's minds, they can cause learning to occur in those minds. By way of contrast, examples of action at a distance in physics are magnets' influence on metals and the attraction that celestial bodies have on each other in their trajectories through the heavens. Psychological action at a distance is caused by, for example, speaking (persuading, questioning, summarizing, cajoling, pleading, describing) and showing (demonstrating, modeling, authenticating, validating) in particular ways. Through questioning, summarizing, etc., we believe we can cause learning in children, even though we are acting on their minds at a distance.

The part of the assumption of psychological causality that underlies teachers' MMs is that although we cannot directly and physically enter the mind to cause learning, we can cause learning outside others' minds by speaking, giving instructions, etc. From a distance, minds can influence other minds. How teachers choose to influence others' minds is deeply related to their MMs of the mind's structure and how learning takes place in it.

In sum, I attempted to show in this first section that teachers have espoused and in-action MMs. They are different from each other epistemologically. They constrain the ways that teachers speak about how they teach and the ways they actually teach. The espoused MM that guides the ways teachers speak about how they teach and the in-action MM that steers the ways they actually teach belie their folk psychology because they teach for learning to occur. I use MMs as ways to describe those folk pedagogies. Furthermore, I argue that these espoused and in-action MMs of folk pedagogy are

embedded in their folk psychology understandings of children's minds and how learning takes place in their minds.

This concludes the first section of this chapter. I now turn to the second part that deals with subject matter knowledge (SMK) and its relations to teachers' MMs. Remember that the Massachusetts state teacher examination had considerable SMK items, which fits the conventional view of teaching, i.e., teachers with deep and extensive SMK will teach differently and better than teachers with more shallow and less extensive SMK. I intend to challenge that view.

SUBJECT MATTER KNOWLEDGE

The area of teachers' SMK has many aspects, only two of which are briefly discussed here: definitions of what subject matter (SM) of disciplines is, and how that subject matter is organized mentally by teachers (i.e., what their SMK is).

Definitions of Subject Matter of Disciplines

The psychological description of SM of disciplines, and its related pedagogy, has a century-long history (Shulman & Quinlan, 1996). Among the most influential contemporary scholars to study these issues is Schwab (1962). Space constraints do not allow me to elaborate on issues that swirl around his conceptions. The core of his ideas includes two main aspects of the structure of SM in disciplines: its syntactic and substantive structure.

Syntactic structure of SM and knowing in a discipline. The syntactic structure of disciplines concerns the ways researchers obtain data, interpret it, and draw conclusions. In short, it deals with ways people in a field come to know and understand it. And the ways one knows and understands a discipline are discipline-dependent: Knowing and

understanding music are not the same as knowing and understanding physics or literature or psychology. Those special ways of knowing that characterize each discipline are part of teachers' SMK and their understandings of it should influence how they teach.

Substantive structure of SM in a discipline. This structure pertains to the main concepts of a discipline and their relations. As an example, the main concepts in cognitive developmental psychology, from the structuralist viewpoint, are logico-mathematical structures as the psychological entities that interpret the world and guide behaviors; assimilation and accommodation as invariant psychological functioning; disequilibrium as a mechanism of structural change, etc. For information processing adherents, among the main concepts are knowledge organizations as the principal psychological entities that influence the interpretation of environmental data and that guides behaviors; attention mechanisms that influence which environmental information gets acted on; encoding, maturation, and automatization as mechanisms that foster learning.

Substantive structures influence researchers' views of the discipline and lead them to specific ways they choose what data to attempt to gain, interpret that data, and draw conclusions. In other words, substantive structures influence syntactic structures, and vice versa.

What constitutes a discipline or field has been a subject of intense investigation in the history and philosophy of science and the social sciences. What teachers understand to be the syntactic and substantive knowledge of disciplines comprise most of teachers' SMK. The research reported here is about how teachers come to mentally represent the SM of the discipline they teach, which is their SMK.

Relations Between Teachers' SMK and Their MMs

Teachers' SMK and their MMs are generally seen as two intertwined kinds of knowledge that teachers have and use when teaching and speaking about teaching. I untangle them, re-explore them, and then re-twine them with somewhat different relations. In short, I propose to change the traditional ways of understanding their relations.

The claims made here are not intuitive and are not represented in current theory in the area. Theoretical elaboration has begun only recently (Strauss, 1993, 1996), and several studies have been conducted to put our claims to empirical test (Polansky, 1996; Strauss & Berliner, 1996; Strauss & Meltzer-Rosenberg, 1996; Strauss, Ravid, Zelcer, & Berliner, 1999; Strauss & Shilony, 1994).

The conventional stance about relations between SMK and teaching for children's learning is that the former has priority over and actually guides the latter. The following quote represents the current view. "Recent research highlights the critical influence of teachers' subject matter understanding on their pedagogical orientations and decisions... Teachers' capacity to pose questions, select tasks, evaluate their pupils' understanding, and make curricular choices all depend on how they themselves understand the subject matter" (McDiarmid, Ball, & Anderson, 1989, p. 198). This quote is representative of the conventional view. Others who I believe adhere to this sentiment are Grossman, Wilson, & Shulman (1989), Gudmundsdottir (1991), Even (1993), and Stodolsky (1988).

The ideas behind this quote, although not stated explicitly, are that: SMK is an important facet of teacher knowledge that comes to bear on their teaching, and that SMK has priority over teaching strategies in that it guides many aspects of teachers' teaching,

including posing questions, evaluating children's understanding or, in short, how they make teaching decisions. Teachers with deep SMK will teach differently than teachers who have shallow SMK.

My colleagues and I propose an alternative understanding of the nature of the relations between SMK and MMs. To illustrate that view, I show how teachers' espoused and in-action MMs have priority over their SMK when they speak about teaching and when they actually teach, respectively.

SMK and the Espoused MM

The argument goes as follows. Teachers teach subject matter to children for learning to take place, and it is teachers' espoused MMs of children's minds and learning that guide how they speak about their teaching. If teachers' SMK knowledge base is large or small, and if it is organized deeply or in a shallow manner, teachers will speak about how they teach in the same ways, ways that belie their espoused MMs of children's learning. For example, part of teachers' espoused MMs of children's minds and learning is that a characteristic of material is that it has different levels of complexity. Ideas about complexity and simplicity are profound and elusive, as shown so elegantly by Gell-Mann (1994). Teachers believe that complex material is difficult to learn and, as a consequence, one should break it up into component parts so that it will be easier to learn. This guides the ways they speak about their teaching. Teachers will speak about the breaking up of subject matter if they have considerable or little SMK about the concepts in question and if that SMK is organized deeply or superficially. What this suggests, then, is that teachers' espoused MM overrides and has precedence over SMK when it comes to how

teachers talk about how they teach. The ways teachers speak about how they teach reflects their espoused MM of children's minds and learning.

Along with this, though, what teachers say when they speak about what they teach is influenced by their SMK. Let us take two teachers as an example, one who has considerable knowledge that is deeply organized and one who has less knowledge that is superficially organized. And let us, again, use the example of breaking material into its component parts when teachers speak about realizing that the material being taught is too complex for the children. Both teachers will speak about breaking up the material into component parts. As already noted, this means that these teachers have the same espoused MM of children's learning. But the places where they break up the material will be different, depending on the teachers' SMK. In other words, teachers carve the subject matter at its joints, and the joints are different, given the teachers' SMK. I present an example below where teachers' SMK is wh-constructions in English grammar.

Our prediction, then, is that teachers with high and low SMK organization will have the same espoused MM of children's minds and learning. And that means that the MM has priority over their SMK because the SMK, as interpreted in the ways teachers speak about teaching, is expressed in the framework of their espoused MM.

SMK and the In-Action MM

Here, too, the prediction is that teachers' MM are not influenced by their SMK organization, except that this time I am writing about teachers' in-action MM. This is the MM teachers have that guides their teaching. An illustration might be helpful here to make the point.

Recall the case of the teacher who begins her history lesson by asking the students to retrieve where they left off at the end of the last history lesson. I argued that this seemingly simple request, an almost everyday occurrence, reflects a powerful in-action MM about children's minds and how learning takes place in them.

Among the units in the in-action MM are the cognitive goals the teacher sets for the students: retrieving knowledge. To briefly review this example, this means that the teacher has meta-assumptions, e.g., knowledge exists in children's minds; it can be retrieved, etc. She also believes that cognitive processes, another unit in the in-action MM, can lead to the just-mentioned cognitive goals: searching, locating, and retrieving. And, finally, this teacher has a unit, termed "assumptions", that leads her to believe that she can induce cognitive processes that, in turn, can achieve the desired cognitive goal in her pupils.

Now think about this for a minute. Why should the amount and level of SMK make a difference for that opening question? Should having deeply organized SMK or superficially-organized SMK make a difference in how the above units of the in-action MM operate? Should deep SMK about the structure of syntactic and semantic aspects of the subject matter change that initial question that started off the history lesson?

My answer to this question, as you have surely surmised by now, is that the level of SMK organization should not change that question one iota. Stated more fully, teachers' SMK should not influence the ways they teach, the question about where the last lesson ended being just one of myriad examples I could have chosen to make the same point.

However, the <u>content</u> that interests the teacher in her teaching (e.g., the principal causes of the First World War, what historical evidence is and how it differs from

evidence in a biology experiment, the nature of similarities and differences concerning explanations of historical and physical causality, a comparison of the same historical event from different historical perspectives – thus rendering it different historical events) does influence teachers' teaching. But here the influence is on what is being taught and not how it is being taught. The former is influenced by teachers' SMK about history, whereas the latter is influenced by their in-action MM of children's minds and learning.

In an attempt to put this idea to an empirical test, we conducted several studies. In some of these studies, teachers of English as a second language were tested for their SMK about wh-constructions. These are very difficult constructions for Israeli children because the English form of wh-constructions is quite different than that in Hebrew. Relative clauses are part of the English language curriculum in Israel and are taught in grades 9 and 10 and tested in the Israeli matriculation examination.

I now briefly present wh-constructions and then describe two studies that tested the relations between teachers' SMK and their espoused and their in-action MM.

Wh-Constructions

Wh-constructions are divided into two main parts: Wh-questions and wh-relative clauses.

Wh-Questions

These questions are divided into two kinds: direct and indirect questions.

Direct wh-questions. Wh-questions constitute one of the two major subtypes of interrogative clauses in English: yes/no (or truth) questions, which question the truth value of a sentence, e.g., Is it raining? and wh- (or content) questions, which elicit information about a particular part of the sentence, e.g., What did he eat? Both children

acquiring English as their mother tongue and learners of English as a second/foreign language must become aware of the changes in the structure of the interrogative sentence to produce grammatical wh-questions in English.

Subject and non-subject questions. Direct Wh questions are further classified into subject questions (e.g., Who likes John? about the subject of the sentence) and non-subject or object questions (e.g., Who(m) does John like? about an object in the sentence).

Indirect wh-questions. When a question is embedded in a main clause to create an indirect wh-question construction, subject-auxiliary inversion is forbidden. For example, compare the direct question sentence How did you feel? and the indirect question sentence I want to know how you felt. While both posit the same question, the first has undergone subject-auxiliary inversion while the second has not and resembles a declarative rather than a question sentence.

Wh-Relative Clauses

Relative clauses bear a resemblance to wh-questions in general, and specifically to indirect questions: they contain subordinate clauses that begin with a wh-word which replaces a syntactic element originating at some site in the clause, without subject-aux inversion. Compare, for example, the indirect question construction They want to know whose book you prefer and the relative clause construction The man whose sister you married has disappeared. In both sentences the wh word refers to an NP, but in the first sentence this NP is questioned while the second construction originates in the combination of the main clause The man has disappeared and the clause You married his sister subordinated to the man.

Structure of the Wh-Constructions Test

We developed a research tool that could measure the depth of English teachers' SMK about wh-constructions. It contained 12 sentences with wh words which they were asked to classify. Table 2 presents the classification of the test sentences according to the categories described above. The test contained 9 direct and indirect wh-questions, and 3 sentences with relative clauses marked by wh-question words.

The above described the subject matter of wh-constructions. We now turn to our study of teachers' SMK of wh-constructions and their MMs of children's minds and learning of wh-constructions.

Assessment of SMK (Structure of the Wh-Constructions Test)

The teachers were presented with the list of 12 sentences and were asked to classify them fully according to whichever criteria they deemed correct. After the teachers classified the sentences according to the above instruction, the experimenter gave them another piece of paper and asked the teachers to categorize the sentences according to 'wh'".

Criteria for Levels of SMK

The optimal classification of the sentences done by a linguist would divide questions (direct and indirect) from non-questions (relative clauses), and then proceed to differentiate questions into direct and indirect, and direct questions into subject and non-subject questions. This classification was not found among the teachers.

Teachers' highest classification consisted of 2 classes, each of which was further differentiated into 2 classes; thus, there were two levels down and 4 aspects across. The criterion for high SMK was the full classification and correct labels for each of the

categories. The criterion for middle SMK was a classification with the first categorization (indicating knowledge that the sentences are wh-elements) and either no further classification or an incorrect classification. The criterion for low SMK was that the teachers did not even make the first- level classification, indicating that they did not use wh-elements as the content, despite the fact that the experimenter asked them to classify according to wh.

Relations Between Teachers' SMK and the Mental Models

We conducted several studies to determine the nature of relations between teachers' SMK and their mental models (Polansky, 1996; Strauss, Ravid, Magen, & Berliner, 1998; Strauss, Ravid, Zelcer, & Berliner, 1999). I discuss two studies here, one concerned with espoused MMs and one other dealing with in-action MMs.

Teachers' SMK and their Espoused MMs

Strauss, Ravid, Magen, & Berliner (1998) presented the above SMK organization test to teachers and found, for the expository purposes of this chapter, that the teachers were divided into two groups: high and low SMK teachers. There were 16 teachers in each of the 2 groups.

After each teacher was found to be either high or low on SMK organization, she participated in an interview whose purpose was to determine the nature of her espoused MMs. The findings of the study were just as I expected - teachers with high and low SMK organization of wh-constructions had the same espoused MMs.

Teachers SMK and their In-Action MMs

I briefly report a study that was recently completed.(Strauss, Ravid, Mevorach, & Haim, in preparation). As in the previous study, we found teachers with either high or low SMK about wh-constructions. We videotaped classes where they taught wh-constructions and analyzed them in terms of the teachers' in-action MMs, using Mevorach's (1994) category system.

Our findings were that teachers with high and low SMK have the same in-action MM. In other words, although the teachers are different in terms of the depth of knowledge organization they have about wh-constructions, they are not different in terms of their in-action MM of children's learning. And it is this MM that guides teachers' teaching. These findings are also in line with my expectations and are different from what adherents of the traditional view would expect.

In addition, w found that teachers with different levels of knowledge organization used their identical MMs differently. We found that the teachers with a deep knowledge organization expressed their MMs in ways that were different than those teachers who had shallow knowledge organizations. These different expressions of the same in-action MM showed that high SMK teachers were more learner-centered and low SMK teachers were more teacher-centered.

But what does all of this mean for the importance of SMK? The main argument here is that the nature of relations between teachers' SMK and their MMs is different than what the conventional view holds. Traditionally, theoreticians and researchers claim that SMK has priority over much of classroom teaching. To return to the quote from McDiarmid et al. (1989), teachers' capacity to ask questions, make analogies, listen to

children's answers to questions posed, and more, is influenced by their SMK. In other words, teachers' SMK constrains their pedagogical decisions that are in the service of children's learning.

The alternative view posed here is that teachers' MMs and SMK are separate entities: Teachers' MMs deal with their beliefs about children's minds and learning. And teachers have SMK about their discipline. The structure of children's minds and how learning occurs in those minds is independent of the level and extent of teachers' SMK.

These are claims for keeping MMs and SMK conceptually separate. But they do have relations because SM is taught so that it will be learned. A second part of the claim I am making is that the MM is the framework within which teachers make pedagogical decisions. Teachers will not teach in a particular way if it is inconsistent with their MM of children's minds and learning.

Notice that we cannot make a parallel formulation about teachers' SMK. That is, it sounds peculiar to say that teachers will not teach in a particular way if that way is inconsistent with their SMK. This is because how teachers teach is not dependent on their SMK. What they teach is, though.

My formulation of these ideas is that teachers will not teach in ways that are inconsistent with their MM of children's minds and learning. The MM (folk psychology), then, is the main organizing system which gives rise to how teachers' teach (folk pedagogy). The content of what is taught depends on a teacher's SMK, but that decision is dependent on decisions about how to teach. Teachers' SMK is, then, subordinated to their MM.

Implications for Teacher Education

There are two implications that follow from our theory-building and the empirical results from our studies: (1) teaching teachers to be aware of their own MMs of children's minds and learning and (2) teaching subject matter.

Teaching teachers to be aware of their MMs. The point here is that the MMs we discovered among teachers are implicit, tacit. Teachers are not aware that they hold such MMs, let alone that these MMs guide how they teach. When teachers were taught about learning in their educational psychology courses, nobody taught the MMs they hold. I showed (Strauss, 1993, 1996) that preservice teachers have these MMs before they even take these university courses. Because teachers do not know they have a MM, they do not know that what they are being taught (Piaget, Vygotsky, and others) is an alternative to their tacit understandings of the mind and learning. Of course, it may be the case that university faculty members are teaching about Piaget and Vygotsky with the same in-action MM held by the pre-service teachers.

The recommendation here is to help teachers unearth these tacit MMs. In so doing, the teachers will become aware of what they believe learning is, something that they haven't given much thought to. And when alternative views are presented, teachers can see them as genuine alternatives because they will now know what they believe children's minds and learning are.

The conceptual change literature in science teaching seems particularly relevant here. These studies demonstrate the amazing power of inadequate models children construct about the world of physics, even in the face of contradictory evidence. Thus, children hold the naive belief that water at 10º C, when mixed with water at 10º C,

becomes water at 20º C, even after they measure its temperature with a thermometer. Or, they may hold beliefs that numbers can be added on to infinitely but they cannot be divided infinitely, that hot and cold water mix in such a way that tiny hot globules and tiny cold globules exist side by side, or that sugar when stirred into tea releases sweetness as the sugar disappears. These naive beliefs are not taught. But they are constructed, just as are the MMs of the mind we have discovered. And they are apparently constructed without any formal instruction.

When the falsity of these models, theories, and beliefs are demonstrated in science classes, students often will answer test questions that reveal they have mature "scientific" knowledge--and continue outside of school to hold their original beliefs. This literature does, however, suggest ways that can help teachers overcome the inadequate models of their students. But these methods are time-consuming and clearly not always effective. Nevertheless, if we wish teachers to consider a Piagetian constructivist understanding of learning, a social constructivist model of learning in the Vygotskian tradition, or any other model of learning for that matter, a first step in that process would be to have them examine the MMs they already possess.

Teaching teachers subject matter. Lest the reader interpret this chapter to mean that I have an axe to grind against SMK, I want to dispel that notion once again. I have written here, perhaps too many times, that teachers' SMK is crucial to teaching. The deeper the teachers' SMK, the better they will be at what they teach. Nobody I know, and that includes myself, would claim that teachers' level of SMK is irrelevant to their teaching. Because of its importance for what teachers teach, it is obvious that teachers should be taught to have the deepest possible SMK.

But so that there will be no misunderstanding, I state for the last time, that as teachers gain deeper and more extensive SMK, they will not teach that subject matter differently. Only by elaborating on teachers' folk psychology (their MMs) will they teach differently. Then and only then will their folk pedagogy be de-folked.

Back to the Beginning

I began this chapter with a description of the Massachusetts State examination for prospective teachers and the disappointment many felt at the poor test results found among those who were examined. In my anatomy question about the heart of teaching, I suggested that we should separate SMK and teachers' espoused and in-action MMs. The reasons for this are hopefully clear now.

In keeping with the tenor of this chapter's themes, I believe it is important to test teachers' SMK about content they will be teaching because it indicates the richness of what teachers will teach. I also believe it is important to develop tools to measure aspects of teachers' professional knowledge about children's minds, how learning takes place in those minds, and how we can teach to influence that learning. Teachers should have professional knowledge about the above, knowledge that separates them from laypersons, which is another way of saying that their folk psychology should be de-folked. And were that to happen, teachers would have richer, more varied, and more theory-grounded teaching strategies that could supplement and enrich their wisdom of practice.

What I described in these pages can be viewed as an initial attempt to make a description of teachers' espoused and in-action MMs about children's minds and learning. These are teachers' folk psychology and they lead to the ways teachers speak about how they teach and actually teach (i.e., their folk pedagogy). However, teachers

must go beyond these folk psychology and folk pedagogy notions that have been found to be identical among teachers and non-teachers (Strauss & Rosenberg-Meltser, 1996) because they are only common sense notions and not professional knowledge about the mind and its workings.

How to do this going-beyond is the next phase of our work being done at Tel Aviv University. If our teacher education courses fulfill our hopes that teachers will have richer and more explicit professional knowledge than what they have at present, we can then think about how to assess this knowledge via tests. In this way, teachers' folk psychology and folk pedagogy can be viewed as a baseline understanding of the mind and its workings, and teachers' new knowledge that goes beyond their folk psychology and pedagogy can be seen as professional knowledge that is not shared by non-teachers.

References

Astington, J. W., & Pelletier, J. (1997). The language of mind: Its role in teaching and learning. In D. R. Olson and N. Torrance (Eds.), Handbook of education and human development (pp. 593-619). London: Blackwell.

Atkinson, R. C., & Shiffrin, R. M. (1968). Human memory: A proposed system and its control mechanisms. In K. W. Spence & J. T. Spence (Eds.), The psychology of learning and motivation: Advances in research and theory (Vol. 2, pp. 549-597). New York: Academic Press.

Bartsch, K., & Wellman, H. M. (1995). Children talk about the mind. New York: Oxford University Press.

Cazden, C. (1988). Classroom discourse. Portsmouth: Heinemann Educational Books.

Flanders, N. A. (1970). Analyzing teaching behavior. Reading, MA: Addison Wesley.

Gell-Mann, M. (1994). The quark and the jaguar. New York: Freeman.

Gentner, D., & Stevens, A. (Eds.). (1983). Mental models. Hillsdale, NJ: Erlbaum.

Grossman, P. L., Wilson, S. M., & Shulman, L. S. (1989). Teachers of substance: Subject matter knowledge for teaching. In M. C. Reynolds (Ed.), Knowledge base for the beginning teacher (pp. 23-36). New York: Pergamon.

Gudmundsdottir, S. (1991). Pedagogical models of subject matter. In J. Brophy (Ed.), Advances in research on teaching (Vol. 2, pp. 265-304). Greenwich, CN: JAI Press.

Even, R. (1993). Subject matter knowledge and pedagogical content knowledge: Prospective secondary teachers and the function concept. Journal for Research in Mathematics Education, 24, 94-116.

Gell-Mann, M. (1994). The quark and the jaguar. New York: W. H. Freeman.

Johnson-Laird, P. (1983). Mental models. Cambridge, MA: Harvard University Press.

McDiarmid, G. W., Ball, D. L., & Anderson, C. W. (1989). Why staying one chapter ahead doesn't really work: Subject-specific pedagogy. In M. C. Reynolds (Ed.), Knowledge base for the beginning teacher (pp. 193-205). New York: Pergamon.

Mevorach, M. (1994). Teachers' in-action mental model. Unpublished Ph.D. thesis. Tel Aviv University.

Mevorach, M., & Strauss, S. (under revision). Teachers' in-action mental models of children's minds and learning. Manuscript submitted for publication.

Norman, D. A. (1983). Some observations on mental models. In D. Gentner & A. Stevens (Eds.), Mental models. Hillsdale, NJ: Erlbaum.

Perner, J. (1991). Understanding the representational mind. Cambridge: Bradford Books/MIT Press.

Polansky, C. (1996). Teachers' subject matter knowledge about finding the main idea in a text, their understandings of how that occurs in children, and their mental models of children's learning. Unpublished masters thesis. Tel Aviv University, Tel Aviv, Israel

Reddy, M. (1978). The conduit metaphor: A case of frame conflict in out language about language. In A. Ortony (Ed.), Metaphor and thought (2nd ed., pp. 164-201). Cambridge, UK: Cambridge University Press.

Rips, L. J., & Conrad, F. G. (1989). Folk psychology of mental activities. Psychological Review, 96, 187-207.

Schon, D. A. (1983). The reflective practitioner. New York: Basic Books.

Schwab, J. (1962). The concept of the structure of a discipline. Educational Record, 43, 197-205.

Sfard, A. (1998). On two metaphors for learning and the dangers of choosing just one. Educational Researcher, 27 (2), 4-13.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. Educational Researcher, 15, 4-14.

Shulman, L. S., & Quinlan, K. M. (1996). The comparative psychology of school subjects. In D. Berliner & R. Calfee (Eds.), Handbook of educational psychology (pp. 399-422). New York: Macmillan.

Stodolosky, S. (1988). The subject matters: Classroom activity in math and social studies. Chicago: University of Chicago Press.

Strauss, S. (1993). Teachers' pedagogical content knowledge about children's minds and learning: Implications for teacher education. Educational Psychologist, 28, 279-290.

Strauss, S. (1996). Confessions of a born-again structuralist. Educational Psychologist, 31, 15-21.

Strauss, S. (1997). Cognitive development and science education: Towards a middle level theory. In W. Damon (Series Ed.) & I. E. Sigel & K. A. Renninger (Vol. Eds.), Handbook of child psychology: Vol. 4. Child psychology in practice (5th ed., pp. 357-399). New York: Wiley.

Strauss, S., & Berliner, D. (1996). Teachers' mental models of children's minds and learning. (Final Report submitted to the United States - Israel Binational Science Foundation). Jerusalem.

Strauss, S., Mevorach, M., & Greenberg, B. (1998). Kindergarten teachers' in-action mental model of children's learning when they teach in a directed or serendipitous manner. Manuscript in preparation. School of Education, Tel Aviv University.

Strauss, S., Mevorach, M., & Litman, T. (1998). Effective and less effective junior high school mathematics teachers' in-action mental models. Manuscript in preparation. School of Education, Tel Aviv University.

Strauss, S., Ravid, D., Magen, N., & Berliner, D. C. (1998). Relations between teachers' subject matter knowledge, teaching experience, and their mental models of children's minds and learning. Teaching and Teacher Education, 14, 579-595.

Strauss, S., Ravid, D., Zelcer, H., & Berliner, D. C. (1999). Teachers' subject matter knowledge and their belief systems about children's learning. In T. Nunes (Ed.), Learning to read: An integrated view from research and practice (pp. 259-282). London: Kluwer.

Strauss, S., Ravid, D., Mevorach, M., & Haim, O. (in preparation). Relations between teachers' subject matter knowledge and their in-action mental models.

Strauss, S., & Rosenberg-Meltser, H. (1996). Teachers' and non-teachers' mental models of children's minds and learning. Unpublished Manuscript. Tel Aviv University, Tel Aviv, Israel

Strauss, S., & Shilony, T. (1994). Teachers' models of children's minds and learning. In L. A. Hirschfeld & S. A. Gelman (Eds.), Mapping the mind: Domain specificity in cognition and culture (pp. 455-473). New York: Cambridge University Press.

Wellman, H. M. (1990). The child's theory of mind. Cambridge, MA: Bradford Books/MIT Press.

Wilson, S. M., Shulman, L. S., & Richert, A. E. (1987). '150 different ways' of knowing: Representations of knowledge in teaching. In J. Calderhead (Ed.), Exploring teachers' thinking (pp. 104-124). London: Cassell Education.

Table 1

A Description of Teachers' Espoused Mental Model

The child's mind is the box and, through instruction, teachers attempt to get material into the mind and moved along the mind in such a way that it stays there for a long time, which is another way of saying that it gets learned.

On the left side of the Figure are categories that are not part of learning as such, but they do influence it. There are five categories here: (1) Characteristics of the Material to be taught (e.g., it is complex); (2) the Teacher as Intermediary between the material and the learner (e.g., the teacher breaks a problem into parts for the children); (3) aspects of Instruction (e.g., asking questions); (4) aspects of the Child's Environment (e.g., mass communication); and (5) Characteristics of the Learner (e.g., abilities, intelligence).

We now move from the categories that are not learning as such to the sixth (6) category that involves how the material enters the child's mind. We have labeled that category "Means" because this category's components are the means by which material external to the mind enters it. This category gets at the seam between the external world and the mind. The openings have "flaps" next to them allowing material to enter when they are up or preventing the material from entering if they are down. As mentioned above, these flaps are regulated by the affective system; i.e., if the child is interested and motivated or not.

The mind itself has five categories: (7) Already-Learned Knowledge that exists in the mind. These are concepts, skills, and so forth that have already been learned; (8)

Characteristics of Already-Learned Knowledge, such as amount of knowledge; (9) mental Processes that allow new material that just entered the mind to become part of the already-learned knowledge or, in other words, to become learned. An example would be analogies between new and old knowledge. The next category, Products (10), deals with what happens to the old knowledge when the new knowledge gets learned; e.g., it gets expanded. We labeled this Products because they are the products of learning. And there is a category of the mind that involves they ways the learner (11) Demonstrates Uses of the New Knowledge; e.g., the learner can solve problems that are similar to those just learned.

Table 2

Classification of Wh sentences in the test.

Questions
Direct questions
Subject questions
Who saw the murder?
Whose students drink coffee every morning?
Which books belong to you?
Non-subject questions
Who did he see?
Whose papers does he always steal?
Which students do you like?
Indirect questions
She told me which students she liked in that class.
He always mentions how many stories he writes every year.
They want to know whose book you prefer.

Relative Clauses

I didn’t like the man who spoke first.

The books which re recommended were boring.

The man whose sister you married has disappeared.

Figure Caption

Figure 1. Teachers' espoused mental model of children's minds and learning