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ORIGINAL ARTICLE

"They probably aren't named Rachel": Young children's scientist identities as emergent multimodal narratives

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Abstract In this research we put forth a theoretical framework that explores the nature and value of multi-modal narratives as a tool for studying young children's conceptions of themselves as scientists as they exist in relation to scientists out in the world. This framework shapes and is shaped by an empirical study that took place within the context of a year-long program that engaged children in integrated science-literacy experiences around two units – one on matter and one on a forest ecosystem. Thirty-six children were asked twice to draw and discuss two pictures of times they were scientists. We present our findings in two main ways. First, we use case studies of three students (one each in the first, second, and third grade) to show how the various constructs in the theoretical framework come together in the empirical study, and to explore in depth the various ideas that the children revealed. Second, we share a summative descriptive analysis of the differences between the pre and the post interviews. One of the important findings included the increase in the number of pictures from the pre-interview to the post interview in which children represented themselves as scientists (31 to 61). The children also showed themselves and scientists out in the world as engaging in practices with a range of materials, for a variety of purposes, and with particular kinds of epistemological commitments.

Keywords Identities · Scientists · Narratives · Multimodalities · Epistemologies

Educational research has experienced a surge of interest in the construction of academic identities, including those in the domain of science. We believe that by understanding identity and identity formation, we can come closer to understanding why people make the life-path choices that they do, especially in relation to the material, social, discursive, and institutional opportunity and marginalization of certain identities for certain kinds of people. Furthermore, access to science and scientific practice has been an important topic for groups, such as women and ethnic minorities, who have been historically marginalized or

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undervalued, in spite of individuals' substantial contributions to the many fields of science. Developing scientific identities is important as it allows for participation in scientific activities, developing opportunities for ways of living. Our study looks at how young children enact certain kinds of identities entailing certain kinds of ideological commitments to the nature of science.

First, we recognize that learning occurs through interaction. This interaction produces the "kinds of people" (Gee, 1996) we become. But we also use our identities as "kinds of people" to mediate our interactions with other people and to come from certain recognizable positions when communicating with others. When we choose to come from a certain position, we choose the ideological elements with which to represent ourselves. That is, our position *represents* our commitments to ideas, values, beliefs, and practices associated with entities beyond our corporeal body. In our paper, we discuss how young children's positions were constructed through the choice of certain ideological elements associated with different stances towards science. These elements come in the form of the kinds of tools, processes, and activities that students, in interviews with us, represent about themselves as scientists. We explore students' identities as multimodal narratives created not only *during* two interviews but also *for* the interviews.

Although we will be focusing on something called "scientific identity," we do not consider it the only, or most important, identity students develop in their lives. We do not deny the existence and importance of other practices and identities with which children come to and enact in school in the course of their development as different kinds of people. Students are members of ethnolinguistic groups, nationalities, families, classrooms, churches, sports teams, and secret best-friend clubs. They have different identities at different times, according to their needs in the different spheres of their lives. They adapt themselves to "fit" into the contexts in which they engage. Choosing to be a scientist is to choose to be one thing of many at a specific time and place. Similarly, we also recognize the importance of creating a hybrid, third-space that allows for the intermingling of identities and discourses of "official" and "unofficial" lives that Gutierrez and her colleagues (Gutierrez et al., 1995) and Moje and her colleagues (Moje et al., 2004) articulate in their studies of students' discourse practices in classrooms. In many parts of our curriculum we offer spaces for students to bring their practices, beliefs, and values from outside of the classroom as resources for learning inside the classroom (for a synopsis of various intertextuality categories we have developed see Pappas et al., 2003). Indeed, the present article offers insight into some of these sources of knowledge. However, in this paper we are concerned with what children appropriate as scientific identities, as these children may be the kinds of people who are *not* becoming scientists.

Identities as narratives

As Gee (2000–2001) has noted, scholars have "moved the emphasis from individuals and the identities that seem to be part of their "individuality" to the discursive, representational, and semiotic processes through which identities are created, sustained, and contested" (p. 114). In our research we consider identity to be a social semiotic sign that, like any sign, has both an inner life in people's minds and an outer representation. It is made of our conceptions of ourselves, others' conceptions of ourselves, and our performances of ourselves in social interactions (Tonso, 2006). Such a position toward identity is based on an "ecological view of communities" (Lemke, 2001). In such a view, the languages, belief systems, and specialized discourses and practices of communities that people inhabit shape their identities.

We consider identity to be not only created in discursive activity, but also as a factor that shapes that activity. Our identities are produced because of our unique historical and sociocultural circumstances. They are only possible at the times and places in which we live, formed in our engagements in everyday activities. They are produced by the words we say, the subject matter we take up, the ideological positions we assume, and the people with whom we interact as we co-construct our lived worlds with others. Identities are representations of kinds of people engaged in kinds of social practices over periods of time, "thus, identity, knowledge, and social membership entail one another" (Lave & Wenger, 1991, p. 53). Identities are the embodied performances individuals give to their values and beliefs embedded in the daily activities of their lives.

As students experience the world, their conceptions change regarding the ways they see themselves. They interpret themselves in new ways through their new information. This means their identities are always in process. As children learn science, "they also learn a lot about who they are (and can be) and what science is (and can be)" (Barton, 1998, p. 382). That is, children's identities develop, are in-process, only within a realm of possibility (Bruner, 1996). They cannot become people whom they view are impossible to become. But possibility comes with experience. As interlocutors, we help construct experiences *and* possibilities for identities.

Although identities form and are formed by our interactions, identities and interactions are not equivalent. We cannot say that any one isolated instance of our engagement in an activity is our identity. Our in-action-on-the-spot social beings are more compatible with the timescale of subjectivities (Davies & Harre, 1990). Subjectivities are the reflection of a position that is enacted in the moment by the social agent, and they operate on a shorter time-scale than identities. They are better suited to the time scale of interactions that may last less than a second or over several hours, until a role is completed. As we take up the same subjectivities again and again, we form more stable dispositions and we tend to see ourselves become people who take on certain roles in certain situations. For example, we may be a student, a nature lover, or a researcher. Rather than momentary concoctions, identities are built over time. And though still dynamic, they are long-term. More than any one story, we see identities as the *accumulations* of the daily stories and positionings that result from our daily interactions with others, and change as we gain new experiences. Thus, early exposure to, and many choices for, scientific identities may give students more chances to tell the stories of their scientist-ness. But we consider stories to be more than verbal narratives; they also include the ways in which we get dressed in the morning; the bobs of our heads to certain kinds of music; or in the case of our interviews, the pictures we draw as they fit into the contexts of our lives.

As such, "individual identity is not necessarily either single or stable. A person can be a part of, or aspire to, many different communities simultaneously" (Brickhouse et al., 2000, p. 443). If multiple identities can be tied to one person (e.g., chemist, graduate student, brother) then identities cannot be held to be one person's essence or core. Identities are not representative of an essence of a human being. An identity represents one aspect, one social role, of being human in social activity. And the meanings people make of these activities are not static, nor are they the same for everyone. They are constructed by different people who take up different roles and, as such, reflect the kinds of values, ideologies, practices, and communities in which people engage.

Furthermore, people's identities are formed not against a stable landscape of constant values, practices, and communities, but through the dynamic experiences of nature, time, space, and culture. The world is changing at the same time the individual is changing. The developmental trajectories of the individual and the social world are concurrent, intertwined,

and mutually interdependent (Cole, 1996), even as they happen on different timescales, one changing at a different rate than the other (Lemke, 2003). The two processes, the one of individual development and the other of social development, exist in a dialectical relationship, each constituting and constituted by the other.

In this paper, we offer the view that *identities as multimodal narratives* is a useful analytic frame for examining students' views of their emergent present and possible identities. Identities are not being represented *by* the communication; instead, they are the representations themselves. These representations are constituted through spoken language, written language, images, and their interaction.

As children enact being scientists or watch others being scientists, they create and share narratives about themselves. These narratives include the performances of self within moments, but also reach across moments to embody "collections" of legitimate and "endorsable" stories, representations, and semiotic acts (Sfard & Prusak, 2005). These stories present the children's sense of their interactions with others, and the children's sense of others' ways of thinking about and interacting with them.

Conceptualizing students' identities as multimodal narratives fits with the method we chose to explore identities. The student and the researcher negotiated who this student was in the context of a very specific interview. The researcher was asking, "When were you this kind of person?" and the student was answering, "When I was this kind of person I engaged in activities in this way. . ." Within the interview Discourse (Discourse with capital "D" to denote ideological ways of talking, acting, behaving and being as discussed by Gee (1996)) that shaped the adult and the student as kinds of people in an institutional setting, the student decided to represent his or her making sense of the interaction in a certain way, making choices about what best fit the question being asked. Coupled with the researchers' and the readers' subsequent interpretations of these representations of a student as a kind of person, a social semiotic construction is built about the student. This construction is only one lens of who the student is. This is why we asked the students to draw two pictures, and why we asked about identity at two different times (roughly at the beginning and the end of the school year). It gave us more stories about each student.

Narratives as multimodal constructions of emergent identities

Within educational research, there is increasing emphasis on the need for multimodal ways of expressing ideas, beliefs, and knowledge. Although drawings are used rarely in educational research, scholars have used drawings to explore children's conceptions of standardized testing, technology, student teachers, and subjects in school such as math and reading. Pictures have also been used to examine young children's general conceptions of literacy and family literacy.

However, to date, most of the research that has used visual images to study children's perceptions of scientists has been around for over 50 years and has focused on stereotypical indicators, specifying various characteristics students attribute to scientists and reasons that led students to these characteristics. The Draw-A-Scientist Test, DAST (Chambers, 1983), and its adaptations and supplemental interviews (Sumrall, 1995) reveal children's stereotypes about scientists in terms of appearance, race, gender, work setting, and so forth. However, these studies offer limited understanding of children's epistemological beliefs of science and especially of children's own identities as scientists.

In order to find out students' conceptions of scientists, and about themselves as scientists, researchers have primarily used oral or written language. However, a singular mode can be

problematic for accurate representations of young children's knowledge. Language is still being mastered by young children. It may be that language is just not enough for the child to represent what he or she knows, and by limiting ourselves to verbal reports we may be limiting our knowledge of our children. This is not to say that pictures do not have their own problems for representation. It is not uncommon in our interviews, or in the classroom, to hear a child express his or her own shortcomings as an artist. With that in mind, we asked students to draw *and* talk about their ideas of who scientists are because we wanted to give them the opportunity to express their ideas in as many ways as possible. The modality of images allows different kinds of meanings to be made than does the modality of verbal language. Images allow students to see themselves differently than in words. In turn, we see them differently as well.

Modalities other than spoken or written language carry potential for meanings that also represent children's existential beliefs about the world. As Kress and van Leeuwen (1996) note, "representation requires that sign-makers choose forms for the expression of what they have in mind, forms which they see as most apt and plausible in the given context" (p. 11). Visual representation and language bring out two sets of meaning that Kress and van Leeuwen claim are neither "fully conflated, nor entirely opposed" (p. 18), thus being useful in offering us multiple, related windows into students' minds. That is, although words and images offer different potential for meaning, a student's drawing as a scientist can be as much a narrative representation as a verbal story. In almost every single one of the drawings, the children's representations contained an actor (the student) engaged in behavioral (i.e., making, exploring) and/or mental (e.g., thinking) processes with an eye towards a goal or future outcome (i.e., to find out about worms, to help people). These are conventions of narratives in both language and images.

Furthermore, different modalities can work together to create a multiplicity of meanings as Lemke (1998) demonstrates in his analysis of multimodal reading paths in science textbooks. In our interviews, the students moved between visual and verbal representations to tell us about specific times they had engaged in scientific activities or specific activities in which they wished to engage in the future. They were able to build meanings from both the spoken words and the illustrations to craft more substantive stories. Our interviews were multimodal. We co-constructed the narratives and their components not only from the words the students spoke, but also from the pictures they drew, the words they wrote, and the interplay between the different modalities of communication as the interview was constructed.

Another factor to consider is that we asked children to respond to us in a way we value, namely, by telling us a story. Of course, children's facility with the structure of narrative, in both oral and pictorial form, will shape the kinds of stories they can tell. Adults can give quite complex accounts of the interconnectedness of their life events. Our students have not had as many experiences as adults, and they have not had as many chances to tell stories of who they are (to, in the first interview, unfamiliar adults). But they are not completely un-practiced, and their rich mental and physical lives allow for a flush of possibilities.

Actual and designated identities as they relate to ideological conceptions of scientists and the nature of science

According to Sfard and Prusak (2005), the concept of identity can be split into two types, *actual* and *designated* identities: Actual identities consist "of stories about the actual state of affairs. Designated [identities] consist of stories which, for one reason or another, are *expected* to be the case" (emphasis in original, p. 18). In our study, we use the concepts of

actual and designated identities to consider the narratives that students identify as belonging to scientists out in the world (designated) and narratives they identify with their own past and present (actual) and future (designated) identities. Designated identities develop from personal experiences inside and outside of school, from family members' experiences, from media sources, or any number of daily interactions the child has.

Within this framework, then, we must consider where actual and designated identities come from, how they might be different at the beginning and the end of one year, and how students see the relationship between their actual identities and the identities they designate to scientists out in the world. The identities that count are the ones that are reifying, endorsable, and significant to the child in the context of the interview. Students have made choices to represent themselves. Within the configuration of these choices lie students' ideological commitments about the nature of science.

Of course, some of these identities and the ideologies they draw on are not only valued, but are also supported explicitly by our research project, by the teacher, and by the institution of schooling. Thus, children's ideas about scientist identities are subject to, and constructed within, the production of these ideological and material spaces. As students' ideas change about who scientists are and who they are as scientists, the relationship between who they see themselves as, and who they see scientists as, changes, becoming either more similar or more differentiated. In this way, identity formation is a coordination and negotiation between how people recognize themselves as embedded in the world and how others recognize the world as embodied in them (Brickhouse et al., 2006).

In describing students' actual identities as related to their designated scientist identities, we describe the elements of the activity structures that the students draw on as they construct who they are in these activities. These elements outline the students' uptake of ideological stances towards science. We argue that their representations of certain practices and materials as belonging to *their* scientific activities can offer us insight into their ideological positioning. Within this ideological positioning, they represent themselves as certain kinds of people who practice certain kinds of science. As such, below we describe what we see as the children's nature of science and how we can think about their conceptions of themselves as engaging in certain kinds of science.

Philosophers, sociologists, historians of science, science educators, and scientists themselves do not share a common view of the nature of science (Alters, 1997). One of the contested issues centers on the dialectic between theory and data, and the inductive-deductive continuum. Lederman et al. (2002) remind us that:

> Scientists observe, compare, measure, test, speculate, hypothesize, create ideas and conceptual tools, and construct theories and explanations. However, there is no single sequence of activities (prescribed or otherwise) that will unerringly lead them to functional or valid solutions or answers, let alone certain or true knowledge. (pp. 501–502)

One of us has recommended that both inductive (data to theories) and deductive (theories to data) directions of scientific activity ought to be emphasized in science education (Varelas, 1996). But, the prevalence of the inductive stance in schools may be promoted by the emphasis on inquiry activities that sometimes are interpreted as *discovering* relationships between variables, or observing behaviors and characteristics, instead of *testing out* relationships and features predicted by a theory, that is, by a way of looking conceptually at the world. Several science educators, however, articulate a view of inquiry in science education that does not privilege the inductive over the deductive approach. However, Varelas also pointed out that the deductive approach (developing theories and testing out in the real world claims, predictions, and hypotheses that derive from these theories) is at a disadvantage relative to the inductive

approach because of a particular differentiation that learners need to achieve to be able to understand and operate within this approach. This is the differentiation between two ways of knowing – knowing from thinking about something by relating ideas, concepts, constructs together, and knowing from empirical evidence (that is, of course, always theory-laden to some degree). If such differentiation is not achieved, finding out something we already know does not make sense and, thus, the learner may resort to the more inductive approach, that is, collect data to find out something that is not known.

A related issue is the continuum of science as an enterprise that develops a particular type of knowledge that has particular intellectual concerns versus an instrumentalist view that considers science as solving problems, and, at times, designing products to address societal or personal needs, thus focusing more on applied concerns. Rudolph (2005) discusses how inquiry activities encouraged by science education reform fall along the design end of the continuum and influence students' understanding of the nature of science. Furthermore, Wong (2002) highlights another distinction relevant to the nature of science, namely, appreciating individual variation versus focusing on commonalities shared by scientists as a group that represent a standard practice. He argues that it is important to teach our children in ways that highlight variation, nuance, details, uncommon features, uniqueness, and complexity so that they see science as "fundamentally human and vital" (p. 398).

Undaunted by the expanding plurality of what constitutes scientific practice, science education researchers have been concerned with the structure and development of students' knowledge about the nature of science. There is an extensive body of research that has explored students' (especially those of middle school age and above) epistemologies of science and possible relationships between such conceptions and classroom practice. In our study, we link students' epistemologies with ideologies. When students represent epistemological stances, they foreground certain configurations of beliefs, values, and practices. Through the construction of the interview, these epistemologies (filled with ideological commitments) become translucent, giving us a window into the children's highly situated views of the nature of science.

Researchers have used particular instruments, such as VNOS – Views of Nature of Science (Lederman et al., 2002) – to capture and measure students' knowledge of the goals and methods of science. Others have focused on qualitative methods of data collection, such as interviews, that may have been complemented by such instruments. This research exposes a variety of students' conceptions of the nature of science and warns that without explicit attention to the nature of scientific practice and the scientists' work, students do not develop sophisticated understandings, but maintain naïve views about the ways science is done (see Schwartz et al., 2004, for references on supporting studies). Engaging students in inquiry-oriented activities, such as ours, may not be enough for them to develop complex models of scientific activity.

To further explore the difference between engaging in scientists' activities and developing sophisticated concepts about scientists' work, Hogan (2000) puts forth a useful distinction between two categories of students' understandings of the nature of science – distal and proximal knowledge – to depict the relative distance of such knowledge from personal, lived experience. Distal knowledge is students' knowledge of the practices, products, and habits of mind of the professional scientists. Proximal knowledge is students' knowledge of the practices, products, and habits of mind that they themselves use, develop, and think about in their own activities that they recognize as science. Similar to Hogan's distinction, Sandoval (2005) distinguishes between formal and practical epistemologies – *formal* denotes students' conceptions about professional, formal science, and *practical* denotes how they see themselves doing science. When it comes to practical epistemologies, Sandoval explicitly focuses

on students' "epistemological ideas that students use to guide their own practice" (p. 636), which he differentiates from Hogan's proximal epistemologies view that he claims "conflates views about oneself as a learner with views about knowledge" (p. 636). Furthermore, the distal/proximal dichotomy negates the relative interpersonal proximity students have to their sources of knowledge. Students learn about science from their peers, their families, and various media with which they engage. We find these ideas compatible, though not symmetrical, with the notions of actual and designated identities we adopt. However, our emergent perspective proposes that students' knowledge is neither a dichotomy between distal or proximal nor formal or practical, but an interwoven tapestry of knowledge that comes from a range of "lived" experiences – even if these experiences consist of watching television.

As Hogan points out, students do have meta-cognitive knowledge of their engagement in scientific activities. They are aware of the fact that they engage in activities which are more or less scientific, and that they engage in these activities as people who act "as scientists" or not. In order to explain their positions to us in the interview, students must juxtapose knowledge of their own practices with those of scientists out in the world. They must be aware of the nature of their own activities as well as those of other scientists. In this case, their knowledge is emergent, but integrated. It is neither declarative knowledge about others, nor procedural or meta-cognitive knowledge about themselves. It is a developing integrated knowledge of their own practice in relation to other people's practices.

Finally, students do not just move from proximal to distal (or actual to designated) notions of science. That is, they do not build ideas of scientists from their own particular activities and then generalize to some abstract scientist. They constantly renegotiate their identities through the activities they engage in, the roles they take on in these activities, and the spaces others give them. These activities come from a variety of places. For instance, as a source of students' knowledge about science, "That's so Raven" is a Saturday morning television show produced by Disney that has come up more than once in our interviews with children. But students' sources also include stories of family members dissecting frogs in their "scientist high school," and personal experiences in and out of school. These are *all* lived experiences for children. In these experiences they are scientists some of the time and they are observers or wishers-to-be at some other times. But they always develop ideas of themselves in relation to science, scientific activity, and scientists. It is part of their meaning making.

Research focus

For the purposes of making sense of the complex development of identity and activity, and relationship between them, we adopt Penuel and Wertsch's (1995) perspective that frames the tension between the various interpretations of approaches to identity formation as an issue that "lies in. . .the *analytic primacy* ascribed to either individual mental functioning or sociocultural processes in development" (p. 84). As researchers attend to the concept of identity, at times they give primacy to the individual and the choices he or she makes. Other times they privilege the multiple activity systems within which individuals enact identities that shape and are shaped by these systems.

When we interview children and they respond with a narrative, we are giving analytic primacy to the identity of the individual. As we foreground individuals, we background the sociocultural formation of the identity in an activity system. However, by studying the children's narratives, we can explore children's own choices, ideologies, and commitments *as a part of* the social activity systems with their particular tools and signs that influenced the children to form the identities they portray. In the present study, though, we do not explore

how the children's identities shape the activity systems in which they are enacted. (We are working on this facet of identity construction in other papers.)

Here, the questions we work on are: Do students see themselves as scientists? If they do, what kinds of scientists do they see themselves as? What do they do as scientists? What kinds of materials do they use? Where do they engage in science? In what ways do they see science as a social activity? What are their epistemological commitments? What do they see as the purpose of science? And in what ways are the activities they engage in as scientists similar and different from the activities scientists out in the world perform? We frame our inquiry around two interviews eight months apart.

Participants, setting, and context

Participants include 36 children in 1st (11 in two classes), 2nd (15 in two classes), and 3rd (10 in one class) grades in public school classrooms in a large Midwestern city. The children were taught by five teachers across four schools who participate in a collaborative school-university research project that aims at exploring various dimensions of integrated science-literacy teaching and learning. Two classrooms (2nd and 3rd) were 100% Latina/o. The second grade class was an English Language Learner class conducted in Spanish and English. One of the first grades was predominately Latino/a, and the other two classrooms had children from diverse ethnolinguistic backgrounds. In the present study, we chose to treat ethnicity as a descriptive variable, studying the responses of children who engaged in unique "repertoires of practice," each with their own histories, and not as an analytic lens for looking at children's actual identities (Gutierrez & Rogoff, 2003).

This study is part of a larger project titled "Integrated Science-Literacy Enactments" (ISLE). The two integrated science-literacy units implemented in the classrooms, which teachers and university educators have designed together, were each about 10 weeks long and incorporated the following features: (1) hands-on explorations, plus whole-class discussions around them; (2) interactive read-aloud sessions using a range of children's informational books on the topic being investigated; (3) many writing (and drawing) experiences related to the inquiries, including students' own illustrated information book created at the end of the unit; (4) small-group literature circle inquiries using informational books; and, (5) home projects (that included a science activity and a related children's literature information book) on the topic that are then reported in the classroom. The *Matter* unit centers on characteristics of matter in different states, changes of states of matter and how they take place, and how these changes are related to how rain is produced. Discussions on weather provide one of the contexts for this unit. The *Forest* unit centers on plants and animals that live in a forest community – underground, on the ground, and above the ground – their characteristics, the classes they belong to, and relationships among them, including food chains and webs. Epistemologically, these units intended to engage the children in science that is both inductive and deductive, downplaying an instrumentalist view of science.

Interview and analytic procedures

Because identities are stories, and stories are always told to another person in a social setting, the context in which they are told is important, for it gives the story its legitimacy. Where, when, to whom, and in what ways the stories are told have a bearing on the kinds of identities that are constructed in the narrative depictions. It is the interviewer and the child together

in the context of the institution who construct the identity of the child. Furthermore, the participants' quest to figure out what it means to answer the directive "I want you to think of two times you were a scientist" also shapes the story that is told. Roth and Middleton (2006) describe interview participants' desire to resolve uncertainties about expectations or answers as a major aspect of the kind of meaning making that goes on in interviews. The "uncertainty" of our conversation includes the construction of self across multiple timescales – not just the conversation at hand. To answer our questions, participants construct both notions of the past and future as they perform their identities in the present. Using Lemke's (Lemke et al., 2006) characterization of reality, we see identity as living "across our experience and not just in each moment of it" (p. 85).

As researchers we have preconceived notions of what science is and who scientists are. We are setting up a particular kind of context in which students' ideas about who they are will be validated and recognized. What we are really asking must also be validated and found "significant" by the children themselves, for it is they who are doing the telling. But this validation has to hold up in the context of the interview and is relative to what both participants dynamically (in the course of the interview) and holistically (the interview as a whole) construct as an appropriate answer, even if it is "I can't [draw and tell about a time I was a scientist]." Furthermore, the interviewers are representatives of "school" (in as much as we are in the school and supporting the teacher) and "science." These memberships entail the ideological commitments of what children think schools are for. Thus, children's identities are constructed only because of the opportunities embedded in the interview within the context of the institution.

For the interview, children either sat with the researcher in the hallway, or in a quiet place in the classroom. In the first interview, they did not know the interviewers very well. They had perhaps met the interviewers once or twice before and only to review and sign the child assent form for participating in the research, or in brief whole-class introductions and observations. By the time of the second interview, children had spent the better part of the year with the interviewers going in and out of their classroom, and having informal conversations and interviews about both the information books they had written and the two units' content in general. Thus, the relationships between students and interviewers had changed between interviews. Some students resented being interrogated. Others welcomed the chance to spend one-on-one time with an interested adult.

There were three interviewers: one for first grade, one for second, and one for third. The interviewers were all graduate students in education who were working on the project as research assistants in the respective grade levels. Two of the three interviewers had previously been trained in ethnographic methods. One was trained just prior to conducting the research. As well, two of the three interviewers spoke English as a second language. Both of these interviewers were female. The native English speaker was an Anglo male, the first author in this paper. In fact, one of the interviewers who spoke English as a second language (but who spoke four other languages) interviewed Spanish/English speaking second graders in an English Language Learner classroom. These interviewer characteristics are some of the possible factors that might have shaped the content of the interviews.

In the interview, children were told the following: "I want you to think of two times you were a scientist. I would like you to draw a picture of each time you were a scientist. We won't have time for you to do a real detailed drawing. I would just like you to give me a sketch. If you can't think of two times, maybe if you just draw one, you will be able to think of another time." After children drew their pictures, they were asked to tell the interviewer about each of their pictures and explain how they thought of themselves as scientists in each picture. They were asked to clarify if this was an occasion that had taken place in the past or it was

something they would like to do in the future. Furthermore, they were asked the following questions: "Why do scientists do the things you showed?" "Are there things that scientists do that you didn't put in your pictures?" "Are there things in your pictures that scientists don't do?" The interview was administered twice to the children, early in the school year before the start of the Matter unit, the first unit of our program, and at the end of the year, after the Forest unit.

All interviews were transcribed. Content analysis was used to analyze the transcribed data. Each transcription of each interview was read line-by-line, and then divided into meaningful analytical units that were then coded by the research team. Considering both the children's drawings and their discussion of these drawings, and guided by the constructs we discussed earlier, we developed a coding scheme that included the following categories: (a) the *when* and the *who* of each activity – whether the activity in the drawing was experienced, and if so whether it was experienced by the child or by somebody else, or whether the activity would be done in the future; (b) the *where* of each activity – whether the activity was (would be) done at school and being related to our curriculum, or at school and not related to our curriculum, or outside of school, or not specified; (c) the *how* of each activity – whether the activity was a hands-on one, one involving print material, one involving other media, or not specified; (d) whether or not the child portrayed him/herself in the drawing and whether or not the child talked about him/herself during the interview; (e) whether or not others were part of the activity depicted in the drawing and expressed in the talking about the drawing; (f) the artifacts involved in the activity and depicted in the drawings; (g) the actions depicted and discussed that were part of the activity; and (h) the ways of being/identifying with science. We also coded the stance towards the goals of science depicted in each activity using the following codes that emerged from the ideas we discussed earlier about the nature of science: inductive explorer, deductive tester, problem solver, engineer, knowledge developer (when there was not enough information to determine whether the child was using one of the four previous specific goals), knowledge presenter (when the emphasis was in the sharing of knowledge with others as opposed to developing the knowledge), and not known. Finally, we coded the comparisons that children explicitly talked about between the activities they depicted and what scientists out in the world might do or not do – that is, between their proximal or actual and distal or designated conceptions. We used the following eight codes that we identified as we examined the data: (1) material processes (acts on or with artifacts, e.g., mixing, pouring, observing); (2) material artifacts (tools, equipment, materials, e.g., magnifying glasses, bowls, food coloring); (3) textual (acts with print, images, or other media, e.g., reading or writing a book); (4) cognitive (references to thinking, knowing, understanding); (5) social (acts with other people, e.g., working with partners); (6) affective (description of feelings, attitudes, emotions, e.g., smart, cool, excited); (7) physical environment (places where activities are done, e.g., at my home kitchen, outside); and, (8) verbal (verbal language, e.g., talking or answering questions).

Three narratives of students as scientists

To present our exploration of students' multimodal narrative construction in greater depth, we chose pre and post interviews from three students. Because we wanted to present for readers examples that would be rich enough as data sources, yet still fit within the reasonable length of a journal article, we purposely sampled interviews from students who offered good stories in both their words and drawings. We present two 3rd grade Latino students, a boy, Arturo, and a girl, Ada, and one 2nd grade Anglo girl, Monica. As we tell "stories" about

these children, we exemplify constructs we discussed earlier, and we introduce some of the patterns we found among all children that we address in the section following these three narratives.

Arturo

Arturo's classroom was in a school that served a predominately Mexican-American community on the city's south side. Ninety-five percent of the students received free or reduced lunch. Although the school's population is 98% Latino/a, all the children in Arturo's class were identified as Latino/a by their teacher.

Arturo's pre-interview

In his first interview, Arturo drew two pictures (see Figure 1).

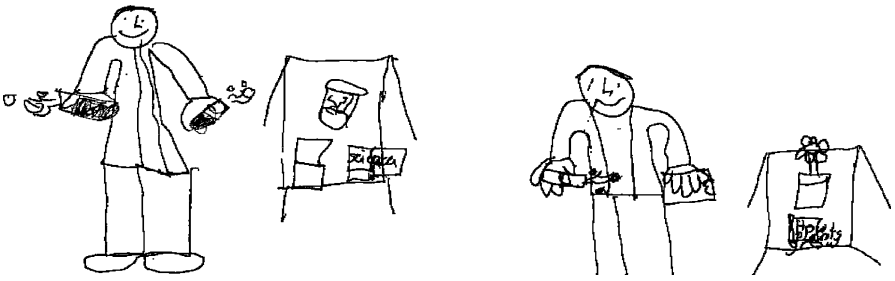

Fig. 1 Arturo's pre-interview drawings

In his pictures, Arturo drew himself as the only actor. This was typical of the children's drawings in the pre interview (77% of the pictures included the children themselves), which might have been expected from the directive "draw *yourself* as a scientist" (emphasis added). Both pictures show Arturo's drawing of himself as the largest entity in them. This perhaps marks for Arturo what he finds important in the representation, *himself* as a scientist. Also, in written language and images in western cultures, Kress and van Leeuwen (1996) argue that already known, or given information, is on the left-hand side of the sentence or image. The left-hand side is the "departure point" (p. 55) for viewers to make sense of the picture. On the right-hand side of the text is where new information is placed. In both cases, Arturo has placed himself on the given side, as an already known entity, and the "science" on the right-hand side as a newer entity. He not only drew himself on the left-hand side, but we also witnessed him draw himself first, before anything else in his picture. This is not a complete spatial division of knowledge; in both pictures he is holding tools of the trade that allow him to complete the actions that are being carried out at the table on the right. In the left-hand picture, it is a bubbling, steaming test tube in each hand. In the right-hand picture, he carries something we cannot identify, along with a clipboard for writing.

In both pictures Arturo is performing material actions; that is, he is manipulating concrete objects. His drawings represent the ideological commitments he has made to actions. Arturo also does his work on tables, typically an indoor artifact. We can infer that for Arturo, science is an activity conducted inside, but we do not know where exactly he is. Questions come up about whether he is at school or some other place. And like most of the children's drawings of themselves, Arturo has drawn himself smiling. Apparently, he is enjoying his work.

The precise goals of Arturo's activities are not apparent from his pictures, but the interview tells us more:[1]

21 Inter:	Um, I'd like you to tell me about your pictures one at a time. Can you explain to me how you thought of yourself as a scientist?
22 Arturo:	Thought of myself as a scientist while I was mixing this two stuffs together. And made a little fireplace so when // so they can mix up all together with the fire. So then I made a little book of science and then another book so I could see how they do it. And then I just try to mix 'em up together and put 'em in this pan.
23 Inter:	Alright. What do you mean, see how they do it? What do the books like*. . .
24 Arturo:	Um, show you how to um mix them all together.
25 Inter:	Okay, and so why do you have two books?
26 Arturo:	Cause*. . .
27 Inter:	Is one book different from the other?
28 Arturo:	Cause I made two parts. This one [the left-hand book] is for one on discovering plants.
29 Inter:	Oh, that's for your other picture?
30 Arturo:	Yeah.
. . ..	
39 Inter:	Alright, can you tell me what's happening in the second picture?
40 Arturo:	Um. . .#this is#
41 Inter:	#Um, how you# thought of yourself as a scientist.
42 Arturo:	This is me discovering how plants grow.
43 Inter:	Okay.
44 Arturo:	And how // and how would they look if I mixed them with like experiment stuff.
45 Inter:	Okay. Okay.
46 Arturo:	And this is me writing it. How it would look.

Through our talk, the goals of the actor (Arturo) in Arturo's pictures become more accessible. In the left-hand picture, Arturo is mixing things, and he does read about this information in a book although he does not explain why in the interview. He has an emergent idea that information for scientists is found in books. In the right-hand picture, he is testing the growth of plants when they are exposed to different substances. We have identified Arturo's epistemological stance in this picture as an Inductive-Explorer. He is finding out "how it would look" (unit 46).

In either case, Arturo is using books to tell him "how to do it," but he is also "writing how it would look." Arturo has also titled the books. The first one is generic, simply "science;" but the second is more explicit "how plants grow." In this way, Arturo shows his awareness of book genre titles. "Science" may reflect a vague, abstract, unapplied notion of science, but

[1] Speaker turns are indicated by their original numbers in the whole transcript of the particular interview. Also, transcription conventions are as follows: //: false starts or abandoned language replaced by new language structures; . . .: short pause within language unit . . . . .: longer pause within language unit * . . .: breaking off of a speaker's turn due to the next speaker's turn (***): one word that is inaudible or impossible to transcribe (*** ***): longer stretches of language that are inaudible and impossible to transcribe; # #: overlapping language spoken by two or more speakers at a time; [ ]: identifies what is being referred to or gestured and other nonverbal contextual information; . . ..: part of transcript has been omitted; < >: uncertain words; *Underscore*: emphasis.

it might also reflect the title of a school subject or a textbook in that school subject. "How Plants Grow" is titled in the style of an information book, not a storybook. Arturo seems to have an understanding that a story book like "Jack and the Beanstalk" for instance, would not be appropriate to capture his thoughts and findings about how to grow plants, or contribute to scientific understandings. Arturo is able to classify books as scientific. He has made an ideological commitment about what is appropriate for science.

When Arturo describes himself as a scientist, he describes and draws himself as someone who engages in explicit literacy practices. This was not a typical response in our pre-interviews. Importantly, both pictures are something Arturo has not done before, but "thinks about doing." Other activities are more salient to him, "my real thing is singing and dancing. . .Heh, heh, I'm a singer and a dancer." Arturo's father runs a dance studio where Arturo regularly practices. "Scientist" is not part of Arturo's actual identity. It is not a story he tells of himself in the present, like the "singing and dancing." A scientist identity for Arturo is one that is designated. It exists, but only in his thoughts, and perhaps only in the construction of this interview. For instance, Arturo told us that his pictures were similar to and different from scientists' practices out in the world because "no one's ever discovered flowers and how they mix together. . .It's just something that no scientist never did. . .But they will always do this [mix things together].". The words "never" and "always" express a high degree of modality. That is, they strongly modify the actions associated with them. When one says that something "always happens," it expresses a high degree of "given." It just "is." Sfard and Prusak (2005) suggest that strong modalities, such as these, are associated with designated identities, types that we are less personally connected to. These are the activities that Arturo associates (or does not associate) with scientists, and these are treated rather uniformly, as part of a distant activity that is monolithic and hardly nuanced, a stance that reinforces Wong's (2002) assessment of the broad treatment of scientists in schools. Arturo's use of modality is different in his use of the word "sometimes" in the following account of why scientists do the things they do in his pictures:

> 56 Arturo: Like, how to make it // how to make experiment stuff. How to make all the other experiments people want to know all around the world. Because *sometimes* [italics added] people like to be scientists and they just use *their* ideas and just do it and try to think of how the ideas are gonna work. So then they just try to // so they // they will keep trying to figure out how they get it right and just // and just // and then if they get it again they'll just keep doing it some time everyday.

Arturo uses the word "sometimes" when we ask him a question that explicitly draws a link between himself in the picture and scientists out in the world. The word "sometimes" is a weaker modality than "always" or "never." It connotes less commitment to a universal truth. This type of modality is more characteristic of an *actual identity*. So Arturo might be able to see himself as a scientist, because of the idea that he and scientists share desirable abstract mental processes, "they use their ideas." It may also be the case that Arturo knows that we think it is possible (and probably good) to be a scientist. Perhaps more convincing of Arturo's *actual* sense of self is his impromptu offer for himself of the labels "singer" and "dancer" that we discussed above, and his explicit separation of scientist from his current tastes and practices. For Arturo, at least in this representation, being a scientist is about testing "how the ideas are gonna work" (unit 56), and it is a possibility for him.

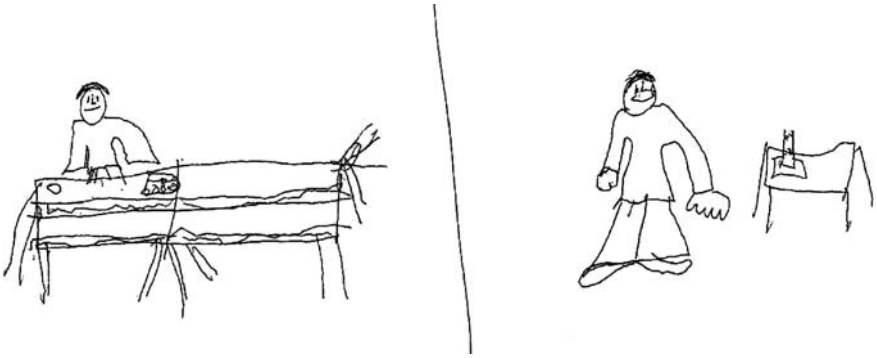

Fig. 2 Arturo's post-interview drawings

Arturo's post-interview

Both of Arturo's post interview pictures depicted activities that he had participated in as part of the ISLE curriculum (see Figure 2).

In contrast to his pre-interview pictures, Arturo has drawn two activities he has done, not ones he "just thinks about doing" (as in the pre-interview). Arturo now has the experiences and the resources to think of himself, and to make commitments, as a scientist. He has moved from a future, designated identity orientation to an orientation in which an actual identity of his is like that of a scientist. In the post interview, 70% of children's representations were similar to Arturo's, ones in which the students had "done" the activity in which they had been scientists (although not all were ISLE related). In fact, while describing the right-hand picture, Arturo stated that it is an activity that is "something I've already done *and* something I want to do in the future again."

Like the pre interview drawings, Arturo occupies the left-hand side of the image and a table or desks occupy the right-hand side. This is slightly complicated in the left-hand picture. He positions himself behind the group of desks – but he is on the left-hand side of it. Again, in each picture Arturo is smiling. This time, he has presented artifacts from two different ISLE activities, but he has not presented any textual materials, only the environmental print is evidenced in the nametags on the students' desks. In Arturo's representation, the reading and writing aspects of the activities are absent, while the hands-on components are foregrounded, even though during the lessons he engaged in writing as part of these activities. This is in contrast to Arturo's pictures in the pre interview in which he used books to help him. From Arturo's post-interview pictures, we can tell that what seems important to Arturo's sense of himself as a scientist are the physical artifacts that he is observing and/or manipulating. Thus, the artifacts in his representations are not only mediating tools with which he makes sense of the world, but also function as the *objects* of his study.

Interpreting Arturo's visual representations of activities as manipulations and observations, without involving writing, is corroborated by his verbal responses to interview questions. Below is the main part of Arturo's description of his pictures:

8 Inter: Um, so now I'd like you to tell me about your pictures one at a time, okay? Can you explain this // in this picture on the left, can you explain to me how you thought of yourself as a scientist?

9 Arturo: Well, that was <when I was a scientist> (***) like which seed was lighter and which ones were heavier. Like which seed would float and which one wouldn't float.
10 Inter: Okay. And so it // is this you? Okay, and is this a seed?
11 Arturo: Yeah, I'm about to put it in.
12 Inter: In what?
13 Arturo: In the water to see if it will float or not.
. . ..
34 Inter: Okay. Alright and then uh what's in the right hand #picture#?
35 Arturo: Well, #this# one is like (***) one of those like cups like you measure with water and you see which one will evaporate.
36 Inter: Yeah. A cylinder?
37 Arturo: Yeah, graduated cylinder.
38 Inter: Graduated cylinder, there you go. Okay. And so what // what do you // how // how did you think of yourself as a scientist in this picture?
39 Arturo: Like I was still seeing which // how much it would evaporate more.
40 Inter: Seeing how much it evaporated?
41 Arturo: Yeah.

Both of these accounts reflect what we have labeled as an Inductive-Explorer stance. In units 9 and 13, Arturo explains that he is seeing if the seeds will float or not. He does not have an explicit idea about why or whether they will float or not, he is engaging in observing and finding out. This is similar to the process Arturo describes in his right-hand picture in which he is again "seeing" (unit 39) how much his water evaporates and comparing it to others (units 35, 39). His identity as a scientist entails commitments to ISLE as science, and science as an inductive endeavor.

As Bruner (1996) intones, we need to be cautious about calling children "little scientists." What children do in school is *not* what practicing scientists in the field do, it is an approximation. Arturo recognizes this as well:

64 Inter: Okay. Alright. And, are there things that scientists do that you didn't put in your picture?
65 Arturo: Well, sometimes scientists never try to see which water would evaporate with the graduated cylinder because it's like a trick you learn in school that your teacher tells you to do. So that sometimes if you grow up to be a scientist you can like <spread it out> and people will know about what you // well, the idea.
66 Inter: Okay. Um. . .so in one sense you're saying, um, scientists might not do the same experiment you did, right?
67 Arturo: Yes.
68 Inter: But, on the other hand they might tell other people about the experiments that they do do.
69 Arturo: Yeah, like, when they get older and older then they grow up to be scientists, they // they learn // they learn about um doing // well they // what the person did a long time ago.

Arturo discusses differences between himself and scientists out in the world by focusing on material artifacts and processes. In unit 65, he recognizes that what he is doing is a "trick you learn in school." But in the same unit, he also believes it is like scientific practice in the real world and that the kind of activities he is engaging in will prepare young people to be

scientists when they "get older" (unit 68). Arturo knows scientists are adults. On his way to adulthood, will he continue to have the kinds of experiences that will make him want to engage in what he's "already done" in the "future again"?

Ada

Ada's pre-interview

Ada, a classmate of Arturo's, drew one picture in her pre-interview (see Figure 3). Through her picture and words, Ada told us a story about something she did "in second grade."

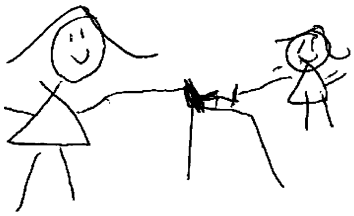

Fig. 3 Ada's pre-interview drawing

In the pre-interview, 31% of the students drew only one picture and 19% were not able at all to draw any picture of themselves as scientists. In this way, Ada's interview was typical of approximately one third of the students.

Only 23% of the students drew more than one person in the pre-interview, like Ada, but 45% of all students talked about other people engaging in the activity with them. This was one important benefit to our multimodal interview. It allowed us access to information through a variety of channels. In this case, Ada has drawn not only herself but her "partner," too. In Ada's drawing there are two figures, their bodies shaped like triangles and arms sticking straight out. The triangle bodies and long hair of the actors are common cultural conventions for representations of girls, as seen on many public signs. In her picture, Ada has appropriated certain dominant ideological representations of gender. The girls' stick arms extend to a "seesaw" on a table that is shown between the two girls and that Ada is using to test "how stuff can be heavy and how stuff can like be lightweight." Ada *has* been a scientist, but she could only draw one experience:

123 Inter: . . .draw one time when you were a scientist. Okay?
124 Ada: That's all I could think of.
125 Inter: That's all you could think of?
126 Ada: That's the only test I could talk about.
127 Inter: That's you testing the books? Okay. Um, can you tell me a little bit more about that?
128 Ada: Um // like we're talking about ah // um, like // we're talking about // like how it works and how like the fancy words for like up and down.
129 Inter: Oh? Do you remember those?
130 Ada: I remember one, um. . . . . .
131 Inter: No? Okay, that's alright.

Previously in the interview, Ada had mentioned she was drawing a picture about a time she "tested books." To Ada, being a scientist is about "testing," a word she introduces into the conversation in unit 126. And this is the only time she has ever tested anything. In addition to being a scientist by testing objects for their weight, Ada, her partner, and the other people in her second grade class were talking about what they were doing. She was foremost manipulating materials, as was Arturo, but for Ada her representation of herself as a scientist has a social element. In her narrative, Ada communicates ideas about "how it works" (unit 128). And although she does not remember the "fancy words" she does know that there are words that are used in science that are not everyday words. They are perhaps the words of a different kind of register, a scientific one (Halliday & Martin, 1993).

Ada's post-interview

Ada has drawn two pictures in her post interview (see Figure 4).

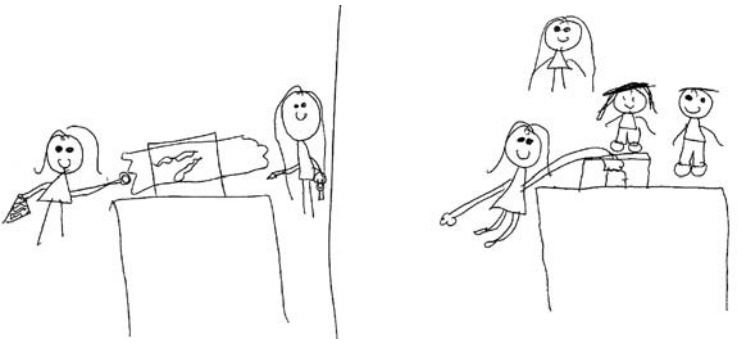

Fig. 4 Ada's post-interview drawings

Both of Ada's pictures are from the ISLE units. In this respect, her pictures are representative of 45% of all of the children's post-interview pictures. However, her pictures are *not* representative of other children's pictures in a very different, important way. Like her pre-interview picture, Ada has included others in her drawings. Moreover, these are specific people; Ada attaches specific names to the people in her pictures. In the left-hand picture, she again draws herself and her partner, Sylvia, a classmate. And in the right-hand picture, she identifies the members of her group for that particular exploration: Serena, Arturo, and Sylvia. Serena is in pants but has long hair. These actors are not made up for the purposes of the interview. Instead, they are her faithful representations of her actual group members, indicating she is trying to depict the event as accurately as possible. For Ada, science consists of activities done with others.

In the left-hand picture, both girls have long hair and triangle shaped bodies. While this may seem to be typical of children's drawings, we have never seen Ada or anyone in the class wearing a skirt or dress. Girls and boys alike always wore pants at each of our visits over the course of the year. In this sketch, then, the triangles and long hair are Ada's resources for representing her intended meanings. They are the taken-for-granted realities of her ideological becoming.

Like Arturo, Ada has positioned herself on the left-hand side of the image in both pictures, which, as indicated above, is the "given" position in images. Such depiction is reasonable,

considering the question we are asking her is to draw her self. What are new are the sites of her activities and the kinds of science she is engaging in. In the left-hand picture, Ada has drawn the worm observation activity.

171 Inter: Can you tell me how you thought of yourself as a scientist in this first picture?

172 Ada: Um I thought of myself as a scientist cause I was like examining the earthworms that also scientists do. They always check to see if there's something new about earthworms. And this is my partner Sylvia.

173 Inter: Umhmm.

174 Ada: And this is like a little notepad so that I could write down what they're doing, how they're moving and this is my little magnifying glass so I could see how they act and this is a pencil.

175 Inter: And this is // what is she*. . .

176 Ada: That's a magnifying glass.

In the picture Ada is engaging in an activity "that also scientists do" (unit 172). Unlike Arturo, she does not see it as a trick you learn in school, but something authentically scientific. Scientists would want to know if there was something about worms they did not know before. Also, she carries some of the tools of the discipline. She and her partner both have magnifying glasses to "see how they [the worms] act" (unit 174). But they also have something else, a notebook and a pencil. Ada has depicted this activity as comprised of at least two parts. One is the physical act of observing how the earthworms behave. The second is to "write down what they're doing, how they're moving" (unit 174). As we will discuss later, the percentage of similarities and differences coded along textual lines that students brought up increased from 6% in the pre-interview to 18% in the post-interview. The textual emphasis is evident in Ada's description of why she chose to include these elements:

217 Inter: So why do scientists do the things that you showed?

218 Ada: Um scientists do that // they do this to see what's new about earthworms and to see how they move, act with each other and they // I will um like she // Ms. Shamah put // made us write a notepad because that's like // that's what scientists do when like they're examining something. They're writing down what's happening. And um // and the magnifying glass so they could see them real closely. So if they moved like that they could see them.

For Ada, scientists write down what they are examining. And her knowledge of this is constructed from the activity she engaged in and the way that she engaged in it. Her teacher asked her and her classmates to write down in their science journals what "was happening," and what was happening was in the context of an observation of two earthworms, to "see how they move [and] act with each other" (unit 218).

In this activity, then, we have labeled Ada's epistemological stance as an Inductive-Explorer. Ada is not building a machine, or testing out an idea, she is observing natural phenomena – the behavior of worms. Her choice of the words "that scientists also do" (unit 172) and "that's what scientists do" (unit 218) explicitly align Ada's actual identity with the designated practices of scientists. She sees herself as the kind of person who engages in the activities of scientists in an authentic way, "to see what's new about earthworms" (unit 218).

In the right-hand picture, Ada has also depicted an activity from the ISLE curriculum.

191 Inter: And then can you tell me about // about this one?
192 Ada: Um, this is one where um // where we were um testing to see // um we would put like a water // and we would put a piece of towel in the water // no // ooh um with the cup // I mean um the cup had a paper towel in it and I put it in the water and I was sitting near the water. And those are // this is Serena, Arturo, and Sylvia. And I was putting it in and when I got it out it // the paper towel was not wet.
193 Inter: Okay. . .and um, this is something you did or*. . .?
194 Ada: We did it.

In this picture and the talk around it, the focus is on the material processes and artifacts of the activity – the dipping of the cup in the water. There is no mention of writing or notebooks. Additionally, when Ada actually did this activity, she had more partners than she did in the worm observation. In her picture, she has included them all, again, representing the social nature of the activities. Even though Ada uses the word "I" several times in her account of the carrying out of the material processes, and her place as the main actor is central to her narrative, she still finds a way to foreground the idea that she did not do this activity in isolation – "we did it" (unit 194). Also, Ada has attempted faithful representations; Sylvia has long hair, Serena has thick hair, and Arturo has short hair. The hair types are Ada's resources for drawing her partners as individuals. Ada's details in her narratives are evidence of a description of an actual identity. This is an activity she has engaged in with people whom she knows. When asked how her right-hand picture depicted the things that "scientists do," Ada responded:

220 Ada: Um and here we're putting a cup for like 5 seconds to see if it will come // like to see if it will dry or be wet and if it was dry you did it right, but if it was wet you did it wrong. And they um // they would check to see if something would be dry so if someone ever tries to <help> it could work.

In her comparisons, Ada does not pretend that what she is doing in either picture is the exact same activity as the activities scientists engage in. In response to later questioning, she is able to note where these differences lie. She chooses not the actual material processes or artifacts, but again chooses to focus her commitments on the social and textual aspects of the activities.

221 Inter: Okay, um, are there things that scientists do that you didn't put in your pictures?
222 Ada: Um, here they probably write what's happening*. . .
223 Inter: Oh, in that picture with the water cup you said?
224 Ada: Umhmm.
225 Inter: Okay.
226 Ada: And here they probably have more partners to // to help them.
227 Inter: Okay.
228 Ada: So they could write down how um // so someone could be on the computer looking for something like um earthworms live in the // some live in the ocean or something like that.
229 Inter: Umhmm. Okay. Um, are there things in your pictures that scientists don't do? Are there things that you drew that scientists don't do?

230 Ada: Oh, like um // like here I didn't draw a note (***) card.
231 Inter: You didn't draw what?
232 Ada: I didn't draw a notepad.
233 Inter: Yeah.
234 Ada: Oh I know what you're saying.
235 Inter: See what I'm saying? It's the opposite of the other question.
236: Ada: Umhmm. They probably don't have a pencil in science.
237 Inter: Okay.

In the right-hand picture, Ada has not drawn herself or her partners writing something down. But she knows scientists "probably write what's happening" (unit 222) on a "notepad" (unit 232) even if they do not "have a pencil in science" (unit 236). The other main thread in the differences Ada talks about is the social one. In the left-hand picture, Ada states that scientists probably have more partners. One of the benefits of having more partners is that scientists can "be on the computer looking for something like um // earthworms live in the // some live in the ocean" (unit 228). For Ada, research on the computer is a designated scientific practice, but not one that she actually engages in.

In a way, Ada is also able to distinguish levels of complexity between the two activities. In her description of the water cup activity, Ada says:

238 Ada: Right here and um here they probably have less partners. Because this is just so they could see where this is happening.
239 Inter: So in the worm experiment they might have more partners and in this one they might have less partners.
240 Ada: Umhmm.

In the earthworm activity, Ada was authentically engaging in the search for something new about earthworms. However, the water cup activity was not as much about exploring as it was about "do[ing] it right" (unit 220). In this activity, she and her partners were trying to do the activity so that if someone else tries to do it again they would be able to show them what to do. The left-hand picture is about figuring things out, but the right-hand picture is about demonstrating and sharing. Ada sees herself as being able to engage in both kinds of science, and at the same time is able to assign a differential complexity level to each activity.

Monica

At the time of the interviews, Monica was a second grade Anglo student in an ethnolinguistically diverse classroom on the city's north side. Her school was 30 % European American, 10% African-American, 56% Latino, and 3% Asian. Fifty-nine percent of the students qualified for free or reduced lunch. Monica's classroom reflected the ethnic make up of the school.

Monica's pre-interview

Monica drew two pictures of one event in the pre-interview (see Figure 5).

Monica explained that the second picture "was the same picture [as the first picture]." There are actual differences in the drawings (e.g., orientation of actor, sock color, location of numbers, shape of vessels), but there are no differences in how she talks about the two

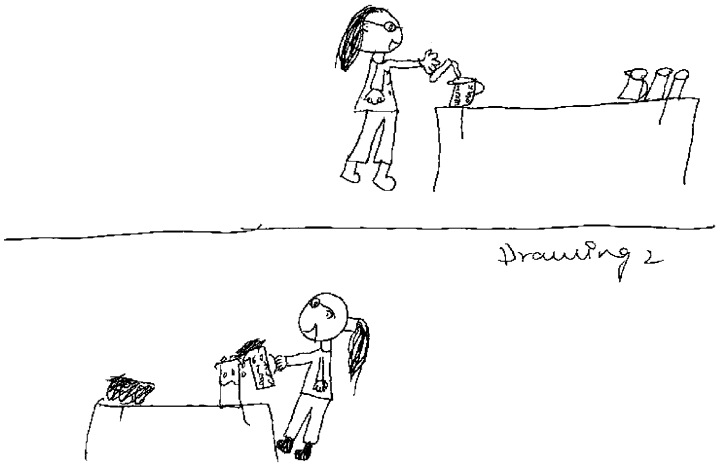

Fig. 5 Monica's pre-interview drawings

pictures. Because she identified both pictures as representing the same activity, we coded the two drawings as one event. Therefore, we will describe it as two sequential times of one represented event rather than as two representations of separate events, as we have done with the other children's illustrations.

It seems that Monica has chosen to represent the activity from opposite sides. The two drawings appear approximately to be reflections along a vertical mirror. In the top picture, Monica, as the actor, has placed herself first, in the left-most part of the image. She is "given" and the science is "new," whereas in the bottom picture, it is the science that is "given" and she that is "new." This can be interpreted as a visual representation of a convention of written language, the positioning of previously new information as given in the next sequential utterance. It exemplifies another way images can tell stories, through seriation.

From both angles, Monica has drawn numbers on one of the vessels. In the top picture she pours something from a skinny test tube into the numbered cylinder. In the bottom picture she has taken the numbered cylinder and poured it into a third container that bubbles. The numbers are a semiotic element that Monica has associated with scientists. However, the bulk of her representation centers on the action of mixing. For this bottom picture Monica states:

8 Monica:	I am trying to make something black. I am trying to make a new color.
9 Inter:	A new color. Okay, so what are you doing here?
10 Monica:	I mixed them.
11 Inter:	So, you have a cup which is numbered. So what are you doing with the numbered cup?
12 Monica:	I am trying to see, um how, how (***).
13 Inter:	Umhmm.
14 Monica:	Oh, I was trying to if // cause I didn't // I was trying to see if the two colors together, they have the same amount in it. I think I // I wrote down the number that I think it would go on. I put the number // I got the number right.
15 Inter:	What two colors are you mixing?

16 Monica: Two colors. Green and purple.
17 Inter: Umhmm. Have you done this experiment or are you thinking of doing it in the future?
18 Monica: I was thinking of doing it in the future.
19 Inter: Okay, why do // why do scientists do things you have shown here?
20 Monica: Well, I don't really // this is just what I think scientists do.

Monica has depicted herself engaging in an activity that she "think[s] scientists do" (unit 20). We cannot know for sure, but mixing colors is probably something, Monica has probably done as a seven- or eight-year old child, but she does not know if it is scientific. Up to this point in her life, she is not really sure what scientists do. Perhaps because of the emergent character of her knowledge, she does not see herself as an actual scientist, or as actually engaging in scientific practices, but as someone who possibly could have. Monica has not had practice engaging in activities that have been labeled scientific; she does not see herself as the kind of person who has engaged in scientific activities. However, like Arturo and Ada, her ability to respond to the request to draw herself as scientist, even tentatively, indicates that she sees possibility for herself in scientific activities even if what she does and what scientists do are somewhat different. For instance, instead of colors, scientists "mix chemicals together."

37 Inter: Why do you think scientists would be doing something like that?
38 Monica: Maybe because // making things. Making different medicines for people.

It seems then, that Monica is trying to fit activities she has engaged in with those that she thinks scientists engage in. In doing so, Monica has focused on the "mixing," a not uncommon response among the children's pre-interviews. She and scientists both mix things together, but their materials are different. We have coded Monica's epistemological stance Engineering – she is producing/making a new color. This approach reflects 27% of the students' epistemological stances in the pre interviews. However, instead of making colors as Monica has done, scientists make medicine. Thus, it appears that what is similar regarding Monica's actual identity and the designated scientist identity is the material processes, but what is different are the material artifacts that they work with as well as their ultimate products, "colors" (unit 14) versus "medicines" (unit 38). For Monica, being a scientist is tied to the particular set of artifacts that are used in the activity.

Monica's post-interview

In her post interview, Monica drew two pictures (see Figure 6).

Fig. 6 Monica's post-interview drawings

Unlike Arturo and Ada, but similar to 55% of the children's responses, the instances in which Monica represented herself as a scientist were not part of the ISLE units. Also unlike Arturo and Ada, Monica has placed herself on the right-hand side of both pictures. In these cases, it is the scientific artifacts and settings, not the person who is "given." In the left-hand picture, Monica has drawn test tubes and beakers (one of which, to the far left on the table, resembles one of the graduated cylinders Arturo chose to depict for the water evaporation experiment). She has also chosen to include a poster of animals, perhaps a reference to the content she learned in the Forest unit. What is more subtle, but no less important, is the pencil behind her ear. Although she is not writing in the left-hand picture, she has the tools to do so. In the right-hand picture, this reference to textual processes is more pronounced, as Monica has drawn herself holding a clipboard with lines on it, presumably writing.

Also, Monica has included speech bubbles. Speech bubbles are characteristic of some forms of pictorial genres, such as cartoons, and are also present in some of the information books in the ISLE curriculum. Monica uses this communicative resource to represent a verbal dimension of her being a scientist along with other dimensions, namely material and textual processes, and artifacts. In the left-hand picture, Monica says, "I wonder what experiment I'm doing next," and in the right-hand one she has written, "Look the glass weighs more than the wood."

When asked to talk about her pictures, Monica says:

24 Inter: So what are you doing as a scientist here?
25 Monica: I am making a different type of medicine. To see if I have enough for two bottles even though they are different shapes.
. . ..
30 Inter: So what kind of medicine is this?
31 Monica: For people who need it. Like something like Tylenol.
32 Inter: Tylenol?
33 Monica: Not Tylenol. When you have cancer, you can't cure it. I would be the first one to cure it.

In her left-hand picture, Monica revisits an idea from her pre-interview that scientists make medicine to help people, which is significant because these interviews occurred eight months apart. We can infer that making medicines and the practices of scientists were consistently highly related for Monica. She also includes here knowledge of specific medicines and specific diseases, but also specific practices.

46 Inter: Why do scientists do the things you have shown here?
47 Monica: Well, because they want to find // the (***) // try to find the things to cure the (***) and find a cure for cancer.
48 Inter: Okay. Are there things scientists do that you didn't put in your picture?
49 Monica: Um, yeah.
50 Inter: Like what?
51 Monica: They // they // they experiment on animals and find out what happens so they can put it in a science book, so we can read them.
52 Inter: Are there things in your picture that scientists don't do but you have put in them? Like, is there something which the scientists don't do but you have shown it here?
53 Monica: Not really.

It seems that Monica knows that scientists test their products on animals. She knows now, too, that scientists write books about animals. This may or may not be a result of reading numerous books about animals in the Forest unit and writing her own book on "Underwater Creatures." More significantly, Monica has only included in her pictures elements that she thinks scientists do (units 52 and 53). Thus, Monica has portrayed an identity wholly within the context of what a scientist does. We do not know if the left-hand picture is an event Monica has engaged in, although we can guess that she probably has not. Monica does say that the event in right-hand picture is something she has done in school.

35 Monica: I am trying to see which one weighs more, the wooden marble or the glass marble.
36 Inter: The wooden marble or the glass marble?
37 Monica: We have actually done this experiment in our classroom.
38 Inter: Oh really? And what did you find out?
39 Monica: I found out that the glass marble // the glass weighs more than the wood.
40 Inter: And what is this in your hand? I see something in your hand.
41 Monica: It is a clipboard. So, I write down // write down my // what happened.

In these pictures, Monica has depicted herself as someone who "actually" engages in scientific practices. She is also more descriptive than she was in the first interview about the practices of the designated scientists. This time they "find a cure for cancer" (unit 47) and "experiment on animals" (unit 51). Furthermore, her epistemological stances between interviews also shift, from one of making things (Engineering) in the pre-interview, to a Problem-Solving stance (people have cancer and she is going to find a cure for it) and an Inductive-Explorer stance (she is finding out which marble "weighs more") in the post-interview. Her understandings of scientists and their practices are becoming more nuanced, more in tune with the variations among scientific practices. We can interpret this as a possible move toward more complex and complete understandings of science as a multi-faceted and multi-functional enterprise. It involves different kinds of approaches, depending on what activity one is engaged in, and it involves material, textual, and verbal processes as well as the ultimate goals of greater knowledge for everyone, "They experiment on animals and find out what happens so they can put it in a science book, so we can read them" (unit 51).

In the three cases, we have provided detailed descriptions of children's multimodal narratives. We have presented and discussed the images, the inclusion and positioning of entities in the pictures, and some of the talk during the interviews. We have used these data to show how ideological commitments to science and scientists can be represented in interviews. We have also shown how young children responded to our questions at two different times, before and after they engaged in our units.

Synthesis of student profiles

We turn now to a descriptive analysis of the patterns we see when we combine the data from all of the children's interviews. As we looked at various cuts of the data, we examined a number of related aspects of children's narratives: the epistemological stances that are implied in students' actual identities (how science is done and what it is for specifically as it is portrayed in the scientific "events" that they brought up); the kinds of differences and similarities between themselves and scientists out in the world that they explicitly brought up; whether children had done the activities that they represented or not; and the places where

the activities took place and the people involved. We explored these aspects with an eye on potential similarities and differences between the pre- and post-interviews. We discuss these by explaining them in light of our curricular activities.

As the section on case studies reveals, children showed themselves and scientists out in the world as engaging in practices with a range of materials, for a variety of purposes, and with particular kinds of epistemological commitments. In the pre interview, the 36 children represented 44 different "events" in their pictures and narratives (out of a possible 72 events, as each child was asked to draw two times she or he was a scientist). In contrast, in the post interview, 64 events were represented by the children (about 50% more than in the pre interview). The increases mostly occurred in 1st and 2nd grades, with 1st graders' events about doubling between pre- and post-interviews. As children were more able at the end of the year to position themselves in the world of science, and consider themselves scientists in more occasions, they also showed some shifts in the epistemological stances they portrayed.

Epistemological Stances

Figures 7 and 8 show how all children's stances (developing knowledge [DK], presenting knowledge [PK], inductive explorer [IE], deductive-tester [DT], engineering [ENG], problem-solving [PS], and not enough information [NEI]) were distributed in the pre and the post pictures and narratives the children created.

The *Engineering* stance (scientists make things) decreased from 27% of the pictures in the pre interview to only 5% in the post interview. The *Inductive-Explorer* stance (e.g., "We put two ice cubes in one [cup of water] and one ice cube in the other [cup of water] to tell which one melted faster." [2nd grade, post interview]) increased from 27% in the pre interview to

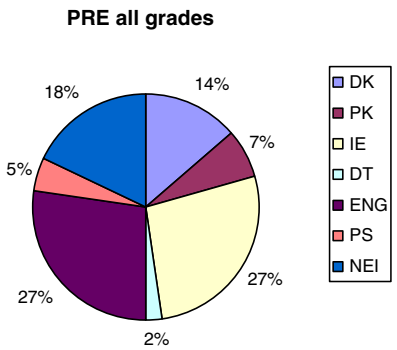

Fig. 7 Percent of each stance children portrayed in pre-interview. Pie chart read clockwise beginning at 12 O'clock

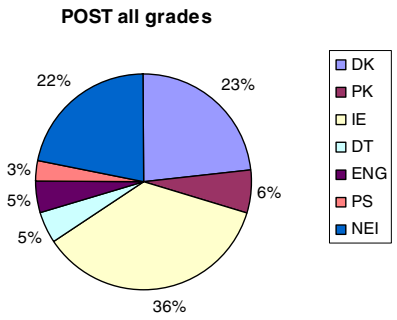

Fig. 8 Percent of each stance children portrayed in post-interview. Pie chart read clockwise beginning at 12 O'clock

36% in the post. The *Developing Knowledge* stance (which refers a general kind of "finding out" or describing the world) increased from 14% to 23%. These findings make sense in light of the experiences that children have had in their classrooms using the ISLE curriculum. There is very little emphasis on an engineering approach in our curriculum. Children are not engaged in activities where they build things, systems, or models. Instead, they observe entities and phenomena, such as worms, plants, and rain being formed from boiling water, and they do experiments to find out how fast water evaporates, whether worms prefer light or darkness, and how a bean plant's height changes over time. Thus, the inductive approach is nurtured by the ISLE activities.

However, it is worth noting that we (school-based and university-based educators) have been planning these activities with an eye on the deductive approach, too. Children are at times read information books that help them form ideas, expectations, and predictions about certain phenomena *before* they observe or do an experiment. In these cases, their hands-on explorations are supposed to be more empirical tests of these ideas and predictions, thereby fitting a more deductive approach. Nevertheless, the actual classroom discourse does not necessarily foreground this idea. Many times, teachers and children talk about doing an ISLE exploration or experiment to find out something – whether ice cubes melt faster in cold or hot water, whether plants grow better when watered, or whether worms prefer wetness – even when students have explicitly stated their predictions earlier and have offered reasons for them. By using the language "let's find out," a more inductive approach is emphasized. In this case, expectations, predictions, and understandings a person already holds are not acknowledged, and, therefore, a more deductive stance of "let's test out our ideas and see if they are true in the real world" becomes hidden and underdeveloped.

Finally, the increase in *Developing Knowledge* may be a result of these primary-grade children's emergent and implicit understanding of what science is. That is, their epistemological stances are forming at this stage. At the same time, their differentiating abilities may be forming too. As we brought up in our discussion on actual and designated identities, Sandoval's concern with Hogan's proximal and distal identity constructs is that it fuses conceptions of the nature of science with that of the nature of the learner of science. The increase in the *developing knowledge* stance, we believe, is an example of how the two may be difficult to tease apart when we try to capture children's developing epistemological stances.

Comparisons with scientists

Focusing on what children identified as similar or different between themselves and scientists out in the world, we found that students were more drawn to representing material processes and artifacts rather than other categories. Figures 9 and 10 show the distribution of the types of comparisons all children made between themselves as scientists and scientists out in the world (textual [T], material processes [MP], material artifacts [MA], social [S], affective [A], cognitive [C], physical environment [PE], and verbal [V]). In the pre interview, children made 94 such comparisons, and in the post interview, they made 108. The 1st graders were the ones that mostly contributed to the small increase in the number of comparisons, approximately doubling their contributions (from 12 to 21), probably because 1st graders' number of pictures doubled from the pre- to the post-interview.

In the pre-interview, children seemed to focus mostly on material processes and material artifacts, accounting for more than 60% of the total comparisons the children brought up. These two types also dominated in the post-interview. As we presented in her narrative, 3rd grader Ada shared in her post-interview, "I was like examining earthworms that also scientists do. . .Ms. Shamah made us put // made us write a notepad because that's like // that's

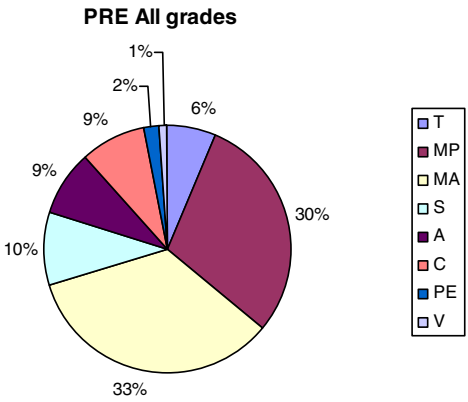

Fig. 9 Percent of each comparison type children shared in pre-interview. Pie chart read clockwise beginning at 12 O'clock

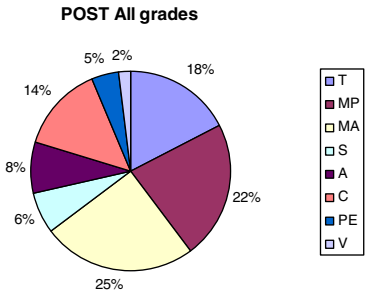

Fig. 10 Percent of each comparison type children shared in post-interview. Pie chart read clockwise beginning at 12 O'clock

what scientists do when, like, they're examining something. They're writing down what's happening. And uh // and the magnifying glass so they could see them [earthworms] real closely." Ada's quote shows how children made comparisons regarding material processes and artifacts, but also reflects another type of comparison, a textual one. In fact, as Figures 9 and 10 indicate, there were fewer material processes and artifacts comparisons made in the post interview. At the same time, textual and cognitive types increased. The percent of the textual references (which include digital and paper media) tripled from 6% to 18% and the cognitive references (e.g., "They know what not to do and what to do." Ulises, 2nd grade, post interview) also increased from 9% to 14%. Thus, the ISLE curriculum seems to have supported children's thinking about the material processes and artifacts they and designated scientists use, as well as promoted their attention to the textual and cognitive dimensions of scientific practice. Such increased attention makes sense in light of the heavy integration of texts with hands-on explorations in our curriculum.

To study further the comparisons that the children made between their work and that of scientists, we looked at whether the children made references to similarities or differences in each of the types of comparisons they made. Figures 11 and 12 show the ratios of similarities (S) and differences (D) in each type.

In the post interview, children drew and talked more about *similarities* between artifacts that they and scientists used than they did in the pre interview. All grade levels seem to have contributed about equally to comparisons that addressed material artifacts. Children felt that they were like scientists by showing in their pictures such objects as chemicals (Gilberto, 3rd grade), worms (Carmelita, 2nd grade), and little animal parts (Uma, 1st grade). Interestingly, as both the textual and cognitive types increased in the post interview, the ratios between

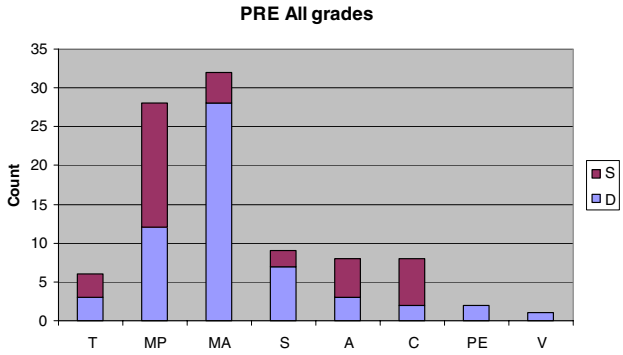

Fig. 11 Ratios of similarities and differences for each comparison type children shared in pre-interview

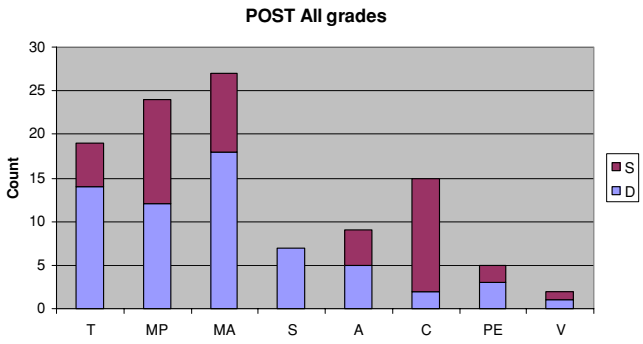

Fig. 12 Ratios of similarities and differences for each comparison type children shared in post-interview

similarities and differences were inverted. Children brought up more textual differences than similarities, but more cognitive similarities than differences. Mostly, the textual comparisons were contributed by 1st graders, and the cognitive comparisons by 3rd graders. In her post interview, 1st grader Manuela raised a difference between herself as scientist and scientists out in the world that is both textual and cognitive: "Sometimes they don't read. They're just there from their head." In contrast 3rd grader Serena raised a similarity between the activity she was describing and scientists' work, which is both affective and cognitive: "they're trying // they're trying to do stuff // they're trying to do stuff and it doesn't work they um they didn't give up but they will // they um // they start // and // if they start they finish it."

Who, when, and where of children's activities

We turn now to whether the children themselves had done the activities they represented in their pictures and the place where these activities had occurred or would occur. The overall data reveal that, in the pre interview, 57% of the pictures represented activities that children had done themselves, but, in the post interview, this percentage increased to 70%. The contributors to this change were the 1st graders (a 25% positive change) and the third graders (a 16% positive change). This finding should be considered together with another one related to where the activities took place. In the pre interview, children's pictures were mostly split between activities that took place outside the school (34%) and at a place we could not

determine because we did not have enough information (45%). (Most of the times we coded this latter category, it involved the activities that the child had not done yet, and that he or she would probably do in the future.) However, in the post interview about half of the pictures (45%) represented activities that took place within the ISLE curriculum. Thus, it seems that the children were using the ISLE activities that they had experienced as their ways of seeing themselves as scientists. For example, 3rd grader Javier drew himself next to a book and a poster laying on a table, and he said that he "was doing the turtle book. . .and had to think of a lot of ideas. . .this is me and this is a table and this is when we were doing the posters // the big poster and my partners were helping me draw it more. . .and like one at a time one drew then one wrote then one drew and one wrote." He later associated these ISLE activities with being a scientist, thus portraying cognitive, social, and textual similarities between himself as a scientist and the scientists out in the world.

Furthermore, when we look at who the children included in their pictures, we find that almost all of them drew and talked about themselves, which is not surprising since we asked them to draw times they thought they were scientists. Although only a quarter of their pictures in the pre interview and about a tenth in the post interview included other people, when the children were talking about half of their pictures (in both interviews), they referred to others who were part of the events they were describing. Such a finding underscores the need for the use of multiple modalities when exploring children's thinking, identities, and interpretations. Children may have had various reasons why they did not draw others in their pictures even though they talked about them, for example, Javier's explanation to the interviewer for why he drew himself and not his partners who he had talked about (as presented above): "because like we have // you have to leave and so I drew it real fast." The decrease in depicting others in the pictures between the pre- and the post-interviews can be explained in various ways. One is that in the post interviews, children drew more pictures and had more to share than in the pre interview. Thus, they did not take the time to draw others, although they referred to others in their discussion about their pictures. But, in the post interview, children talked about others as frequently as they did in the pre interview. This may mean that ISLE did not particularly foster children's sense that often science is done with, and in the midst of, other people. Or, it may mean that, as children had more to say and share about themselves being scientists in the events they depicted in the post interview, they forgot, or did not bother, to bring up others who may have been involved. It may also mean that children were deeply involved in the science activity for themselves that others were not salient in their minds. In the post-interview, 2nd grader Melissa noted that one of the things scientists do not do, which she had shown in one of her pictures (that consisted of herself with a speech bubble saying "The bears eat worms"), is that they "don't shout // shout their answers out because other people won't. . .// and the other person is going to say that you are copy-caters." Such behavior may be considered by Melissa as a form of cheating, and illustrates yet another way of children's negotiation between actual and designated identities.

It is also important to remember that for some children, their conceptions of scientists, and their actual identities as scientists in the particular situations that they brought up, were taken on in the midst of other identities. Melanie's (Grade 3) first reaction when asked to make the drawings was "I've never been a scientist," although she had *done* some science in school, and she subsequently proceeded with creating her drawings. As noted earlier, her classmate Arturo replied, "I just think about doing [mixing potions] because my real thing is singing and dancing." For 2nd grader Rachel the relationship with science was complex as she went back and forth in terms of taking on a scientist identity. In one of her pre interview pictures, she showed herself and her brother exploring with "chemicals [found] in shoeboxes" and saying, "Hey, let's go *play* scientist [emphasis added]." In her post interview, she explicitly

identified herself as a scientist – "scientists like to find out things because they're curious like me," but as she was talking about things that may be in her pictures that scientists do not do, she doubted that a scientist would be named Rachel and remarked that this "never gonna happen." An identity-as-scientist is an available alternative for some children and it is less of an option for others. If we are to work towards pathways for all children in scientific fields, we must provide opportunities for all of them to see themselves along those pathways.

Ideological emergence amidst institutional notions of science

Bakhtin (1981) noted that any form of "language is not a neutral medium that passes freely and easily into the private property of the speaker's intentions; it is populated – overpopulated – with the intentions of others." (p. 294). In many important ways it is *our* intentions with which the students' responses are populated. We not only co-designed with the teachers the curriculum and worked with them as they implemented it, but we also co-constructed students' opportunities to talk about it. Children's drawings and conversations around them represent their efforts for communicating their ideas about aspects of their scientist identities in response to our questions, and what they perceived to be our goals as ascribed to the "kinds of people" they thought we were. Their narratives may not be ones that they would choose to offer voluntarily. But, through the words and pictures, children built stories of performing as scientists and thinking of themselves as scientists.

In the pictures, children were able to lay out an outline of an activity. They put people and artifacts in an immediate experience. In their words, they were able to describe their actions and the differences between what was in their picture and what might be part of scientific practice outside the borders of their page. The pictures were much more than just "pivot pieces" for directing the conversation. The two modalities worked through and against each other to create a representation. And the resulting dialectical unity of drawing and speech worked as a multimodal, mediational tool to express children's ideological commitments to scientists and the activities scientists engage in.

The use of this kind of tool was important for us. It helped us to construct ideas of young children's emergent knowledge of and about science. From such a perspective, children's ideas and resulting practices are not complete, neat little packages that are popped into their minds by others. Children enter situations already knowing, and new information must be integrated with old. Children do not march linearly from one stage of thinking to the next. Their networks of ideas are constantly shaped and reshaped over time, depending, in part, on the nature of their activities, on what the context calls for, and on how they adapt themselves to it. Perhaps, for our study participants, this is even truer than it is for others. They are experiencing and making sense of new activities and new knowledge domains for the first time in their lives, just as they are also making sense of the structure of the interview. This emergent thinking and meaning making may partly explain the many activities we coded as portraying a "developing knowledge" stance. In our interviews, children knew scientists "learned," but they did not describe the nature of that learning in very much depth. Furthermore, an emergent perspective has allowed us to see the nuance and degrees of difference in students' knowledge as we consider their representations of identities as integrations of a heteroglossia of voices.

Children's resources for building conceptions of scientists and the social spaces in which children interact are diverse and lie on a continuum of proximity to their lived experiences. That is, they exist in a number of forms: as speech acts consisting of what scientists do as told to them by others: images from television and the movies; experiences that children

have had with their grandmother, father, cousin, or sister; or experiences they have had in school, such as the ones in our unit. Obviously, we cannot generalize from our findings about actual and designated identities that young children have and develop in school when engaged in science in a particular way. Our data come from relatively few students from only five classrooms fraught with the limitations that we have noted. What we see may very well be particular patterns for these particular children and their particular teachers. However, we believe that our in-depth analysis of the three children, together with the overall patterns that we presented and discussed, offer us examples, instantiations, differentiations, and categorizations of ideas students have about themselves as scientists. And thus, such analyses show how the curricular (embedded, of course, in the instructional) experiences children have may shape their actual scientist identities and the comparisons they construct regarding designated scientist identities.

The activities, processes, materials, thinking, social interactions, and so forth, that children depicted and spoke of reflected commitments to dynamic, emergent, and evolving configurations of ideologies, akin to Gee's (1996) "tool kit." As the voice of our curriculum became more prominent to them, they were able to recontextualize their representations more keenly. For example, over the year, they shifted from drawings displaying an engineering stance to ones that displayed an inductive-explorer stance. They also included many more references to textual elements, a major focus of our units. This is not to say that children should only engage in inductive approaches to science. They need to learn about the range of experiences that sciences and scientists use, including engineering models. But it should be no surprise that the *kinds* of experiences the students have, and the roles they think they play in these experiences, shape what they think science is. The variation, nuance, and uniqueness that came through in their profiles could very much be the result of the varied amount of pleasure, satisfaction, and pride the children got out of these experiences–ideas that the interviews did not explicitly explore.

We have learned that young children can and do see themselves as scientists engaged in culturally authentic scientific practices. The piece missing in our research to this point is how this happens over time and experience. The next steps for us will be to systematically study students' classroom experiences that shape these representations. What we would like to understand are the specific features of contexts that give rise to students' conceptions. Future analyses will include consideration of classroom events as activity systems and the role of activity in shaping the moment-to-moment subjectivities that contribute to the development of identities over longer time scales. Another analysis explores the construction of discursive identities of the students as scientists. That is, when the teacher tells the students they are scientists, what is it that she says scientists do? And, do the students spontaneously self-identify with the label "scientist" (Tucker-Raymond et al., 2006)?

We end by offering a set of questions that emerge from our study. As students engage in science curricula, in what ways and under what circumstances do children take on actual identities as scientists? To what extent do these match their representations of scientist identities out in the world? Where and how do these conceptions diverge in the moment of interaction? And, since they more likely exist within a network of knowledge resources and discursive social spaces, how do they interact? And finally, will a focus on identity building help students become better scientists or, at least, better at science? We think so, but it remains to be seen.

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