

THE ‘MORE KNOWLEDGEABLE OTHER’: A NECESSITY IN THE ZONE OF PROXIMAL DEVELOPMENT?

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- Ameed* So one half and
- Hazem* Two fifth
- [They set the fraction strip of 1/2 and the two strips of 1/5 in a row]*
- Hazem* Wait wait wait, we need the, ONE, Where did the one go? *[puts the strip of one whole above the row of 1/2 and 2/5s]*
- Ameed* We need to see what piece is missing *[pointing to the leftover space between the end of the 1/2+2/5 row and the one whole]*
- Hazem* *[chooses a 1/10 strip]*
- Ameed* *[chooses a 1/12 strip]*
- Ameed* *[puts his 1/12 into the leftover space]* No, so then one ten.
- Hazem* *[puts the 1/10 strip into the leftover space]* So that means they are nine tenth, basically one minus one tenth is nine tenth.
- Ameed* I think we got nine ten.

Ameed and Hazem knew how to add two fractions using a common denominator before I gave them fraction strips to add $1/2$ and $2/5$. In their interaction with the fraction strips, they learnt a new form of expression and action with regard to adding two fractions. This form of expression was very different from the one with which they previously were familiar; that is, using a common denominator.

This interaction did not unfold in this way solely because of the general fraction concepts that the children already knew (i.e., $1 - 1/10 = 9/10$). There was also something about the fraction strips that contributed to the way in which the interaction happened. Gibson (1977) calls whatever it is about a tool that contributes to the interactions that happen its *affordances*. He contends that an affordance is a specific property of a tool that interacts with the perception of the child in such a way that an activity can be supported. For example, the physical properties of fraction strips might be perceived as being useful for building a choo-choo train. If the task at hand is train-making, then the perceived affordances are useful. On the other hand, if the task is to add $2/5$ and $1/2$, then the perceived affordance (i.e., making a train) is not useful. Hazem and Ameed perceived some of the affordances of the strips in order to work on the task of $1/2 + 2/5$. These affordances included, for example, the lengths of the pieces, the interrelationships between the lengths, and the mobility and rigidity of the strips that means they can be placed in a row.

The physical properties and the affordances of the fraction strips as well as the previous knowing of Ameed and Hazem guided them to learn a new form of expression and action. I would like to raise this question: For such learning to occur, what happened among Ameed, Hazeem and the fraction strips?

Learning with more knowledgeable others

The Vygotskian perspective assumes that we learn in the presence of other people: *others* who have a better knowledge of certain historical and cultural practices, *more-knowledgeable-others*. Vygotsky did not just claim that children learn and develop in the process of engaging in interaction with others; he made this notion of learning with others explicit, in connection with the Zone of Proximal Development (ZPD). He described the ZPD as “the distance between the actual developmental level as determined by independent problem solving and the level of potential



Figure 1. Comparing one half and two fifths.

development as determined through problem solving under adult guidance or in collaboration with more capable peers” (1978, p. 86).

In Ameer and Hazem’s interaction, I saw the emergence of the ZPD. Ameer and Hazem solved the problem under the guidance provided by the vestiges of the design of the tool (the interrelationships among the sizes of the pieces) and by their own previously learnt general concept of fractions—but not necessarily by what they knew about the addition of fractions.

The boys at various times were the more-knowledgeable-other, as their knowing of the general concept of fractions was used to assist them to think about the problem. For example, when Hazem stated that they needed the strip of one whole in order to be able to add $\frac{1}{2}$ and $\frac{2}{5}$, he said: ‘Wait wait wait, we need the, ONE, where did the one go?’. He also was the more-knowledgeable-other when he said ‘So that means they are nine tenths, basically one minus one tenth is nine tenth’ while putting the $\frac{1}{10}$ piece into the leftover-place piece between the end of the row of the one whole strip and the end of $\frac{1}{2}$ and $\frac{2}{5}$ (which was shorter in length).

At various times the traces of the thoughts of the designer of the fraction strips made the tool the more-knowledgeable-other. As part of their interaction, the boys did not employ their previous knowing of the addition of fractions. In other words, they did not look for the common denominator or for the equivalent fractions. Instead, they used the guidance provided by the affordances of their created artefact—the pieces of $\frac{1}{2}$, $\frac{1}{5}$ and $\frac{1}{5}$ set underneath the one whole unit. They chose one strip of $\frac{1}{12}$ and one strip of $\frac{1}{10}$ and used the interrelationships between the sizes of the pieces to work on the task.

In this case, the children used the specific elements of the design of the strips, which this time were comprised of the interrelationships between the sizes of $\frac{1}{10}$ and $\frac{1}{12}$, to try to determine the one that would fit the missing piece. The resource provided by the tool—that is, the interrelationships between the sizes of its strips—provided the children with the necessary guidance to perceive that the piece of one tenth would fill up the missing section, as can be seen in Ameer’s statement ‘so then one ten’. At this point—and I emphasise *specifically at this point*—I can refer to the tool as the more-knowledgeable-other because the interrelationships between the sizes of its strips were used to think about the problem and to see that there was a missing piece and that the $\frac{1}{10}$ strip would fit underneath it. Yet, referring to the tool as the more-knowledgeable-other would certainly undermine the more-knowledgeable-other-ness of Ameer and Hazem, who arranged the pieces together in such a specific form only a few seconds before this point in time.

Who/what is the more-knowledgeable-other?

Drawing on a Vygotskian perspective I ask: What is the role of the more-knowledgeable-other? And who/what becomes one, in an interaction? Vygotsky’s concepts of the ZPD and the more-knowledgeable-other have been interpreted and re-interpreted in the field of mathematics education at various degrees of depth. Further, the notion of the *alternation* of the more-knowledgeable-other has been widely and successfully used to examine and explain the mathematical learning of children in certain kinds of interactions in which the participants become

both teachers and learners (Roth & Radford, 2010). Following Vygotsky, many researchers have studied children’s mathematical learning within the ZPD, viewing the more-knowledgeable-others as agents and viewing the role of the more knowledgeable as alternating—in other words, pointing to an ‘other’ who is the more knowledgeable, regardless of whether he or she is a child or an adult (Goos, Galbraith & Renshaw, 2002; Graven & Lerman, 2014; Wertsch & Rupert, 1993). Through the detailed and careful examination of statements made by the participants, the researchers were able to identify a more-knowledgeable-other at each of the different stages of thinking about or solving a problem, as the status of being the more knowledgeable shifted among the adults and the children. Examples of successful characterisations of the alternation of the role of the more-knowledgeable-other can be found in the following studies: Wertsch and Rupert (1993), in which they analysed the alternation of this role between Tanya and her father as they took turns talking about the sides of a pyramid and Euler’s formula; Graven and Lerman (2014), in which they analysed the alternation of the role between Lila and her mother as Lila used the television remote control and the prompting questions of her mother to count in threes; Roth and Radford (2010), in which they analysed the alternation of the role between Connor and his teacher as they talked about the properties of squares and cubes; and Lerman and Meira (2001), in which they analysed the interaction between Pedro and his teacher in a nursery school in Brazil as they talked about a plantation.

To this more knowledgeable-ness of others, I add tools—since the ‘better knowing of certain historical and cultural practices’ of tools is incorporated within them through the thoughts and perceptions of their designer (Abtahi, 2014; 2016). More specifically, my rationale for viewing tools as potential more-knowledgeable-others stems from my perception of tools. By their design, tools can afford some actions but not others. The particular affordances of the tools, if perceived by the child in relation to the task at hand, sometimes can guide him or her in the process of thinking about a mathematics problem or of solving it. Although the affordances can be viewed as the characteristics of the tools, I see them as being socially designed, created and developed, within a particular historical context and over time (del Río & Alvarez, 1995). Recourses provided by the physical properties and affordances of the tools at times guide (or do not guide) children in the process of thinking about a mathematics problem or of solving it. For example, the fraction strips, through the specific elements of their design, reflect the perceptions of individuals who, over time, have used, modified and reused this tool. The more-knowledgeable-other-ness of the strips carries within it traces of its social-cultural design and development.

Thus, stated in general terms, I may assume that the ZPD is a sign-/tool-mediated zone of guided action and discussion within which children become acquainted with newer historical and cultural forms of expression and action, with the vestiges of the history and culture being embedded in an agent or in a tool, and with the more-knowledgeable-others being the participant(s) in an interaction whose resources (knowing, experiences and ways of doing) are used to think about the problem and/or to solve it.

Two issues

Although the role of the more-knowledgeable-other and its alternation among the participants in an interaction have been proven in many studies to be valuable in the analysis of mathematical learning, the two specific issues that I would like to emphasise in this writing are, first, the complexity (or even the impossibility) in some interactions of pointing to an 'other' that is more knowledgeable and, second, the impossibility of identifying what might be the 'knowledge' of the more-knowledgeable-other. Raising these concerns in turn provides a basis for identifying and examining episodes of learning or for talking about mathematics by placing less emphasis on pointing to an 'other' that is more knowledgeable and more emphasis on scrutinising the possibilities for the co-construction of 'knowing' as the interactions unfold, without one 'other' being responsible for it.

To what extent is it actually possible to point to the individual who is more knowledgeable in the interaction between Ameer and Hazem? Is the knowledge of ' $1/2 + 2/5 = 1 - 1/10$ ' in the tools or in the children—or is such knowing only constructed while the children were interacting with the tools?

Later, I asked Ameer and Hazem how they solved the task:

Yasmine Okay, how did you do that?

Ameer It was one half, then it was two fifth. We know one fifth plus one fifth is two fifth, And we measured them with the whole number, the whole one, and we had a little spot missing. We fit that, we fit, the only thing that fit was the one tenth. And we knew, we knew, and then we minused it and we got nine tenths.

Over the course of their interaction with the fraction strips, Hazem and Ameer at times used the resources provided by the strips, as for example when Ameer said: 'We measured them with the whole number [...] We fit, the only thing that fit was the one tenth'. But the guidance provided by the tools in this situation was not only in the form of the design of the sizes and the interrelationships between them, but also in the form of the positioning of the two rows of strips (*i.e.*, the white strip of one whole unit compared with the sizes of blue $1/5 +$ blue $1/5 +$ orange $1/2 +$ yellow $1/10$). These strips were positioned based on the general mathematical knowing of the children, considering the fractional design of the strips. Hence, given the little back-and-forth binaries of more knowledgeable-ness in this situation, I believe that this approach is rather simplistic. By 'little back-and-forth binaries' I for example mean to point to the tools as the more-knowledgeable-other when the children used the designs of the tools to select the strips of $1/5$ or $1/10$ or to point to the children when they tried to position them into two rows.

The difficulty that I have in pointing to the more-knowledgeable-other at this stage of the interaction stems from two sources. The first is the fact that I see the boys' knowing of fractions and perceptions of the affordances of the artefacts, of the physical properties of the fraction strips and

of the task at hand as being so intricately intertwined that any characterisation of the interaction in terms of locating 'a more-knowledgeable-other' that is purported to reduce the complexity of this multifaceted interaction to a mere back-and-forth movement appears to be an oversimplification.

The second source is the confusion associated with identifying what might be 'the knowledge' that one has beyond that of the other. In their interaction with the strips, Ameer and Hazem learnt that $1/2 + 2/5$ is $1 - 1/10$. If we call this new learning 'knowledge', then the question that I ought to raise is as follows: who was in possession of such knowledge before or even during the interaction who then can be called the 'more-knowledgeable-other'?

In general, in this writing I articulate my thinking regarding the emergence of the ZPD through the collaborative interaction of Ameer and Hazem and the fraction strips whereby Ameer and Hazem learnt a new form of solving $1/2 + 2/5$. Within this ZPD, the guidance was provided both by the tools and by the boys' own general knowing of the concept of fractions. During some stages of this interaction, I found that it was difficult to identify an 'other' that was more knowledgeable.

Discussion

In this article, I highlight subtle alternations in the identity of the more-knowledgeable-other as the resources provided by the tool or by the children were used at different stages of the process of adding two fractions. I identify these subtle alternations in order to then emphasise the interactions in which it is rather difficult to pinpoint the more-knowledgeable-other and in order to emphasise the fact that it can be a rather complex exercise to show how this role shifts back and forth.

My assertion about the more knowledgeable-ness of the tools in the episodes involving Ameer and Hazem provides a basis for examining and questioning the possibility and usefulness of pointing to an 'other' that, in certain interactions, is more knowledgeable. An issue that I have tried to raise here is the emergence of the ZPD(s) and the resulting learning that occurs without one participant necessarily being 'the' more-knowledgeable-other. In the case of Hazem and Ameer, I highlight new forms of reflecting, acting and expressing in relation to adding two fractions and show how the new forms of action, reflection and expression became available to the children as they participated in interactions with the fraction strips. I conclude that the children learnt in these interactions by at times drawing on the guidance provided by the interrelationships among the specific elements of the fraction strips' respective designs. At various times, this made the tools the more-knowledgeable-other.

I further highlight one instance in which the guidance was complexly provided by the interrelationship between the affordances of the strips as well as by the children themselves, thus making both the fraction strips and the children the more-knowledgeable-others. This complexity was the basis of my difficulty in identifying 'the' more-knowledgeable-other—in the same instance. In closely looking at this interaction, one might notice that the resources provided by the strips were not always provided by the specific elements of the designs of the strips in and of themselves; instead, the guidance was at times provided by what the chil-

dren ‘made’ using the strips. The strips of one whole, one $\frac{1}{2}$ and two $\frac{1}{5}$ s scattered on the table would not have assisted the children with the approach that they actually used (*i.e.*, ‘to minus it and to get nine-tenths’). Rather, it was the complex combination of the mathematics that they already knew, the perceived usefulness of the resources provided by the different layouts of the fraction strips, and the designed properties of the strips (*i.e.*, the sizes of the pieces) that assisted the children in solving the task.

Neither the specific design of the strips nor the children’s knowing of fractions independently guided them through the problem-solving process. As a result, the more-knowledgeable-other was neither the children nor the strips. Instead, the process unfolded firstly through the ways in which the children perceived the usefulness of the affordances provided by the fraction strips as well as their knowing of the concept of fractions to create artefacts, and secondly through the ways in which the children put different pieces of fraction strips together to think about or solve the task. These created artefacts carried within them not only the mathematical knowing of the children who had created them but also the specific elements of the designs of the strips that had been used by the children as part of this process. Such complexity of interaction between the tools and the children made it difficult to pinpoint ‘whose’ knowledge and resources was being used at what stage, and this made pointing to a more-knowledgeable-other rather difficult.

The second source of confusion that I emphasise throughout this writing is in relation to the ‘knowledge’ of the more-knowledgeable-other in the mathematical interaction among Hazem, Ameer and the fraction strips. More specifically, the question was raised of whose knowing it was that led the children to express the addition of fractions in the newer form of $\frac{1}{2} + \frac{2}{5} = 1 - \frac{1}{10} = \frac{9}{10}$, rather than in the form that they knew from before, namely: $\frac{1}{2} + \frac{2}{5} = \frac{5}{10} + \frac{4}{10} = \frac{9}{10}$. What was the knowledge that one had more the other? Such confusion led me to the series of thoughts and open-ended questions in relation to knowledge and knowing with which I will end this writing.

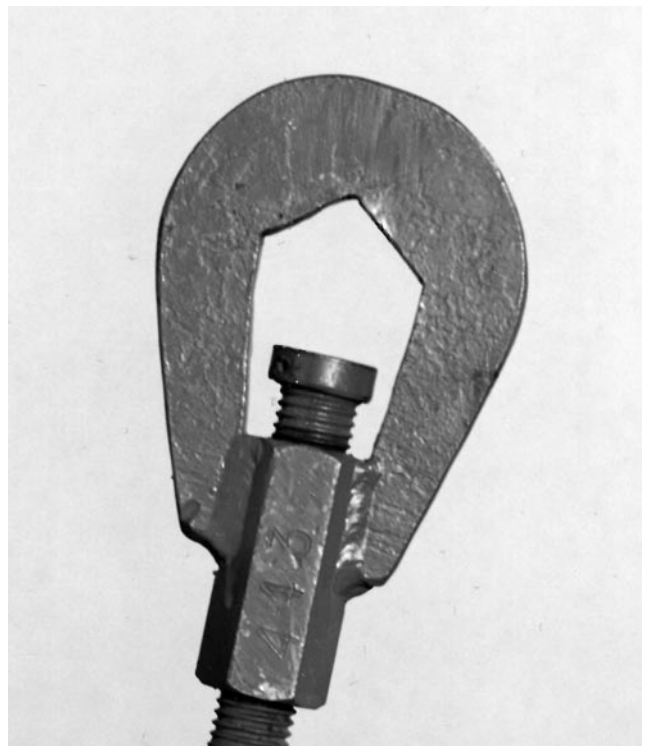
The phrase ‘more knowledgeable’ within Vygotsky’s notion of the ZPD led me to wonder what it might be that Vygotsky calls ‘knowledge’ that one person might have more than another person. It might seem that social and cultural practices fall within the scope of this kind of ‘knowledge’. Are social and cultural practices static enough to be characterised in this way? Such questions then led me to another question: is there a difference between whatever is called ‘knowledge’ and whatever is called ‘knowing’? The two examples set out below have helped me think about this question. Once I read a text explaining why indigenous com-

munities do not write down their stories. This topic was also brought up in a conversation that I had with Lisa Lunney Borden. When written down, the stories become fixed and do not have the feeling of ‘now-ness’ and ‘in the moment-ness’. For members of these communities, the same story varies each time that it is told, based on who is telling it and when the telling is happening. They possibly do not like to create a pool of ‘knowledge(s)’. Instead, the ‘knowing’ is happening as they do things together (*i.e.*, tell stories). Then I thought that this is probably why many old Persian texts are in the form of poetry. They are not ‘knowledge(s)’, instead they may become forms of ‘knowing’ based on who is reading the stories and when this is happening. In both of these cases, the knowing is constructed as people do things together (*e.g.*, tell stories, read poetry and so on). There is no knowledge that is independent of a particular place and time. On the contrary, there is knowing that is fluidly happening.

If we assume that knowing is something that happens as we do things together, then possibly we do not always learn in the presence of an ‘other’ who is necessarily any ‘more knowledgeable’; instead we come to know as we interact with one another. Extending my above-mentioned thoughts and questions to Vygotsky’s notion of the ZPD, I would like to propose a new look at the ZPD, without any emphasis on ‘the more knowledgeable’—namely *a zone within which we learn (we come to know?) with others.*

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Operating nuts on fire hydrants in Paris (upper left), Bremen (upper right), Vancouver BC (lower left) and a firefighter's adjustable wrench.