

TEACHER GUIDANCE OF KNOWLEDGE CONSTRUCTION *

Baruch Schwarz
Hebrew University

Tommy Dreyfus
Tel Aviv University

Nurit Hadas Rina Hershkowitz
Weizmann Institute of Science

This paper focuses on how teachers guide construction of knowledge in classrooms. We suggest that guidance hinges on the kind of dialogue teachers choose to engage students in. We propose several classroom dialogue types relevant for the construction of knowledge and suggest that critical dialogue is particularly effective for knowledge construction. We describe a lesson on probability conducted in a Grade 8 classroom in order to illustrate how a teacher chooses dialogue types, and to what extent she attends during dialogue to epistemic actions, which are constitutive of knowledge construction.

INTRODUCTION

This paper is about the role of teachers in the construction of knowledge. It continues an effort we initiated in the study of the construction of knowledge in different social settings (Hershkowitz, Schwarz, & Dreyfus, 2001; Dreyfus, Hershkowitz, & Schwarz, 2001 – henceforth referred to as HSD and DHS, respectively). In HSD, we studied one student constructing knowledge while solving a problem about functions. In DHS, we studied two dyads constructing knowledge while solving a problem in algebra. These studies helped us to elaborate a model of construction of knowledge, the dynamically nested RBC model, based on three basic epistemic actions, *Recognizing*, *Building-with*, and *Constructing*. Recognizing means that the learner identifies the result of a past activity as relevant. Building-with designates the use of past actions to satisfy a given goal. Constructing means assembling knowledge artefacts resulting in a vertical reorganization of knowledge. The model is nested since constructing usually incorporates recognizing, building-with and other constructing actions. Epistemic actions then have a “historical” dimension. They also have a social dimension: in DHS we showed how epistemic actions were distributed among peers. The present paper is a first step in the direction of incorporating into the RBC model the role of the teacher in the construction of knowledge in classrooms.

Given learning goals that include constructing in the above sense, two crucial teacher tasks are to set appropriate activities and to initiate and manage dialogues about them. Accordingly, our study of the construction of knowledge in HSD and DHS relied mainly on the analysis of the talk while students were carrying out activities set by the teacher or researcher. In classrooms, the teacher’s role during activities tends to be indirect. During dialogue phases, however, the teacher’s role is often direct and thus easily observable. Therefore, dialogue phases are suitable for observing the teacher’s guidance of students’ construction of knowledge. The teacher’s input into

* Research partially supported by THE ISRAEL SCIENCE FOUNDATION (grant No. 973/02-1)

the dialogue, what she says, how she says it, her actions, and the ensuing dialogue types are components of guidance to the construction of knowledge that the teacher provides. In this paper we concentrate mainly on dialogue types.

BACKGROUND AND THEORETICAL FRAMEWORK

Specialists in the structure and the norms of dialogue have identified the fundamental concept of *commitment*. When people engage in talk together, they are committed in different ways (Walton & Krabbe, 1995) and their commitment influences the dialogue. For example, *critical dialogue* has structural and formal properties that characterize a commitment to understanding and accommodation of divergent viewpoints whereas *disputational dialogue* conveys the commitment of the participants to win. Commitment induces implicit dialogue rules that interact with the cognitive processes of the participants. The identification of kinds of classroom dialogues therefore constitutes a step in the study of the construction of knowledge in classrooms.

Researchers in cognition and instruction have attempted to analyze talk in classrooms by identifying episodes initiated and controlled by the teacher (Leinhardt & Greeno, 1986; Leinhardt, 1989; Leinhardt & Schwarz, 1997). They found that teachers are very skillful at initiating and controlling presentation, discussion, and summary episodes, and that students are generally receptive and adapt their talk to the teacher's goal. However, these studies focus on the skills of the teacher and are therefore only partially relevant here. Mercer's (1995; 1996) approach to identifying different kinds of talk in classrooms, on the other hand, combines a dialogical description of reasoning with a version of Vygotsky's account of individual development: Reasoning is a social process in which personal development results from social practices. It therefore fits the RBC model of construction of knowledge. Inspired by Mercer's talk categories, we propose the following distinct kinds of classroom dialogues, each referring to a different commitment:

Grounding dialogue: Participants are committed to share common knowledge. The teacher presents a topic, often a new one and checks that students are acquainted with the subject to be treated and have the background knowledge needed to achieve the learning goals such as solving a task to be assigned and constructing new knowledge.

Prospective dialogue: The commitment here is to prepare to learning. The teacher clarifies the problem at stake and the goals to be attained and encourages the students to participate and state an initial point of view. Interventions are not elaborated.

Critical dialogue: Participants are committed to understand and accommodate divergent viewpoints. They elaborate and develop new ideas, raise reasoned arguments, challenge and counterchallenge each other's views. The teacher encourages all students to participate.

Reflective dialogue: The participants are committed to integrate and generalized accepted arguments. They recapitulate actions and draw lessons from their experiences. Talk is often about the process rather than about the results obtained.

Lesson delivery dialogue: Participants are committed to transmission of knowledge. The teacher presents a prepared lesson with ready-made explanations. Lesson delivery can vary from lecturing through reading from the textbook to presenting a “didactic” lesson in which the teacher asks prepared questions.

This list is not exhaustive. It is limited to dialogue types that are potentially relevant to the construction of knowledge. Table 1 shows how the above types of dialogue differ according to commitments, goals and methods. The table also gives a summary description of the dialogue types. A more detailed description of would include the specific methods used for conducting each dialogue.

Dialogue type	Commitment	Methods	Teacher’s goals	Students’ goals
<i>Grounding</i>	Triggering interest	Describing	Anchor knowledge	Orientation
<i>Prospective</i>	Preparation to learning	Brainstorming Conjecturing	Engage students	Express position
<i>Critical</i>	Understanding Accommodation of divergent viewpoints	Hypothesis testing Elaborating Arguing	Support argumentation and knowledge construction	Share opinions, Persuade
<i>Reflective</i>	Integration Generalization	Recapitulating Evaluating	Elicit conclusions	Draw conclusions
<i>Lesson delivery</i>	Transmission of knowledge	Lecturing Clarifying	Convey content	Grasp content

Table 1: Characteristics of main classroom dialogues

Since this paper is about the role of teachers in knowledge construction, we elaborate a little on the methods of the teacher in critical dialogues. The teacher may first request explanations and conjectures, and then their elaboration by argumentative process. Methods to support the argumentative process are most challenging to implement. They include *Sourcing*, *Eliciting argumentation*, and *Mediating argumentation*. Sourcing means adding necessary information for triggering discussion. Eliciting argumentation consists of encouraging participants to express opinions and to engage in the discussion. Mediating argumentation is similar to eliciting argumentation, but the teacher attempts to ask for reasoned arguments and to connect/contrast specific arguments in order to activate discussion. These argumentative methods are very difficult to implement. Thus teachers usually precede critical dialogue by *grounding* and *prospective* dialogue. Moreover, they need to be active during the argumentation, and to help students reflect on their actions during the *reflective* dialogue in order to abstract the knowledge previously constructed in critical dialogue (Hershkowitz & Schwarz, 1999). In other words, the teacher plays at least two central roles in dialogical guidance for knowledge

construction, namely choosing (a) how to arrange types of dialogues during the lesson, and (b) how to implement specific methods during dialogues (and crucially argumentative ones during critical dialogues).

So far, our considerations are theoretical. They need to be illustrated. In the empirical part of this paper, we will analyze a classroom episode with the aim of showing how the teacher manages the discussion so as to determine the kinds of dialogue, in which the students will engage, in accordance with her goals, and some of the salient methods she implemented.

A CLASSROOM DISCUSSION

The classroom discussion to be considered occurred during a 10-lesson unit on probability, which includes five activities organized in tasks for small group collaborative work. The activities were designed by the researchers so as to create opportunities for the construction of knowledge. One set of tasks during the second activity was designed to introduce students to the issues related to repeated events, by asking them to locate the probability of various repeated events on a chance bar. To the best of our knowledge, no student had solved similar tasks in the past. The task under discussion is presented in Figure 1.

You spin a Chanuka dreidel 100 times (the letters that appear are **N**, **G**, **H**, **P**). Mark approximately, on the chance bar, the letter that designates each event, and explain:

- A: The outcome was **N** all 100 times.
- B: The outcome was never **N**.
- C: The outcome was **N** between 80 and 90 times.
- D: The outcome was **N** between 20 and 30 times.
- E: The outcome was **N** exactly 25 times.
- F: The outcome was **N** exactly 26 times.

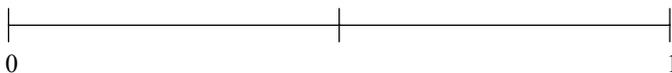


Figure 1: Chance bar and task 5 of the second activity

The following transcript displays part of the protocol of the classroom discussion about tasks 5A and 5B. The researchers independently segmentized the protocol according to dialogue types. On a scale of several utterances, there was full agreement between the classifications of all researchers. Minor disagreements concerning the precise locations where one dialogue type ended and another begins were settled by discussion until mutual agreement was reached. The resulting classification is:

- 1-32 Grounding dialogue
- 33-38 Prospective dialogue
- 39-55 Critical dialogue
- 56-58 Prospective dialogue

59-69 Critical dialogue

The teacher draws a chance bar on the whiteboard and begins the following dialogue. In the transcript, the speakers' names are abbreviated as follows: Teacher – T, Ian – I, Mike – M, Guy – G, Eve – E, Dan – D, Ann – A, Yvonne – Y. Other students – S.

- T33 In the second booklet you have, look at task 5. You weren't supposed to do it. [Reads:] "You spin a Chanukah dreidel." You know what that's about? ... Guy, are you with us? "Mark, approximately, on the chance bar, the event 'The dreidel falls 100 times on the letter N'."
- T34 You understand what's the event A? You spin the dreidel 100 times, and all 100 times it falls on the letter N. [To Ian:] You mark, and we will relate to it. [Ian marks the letter A close to 1/4.]
- T35 What do you think? Would you have marked at the same place? Elsewhere?
- I36 That's supposed to be impossible.
- T37 Wait, you marked, now sit. Let's see what others think about this.
- M38 There is a chance that this happens. It's closer to zero.
- T39 Because ...
- M40 Because there is a smaller chance that it happens.
- T41 [To Ian:] Look at this situation: You have a dreidel, you spin it 100 times, and *all 100 times* the dreidel falls on the letter N? You marked that this is about a quarter of the cases.
- I42 Right, but compared to the letter N, there are four letters ...
- T43 Right!
- I44 And N, out of these, is one letter!
- T45 What do you reply to this? There are four letters, N is only one letter. Guy, what do you reply to him?
- G46 There are, like, each time you spin, there are four letters on which it can fall. Thus, each time the chance divides again by 4, and the chance gets smaller. The more times I throw, there are fewer possibilities that it will again fall on N. Each time it divides by 4. It gets smaller each time you spin.
- T47 So you support him?! You say that the mark is correct?
- G48 No, it needs to be made smaller.
- T49 Because?
- G50 Because each time there is a much smaller probability that you spin twice and it will fall on the same letter. Thus the probability becomes smaller.
- T51 [To Ian:] Do you understand the point? We did not mark what's the chance that if there are four letters it will fall on the letter N. We marked, once more I describe the event, the dreidel will fall *all 100 times* on the letter N. Do you all see the difference between these two things?
- T52 Is the event A clear to you? [Dan expresses doubts.]
- T53 Where would you mark the letter N? Here, does it suit you? [Marks close to 0.]
- D54 But still, one cannot be certain!
- T55 Right, we say what's the chance. We do not say anything in a definite manner.

- T56 Event B says: The outcome was never N ... Again we spin the dreidel 100 times, we look, and not even a single time it fell on N. [Mike makes a mark on the chance bar between 0 and A.]
- T57 Mike marked [B] between A and 0. What do you think? Would you change it? Not change it? Do you agree? Do you disagree?
- E58 I think, wrong!
- T59 Wrong because ...?
- E60 At least for some students it will fall on N: It doesn't make sense that it should never fall on N; at least a few times the outcome should be N.
- T61 And what did we mark right now? What did Mike mark? Mike said, claimed, that it is very unexpected, it's almost zero, that if we turn a dreidel 100 times that zero times it will fall on the letter N.
- E62 I think that it will be more toward the end. [Proposes a mark close to 1.]
- T63 What do you say? We have a tendency to the beginning and a tendency to the end. That's a very big difference ... [Points with her hand to an imaginary chance bar in the air, and to its two ends.]
- Y64 It needs to be a little after A, because the probability for no N at all as compared to 100 times N.
- T65 What do you think? Ann, what do you propose?
- A66 [Inaudible; based on researcher notes.] B is a little higher than A because it means that the other three letters came up every time.
- T67 What do you think about Ann's reasoning?
- S68 We support her ... [Many students raise their hands.]
- T69 In both cases, the chance is very low, but we want to compare between event A, which says that all 100 times N came up and no other letter came up, and between the event that all 100 times the other three letters came up and never N. We are trying to compare these two events, and there is a claim that B is a little higher than A.

CLASSROOM DIALOGUE AND KNOWLEDGE CONSTRUCTION

In this section we analyze how the teacher's interventions in the above classroom discussion have influenced dialogue types and knowledge construction. This analysis necessarily remains tentative since the data about the students are not sufficiently dense to allow definite conclusions about knowledge construction. The methods adopted by the teacher within each of the dialogue types are italicized.

After some grounding dialogue about the chance bar, about impossible and certain events, and about the placement on the chance bar of the event "the outcome of the throw of a die is 2" (lines 1-32, not reported), the teacher *repeats* (T33) and *rephrases* (T34, T41) event A, *asks* a student to mark a *conjecture* on the chance bar (T34), and *elicits argumentation* by soliciting reactions and new ideas (T35) thus giving the dialogue a prospective character. However, she soon begins *mediating argumentation* by asking the students more and more penetratingly to provide

reasons for their claims (T39, T45, T47, T49) and thus causes the dialogue to become more and more critical.

Let us observe how the teacher actions we just described relate to students' epistemic actions. Ian's contributions express the tension between the single outcome probability (I34, I42, I44) and the repeated outcome probability (I36). This repeated outcome probability is assessed at first intuitively (I36, M38, M40), by Ian and Mike and later more analytically (G46, G48, G50) by Guy. This more analytic way of responding corresponds dialogically to the teacher's demand for reasons and thus, critical dialogue. Nevertheless, it is remarkable that the teacher's requests for reasons are content free – she appears to ignore not only the intuitive but also the first two analytic contributions, in spite of the fact that in G46 Guy provides a complete and detailed reasoning. Only in T51 does the teacher finally relate to the complete idea and *rephrase the conclusion*. She then links it to the initial problem, emphasizing the difference between a single outcome and same outcomes in repeated experiments (a *sourcing method*). While the data do not allow us to assess to what extent any specific student constructed this knowledge, the class as a whole, represented by the three participating boys, did (see DHS for a more detailed discussion on distributed construction of knowledge), and it did so during the critical dialogue engendered by the teacher, while seemingly ignoring the students' contributions to the dialogue.

Event B being a variant of event A, the teacher now moves more quickly through the prospective phase (T56-E58) into the critical phase (T59-T69). We note that while some of her demands for reasons are still general (T59, T65, T67) others are now specific and include detailed reactions to Eve's reasoning (T61, T63) (all these methods *mediate argumentation*). As before, the class as represented now by the three girls who took part in the dialogue about event B appears to have constructed, at least intuitively, not only the low probability of event B but also the fact that this probability is higher than that of A. This is an indication that (at least partial) knowledge about event A was constructed by a subset of the class that includes at least the girls active in the discussion of event B, in addition to the boys active in the discussion of event A. Indeed, it is notable that Yvonne (E64) not only relates to Eve's conjecture (E62) and the teacher's question about it (E63) but in addition places event B in relation to event A, and that Ann (E66) then provides a reasoning supporting Yvonne's claim. It seems then that in event A as well as in event B, the teacher did not attend to the specific epistemic actions shared by students. The teacher could and did elicit or mediate argumentation without attending in detail to the epistemic actions developed by the students. Of course, this observation does not necessarily lead to hasty generalizations: we believe that in numerous cases, the teacher needs to be deeply engaged and attend to the students' epistemic actions. But sometimes, this is not necessary, in particular if the teacher is skilled in applying argumentative methods of guidance. We also believe that sometimes a teacher's explicit attendance to students' epistemic actions may impair construction of knowledge since the teacher risks to impose her view and thus spoil the argumentative process.

CONCLUDING REMARKS

We saw that the teacher used types of dialogue to guide classroom interaction by shifting in good time from Grounding to Prospective and Critical dialogue. In the discussion of event A, she did not share the ideas developed by Ian, Mike and Guy until the very end; instead, her critical dialogue skills and her almost routine demands to support and explain claims gave the reasoning process opportunities to be phrased and developed in spite of her lack of attention to the boys' reasoning. In discussing event B, we observed more explicit attention to students' reasoning. We presume that in many cases attendance by the teacher to students' epistemic actions is necessary to help in construction of knowledge. Of course, the problem is that although attendance to students' epistemic actions is sometimes necessary, it is often very difficult to undertake. We don't know whether in the case we discussed, the non-attendance of the teacher was due to her limitations to track "on-line" the arguments developed during the lesson, or rather to a strategic choice. At any rate, we can conclude that guidance in construction of knowledge relies on how the teacher designs dialogue types, which teaching methods she implements in these dialogues, and to what extent she attends to students' epistemic actions in the classroom. The study of these three aspects of teaching and their relations to construction of knowledge is a complex endeavor. It constitutes a program of research to which we are currently committed.

References

- Dreyfus, T., Hershkowitz, R., & Schwarz, B. B. (2001). Abstraction in context: the case of peer interaction. *Cognitive Science Quarterly*, 1, 307-358.
- Hershkowitz, R. & Schwarz, B. B. (1999). Reflective Processes in a Technology-Based Mathematical Classroom. *Cognition and Instruction*, 17, 66-91.
- Hershkowitz, R., Schwarz, B. B., & Dreyfus, T. (2001). Abstraction in context: epistemic actions. *Journal for Research in Mathematics Education*, 22, 195-222.
- Leinhardt, G. (1989). Math Lessons: A contrast of novice and expert competence. *Journal for Research in Mathematics Education*, 20, 52-75.
- Leinhardt, G., & Greeno, J. G. (1986). The cognitive skill of teaching. *Journal of Educational Psychology*, 78, 75-95.
- Leinhardt, G. & Schwarz, B. B. (1997). Seeing the problem: an explanation from Pólya. *Cognition and Instruction*, 15, 395-434.
- Mercer, N. (1995). *The guided construction of knowledge. Talk amongst teachers and learners*. Clevedon, UK: Multilingual matters.
- Mercer, N. (1996). The quality of talk in children's collaborative activity in the classroom. *Learning and Instruction*, 6(4), 359-377.
- Walton, D., & Krabbe, E. (1995). *Commitment in dialogue: Basic concepts of interpersonal reasoning*. Albany, NY, USA: State University of New York Press.