Chapter 10
Schooling: Domestication or Ontological Construction?

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The growing adoption of a sociocultural framework for the study of learning and development has met with some opposition, notably from those who see in it a lack of attention to the child's active construction in these processes. This, so the claim goes, is a central tenet of constructivism – whether that of Piaget (e.g. 1937/1955) or of von Glasersfeld (e.g. 1993) – even though it is granted that constructivism has not paid sufficient attention to culture, so that what is needed is a "synthesis" with socioculturalism. Such syntheses have been offered by Greeno (e.g. Greeno & MSMTAPG, 1998) and by Cobb (e.g. Cobb & Yackel, 1996), among others.

Wertsch and Kazak (Chapter 9) offer us another such synthesis, in the form of a "socioculturally situated constructivism." They explain its principle premise:

> In order for instruction to be maximally successful, there must be room for the active construction and negotiation of meaning on the part of students. But this construction is viewed as occurring within the confines established by a set of semiotic means that have emerged in a sociocultural setting. From this perspective, students are invited to discover the meanings that can be worked out when using certain sign vehicles, but they are not invited to discover cultural tools themselves. (p. 165)

I have argued (Packer & Goicoechea, 2000) that neglect of children's active construction in development is not in fact a failing of sociocultural theory or research. That some constructivists see things this way is a consequence, we propose, of the difficulty of dialogue and understanding across a chasm between incommensurate paradigms, which of necessity share very few basic assumptions. At the same time, some formulations of socioculturalism have made, as it were, only a partial leap. Socioculturalism – appealing to Vygotsky rather than Piaget, and hence to Hegel rather than Kant – rests upon a non-dualistic ontology which is quite distinct from the subject-object dualism of constructivist theory and research. Because this ontology is unfamiliar, even peculiar at first glance, it has often gone unnoticed and sometimes been resisted. Certainly it has not been recognized by most constructivist critics.

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Packer and Goicoechea (2000) suggested that what is needed is not a synthesis of constructivism and socioculturalism but their reconciliation, in which we take constructivism as adequate for specific cultures and times. Constructivism assumes a split between subject and object which is a product of particular cultural conditions. In short, it presumes an alienation of knower from known. Having presumed this split, it cannot explain it. Socioculturalism, in contrast, can explore and explain the cultural and historical circumstances that give rise to this condition, in which mental activity is accorded higher status than the embodied practical activity that makes it possible.

When Wertsch and Kazak write of a construction by children that can operate only "within the confines" of adult expertise, a construction limited to "the meanings" of cultural tools "but they are not invited to discover cultural tools themselves," they are indeed, I will argue, presuming this alienation. Piaget viewed children's construction of mathematical and scientific knowledge as active, but at the same time as constrained by the confines of logical necessity (hence he considered its outcome to be singular and universal). Piaget's is ultimately an unconvincing account (cf. Rotman, 1977) and we need an alternative, but I will argue that Wertsch and Kazak's synthesis does not fit the bill. In their version of synthesis the child's activity is once again seen as needing to be constrained for development to occur, constrained this time not by an ahistorical logic but – disturbingly – by adult power. Wertsch and Kazak have given up too much, I will argue. They have abandoned reason for "mastery."

One of my goals in this commentary will be to argue that the children shown in the Wisconsin Fast Plants® videos are indeed engaged in active construction, and that to fail to take account of this is to offer only an incomplete account of classroom learning. But I will propose that the kind of construction we can observe in these videos is not the epistemological construction that both neo-Piagetians and Glaserfeldian radical constructivists conceive of as the core of learning. It is an ontological construction, in which both known objects (mathematical objects) and knowing subjects are constructed.

To lay out this argument my commentary on the chapter by Wertsch and Kazak will focus on three points which are of central significance. The first is their broad assertion that schooling is a matter of "domestication" or "taming" (p. 155). I will point out several undesirable implications of this conception. The second is their claim that the instructional activities shown in the video-recordings provide an illustration of the classic situation where the adult is an expert, the child a novice, and learning is a matter of the expert guiding the novice. I will point out that the group of children working without adult assistance make considerable progress, while the assisted group does not make the progress attributed to them. The third is their claim that in this mathematics classroom activity the graph paper is an artifact that functions as a "material sign vehicle" (p. 160) permitting, as Wertsch and Kazak put it, interaction even with a low level of intersubjectivity, enabling the children to "say more than they know" and providing adult experts with "leverage" to move the children to a higher "levels of shared understanding" (p. 164). I will propose that the artifact does not have a single appropriate (expert) use, and that a conflict between "preferred representations" gives the children little choice but to concede

to adult authority. I will then sketch an alternative account of this classroom task as the construction and transformation of a sequence of objects in the activity of children, adults, and academics. Finally, I will offer some remarks concerning the use of Vygotsky's work without doing violence to its intimate links to time and place.

Schooling as Domestication?

The core element of Wertsch and Kazak's account of learning becomes evident early in their chapter when they propose that "instruction amounts to a sort of 'taming' or 'domestication' of novices' interpretations of the world" (p. 155). This follows, they suggest, from the fact that the goal of schooling is "to socialize students to use socioculturally provided and sanctioned means" (p. 164).

Several problems are immediately apparent in this formulation. First, schools have been different things at different times and places and will continue to be, quite rightly. Any general and universal claim about schooling risks being ahistorical and acultural, which is not something desirable of a sociocultural theory.

Second, to aim for "domestication" would surely be to place tradition above innovation, and to fail to distinguish cultures that seek merely to reproduce themselves from those which seek to transform themselves. And, thirdly, in many places and times schools have indeed been charged with the task of "domesticating" children, especially from minority groups, who have been viewed as lacking culture, rationality, or morals, and as steeped in primitive, wild, or unenlightened belief systems. We cannot, surely, rid ourselves of such prejudice by extending this domestication model of schooling to all students.

Fourth, the "domestication" view of schooling, with its implication that children are "savage" and must be "tamed," seems to invoke precisely the "enculturation" conception of development that critics of socioculturalism have accused it of (e.g. Cobb & Yackel, 1996). It is hard to see what kind of place can be found in such a conception for the active role of the child as learner.

Fifth, viewing schooling as domestication and taming tellingly gives us no basis upon which to distinguish reason from faith, science from religion. There are of course those who assert that there is no valid distinction, that science is based on the religion of secular humanism, and that creationism should be taught in school alongside, or even replace, evolutionism. To concede this disagreement at the outset by dissolving the distinction between the appeal to a child's reason and the imposition on them of beliefs (or values, or conduct) through will – which "taming" surely suggests – strikes me as regrettable.

In short, the view that schooling is domestication has several unfortunate implications. How easily we can get rid of it, and what view we should replace it with, are matters whose discussion I will develop in the course of this commentary.

Novices Need an Expert?

The second aspect of Wertsch and Kazak's chapter that is important to examine is their claim that what we see in the classroom video-recordings illustrates the

importance for learning and development of the interaction between expert and novice. Wertsch and Kazak put it this way:

> When encountering a new tool such as a statistical instrument. . . the first stages of acquaintance typically involve social interaction and negotiation, between experts and novices as well as among groups of novices. It is precisely by means of participating in this social interaction that interpretations are first proposed and worked out and hence available to be taken over by individuals. (p. 156)

In their analysis of the videos Wertsch and Kazak discuss both a group of students working with adult assistance (Group 3, Excerpt 4) and a group of students joined later by an adult (Group 2, Excerpt 3). Wertsch and Kazak describe both groups as illustrating the inability of students to deal adequately with their task without adult expertise.

Group 3, Excerpt 4: Novices Led by an Expert?

I'm faced with a problem of tact here, because I want to critique Wertsch and Kazak's analysis but it is difficult to do this without seeming critical of Leona Schauble and Rich Lehrer, the researchers who made these videos, and who appear in them. Let me state at the outset that I think they have been extremely generous, even brave, to permit us to view their video-recordings. I apologize in advance for anything I say that sounds unduly critical, and I'm open to correction.

As Wertsch and Kazak interpret the activity in Group 3, which as the video begins has been joined by Leona, she – the adult, the expert – has a considerable responsibility for the learning that occurs. First, she "was able to. . . impose some order on the task"; "to rein in the students' seemingly aimless wandering." She did this in an "attempt to push their thinking to a higher level" (p. 160). She "explicitly and directly proposed" (p. 161) the kind of graph that is needed, and how the graph paper should be used; and then she "moved on ahead with more concrete suggestions" (p. 161) that lead the students to at least some degree of success.

On the other hand, Wertsch and Kazak see the *students* in Group 3 in a much less positive light. At first these students "did not really know what they were doing" (p. 160). They showed "confusion, or misunderstanding of the proper use of the graph paper" (p. 161). Initially they were only "using it at a primitive level" (p. 160). However, they responded with "insight" (p. 162) to the adult's explicit proposal that they construct a frequency chart. And at the end they "are clearly much closer to an expert's perspective than they had been earlier in the session" (p. 162).

This is obviously a very quick sketch of Wertsch and Kazak's analysis of the videotaped episode for this group, omitting many details. And limitations of space prevent me from offering in any detail my own analysis of this same episode. I can only point out a few highlights that illustrate some important points of disagreement.

First, I'm struck by the degree to which key decisions in the task are made by the adult. As Wertsch and Kazak noted, she defines the type of chart to be drawn, proposing columns in which an X would be made for every measure that falls between two numbers:

Excerpt 4 [0:24:14–0:24:18]

```
0:24:14 LS:     Well what if we had (.) a col:umn, (0.5) sa::y
                (0.5) >let me think about this for a ⌈minute<
                (.) two hund'rd- (.) you have two hundred and
                two- (and) thirty, two hundred twenty-five
                num::bers↑ >two fifty<
0:24:18 Edith:                                          ⌊((Rolls
                her eyes))
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She chooses the units of scale for the main axis of this chart, wondering aloud whether the appropriate unit (bin size) is 20, or 10:

Excerpt 4 [0:25:28–0:25:40]

```
0:25:28 Edith:  =and then we could do ninety blahblah
0:25:30 LS:     Or maybe we could do it with twenties I don't
                know lets count, twenty forty sixty eighty
                one (.) ten- twenty forty sixty eighty. That
                would be (.) maybe we could even do it by
                tens↑.
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It is the adult who counts along the axis first in 20s, then in 10s, and announces that 10 will work. And when the students hesitate it is she who writes the labels along this axis.

The adult, the expert, is certainly trying to lead, but are the children, the novices, following her? One might argue that they follow too well. The children seem to be trying to do two things at once: they are trying to negotiate the assignment while simultaneously following the lead of the adult. The two should be compatible, but there are problems. For instance when Leona proposes "Let's see how many squares we have" [0:22:20] the students take this as an invitation to compute the area of the graph paper. When they do this Leona appears puzzled [0:23:08]. When Leona proposes that they draw a histogram Jasmine responds, "Hha ha I don't know what you're talking about actually" [0:24:45]. Edith, in contrast, produces an avowal of understanding, exclaiming, "Oh!," which in an early draft of their chapter Wertsch and Kazak took as suggestive of a "new insight. . . as to how the graph paper could be used. . . to get at the issues of central tendency and variation." But in fact central tendency and variation haven't been mentioned in regard to this new kind of chart. Leona has suggested only that their goal is to "get a sense of the different sizes of fast plants." And when Erica is called upon to actually move the work forward it becomes clear that she doesn't know how to construct the histogram. As she is starting to label the "bins," she stops and exclaims, "This is confusing. How are we gonna dra- (.) how are we gonna draw this out?" [0:28:37]. Jasmine tries next, but ends up asking "What are we doing?" [0:28:52]. It is at this point that Leona takes the graph paper from them and writes the labels herself. The children watch, and

Fig. 10.1 Edith: "I really don't understand this." (Excerpt 4)

Edith says, at first quite loudly, "I *really*: don't' understand this" [0:29:00]. As she's saying this she covers her mouth, as though to hide her confusion (Fig. 10.1).

In general the students don't challenge the adult to explain her suggestions. They offer tokens of agreement that seem to indicate politeness rather than comprehension. On the other hand, these students are not without their own proposals for organizing the data. For example, when Leona asks them to "stop and think about what it is we want to know," Jasmine offers a suggestion (cf. Fig. 10.2):

Fig. 10.2 Jasmine offers a suggestion (Excerpt 4)

Excerpt 4 [0:24:01–0:24:14]

0:24:01 Jasmine: We can like um add these together because you know >one two three four five< we could jam together you know? And then we could use just the even numbers or the odd numbers cuz one is an odd number and then we could just show the odd numbers maybe

In summary, there are several ways in which my interpretation of Group 3's activity differs from the interpretation offered by Wertsch and Kazak. First, where Wertsch and Kazak focus on the children's seeming initial lack of understanding of how to use the graph paper, I would argue that there is a mutual lack of understanding between children and adult. The children don't seem to understand the adult's proposals, despite their nods and polite exclamations. But it's equally true that the adult doesn't understand the children's proposals. Second, it is true that the adult leads, but she does so in a manner that is, to borrow a term from Greeno, "authoritative" (p. 58). The children do not follow her if by "following" we mean not just agreeing to do what the adult proposes but also demonstrating their comprehension of the proposal. For, although Wertsch and Kazak state that the children move closer to the adult's perspective on how to appropriately use the graph paper, there is not much evidence for such a movement. But, as I've said, the children have their own proposals for organizing the data, which we don't yet really understand. We see here something I will explore in more detail later: that the students prefer a specific kind of representation of the data.

Group 3: Novices Lost Without an Expert?

The second group that Wertsch and Kazak examine operates without adult assistance, and thus offers an interesting contrast with Group 3. The video (Excerpt 3) omits the first 5 min of this group's work and so we don't know how they initially approached the task. As we join them they seem to be explaining their work to an adult who is not visible on the screen. They seem to say they'll be constructing a "line chart" which will make it easier to see the average. The adult soon leaves and they continue to work without expert assistance.

Knowing Wertsch and Kazak's position that schooling is domestication and that learning requires expert guidance, one would anticipate that they would expect that a group of novices working alone would not be able to accomplish much. Indeed, Wertsch and Kazak's interpretation of Group 2's activity is that they achieve little until an adult – Rich – joins them and redirects their activity. They describe the students as "far from fully understanding what 'organizing the data' means" (p. 163). In an early draft of their chapter they suggest that "the questions posed by RL seem to have initiated a new level of intersubjectivity between the students and the adult." The final version is more ambiguous about the origin of change: they write "a new level of intersubjectivity seems to emerge" (p. 163).

I don't believe the first interpretation survives close scrutiny of the video. Group 2 has a prolonged, at times heated, but essentially productive debate over how to construct their chart. Rather than indicating a lack of understanding, their interaction evinces a progressive resolution of ambiguities inherent in the task, conducted in a manner that is basically respectful, though not entirely rational, insofar as allegiance to shifting alliances within the group appears to explain some of the choices that are made. To understand the interaction it is key to focus on the way the graph paper begins as figure in the children's activity but ends by being a ground. That's to say,

at the start of the session the graph paper is the object that is discussed, while by the end it is a taken-for-granted background or field upon which lies the object of joint attention. This is what I will later call an "ontological construction."

Discussion begins with the issue of the placement of the chart on the paper: how the "axes" should be oriented in terms of the "sides" of the paper. The students debate the capacity of each side: is it long enough to construct an axis along which they can fit the data values that they need to include? For example, Anneke offers, "Could you put sixty-three: things across here?" [Excerpt 3, 0:11:41]. Jewel counts in fives, then Wally, recommending "Look at this" [0:11:57] counts in tens, the two of them thereby offering competing public demonstrations of the capacity of the short side of the paper. April points out that they will need two axes "anyway" [0:12:37] thus postponing the selection of which side will be the X-axis and which the Y. Wally concurs – "Then we can do it (0.3) *any*way" [0:12:51].

The disagreement over X and Y axes thus circumvented by postponing the decision – "just draw it *fir*s:t" [0:12:54] – construction begins with pencil and ruler, Jewel drawing the long axis, Anneke the short one. While Jewel completes this, Anneke and April collate the data, in a spontaneous division of labor that arises from the needs of the task as they now understand it.

Once Jewel has finished drawing and Anneke has returned from examining the data display, conversation returns to the orientation of the axes:

Excerpt 3 [0:14:06–0:14:15]

```
0:14:06 April:     Okay, what way do we want to do it?
0:14:08 Wally:     This::.
0:14:09 Anneke:    Jewel, you can't do it this way.
0:14:11 Jewel:     >What?<
0:14:11 Anneke:    >Don't do it this way< cuz then >>you can have
                   more room to write it.<<
```

In the course of this discussion disagreement arises about the seemingly straightforward issue of which is the "top" and which the "bottom" axis. Which is "left" and which is "right"?

Excerpt 3 [0:14:35–0:14:49]

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0:14:35 Jewel:     Which is the left?
0:14:37 Jewel:     This is the top, this is the bottom what dya'
                   mean the left? The left would be (.) over
                   here.
0:14:42 Anneke:    The left would be right here. No right here.
0:14:43 Jewel:     No it woul⌈dn't
0:14:43 April:               ⌊Okay you guys, we wanna do this.
0:14:45 Jewel:     You're looking at it from this (0.3) point of
                   view, okay?
0:14:48 Anneke:    No we aren't! We're ⌈doing it this way.
```

The students stumble across the importance of "point of view." Terms like "top" and "bottom," "left" and "right" are of course indexicals – and each of the children, arranged around the table, uses them to refer to a different aspect of the paper. The graph paper is a material artifact and as such, each child engages with it primarily in an embodied manner: touching it, moving it, gesturing to it. In this regard it fits within each child's body-centric frame of reference: perceived as "in front," as having "a left-hand side," "a right-hand side," and so on. This frame of reference defines aspects that seem to be those of the object itself: a "top," for example, and a "bottom," and so on. But the body-centered frames of the children do not, of course, correspond directly, because the children are facing in different directions. "Top" and "bottom" are not properties of the object itself, they are actually defined with reference to the point of view of the agent: what is Jewel's "left" is Anneke's "right." The children recognize this source of confusion without outside help, and agree to adopt a canonical point of view. Jewel, at the suggestion of Anneke and Wally, actually steps around the table to literally look from Wally's point of view [0:17:08]. The four begin to use language that is less indexical, or whose indexicality is to a context that is shared, not body-centric – talk of "the long side" and "the short side," for example.

The topic of talk now shifts from the paper to the chart and its properties. Discussion moves from the issue of how X and Y coordinates are conventionally arranged, and from confusion about which is left and right and which point of view they're looking from, to the substantive issue of which axis will work as an X or Y axis. Indexicals now no longer refer to the sides of the paper, but to the orientation of the chart's axes. The properties of the paper are now pretty much clear and can be taken for granted, but the properties of the graph being drawn on it are not yet agreed upon. Each child projects a possible construction, and apparent consensus keeps dissolving. As yet the distribution that is to be graphed is talked about only in very general terms, such as the number of data values and their range.

Choice of which axis is "the top" and which "the bottom" depends on how much data can be "fit" into each, and appreciation of this issue leads the group to debate the capacity of the axes again. For example, Jewel questions the proposal to fit 200 data values along the long axis: "Can you make two hundred some right here?" [0:15:00]. But the capacity of each axis depends in turn on the choice of units of scale. April proposes that with a bin size of 5 the values will all fit nicely on the short axis: "We can do fives" [0:15:18]. The starting and ending values are important too, and the group check the original data display to see what the largest and smallest data values are.

Excerpt 3 [0:15:24–0:15:44]

```
0:15:24 Wally:                ⌊(    ) go up to two hundred (    )
0:15:26 Jewel:      YES IT DOES it goes above two hundred and
                    twelve.
         Jewel:     No (.) wait
0:15:31 April:      No, hundred ten, two hundred thirty, two
                    hundred fifty (up to here). Okay you guys?
```

As is evident in this exchange, the children challenge each other freely throughout these conversations, in a manner that at times gets heated but remains respectful, and which allows the articulation of their differences.

The choice of X and Y axes still undecided, discussion now turns to the details of the distribution to be constructed: the range in the data values, where a data value gets placed, what is written to identify it, and where this is written. And this leads to the issue of what the graph is "saying" or "telling":

Excerpt 3 [0:18:07–0:18:22]

```
0:18:07 Wally:     =Okay Anneke, Anneke, Anneke Okay.
                   Fifty-three numbers? Okay. that would be
                   telling them with the graph. That's why were
                   making the graph.
0:18:15 Jewel:     We're saying it's Day Nineteen what (.) how
                   is it going?
0:18:19 Anneke:    ↑I see::.
0:18:20 April:     Yah but you haf to label it.
```

The children make easy use of notions of lowest and highest, make implicit use of ranges, and count skillfully in units of 5 and 10. They quickly reach agreement that the unit on each axis cannot be unity, and when they debate and disagree on the choice of unit they appeal to notions of practicality (the size of the paper), and accuracy [0:16:26]. They seem to be searching for the most efficient representation: to make optimal use of the paper by choice of axes, minimal value, etc. This task is challenging, but for important reasons, since alternative strategies must be voiced, explored, debated, rejected, retrieved, and eventually agreed on. Disagreement over the character of the distribution induces appeal to the aim of their activity. Finally it seems that a consensus is reached, and the children recognize, mark and celebrate this, even though Anneke challenges Jewel for being inconsistent in her line of reasoning about labeling the chart:

Excerpt 3 [0:18:27–0:18:44]

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0:18:27 Anneke:    >WAIT a minute< (0.7) (then the)
0:18:30 April:     Oh:::::!
0:18:31 Wally:     Okay finally! Hh huh.
0:18:33 April:     Well you could you didn't you didn't you
                   weren't trying to make that point Jewel.
0:18:20 Jewel:     Yes I was:.
0:18:39 Wally:     No::: you weren't.
0:18:40 Jewel:     Yes I was.
0:18:41 (Jewel):   No::::::.
0:18:42 Wally:     Sixty-three numbers across there.
0:18:44 Jewel:     Okay poop.
```

In sum, the children in Group 2, although they have no adult leading them, are able to agree on the type of graph they will construct (it is presented in Excerpt 12); arrange the orientation of X and Y axes; place start and end points on each axis; and determine the appropriate unit of scale. In other words, this group of "novices" is able "without intervention from a teacher" to make the same decisions that the "expert" adult made for the first group. Their interaction shows, I would argue, productive engagement in the task, an ability to work successfully together, and clear progress in their understanding of the task and of one another. They work very well together, despite the absence of adult expertise.

However, Group 2 does not make a histogram! And when adult authority arrives, in the shape of Rich, they are pressed to justify this. "Did anyone say tha it hada be a *line* graph?" Rich asks [Excerpt 5, 0:41:22]. Should we judge Group 2 a failure because they chose to construct the wrong type of graph until an adult expert set them straight? This question is an important one, for evaluation of classroom practice is the topic that has drawn us together. If we accept the way that Wertsch and Kazak evaluated the students in the first group we would have to say yes, the second group failed too. As I have noted, Wertsch and Kazak write of the first group of students that they showed "a low level of sophistication"; that had "inappropriate," even "primitive" understanding, and "did not know how to use it [the graph paper] as an expert would." They failed to grasp "how it [the graph paper] could help organize their activity in a socioculturally appropriate way" (p. 160). Of Group 2 Wertsch and Kazak write that before the adult arrives, "they are far from fully understanding what 'organizing the data' means" (p. 163). Even after discussion with the adult, "they were still struggling with the question of what it means to organize the data from an expert point of view" (p. 163).

If by this Wertsch and Kazak mean that the students were struggling to understand the adult perspective I would agree with them. But what Wertsch and Kazak evidently mean is that the students hadn't yet grasped the correct way to organize the data, and with this interpretation – and evaluation – I must disagree. The criterion for Wertsch and Kazak's evaluation of both groups' performance is "appropriate use" of the graph paper. But can we be sure that we know what "appropriate use" is? We have arrived at the third claim in Wertsch and Kazak's paper, that the graph paper is "a robust material sign vehicle" which fosters interaction between adult and children.

Appropriate Use of the Artifact?

Early in the lesson the teacher wrote two questions on the board: "What is the typical height?" and "How spread out are the heights?" [Excerpt 1, 0:01:14–0:02:14]. It would seem natural to interpret the first as a question about the central tendency of the distribution of measurements. Wertsch and Kazak write that "In this context, the term 'typical' . . . has a special meaning . . . it points to a measure of the central tendency of a data set" (p. 159). But can we be sure what "typical" suggests to the children? One might see the question as deliberately vague, leaving it up to the

children to explore what typical might refer to. Even if typical does point to central tendency, this could still be mean, mode, or median. We learn from the second video-recording that these, and the differences among them, are discussed the next day. There are important differences among these three measures. One I wish to emphasize is that while mean and median are properties only of the distribution of scores, mode will also be a property of individual plants. There will, by definition, be several plants that have the modal value, while there may be no plants whose height is equal to the mean or the median. The importance of this will become clear later when I argue that the children prefer a form of representation that maintains the identity of their individual plants.

If central tendency can be a matter of mode, as well as mean or median, is a histogram the only "appropriate" way to assess "the typical height"? We learn from the videos themselves that it is not: on the 2nd day Wally presents to the class a chart drawn with Cindy and others which, he argues convincingly, displays the mode of the distribution while retaining all the individual scores. I can see, then, no *a priori* reason for saying that drawing a histogram is the only appropriate way to use the graph paper to answer the question "What is the typical height?"

Secondly, when we examine the teacher's directions to the students we see that he introduces, presumably unintentionally, a disconnection between "organizing the data" and answering the two questions:

Excerpt 1 [0:04:48–0:05:08]

0:04:48 teacher: First you're gonna organize your data
0:04:50 Tyler: Yeah and then we're gonna
0:04:51 teacher: And then we'll probably ⌈discuss how we're going to do this::
0:04:53 teacher: ⌊((*pointing with piece of chalk in left hand toward the two questions written on the board*))
0:04:54 teacher: Ahm: and so you can be thinkin' about that as you as you're starting to organize your data, (1.0) ahm:: (0.4) well we'll discuss how to answer these questions. How we might go about that.

This formulation appears to indicate that the students should "first" organize the data "in some way" (no suggestion here that there is only one way) and only subsequently – "then" – think about the questions. The advice that they "can" think about how to answer the questions as they organize the data doesn't indicate that they should ensure that their organization be designed to facilitate their answers. The indefinite postponing of discussion of "how" to answer the questions also suggests that the organization of the data is a preliminary task. Overall, the teacher's instructions give no suggestion that there is a single "appropriate" use of the graph paper in this classroom activity.

Third, when the graph paper is handed out it is described by the teacher as being "your final copy" which "you will be putting up in front of everyone":

Excerpt 1 [0:05:10–0:05:34]

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0:05:10 teacher:    ⌈⌈Rene want to pass those out? one to each
                    group.
0:05:10 teacher:    ⌊⌊((lifting a stack of sheets of graph paper
                    from desk))
0:05:14 teacher:    This your final copy (.) sheets that you will
                    be putting up in front of everyone so:
0:05:34 teacher:    Here's your final copy, here's your pen for
                    your final copy.
```

Like Clancey (Chapters 15 and 20, this volume) I am struck by the unfortunate consequences of this: the students are discouraged from writing on the graph paper until they have solved the problem. To mark it incorrectly – with a pen, which cannot be erased – is to risk public embarrassment.

The teacher has placed emphasis on product rather than process, on finality rather than open-endedness, on whole-class display rather than group work, on public evaluation rather than safe exploration. (Not to mention the fact that the students have cameras and microphones around them, and that their products are both filmed and photographed!) Consequences of this are soon apparent: students tell one another not to wrinkle the paper; careful erasing is frequent; and we see students gesturing at the paper and talking about what they might do when drawing a few clear but exploratory lines would be more helpful. Even as a material cultural artifact the graph paper is laden with the injunctions of authority and the accountability of public display. Understanding these aspects of the graph paper's role as mediating artifact is crucially important. The students aren't engaged solely in a cognitive task, they are motivated by desire for recognition by teacher, peers, researchers, and whoever they think will be watching the video-recordings (cf. Packer & Goicheia, 2001).

There is a poignant illustration of this when Rich is talking with Group 5. He encourages them to start writing on the graph paper, but Rachel objects that they are "not sure." Rich presses them to "go ahead," and she makes a pleading and conspiratorial gesture to him, saying, "It's our final copy!":

Excerpt 6 [0:49:42–0:49:50]

```
0:49:42 Rene:                  ⌊Well we're not sure if we are
                    gonna do this. =
0:49:43 RL:         = Well go- go ahead↑ write it. (0.9) jus
                    let's see what you have.
0:49:47 Rene:       ⌈It's our final copy.
```

Fig. 10.3 Rene: "It's our final copy." (Excerpt 6)

Rachel's facial expression, her gesture and her tone of voice convey the appeal that Rich should understand their delicate position and not insensitively push them to mess up their paper (Fig. 10.3).

So while I would agree with Wertsch and Kazak that the graph paper does mediate interaction between adult and student – and also interaction among students – I cannot agree that it is straightforwardly a "mediator between different levels of understanding" (p. 164), as they put it. The graph paper's mediation is defined by the roles and responsibilities of the classroom. The teacher's introduction of it as "final copy" defines its social significance as a public display of the group's work, as an artifact for public evaluation and recognition. It is not a resource for the students to work on and explore with. In addition, the teacher has posed the task in a way that disconnects organizing the data from answering the questions. The questions about what is "typical" have been, perhaps deliberately, phrased in an open-ended way. All these considerations, apparent when we undertake to examine carefully the complex ways in which the graph paper actually moves within classroom activity, undermine any effort to claim that the single "appropriate" use of the graph paper is to draw a histogram.

Preferred Representations

However, there certainly is in this classroom what James Greeno calls a "preferred representation" (p. 56). The adults clearly prefer that the students draw a histogram. To be specific, they indicate in various ways and numerous times a preference that the students construct a bar chart showing the frequency distribution of the 63 data points, with its Y-axis labeled with possible heights in the range and its X-axis "binned." Furthermore, as we have seen, they are authoritative about this. In his discussion of Rich Lehrer's interaction with the "novices" of Group 2 Greeno observes

that at least one of these students already prefers a "bar graph" in which "it doesn't matter what the names. . . of the plants are" (April's words: [Excerpt 5, 0:40:20]) and that "the resolution appears to have been more of a concession and less of resolving alternative opinions" (p. 58). Greeno concludes that "the authoritative position that Lehrer held in the participation structure seems needed [from the analyst's perspective] to account for the group's conclusion to omit the plant numbers from its representation" (p. 59). Greeno's observations further challenge the interpretation that interaction with the adult expert leads the novice students to what Wertsch and Kazak term, "a new level of intersubjectivity" (p. 163).

A number of the participants at the conference noted that many of the children clearly prefer not to relinquish data about the individual plants whose height they have measured. In several groups we observe a clear tendency, albeit initially unquestioned, unexamined and hence unarticulated, to include the plant numbers. This tendency finds satisfaction in a variety of different constructions on the graph paper, but not in a histogram, since the binning of data means discarding all indication of the identity of individual plants. There are in fact *two* preferred representations in this activity: one preferred by the adults, another preferred by the students, and these two preferences are at odds.

Why do the students have a preference? Why are they unwilling to forget plant identity? We can only speculate that it is because this would mean forgetting also the identity of the student who first grew and then measured each plant. Garrison (Chapter 18) notes that with this "decontextualization" of the graph "whatever motivational interest may have accrued to the actual process of growing plants and measuring their maturation has departed the pedagogical scene" and as a result "the students seem unable to retain continuity between the two inquiries" (p. 311). If Garrison is correct, as I believe he is, the children's preference shows not cognitive primitivism but their keen motivation and personal involvement in the classroom task.

Sometimes the students strongly defend their preference to the adults who question it. I've already mentioned the occasion when Rich speaks with Group 5, and here as with Group 2 the discussion centers around the fact that they have chosen not a frequency chart but a line graph in which plant identity is retained. Janet is the chief spokesperson for the group at this point, and she makes a strong effort to justify to Rich what the group is doing, which I will quote at length:

Excerpt 6 [0:51:45–0:51:22]

```
0:51:45 Janet:     = >Do you-< do you understand why we need the
                   heights?
0:51:48 RL:        I understand the hei⌈ght.
0:51:49 Malcolm:                       ⌊Hehehehe.
0:51:49 Rene:      Yeah but ⌈(.) we had number twelve. Explain
                   number twelve.
0:51:49 Janet:             ⌊(But this::,)
0:51:52 Malcolm:   Yeah heheheheehe ⌈(                    )
```

```
0:51:52 Janet:                    ⌊°Because° (.) because
                  (it's numbers and it's just like) ⌈okay if you
                  put them in alphabetical or:der,
                  ⌈well what's number twel::ve?
0:51:55 RL:                                         ⌊Okay?
0:51:58 RL:       ⌊Well what's, (.) Janet? Janet? Calm down.
                  ((raising hand))
0:52:02 RL:       So (.) that I understand.
RL:               Let's cgh- think about this >just for a second
                  here though< what (.) let's think about the
                  other ones if we (did) (.) another kind of
                  graph
0:52:12 Janet:    Well we weren't =
0:52:12 RL:       = Wait for, Janet? ((raising his hand)) >Wait
                  a minute.< What other people said (.) was that
                  (.) they were going to do ah do something they
                  called a histogram.
0:52:21 Rene:     A what?
```

There's every indication here that the children are very aware that the adults do not *share* their preference. But their conduct suggests that their interpretation of this is that the adults fail to *understand* their preference. They persist in trying to explain, so vehemently that, on this occasion at least, the adult raises his hand to silence then. If there is no reasoned debate this is not because the students are unable or unwilling to engage in it. Here too, I would propose, we see concession – albeit reluctant – by the children to the adult's authority rather than a reasoned debate in which the adult's preference is accepted because of rationally compelling arguments (Fig. 10.4).

Of course Rich isn't a bully. To him, the preference for a binned histogram is rationally compelling. Continuing to argue for the histogram, he draws an analogy to a previous rocket-launching activity, and now it is Rachel who offers an explanation of their preference:

Fig. 10.4 RL raising his hand (Excerpt 6)

Excerpt 6 [0:53:01–0:53:32]

```
0:53:01 RL:      Well lemme ask you lemme me ask this (0.9)
                 suppose the (.) data were not about plant
                 heights, but they were how high the rocket
                 went?
0:53:13 Janet:   ⌈⌈You'd still use it (for this) to show the
                 different heights the different rockets went,
                 ⌈up and up.
0:53:13 Janet:   ⌊⌊((tapping pencil in an ascending curve across
                 graph))
0:53:17 RL:      ⌊Okay!
0:53:19 Janet:   ⌈⌈(            )
0:53:19 Rene:    ⌊⌊And it um would be the first rocket? tha (.)
                 first one because it's important to see (.)
                 which one it was because (.) ahm (.) which
                 plan- or which:: in this rocket it was because
                 ⌈(0.7) ahm (      )
0:53:31 RL:      ⌊Uh huh.
0:53:32 RL:      Well the rockets we all sent up at the same
                 time right? or almost?
```

Once again there seems to be mutual misunderstanding. The children are strongly defending their preference to include individual data, for either plants or rockets, but the adult does not understand their reasoning. Equally, they evidently don't see the logic of his position. In the absence of mutual understanding the definition of which construction is the "appropriate" one becomes a matter of adult status and power rather than reasoned discussion.

I have argued that we see in these video-recordings conflicts and potential contradictions between the active construction by children and adult authority in the classroom, and that these conflicts have important implications for a sociocultural theory of learning and schooling. Constructivists often expect the child to spontaneously reinvent adult mathematics, because the believe that the latter is logically compelling. Wertsch and Kazak don't take this stand: they state that "no amount of exploration on the part of novice students will yield the discovery of things like graph paper and histograms [because] [t]hese are historically evolved cultural tools" (p. 165). But what they offer instead is a conception of learning and schooling where adults' definitions of "appropriate" use of classroom artifacts are to be accepted without question by children. Learning as domestication. I think Wertsch and Kazak overstate the case – one could imagine that creative children could inscribe a grid on paper (cf. diSessa, Hammer, Sherin, & Kolpakowski, 1991) – but certainly the practices and artifacts of adult professional mathematics may not be spontaneously reinvented by children. These practices, "historically evolved," are products of numerous conventional choices. In the specific case we are considering here, the use of a histogram to represent a distribution of scores is one option among many, and this is the source of something importantly problematic in the classroom. The children are intent on finding a use for the graph paper – and constructing a new kind of object – that the adults apparently did not anticipate and which they

do not consider adequate. When we look carefully at the video we discover that the adults' preferred use is not justified in logical terms, and instead they use their authority to have the children's construction conform to their preferred use. There is this much truth the Wertsch and Kazak's proposal that teaching is – or can be – "domestication." But this is not what Rich and Leona intended. To avoid unnecessary domestication the experts need to recognize that understanding in mathematics, as in any area of human activity, "happens within the boundaries of what is contingent" (Felicilda, 2001). The issues here are not unique to math: in all arenas of learning we must grapple with the problem, both ethical and epistemological, that while we might wish children to do things "our way," our way is generally not the only way, the logical way, or even the best way. "Where two principles really do meet which cannot be reconciled with one another, then each man declares the other a fool and heretic. . .. At the end of reasons comes *persuasion*. (Think what happens when missionaries convert natives)" (Wittgenstein, 1969, p. 81, emphasis in original).

Learning as Sociocultural Ontological Construction

Let me summarize the points I've been making. First, some students in the class make progress in the activity without adult assistance, indicating that adult guidance is not a necessary component, and in this respect I must disagree with Wertsch and Kazak's emphasis on expert-novice interaction as the basis of schooling. I've also argued that it proves difficult to sustain the claim that there was a single "appropriate" way for the students to use the graph paper in this task, given the ambiguity of "typical" plant, the disconnection between organizing the data and answering the question, and the status of the graph paper as "final copy." Wertsch and Kazak elevate to normative status the preference that the adults in the classroom had for one specific representation. This representation was indeed what most of the groups ended up producing, however the students themselves had, at least initially, a different preferred representation, one that preserved the identity of the individual plants. In insisting that the graph paper had one appropriate use, Wertsch and Kazak gloss over and hence legitimate the ways in which the adults' preferred representation "trumps" that preferred by the students. Wertsch and Kazak thus legitimate an element of the Fast Plants pedagogy which involved domestication rather than argumentation.

Wertsch and Kazak seek to contribute to the debate over differences and merits of sociocultural and constructivist theories of learning and development (cf. Packer & Goicoechea, 2000). But their "socioculturally situated constructivism" still focuses only on the construction of knowledge, neglecting the ways both knowers and known are also constructed, and as they conceive of it, knowledge-construction is a solely conservative process, ascending to – and reproducing – the levels of adult-defined expertise. Goicoechea and I have argued that what is needed is not a "synthesis" but a "reconciliation," one that involves seeing that constructivism is an "as if" (Sfard, 1998, p. 12) that presumes that we are cognizing individuals but

does not examine how we may become such an kind of person. Socioculturalism, properly formulated, does tell a complete story, one of "a practical process of construction where people shape the social world, and in doing so are themselves transformed" (Packer & Goicoechea, 2000, p. 234). Such a formulation requires a non-dualistic ontology, which we have proposed has six components: (1) the person is constructed, (2) in a social context, (3) formed through practical activity, (4) formed in relationships of recognition and desire, (5) that can split the person, (6) motivating the search for identity. School is a place where children become new kinds of person (Packer, 2001). As Dewey noted, "a criterion for educational criticism and construction implies a particular social ideal" (1916/1966, p. 99). One such ideal could be that children merely master the expertise of their elders and betters, but such an ideal pays little attention to either the rapid changes in the technology and economy of contemporary society which render adult expertise obsolete, or the existence in adult practices of inequities and inadequacies which we would wish our children to overcome. Most importantly, no single social ideal and consequent criteria for schooling should be enshrined in theory, when the choice of ideal should emerge from a political process of debate and reasoned disagreement.

We witness the construction of objects in the children's treatment of the graph paper. Wertsch and Kazak view it as an unambiguous artifact with well-defined use and meaning, but if we look closely we see the artifact being transformed. It begins as a sheet of *paper*, marked with what could variously be interpreted as cells, or a grid, or a lattice. This paper has properties which the children discuss and debate: it has long and short sides, these have length, numbers of cells, etc. But the paper quickly becomes the ground for the construction of a *graph*, which has new and different properties: axes, with length and orientation, points with position relative to the axes, labels of various kinds. And this in turn becomes ground for construction of a *distribution*, which has range, central tendency, and so on. When the children display their work on Day 27 of the unit, it is the distributions they are sharing, not the graph paper. The paper has become an invisible backdrop to this new construction.

Which of these is "the artifact" – paper, graph, or distribution? The answer has to be that there is no single artifact; what we witness is the transformation, over time and through practical social activity, of an object of knowledge. Even a description of this object, let alone its evaluation, requires an understanding of the context in which it moves and the actions performed on it.

I have just described this changing object from a cognitive angle, but it can be viewed also from a social angle. It begins as "final copy," already caught up in familiar routines of whole-class display and teacher evaluation. It becomes an object of joint yet distributed attention, as the children seated around it must recognize that their indexical references (to "top," "bottom," "here," "there") require a common frame of reference if they are to understand one another and successfully work together. When adults arrive it becomes something to be described, explained and justified. The following day it becomes an exhibit for public display and comparison. Everyone – teacher, small groups, adults, whole class – plays a part in the construction and reconstruction of this object. And this is not the end of its story:

now a completely different audience of academics recontextualizes it and interprets it afresh. It was anticipation of such an analysis, presumably, that motivated the video-recording of the class, and perhaps the design of the instructional task in the first place, so a complete description of "the artifact" would follow it out of the classroom in Wisconsin to a conference room in Illinois and then onto these printed pages, where it has become an element in a wider social and intellectual praxis.

In short, then, knowledge is not all that is constructed in a classroom. The objects of knowledge are constructed and reconstructed in complex trajectories of collective activity. The knowing subjects – the "students" – are constructed too (although tracing the transformations of the children in these short segments of video is much harder than tracing transformations of the objects). Learning is not solely a matter of change in subjective knowledge structures, it is about changes in the world: artifacts in the classroom are transformed, becoming mathematical, physical and biological objects.

It will be clear that I disagree with Wertsch and Kazak's suggestion that "a great deal of the negotiation of meaning and intersubjectivity involved in our example looks like the kind of processes that are of interest to constructivists" (p. 165). I have pointed out that constructivists are interested in the construction of knowledge, while what we can see in this example, and what socioculturalism can and should concern itself with, is the construction of knowing subjects and known objects. While Wertsch and Kazak see a need for a synthesis to which "constructivism has a great deal to offer" I have argued for a reconciliation in which the construction of knowledge is subordinate to a more profound construction or constitution of known objects and knowing subjects.

In addition, while I do not consider myself an expert in Vygotsky, I have doubts when Wertsch and Kazak write that constructivism "indeed addresses a weak point in Vygotskian theory" (p. 165). Vygotsky offers us a powerful illustration of an approach to psychology which, based as it is on Marx and Hegel, places process at center stage, deals with phenomena holistically rather than by dissecting them into variables or elements, shows how the appropriate choice of unit can show the whole in each of its parts, shows the importance of understanding the dialectic between nature and culture, and places all this in service of important social goals. Constructivism doesn't seem to me to have much to add to this.

But Vygotsky's theory cannot be lifted out of its time and place without damage. His aim was to articulate a scientific psychology that was of immediate practical and political value, satisfying the needs of the newborn Soviet Union. "Vygotsky declared that the motto of the new psychology was 'practice and philosophy.' That statement was not a mere declaration, it had a personal significance to him. The unending shuttle-like movement of Vygotsky's thought between practice and philosophy determined his highest achievements" (Yaroshevsky, 1989, p. 16–17), as he and his colleagues were "becoming active builders of socialist culture" (op. cit., p. 71). He sought to forge the tools needed in a new kind of society. "Soviet society demonstrated its potential for transforming the individual's spiritual world on new, humanistic principles. The reality surrounding Vygotsky, the people and their activities were changing right before his eyes. Historical changes were taking place

both in being and in consciousness. Feeling the rapid beating of the pulse of the times, Vygotsky absorbed the principle of historicism and social determination of behavior not only as a philosophical imperative but also as a guiding principle in the transformation of man" (op. cit., p. 104). Vygotsky intended that his scientific psychology would provide the tools needed to bring to fruition the deliberate cultural transformation of human nature (cf. Packer, 2008).

Vygotsky's work shows the mark of its times in other ways. His remarks that novices must be led by experts shows the vanguardism of post-revolutionary Russia, when Lenin (1902/1971, p. 37) could write that revolutionary consciousness could never arise spontaneously in the working class, "It could only be brought to them from without" by "the revolutionary socialist intelligentsia." Vygotsky took Marx's *Capital* as his model of a dialectical science; Marx's earlier, "humanistic" writings, which contained a more subtle account of false consciousness and alienation, were unavailable.

Today in the U.S. of the early twenty-first century we are not so quick to dismiss the ability of the disadvantaged to grasp the inequity of their circumstances, or to judge that "an illiterate person stands outside politics" (Lenin, cited in Davydov, 1988, p. 8). We are less likely to reject attempts at reform and opt for radical revolutionary change. We know how the Soviet vanguard became an ossified party bureaucracy at the center of a totalitarian state. Certainly we don't think of ourselves as having a perfect society within reach. We need, then, to use Vygotsky's writings as a guide as we grapple with our own problems, not as a solution to them. In broad terms our aims will be the same: to comprehend "changes. . . in both being and consciousness" and to foster these in a practice both social and political. But our work must be tailored to and based on an understanding of our historical and cultural circumstances – of post-industrial capitalism, economic and cultural globalization, and religious polarization.

Sociocultural theory is an important step forward from the notion that development is oriented by a single, overarching and universal rationality – a rationality which, oddly, was most accessible to white, male, middle-class westerners. But we must avoid falling into an epistemological and ethical absolutism in which "mastery" is the sole criterion of "expertise," and those who are seemingly deficient must be "tamed." Stripped of its "scientific" legitimation, this absolutism shows itself to be a cultural relativism. (Bernstein [1983] has diagnosed the "Cartesian anxiety" that lies behind both dogmatic objectivism and anything-goes relativism.) Instead, an approach that is sensitive to cultures must be pluralistic, neither universalistic nor relativistic, granting the qualitative differences between child and adult, and also granting that different cultures have valid, though distinct, rationalities. Like contact between adult and child, contact between cultures, and the move from one to another, require dialogue, mutual understanding and bridge-building, not domestication and taming.

Finally, some brief remarks about our general project here, the evaluation of classroom practice. It's become apparent how important it is to study an activity in its entirety: lack of video of how these groups started and finished their activity limits our ability to understand what they've done, and why. It's equally important

to seek norms internal to the activity, and not impose norms from outside. The local interaction, in the small groups, must be understood and evaluated in the context of the classroom as a whole – we've seen that norms of public accountability influence what the students do and don't do. In particular, we need to know the teacher's instructional goals – what was this teacher trying to achieve with this activity? – but we can't take these for granted: we must evaluate them for internal consistency, for transparency, and for the degree to which they are in accord with what schooling has been judged to be by the school as a whole, by the school district and by the community.

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