

A Critique of ZPC and ZPD: Zones of Teaching and Learning

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Norton and D'Ambrosio (2008) examine how student constructions of fraction schemes are impacted when they receive instruction in two zones of learning—the zone of proximal development (ZPD) and the zone of potential construction (ZPC). A secondary aim of the study is to explore the different scaffolding techniques that a teacher implements in order to promote student understanding. In *ZPC and ZPD: Zones of Teaching and Learning*, the authors use data from their protocols to illustrate that students successfully construct knowledge when assistance is within their ZPD and ZPC. Norton's work usually reflects an influence of his radical constructivist roots. However, in this paper Norton and D'Ambrosio choose to examine teaching and learning by bridging two constructs appearing in radical constructivism and social constructivism.

In their review of literature, Norton and D'Ambrosio (2008) briefly describe two different perspectives of constructivism. They highlight peer teaching and the use of technology as examples of current classroom practices that allow students to construct their own meanings of mathematical concepts. I felt that the authors could have offered more background on the social constructivist and radical constructivist views of knowing and learning. This would have helped the reader connect the zone of proximal

development to the social aspect of learning and the zone of proximal development to the idea that individuals continually construct their own realities of the world around them. A description of the zone of proximal development and zone of potential construction is included, and several interpretations of the zone of proximal development are presented. Different ways of providing assistance are emphasized in this section, but in the discussion section, Norton and D'Ambrosio do not mention how different forms of assistance affected Will and Hillary's constructions. Although this section was an interesting addition to the literature review, I did not recognize its significance in the interpretation of the study's results.

When collecting data, the authors used two cameras to capture student work. One camera was aimed at the computer screen to record how students manipulate the TIMA Bars computer program. Each student also had a mouse that was capable of manipulating the screen. Another camera focused on the researcher and the children's interactions with each other during the teaching experiment. The data collection lasted for a semester and rendered 50 episodes of teaching sessions on 100 videotapes. The first author identifies his role as the teacher in the teaching experiment. There was

another observer who took field notes and provided feedback to the teacher about the effectiveness of the learning tasks as well. I think this is a strength of the study because it adds a certain level of validity to the study by triangulating the data. The authors did not mention how often they met with the students or how long the teaching experiments lasted. The authors did discuss how they constructed initial models of Hillary and Will's mathematical thinking based on their activity during fraction tasks. This justified the design of their protocols because Norton and D'Ambrosio identified the fractional schemes each child potentially constructed based on second-order models, and their protocols were written in a way that engendered the construction of subsequent schemes by challenging schemes the students' already constructed.

The authors mention the data used in this study was collected as a part of a larger study. The first author purposefully chose students based on the ways they operate on fractions. The sample from the larger study was chosen from three different 6th grade classrooms. Initially 12 students were interviewed, but after forming initial second order models of the students' mathematical thinking, 3 pairs of students were chosen. Students from two of those

pairs operated on fractions using a part-whole operation while the last pair used iterative operations. The investigators chose to focus on Hillary and Will, the pair of students using iterative operations, because "they exemplified potential differences between ZPD and ZPC" (Norton & D'Ambrosio, 2008, p. 225). Limited information is known about the participants in this study. The only information given about the pair of students is that they are in 6th grade and the pair consists of one male and one female. The lack of diversity and the small sample size is a limitation of this study, and I also feel that using the other two pairs of students could have strengthened the study by examining the ZPD and ZPC at work in those teaching episodes. Further studies should be conducted to see if the conclusions made from the data are sound. It is also possible that different teachers may teach them since the sample was chosen from three different classes, but that is not explicitly stated. Different teachers may expose the students to alternative ways of operating on fractions, which could have influenced their zone of potential construction in significant ways.

Even though both students were operating iteratively on fraction tasks, Hillary was within her ZPC at all times while the only protocol designed to target Will's ZPC was

Protocol 7. Drawing conclusions about the relationship between ZPC and ZPD based on Hillary's sustained success and Will's one instance of success is a weakness of this study. Including more data where Will had the opportunity to function within his ZPC and ZPD would have further strengthened the study. Also, finding two students whose second order models indicate that they have relatively the same ZPC may have resulted in different outcomes of this study. Perhaps, there would have been less student-student interactions and more reliance on teacher scaffolding.

In their discussion section, Norton and D'Ambrosio claim a student's developmental readiness does not solely depend on his or her zone of proximal development. The transcripts from several protocols included in the article show several instances where Will is able to complete certain learning tasks like finding $\frac{2}{3}$ of $\frac{6}{6}$ with assistance from Hillary and the teacher. He was also able to restate the steps he went through to solve the problems. While imitation was considered a form of assistance mentioned in the literature review, this form of scaffolding did not cause sufficient reorganization of conceptual ideas for Will. Only in protocol 7, when the authors structure the learning tasks so that he can use his current schemes to act on fractions, was Will able to

construct a partitive fractional scheme. In the last protocol presented in this article, Hillary was not participating in the teaching experiment. The reason for her absence was not addressed, and I wonder if Will's opportunity to construct a new fraction scheme would have been affected in a negative way if she had been present. I believe the authors' choice of transcripts accurately illustrate the need for teachers to construct second order models of students and design lessons and activities that are within a student's ZPC and ZPD. However, this was only one pair of students so generalizing these findings would be difficult. Further research should be done to explore whether the construction of schemes is truly affected by these two zones of learning.

When gathering data, Norton and D'Ambrosio (2008) used the teaching experiment methodology because this process allows them to embrace the constructivist views of learning as a constant reorganization of cognitive structures. This methodology allowed them to construct second order models of the students thinking based on the actions carried out by participants within the study. Although it is impossible to accurately account for how students are thinking about mathematics during the teaching experiment, the authors were able to form initial models of the students and adjust

the models they constructed based on students' behaviors. This is an appropriate method for gathering data because it allows you to analyze a student's progress. Other research designs such as a classical experimental design do not make affordances for researchers to analyze an individual's development of mathematical schemes and constructs. The constructivist teaching experiment is considered to be "a living methodology designed initially for the exploration and explanation of students' mathematical activity" (Steffe & Thompson, 2000, 273). Using this methodology strengthened the validity of this study.

Norton and D'Ambrosio used the teaching experiment methodology to collect data, and they emphasized that their goal was to think like the students in their study. In addition to this, they discussed the importance of constantly modifying the second order models of students' mathematical thinking. The constant revision of those models provides guidance for the development of new tasks targeting fractional concepts the investigators perceive to be in the students' zone of proximal development and zone of potential construction.

Norton and D'Ambrosio (2008) mention that both Hillary and Will had developed three levels of units for multiplication, but Will experienced more difficulty

applying those concepts to situations involving fractions. Several references were made about Will losing track of the whole fraction unit because he struggled to act on fractions by using three levels of units, but Norton and D'Ambrosio did not clearly define the differences between the three levels of multiplicative concepts. Including a brief description of those multiplicative concepts could help the reader understand the transcripts of the protocols better, and understand the persistent differences in Hillary and Will's construction of fraction schemes.

Norton and D'Ambrosio's (2008) consideration of the zone of proximal development and how it affects the construction of fraction schemes was the most surprising element in this article. Social constructivists support this Vygotskian construct because it takes into account the social aspect of learning. However, I noticed the authors did not emphasize the social aspect as it relates to Vygotsky's general genetic law of cultural development which states that mental functions appear in social settings first and are later internalized (Wertsch, 1985). Instead, the focus was on providing assistance, which from the perspective of a Radical constructivist may just serve as another resource that students can use to construct their own meanings.

It is not entirely clear what role the zone of proximal development plays in this article. From a Radical constructivist perspective, learning tasks should always be within a student's zone of potential construction. Therefore, any assistance given to a child working would naturally be within their ZPD as well, since tasks that engender the construction of new schemes should also be tasks that they could do with a "more knowledgeable other." The assistance provided would be a resource students use to construct new fraction schemes in this case.

In the discussion and conclusion section, Norton and D'Ambrosio (2008) do state, "the difference between the students' constructions cannot be accounted for by considering their interactions alone" (p. 242). It seems they are reaffirming the radical constructivism view that knowledge is constructed on an individual basis without a dominant sociocultural influence. The aim of the article, however, was to show how constructs from two distinct constructivist perspectives simultaneously impacted the processes of teaching and learning. Even though extensive research was carried out in this area, the results do not clearly support the purpose of the study.

References

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