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Phenomenology and Mathematical Experience

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A review article of

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Running Head: Phenomenology and mathematical experience

In *Mathematics Education and Language: Interpreting Hermeneutics and Post-Structuralism* (Dordrecht, Kluwer Academic Publisher, 1997, 270 pages, ISBN: 0-7923-4554-1), Tony Brown relates his experiences and research on mathematics learning and mathematics teacher education to hermeneutics, phenomenology, post-structuralism, and semiology. In this effort, he does not arrive at new claims about knowing and learning mathematics. Rather, he uses ample examples that show how mathematics education can be understood within the various frameworks he outlines. The book is divided into three parts. In “Part I: Experiencing Mathematics,” which consists of three chapters, Brown elaborates his view of mathematics, the production of mathematical meaning, sharing mathematical perspectives. In “Part II: The Classroom Environment,” the author presents two chapters that contain extensive accounts of some lessons and a phenomenology of the classroom. Finally, the two-chapter Part III deals with a teacher perspective on teacher-student interaction and developing teacher practice.

This is an interesting book about mathematics, mathematical experience, and mathematical discourse that raises a host of questions. Some of these questions derive from the fact that the author never takes a definite position and seeks refuge to “oscillating in a hermeneutic circle” (p. 226). Other questions arise because there are tensions in the author’s program of the reduction to language of all mathematical activity and experience (“There is no experience outside the text” [p. 226]). Similar to Brown, I ground my research in phenomenology, semiotics, language philosophy of Wittgenstein, and the writings of Derrida. In my research, there is a tremendous focus on language and discourse. However, perhaps because I study language in the context of students’ interactions over and about materials (objects, representation), I arrive at conclusions that differ from those of *Mathematics Education and Language*. In this review article, I provide a reading of the book through my own (mathematical?) experiences and familiarity with the philosophical and epistemological writings that also ground Tony Brown’s work.

To begin with, I provide an account of my own lived work relating to a (mathematical) task sent to me by a graduate student as part of his research how teachers science teacher to do who was assigned to teach mathematics. As I read the problem, I was interested in my own processes of going about the task and, thereby, to uncover my own (ethno-) methods of enacting practices related to mathematical “problems.” With the following account, I attempt to provide “praxiological validity” (e.g., Bjelíc, 1992) for my own mathematical activity and reading of *Mathematics Education and Language* by exhibiting materials that render the observable, reportable, and teachable elements of the practical contingencies in (mathematical?) activity.

A Non-Mathematician and a Mathematical Puzzle…

> *In a certain town there are two hospitals, a small one in which there are, on the average, about 15 births a day and a big one in which there are, on average, about 45 births a day. The likelihood of giving birth to a boy is about 50%. (Nevertheless, there were days on which more than 50% of the babies born were boys, and there were days when few than 50% were boys.) In the small hospital a record has been kept during the year of the days in which the total number of boys born was greater than 9, which represents more than 60% of the total births in the small hospital. In the big hospital, they have kept a record during the year of the days in which there were more than 27 boys born, which represents more than 60% of the births. In which of the two hospitals were there more such days? (a) In the big hospital there were more days recorded where more than 60% boys were born. (b) In the small town there were more days recorded where more than 60% boys were born. Or (c), the number of days for which more than 60% boys were born was equal in the two hospitals.*

Upon seeing this puzzle, I became so intensely absorbed (as I realized afterward) that I realized only subsequently what had happened.[1] I envisioned on first impulse two distributions, which I immediately drew next to the text (Figure 1).

[1] A number of my colleagues tell me that I had experienced something like “flow.” I captured what had

Figure 1. First sketch following the reading of the task concerning the hospital problem.

I was then drawn away from my desk, but had an image of three children each of them with a probability of 50% of being boy or girl. Unfoldingly I envisioned the following series of rows composed of triplets of numbers, each individual number being a 0 or 1 (Figure 2):

0 0 0

1 0 0, 0 1 0, 0 0 1

1 1 0, 1 0 1, 0 1 1

1 1 1

Figure 2. Approximate image that emerged after I thinking of three children born to a family.

I counted that there were 1, 3, 3, and 1 triplets in each row; the shape of the figure resembling the distributions envisioned earlier. I began to do another example, which would allow me to make a comparison with my 3-children model, choosing a 6-children hospital. But as the first sets of 0s and 1s formed in my minds eye (i.e., 0 0 0 0 0 0, 1 0 0 0 0 0. . . 1 1 0 0 0 0 0. . .), the task of visualizing, enumerating, and counting the frequency of each seemed too complex without paper and pencil.

happened to me in personal notes after the fact. From these notes, I reconstructed the following account.

A seemingly lost image emerged from the past: it was a pair of parentheses enclosing two numbers one on top of the other without a line indicating fraction.[2]

$$\binom{1}{3}$$

But I did not know how to take this image any further.

At this time, I returned to my desk and started up a mathematical modeling program (MathCAD™) that I had previously used extensively with high school students for data analysis in a physics course and for engaging them in mathematics projects (e.g., Roth, 1995). I had also used it with Grade 4 and 5 students as a medium that "talked back" to them about their mathematical activities (Roth, 1998). I thought that I might find something similar to that last image, which I could subsequently use to get me further. But as I looked through the manual of MathCAD™, I could not find anything resembling the representation. However, another image took shape in my mind's eye,

$$\frac{1!}{1!\cdot(3-1)!} = \qquad ,$$

which I quickly typed into the computer. I transparently (without thematizing the keys or looking to the keyboard) held down the keys [⌘][=] which resulted in

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[2] Notations are part of the language games of mathematicians. Here a brief explanation by a non-mathematician. The expression 2! (2 factorial) is used to express 1*2; 3! is short hand for 1*2*3. The notation $\sum_i f_i$ signifies the sum of all f_i. I do not recall the exact use of the notation $\binom{3}{1}$, but it somehow was used to express the probability of one particular occurrence (having one boy) in total of three events (having three children). Simultaneously pressing the keys [⌘][=] makes MathCAD™ recalculate all expressions on the screen.

$$\frac{1!}{1!\cdot(3-1)!} = 0.5$$

Without thematizing what I was doing or the objects that I manipulated, I first changed the numerator to 2, then to 3 and each time pressed again [⌘][=] which yielded

$$\frac{2!}{1!\cdot(3-1)!} = 1 \quad \text{and} \quad \frac{3!}{1!\cdot(3-1)!} = 3 .$$

I then changed the 1s in the denominator into a 2, 3, and 0, yielding 3, 1, and 1 on the right hand side. This sequence of 3, 3, 1, and 1 resurfaced the previous image of the 0s and 1s (Figure 2). From here, events unfolded rapidly. Again without thematizing what I was doing, I wrote:

$$x := 0..15 \qquad y := 0..45$$

$$f(x) := \frac{15!}{x!\cdot(15-x)!} \qquad g(y) := \frac{45!}{y!\cdot(45-y)!}$$

and then generated a graph (Figure 3) that included both functions; the result felt right.

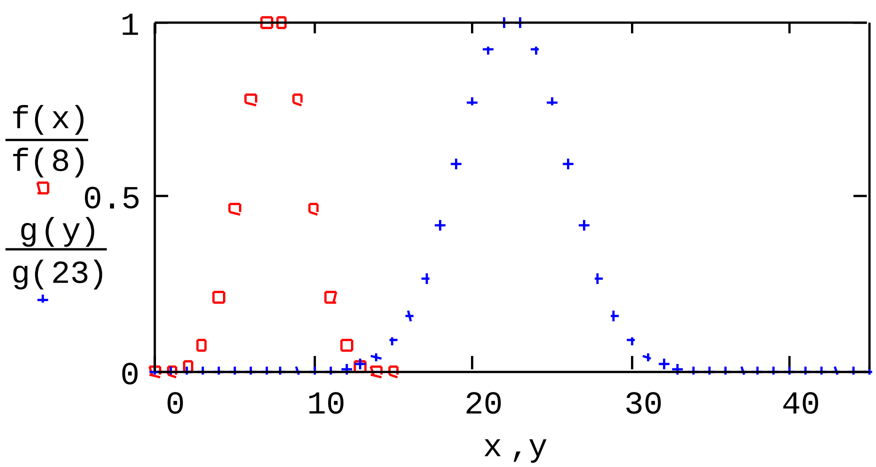

Figure 3. Graphs of functions x and y, representing the relative distributions of how many (boy/girl) mixes there would be.

Looking at the tail of each distribution, an image of $\sum_{\cdot} .$ formed in my minds eye and I then wrote an equation which, after I nonthematically pressed [⌘][=] yielded.

$$\frac{\sum_{9} f(x)}{\sum_{x} f(x)} =$$

must be range

Trouble! I made one more change and added another equation, which, with its result, was as follows.

$$z := 9 .. 15 \qquad\qquad w := 27 .. 45$$

$$\frac{\sum_{z} f(z)}{\sum_{x} f(x)} = 0.304 \qquad\qquad \frac{\sum_{w} g(w)}{\sum_{y} g(y)} = 0.116$$

This brought me back to the image of the town with its two hospitals and a sense that I had solved the puzzle. I envisioned a black-colored tail of the left curve that had a relative area of 0.304 which was larger than that of the right curve, 0.116. I also thought that what I had done looked awfully complicated, like shooting flies with canons. I had the strong sense that a mathematician would probably have a more elegant way of dealing it, and wondered how anyone could expect an ordinary teacher or student to deal with the task. Without further questioning myself, I remember having a strong impression that this is too complicated for school mathematics, and that what I had done was certainly unacceptable in school mathematics.

… But is it Mathematics?

In my experience of this activity, there were very few words. I remember a vague sense of myself absorbed in activity, a predominant presence of images, and a strong, almost physical sense of objects on the computer screen which I pushed and which responded. What I was doing was more akin to my absorbed kneading of sourdough (adding a little flour here, a little oil there) than to any calculative reasoning about what to do next in a game of chess. I visited somewhere where I had been a long time before, even though briefly so that the direction of my activities was guided only by fuzzy images. Although the images were partially in terms of linguistic signs, my experience (i.e., my activity) was largely nonlinguistic and non-thematized. I was absorbed, had forgotten all context; there was not even a sense of “I” or “Self” as an entity separate from the mathematical objects, computer, or activity. There was also no deliberate, metacognitive control of my activity. I did not objectify my Self, activity, or setting (i.e., objects). That is, my experience became something linguistic only after the activity when I thought that it would be worthwhile to capture as much of the activity in writing before the images faded. My experience became a linguistic entity when I began to account for it in my notes, the meeting with graduate students, and while writing this review.

As I read *Mathematics Education and Language*, I had a continuous and strong sense that Brown might *want to* account of my experience as mathematical. But at the same time, he would have trouble accommodating my experience to his Derrida-like claim that everything is text. Was that which I did and experienced mathematics or did it become mathematics only once I began objectifying my experience by writing it down, sharing it with my graduate students during the seminar that occurred two hours later, or when I make its description part of a review article? How would I teach mathematics to children so that they are absorbed in the activities, oblivious of their surroundings and the time (as I had documented it in various studies of open-inquiry science [e.g., Roth, 1995, 1998]).

Ethnomethodologists suggest that “the consensual culture of mathematics is expressed and described mathematically; that is, it is available in the actions of doing intelligible mathematics” (Lynch, 1992, p. 230). Mathematics educators such as Tony Brown or Cobb (e.g., 1994) are likely to agree with such a formulation. This, however, does not mean that the mathematician’s activities are completely described and represented by mathematical formulae. Rather, no such representation can be constructed and at the same time, none is missing. Yet, my account in the previous section raises the important questions, “Were these activities mathematical?,” “What might mathematicians classify it?,” and “Would mathematicians classification differ from that of mathematics educators?”

Historically, (pure) mathematicians are suspicious any time their peers utilized a computer as part of a proof. As a recent historical analysis of the computer-based proof of the four-color theorem showed, many mathematicians are doubtful that a proof involving computers belongs into the domain of pure mathematics (MacKenzie, 1999). There was a sense that if essential elements of proofs are not transparent, cannot be played out such as to be open to direct scrutiny, it was not mathematics at all. From such a perspective, my activities were inherently non-mathematical. Like the Appel-Haken computer proof of the four-color theorem, I had used the computer to enumerate and calculate what would have taken a long time without the computer. At the same time, my practices implicitly rest on other practices (those of computer and software designers, technicians, etc.) which are assumed to be infallible with respect to the mathematical practices that are black-boxed in the computer.

In this sense, the mathematical activities enacted by the children and preservice teachers in *Mathematics Education and Language* are more like those of the traditional mathematicians. Furthermore, because these students were always part of group activities, it is not surprising that Brown comes to the conclusion that mathematical activity is essentially linguistic activity. These claims conflict with others that attribute a lot of what is going on during the activities described by the author to the mind. Yet we may want to visit the question of the location of mathematical activity and therefore, that of mathematical cognition. For example, it makes little sense to argue in my own example that mathematics was in MathCAD™ or in my mind. Without my own agency, the computer would have done very little, and conversely, I would not have done much without the computer. I may not even have attempted to "fiddle" or "play" with the problematic. As I, in a non-thematic manner, pushed objects such as

$$\frac{1!}{1!\cdot(3-1)!} = \quad \text{or} \quad \sum_{y} g(y) =$$

they responded. My actions were non-thematic in the way I type this text without thematizing the computer, keyboard, my keystrokes, and so on. All these rest in the background and establish the indexical ground against which my activity and the responses acquire their sense. But these responses themselves were not imbued with meaning in any absolute sense. Rather, they made sense as a function of my horizon at the moment of the response. Brown would likely agree that any patterns that emerged for me from my activities did so because I viewed the objects through all of the experiences I have had with MathCAD™ and my in/formal mathematics that I enacted in the past. Brown would likely not agree with me when I argue with Bourdieu (1997) that praxis largely occurs before and against a non-thematized ground that we always already take for granted, but which in its very nature and significance cannot be prespecified, enumerated, or made explicit.

Whether or not the experience was linguistic, there exists a possibility of *demonstrability* (e.g., Morrison, 1989) inherent in my activities. That is, these activities left traces (saved MathCAD™ worksheet, my account of experience), one organizational class of material which the other, a language-based explanation that operates on these traces by seeking to point out its relevancies, details, composition, and conceptual underpinnings. Thus, the appropriateness of my solution (and perhaps its meaning) was locally achieved in the connection between the original task and the final result. It is only through the local production of sign-related activities that "problem" and "solution" can be recognized as mathematically relevant objects.

The Nature of Signs

Although I am sympathetic with the general argument about the importance of theorizing learning in terms of language, I part ways with Brown when it comes to signs. He largely draws on Saussurean semiology with the consequence that he, as Derrida (e.g., 1981, 1988), gets stuck in language from which there is no escape. On the other hand, my interactions with the (mathematical?) objects did seem to have another quality not captured in language. There was a non-thematic, nonlinguistic aspect to the experience; the experience was more like that of hammering without thinking *about* the hammer or the nail, but enacting *hammering*. Thus, in my activity the MathCAD™ objects did not differ in kind from that of interacting with materials in our physical world. Because all representation takes material form, people, signs they use, and objects and events (many of them again signs) signs refer to are all part of the same continuum "about which and through which signs speak" (Eco, 1984, p. 44). In this, Eco agrees with Bourdieu (1997) that as subjects, we are what the shapes and structures of the world produced by signs makes us become. Rather than completing a reduction to language as Brown does (p. 214), Eco's reduction to matter is not unlike that conducted by neurophilosophers and their metaphors of parallel distributed processing (P. M. Churchland, 1995; P. S. Churchland & Sejnowski, 1992). Such metaphors, implemented as artificial neural network, have been quite successful in accounting for language learning without innate grammar (Elman, 1993), evolution of linguistic systems and grammars (Hare & Elman, 1994), coordination of material world and representational worlds (Elman et al., 1996), as well as nonrepresentational forms of cognition (Brooks, 1995).

Brown, on the other hand, has to postulate a world of mathematical objects which *parallels* (but is not identical to) that of the world of material phenomena (e.g., p. 155). The danger in such a construction, of course, is that we easily slide into an epistemology which presupposes the isomorphism of {fundamental structure <—> mathematical structure} which have been subject of considerable work and critique in the sociology of scientific knowledge (e.g., Latour, 1993; Lynch, 1991). It also remains unclear how the mental processes and images (e.g., p. 110) attributed to agents relate to the language they use as part of their communicative efforts. For example, whereas Lave (1988) acknowledges the presence (even without reflection) of competent mathematical practices in the everyday world of just plain folks, Brown seems to make mathematical activity contingent on objectifying linguistic practices. That is, to use an analogy from language, truly discursive practices are not only competent but thematize their own structure (i.e., as grammar)—mathematical activity is only mathematical when it is thematized through objectifying activity of reflection. Yet phenomenological work suggests that we can cope in highly competent ways when our practices and their structures remain non-thematized and transparent to our enacting them (e.g., Heidegger, 1977; Merleau-Ponty, 1945). In fact, Heidegger suggests that objectification (by means of language) leads to being cut off from experience and from the background familiarity. For Heidegger, sense is “the structure of the general background that can never be fully objectified but can only be gradually and incompletely revealed by circular hermeneutic inquiry” and “precisely what is left out in all formalization” (Dreyfus, 1991, p. 222). In this, Heidegger, Bourdieu and others are in direct opposition to Husserl and Saussure in whose work Brown grounds himself.

Where is Mathematical Cognition Located?

In *Mathematics Education and Language*, Brown engages in a reduction of mathematics education to linguistic practices. It is therefore not surprising to read that mathematics “is located in individuals and only has life in the acts of these individuals” (p. 172). The statement is also consistent with individualist epistemologies such as radical constructivism, which is a constant referent for the author throughout the book. Furthermore, such statements fit with the individualist approach generally embodied in educational systems that test students by isolating them from material (e.g., manipulatives, computers, programmable calculators, books) and social resources (e.g., teacher, parents, librarian). Thus, when I engaged the hospital task, mathematical activity emerged in the interplay (“playing around”) somewhere at the nexus of task, MathCAD™, my past experiences, and my current horizon. The mathematics could not have been in my mind, for I had developed only a proximate understanding of probabilities during my school years. Of this, there remained only vague images that I took as a starting point for my activities. Part of the structures in the unfolding activity, for example the responses to one of my actions, can be ascribed to MathCAD™. But I also interacted with the manual to see whether there is something that approximated the other notation I associated with probabilities,

$$\left(\frac{1}{3}\right)$$

but I could not find anything and quickly abandoned the search. Thus, my activity may be best understood in terms of a "mangle of practices" that leads to the co-emergence of new conceptual, discursive, and material practices from the situated activities of human agents (e.g., Gooding, 1990; Pickering, 1995; Roth, 1996).

While it makes sense to extend the analytic unit to include agents and their ontology of the relevant setting, actual educational (policy) discourse finds such ("situated") perspectives troubling because it runs counter to the traditional modalities of schooling. Thus, schools and grading practices embody explicit politics: evaluation is a means to stratify, "weed," and stream student populations (e.g., Foucault, 1975; Roth & McGinn, 1998). Brown is caught in the same kind of tensions by attempting to argue for a linguistic and phenomenological approach, but doing so in the context of educational reasoning that focuses on individual prowess. For me, Brown never successfully deals with the tension between curriculum and the implicit politics of "one-fits-all" (content, temporal unfolding, and control of learning). On the one hand, he emphasizes process, the engagement of children in activities; on the other, he also wants children to enact standard mathematics and therefore suggests that children's must have *specific* terminating points and products.

However, such statements would seem inconsistent both within (sociological) phenomenology (e.g., Bourdieu, 1997; Dreyfus, 1991) and within the context of research on everyday mathematical activity (e.g., Lave, 1988; Saxe, 1991; Scribner, 1986). First, from a phenomenological perspective, our fundamental experience is one of *being-*

together-with others such that our understanding of Self, world, and knowledge are intimately tied to the world in which we live; Self (subject) and world (Other) are in a mutually constitutive relationship. We embody (in perceptions, actions, and expectations) the structures of the world because we are the product of this world. Thus, it is inconsistent with phenomenological thought to claim that mathematics is *in* the individual or *in* individual activity. Second, the research on everyday mathematical activity shows that mathematical activity and knowing is best understood as being distributed across both material and social worlds. Thus, the mathematically competent activity of Brazilian child street vendors of candy described by Saxe cannot be understood as the outcome of individualist cognition located in the mind of the person. Although they do not read numbers (face value of the bills), these children return home in the evenings generally having made profits. Thus, the mathematical cognition involved cannot be understood independent of the social context of buying and selling or of the phenomenal structure of the bills used in the transactions.

Meaning

To me the fuzziest notion throughout this book was that of "meaning." It was as if there was not a consistent language game that would stabilize the meaning of meaning. At the 1998 Psychology of Mathematics Education conference, two eminent mathematics educators engaged in a discussion of the relationship between psychological and sociocultural perspectives of mathematics education (Thompson & Cobb, 1998). After an interesting debate, which had lasted over an hour, I questioned the two about their respective use of "meaning," that is, about their respective meaning of "meaning." After some reflection, both recognized that, despite having used the same word, they really had (and unbeknownst to the audience) not meant the same thing when they talked about "meaning." Having heard and used the same utterance, "meaning," both fell prey to the illusion, as Mannheim (1968) pointed out, of having grasped the point of view of others when he merely perceived the other's utterance. Or, in Rorty's (1989) way of putting it, Thompson and Cobb have unknowingly constructed incommensurable *passing theories* about the noises (e.g., "meaning") produced by the other.

Brown uses "meaning" in a problematically oblique way, that is, he never tells us what meaning is but only how it is "constructed," what it requires, and how it is given. Thus, the following is a list of sample statements is indicative of the different (incommensurable?) uses of the term.

a. "It is the very tension between statements and the meaning assigned to them that locates the hermeneutic circle" (p. 50)
b. "The meaning assigned by the girl to the various pieces was consequential…" (p. 53)
c. "Symbols and classifications have particular meanings for any individual derived from that individual's experience of their usage" (p. 53)
d. "The production of meaning always requires negotiation between speaker and interlocutor" (p. 126)
e. "A word in a text does not have meaning in itself, but rather derives its meaning from its relation to the words around it" (p. 178).
f. "Mathematical meaning never stabilizes. . ." (p. 228)

It is evident that the meaning of meaning is problematic. Thus, meanings are entities that can be attributed to signs (a, b, c); at the same time, meanings require negotiation and do not stabilize (d, f). Finally, meanings are separate from signs and exist somehow behind or riding on top of signs (a, e). Such use is inconsistent with phenomenological understanding that much of the time we take the world for granted; events in such a world are inherently perfused with meaning until transparent coping is disrupted by breakdown.

We can never achieve fullness of meaning, because each text and all its subsequent interpretations can always be subjected to yet another interpretation which establishes another signification (Derrida, 1995). But signification does not only arise from other signs. Rather, we might want to think about meaning in terms of practices. In this way, there are other, material practices that, without having to be thematized, contribute to the (tacit) background against and in relation to which a particular practice can be attributed meaning. Levels of meaning can then be established in terms of the degree of connectedness a particular practice with the cothematized practices or the non-thematized background. In terms of my own activity, when the results of nudging ("playing around with")

$$\frac{3!}{x!\cdot(3-x)!} =$$

were conform with the results of another, prior activity of triplets of 0s and 1s, I was able to make one of the connection that contributed to the network of significance (meaning) of both expression. I felt a deep sense of having learned something when I saw *this* expression relate to the distributions (Figures 1, 3) with which I am more familiar. Most importantly, both my activities and the original task came to "make sense," when I was able to relate them with the sense that one was the solution to the other.

The confusion around meaning is associated with a confusion of cognition, the location of learning, and just what knowledge is. The metaphors used throughout *Mathematics Education and Language* are frequently incompatible. Thus, what do students "construct" when they engage in classroom activities. The "construction" metaphor goes well with the notion of cognitive structure in Piagetian and cognitivist discourse, but much less with a phenomenological discourse about learning and knowing as participation in language. For example, how should we understand "communicating conventional mathematical ideas" from within the phenomenological perspective taken by Brown? I draw on Heidegger (1977) to unfold my critique. Mathematical communication (Lat. *communicare* < *communis*, common) is intended to bring the hearer to participate in mathematical ideas that are talked about. Communication, or "sharing" as it is often expressed in school settings, presupposes the "average intelligibility" of the language (and ideas) at hand. But, students find themselves in our classrooms because they do not yet participate in mathematical discourse. Furthermore, there are additional problems with focusing on language only. First, that discourse can be understood without the listener having a "primordial understanding"; thus, "what is talked about is understood only approximately and superficially" (p. 168 [155]). Second, the objectifying tendency that lies in the linguistic reduction inherently cuts us off from the primary and primordial relation to the world. Thus, the participants in studies of mathematics in the everyday world do not thematize their activities in terms of mathematics. They transparently cope with their structured worlds in assembling shipments of dairy products, buying and selling candy, evaluating a best buy, or finding the correct amount of food for a recipe without doing explicit and reflective mathematics.

Associated with the linguistic reduction is a tension between using "hands-on" activities and those conceptual mathematical understandings that students are to derive from them. In order to conceptualize understanding, Brown takes the detour through linguistically mediated interpretation. Crucial to the phenomenological argument is the characterization of being-in-the-world and transparent coping as the fundamental experiences. As such, we exist in a largely non-thematized world: we use tools and materials without thematizing (textualizing) them but by engaging in activity.

Underdetermination of Learning Outcomes and Openness of Learning to the Future

Heidegger suggested that we always already come to a world shot through with meaning, so that we (can) take much of this world for granted. It is only during breakdown, an interruption of transparent copying that we thematize tools and the world. From such a perspective, and in contrast to Brown's assumptions throughout the book that all activity "implies a (hermeneutic) process" (p. 29), the activities in which students engage as part of their mathematics classes do not inherently lead to learning. If children see Dienes blocks as "construction blocks" with which they are familiar, they may draw on their familiar practices with such blocks and, in a transparent way, engage in the construction of some thing currently salient in their world. Here, because the mathematical is not problematized, we therefore do not expect mathematical learning to occur according to the official curriculum. Such issues as what is it that (we want) children (legitimately to) learn in mathematics classes, and the inherent openness of learning toward the future would have deserved more attention than it has in *Mathematics Education and Language*.

Because children do not know the subject matter that the curriculum is intended to teach them, they cannot know where they are to go and end, or whether what they do is appropriate. In a study of Grade 12 physics laboratory activities, I framed this as a double-bind situation (Roth, McRobbie, Lucas, & Boutonné, 1997):

- To know that what they see as the activity outcome is what they were supposed to see, students need to know that what they have done (with the materials) is what they were supposed to do; and
- To know that they have done what they were supposed to do, students need to know that what they see is what they were supposed to see.

Students cannot travel the curriculum in the way we travel to the next city. Learning is a voyage into the unknown, where even the details of the modes of traveling are unknown to the participants. While Brown takes a phenomenological stance, I found this aspect of the fundamental double-bind of learning insufficiently thematized and problematized. For example, we may conceive of the enacted curriculum as an organizational structure and constraint in which students find the grounds for construing an orderly sense of mathematical activity. That is, within the constraints of the (negotiated) curriculum, the ordering and pedagogic arrangement of activities will figure as a specification of order of coherence for the rational visibility of the (mathematical?) objects arising from students' activities. That is, legitimate mathematical activity arises when students' agencies are enacted within curricular constraints as both observable and intelligible event.

Concluding Remarks

Mathematics Education and Language certainly is a recommendable book. While it does not present the results of empirical studies, it describes a heterogeneous framework for understanding the activities in mathematics classroom. There are many richly described episodes of mathematical activities that serve as examples rather than as an empirical base from which a theoretical framework is constructed. In (under-) graduate seminars, these could become a common ground for fruitful discussions of the topics addressed in the book.

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Phenomenology (from Greek phainÃ³menon "that which appears" and lÃ³gos "study") is the philosophical study of the structures of experience and consciousness. As a philosophical movement it was founded in the early years of the 20th century by Edmund Husserl and was later expanded upon by a circle of his followers at the universities of GÃ¶ttingen and Munich in Germany. It then spread to France, the United States, and elsewhere, often in contexts far removed from Husserl's early work. Phenomenology is the study of structures of consciousness as experienced from the first-person point of view. The central structure of an experience is its intentionality, its being directed toward something, as it is an experience of or about some object. An experience is directed toward an object by virtue of its content or meaning (which represents the object) together with appropriate enabling conditions. Phenomenology as a discipline is distinct from but related to other key disciplines in philosophy, such as ontology, epistemology, logic, and ethics. Phenomenology has been practiced in v 70 Downloads. Keywords. Mathematical Knowledge. These keywords were added by machine and not by the authors. This process is experimental and the keywords may be updated as the learning algorithm improves.Â Husserl, E.: 1973a,Experience and Judgment, J. Churchill and K. Ameriks (trans.), Northwestern University Press, Evanston, Illinois.Google Scholar. Husserl, E.: 1973b,The Phenomenology of Internal Time-Consciousness, J. Churchill (trans.), Indiana University Press, Indiana.Google Scholar. Kaufmann, F.: 1978,The Infinite in Mathematics, P. Foulkes (trans.), Reidel, Dordrecht.Google Scholar. Kolmogorov, A.: 1932, â€˜Zur Deutung der Intuitionistischen Logikâ€™,Mathematische Zeitschrift 35, 58â€“65.Google Scholar.