Mediating the Big Idea
Wendy Sink
Dr. Jennifer Cartier
Instruction and Learning
wms2@pitt.edu
(412) 708-3571

1) Statement of the Problem

Kit-based instructional materials are becoming more prevalent in elementary school science classrooms, and teachers are expected to use them effectively. Roth, Tobin, & Ritchie (2001) noted that teachers may create individual activities which superficially connect to scientific phenomena, in which students appear engaged in scientific practices. However, these activities only expose students to ideas without providing the scaffolding necessary to make those experiences productive. Kits, on the other hand, are thought to remove the hit-or-miss creations of individual teachers, replacing them with correlated, hands-on investigations around a specific topic. On one hand, there seems to be a sense that these materials provide everything an elementary teacher needs to teach science effectively. On the other hand, these materials are often not explicit about how ideas connect across investigations. Our observations suggest that some teachers may adhere to the published investigations closely, providing time for the students to collect all of this data yet leaving the students to construct their own understanding of connections across the investigations. Others may choose to emphasize a Big Idea, focusing student attention on the relevant patterns from several activities, thus providing a bridge across investigations, and units. We consider this latter***, Big Idea*** approach to be the more effective use of these kits.

In a project currently underway in a local public school district, teachers are partnered with scientists and together they engage in a process of Critical Materials Implementation (CMI). CMI can best be characterized as a particular stance toward curricular materials. Rather than implementing materials, 'as written', teachers are asked to consider each unit within a framework of ***Big Ideas*** which connect concepts across investigations, ***tools*** which scaffold student learning of these big ideas, and forms of ***talk*** that engage students in active construction of conceptual knowledge (Cartier & Huang, 2005). We are interested in answering two questions:

1) How does using a Critical Materials Approach in the presence of a graduate science fellow influence the planned curriculum?

2) How does using a Critical Materials Approach in the presence of a graduate science fellow influence the enacted curriculum?

While this project is funded through another grant, that source specifically prohibits using the funds for research on the project. Recipients are expected to obtain research funding from outside sources. I believe this work is delivering significant results, and therefore I am asking for funds to analyze data collected as part of the project.

2) Theoretical/Conceptual Framework

This work is based on a working framework of curriculum proposed by Remillard (2005), the theoretical work of Lev Vygotsky (1986), and the cultural tool categories of Kazulin (1998). In the following section I will briefly explain how their work informs this research. First, I will discuss the framework of Remillard, which provides a lens for studying the activity of teachers. Next, I will delve into the work of Vygotsky and sociocultural theory. More specifically, his ideas of mediated learning. Finally, I will share work from Kazulin (1998) to anchor the specific products which are the focus of this research.

This professional development is targeted toward two specific activities in which teachers engage: planning curricula and enacting curricula. This division of activities is proposed in Remillard's framework of a

teacher-curriculum relationship. In this framework, Remillard proposes considering the work that teachers do with the curriculum as a relationship between teacher and curriculum. This is a distinct divergence from previous research that conceptualized the teacher as users of curriculum. Sometimes, teachers were seen to be faithful or subversive to a static document. At other times teachers were found to draw on the text, or interpret the text. Finally, some researchers framed the teacher as participating with the text, at times allowing her actions to be determined by the text and accompanying materials, and at others taking a designer role to supplement or override the materials. Remillard proposed that a more productive way to consider the work of teachers with curriculum as engaged in a *relationship* with curriculum. Within a relationship, each participant has the ability to affect the other. Teachers may change the goals and activities of a curriculum. Similarly, a curriculum may influence the way a teacher scaffolds activities, or her beliefs about student abilities and student learning (Remillard, 2005). Considering the work of teachers as a relationship with a cultural tool (the curriculum) situates Remillard's work squarely within a Sociocultural perspective of teaching and learning. I will next briefly explain Sociocultural theory as it applies to this research.

Sociocultural Theory suggests that **mediation of events** through **cultural tools** is necessary for the development of concepts (Vygotsky, 1986). Mediation of events refers to the idea that all conceptual development is a negotiation between a learner and a more knowledgeable other, or between a learner and a cultural tool. In contrast to the traditional view of learning, however, it is observed that both the more knowledgeable other and the learner co-construct knowledge through the interaction (Daniels, 2001)

Cultural tools may be symbolic systems such as language, or objects such as hammers. A mediator uses cultural tools to scaffold concept development. Tools such as a written alphabet, phonics, etc. are used to mediate the development of a concept that is unavailable through the senses alone. These concepts are based in cultural understanding, and learning them is the goal of formal schooling. Much of the canons, which represent the various science disciplines, are this type of concept - not based solely on perception, but dependent as well on conventions established by each culture.[1] Culturally derived concepts, then, are the focus of our educational system, as are the cultural tools used to teach them. In order to think more deeply about these tools, a better understanding of their complexity is necessary.

Alex Kazulin advocates for a division of these tools into two classes: ***Material tools***, and ***Psychological tools***. Material tools are those things designed to act upon the object of study (a hammer, a caliper, or a Bunsen burner). Material tools, while appearing simple and culture free, nevertheless carry the cultural assumptions implicit in their development through the needs of that culture. For example, the left-to-write numbering system on a ruler contains the bias integral to a reading system that proceeds from left –to right. Psychological tools are symbolic representations ranging from highly organized systems such as languages to localized sketches of phenomena [scribbles on a napkin or in the sand] in the moment of discussion (Kazulin, 1998). A psychological tool might be thought of as a way to organize thought. A suggestion from the culture about how a concept may be stored for retrieval, connected to previous concepts, or re-designed as a building block for other concepts. Often material tools are recruited to help students recall information or as representative objects in abstract systems. In these cases, the line between material and psychological tool may be blurred. One must think carefully about use to effectively determine whether a tool is material or psychological in any given situation.

The work of teachers as they plan and enact curriculum might be considered as an iterative process of selecting or creating tools. When they plan, teachers select material tools and psychological tools they believe will best help their students construct a target learning goal connected to a big idea. When the plan is enacted, teachers recruit additional material tools and psychological tools to facilitate this learning in more immediate and localized ways. I believe that when they engage in CMI, the teacher will choose material tools and

[1] The international scientific community has established cross-cultural ways of representing certain ideas as a way to make communication of those ideas across languages. A prime example of this is the periodic table of the elements, which utilizes common symbols, O, Hg, Au, for elements irregardless of the specific common name Oxygen, Mercury, Gold, vs. Oxygen, Aurum, Hydrargyum) of the element within individual cultures.

psychological tools that support the big idea. Further, that they will make these choices during both planning and enacting phases of teaching the curriculum.

3) Methods, Design and Procedures

In the following section I will introduce the participants of the project. Next, I will explain the activities in which teachers and fellows engage. Finally, I will outline the types of data collected, along with the methods of data collection.

Partner Teachers from elementary and middle school classrooms (hereafter referred to as PT) are paired with Science Fellows (hereafter referred to as SF) at the beginning of the year, and both participate in a week-long workshop in which they engage in long-range planning using the CMI approach to focus on district-mandated curricular materials. SFs continue to work with teachers on a weekly basis throughout the school year, spending approximately 1/3 of their time engaged with teachers and/or CMI, and 2/3 of their time in the classroom during instruction. SFs continue to conduct their own research during this time as well.

Two times each year, SF and PT are asked to participate in a Focus Lesson. Partnerships plan using CMI, enact the lesson, and reflect on the student outcomes based on stated learning goals. Planning and reflecting are digitally recorded, and lesson plans are submitted digitally, along with any supporting tool documentation (e.g. worksheet or list of materials).

The planning conversation is open-ended, without the presence of an observer other than the recorder. This recording will be transcribed and analyzed for references to tools considered, as well as conversation around learning goals and the Big Idea, The best documentation for lesson enactment would be videotape, however the project does not have permission for this type of data collection. Therefore the lesson enactment is observed in multiple iterations (throughout the course of one school day) and documented with field notes. This allows multiple opportunities to document the ***tools*** used during the lesson. These notes are immediately and subsequently reviewed and tools used documented in a table.

The PT/SF reflection is focused through a semi-structured interview format (Rubin & Rubin, 2005). During this interview, fellows and teachers are asked to consider the tools that documented during the enactment, as well as any outlined in the planning document. For each tool, the partnership is asked to talk about the source, purpose, and success of the tool, as well as other tools considered, and any changes they would make to the tool in subsequent uses. Additional documentation from the observations include board notes, classroom diagram, and any residual tools on display around the classroom.

4) Data Analyses

Because this research is qualitative in nature, it is expected that initial analyses and coding may give rise to other analyses not anticipated in the initial overview. In other words, I am leaving open the possibility that analyses will yield patterns not expected at the outset, and that the questions answered may be different than those asked. What I will outline here is the expected course of analyses given the anticipated findings.

FOSS Material survey. In order to determine the extent to which teachers have adapted, altered, or replaced materials suggested by the kits, a thorough examination of the kit is necessary. The units that form the basis of the lessons enacted will be read in their entirety, and a catalog of material and psychological tools suggested by FOSS will be developed. These tools will also be coded for location, and explicit connection to the units stated learning objectives. I will establish reliability through a second survey of one unit by another person familiar with the Kazulin's tool categories.

FOCUS lesson Material, Observation, Reflection. Transcriptions and all documents will be analyzed for references to tools and their use. Each tool will be coded for:

Type: Is the tool material or psychological according to its stated, observed, or intended use?

Source: Are they recommended (by FOSS) adapted (from FOSS), replaced (for FOSS suggestion) or Inserted?

Location: Where they are observed (planning, observation, reflection) will be documented, allowing for multiple coding if they are present in both planning and enacting of the lesson?

Big Idea: Is there a stated connection between the choice to use , adapt, replace or include this tool and the Big Idea?

Partner: Who makes the connection between the tool and the Big Idea?

Each of these categories will be correlated to see if there are any associations between them.
Reliability will be established through analyses of one partnership documentation.

5) Contribution to Education

As I stated earlier, elementary science in the twenty-first century is often kit-based. School districts purchase or share commercially designed kits that provide materials, activities, and factual knowledge to teachers. Districts may expect teachers to enact these kits 'as written' in an attempt to standardize student learning experiences across schools. However enactment still depends on the skill and knowledge of the teacher in the science disciplines. Simply put, this *material tool*, in the hands of a member of one culture (science) yields different results than one in the hands of a member of another culture (elementary education). According to Linda Darling-Hammond, "The Vision of practice that underlies the nation's reform agenda requires most teachers to rethink their own practice, to construct new classroom roles and expectations about student outcomes, and to teach in ways they have never taught before" (Darling-Hammond, 1995, p. 597). I hope to show that CMI is an effective tool for teachers to use when planning and enacting kit-based curricula.

6) References:

Castles, castles, castles! And where's the science? In Roth, W. M., Tobin, K., and Ritchie, S. (Eds.), *Re/Constructing Elementary Science*, pp. 213-237, New York: Peter Lang.

Cartier, J. L., and Huang, T. (2005, April). Changing teacher practices by BITTs and pieces. Paper presented at the annual meeting of the National Association for Research in Science Teaching. Dallas, TX.

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Darling-Hammond, L., 1995. Policies that support professional development in an era of reform. Phi Delta Kappan: 76 (8). Pp 597-605.

Kozulin, A., (1998) Psychological Tools: A Sociocultural Approach to Education. Massachusetts: Harvard University Press.

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This proposal is related to a grant funded by NSF. The grant covers costs of the project, but not those related to research into educational benefits of the program.

Budget	Completed By Researcher	Paid by Other Grant	**Requested from SOE**	Project Total
Participant interviews (2 hours X 11 participants @ workshop rate of $22.05)		$485.10		$485.10
Reliability Coder (20 hours @ $15.00/hour)			**$300**	$300
Transcriptions (1054 minutes @ $2.00/minute)	$1092 (546 minutes)		**$1016** (508 minutes)	$2108
Poster (To present at CGSE research conference)			**$100**	$100
Total	$1092	$485.10	**$1416**	$2993.10

Justification:

Participant Interviews – necessary to determine explicit connections of tools to Big Ideas

Reliability Coder – necessary to insure coding measures are consistent across data.

Transcriptions - Approximately half of the data in this research is from interviews. While the primary researcher will be transcribing much of the interviews, time constraints necessitate contracting a certain portion of the transcription to other sources. The primary researcher collected the data and is therefore familiar enough to outsource some of the transcription. Unattended planning data will be transcribed by the researcher.

Poster – Communicating research in a public forum promotes more careful scrutiny of conclusions.