

STUDENT ASSESSMENT: ISSUES FOR TEACHER EDUCATION

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Teachers are expected today to assess student understanding by using a combination of various assessment methods and tools. Among them, observing students solve problems in class and listening to their mathematical discussions. Yet, not much attention has been given to the question whether teachers need to learn these practices. This study begins to unpack what it might mean for a teacher to hear students (i.e., understand what students are saying, showing, feeling and doing) and to interpret their talk and action. We classify types of teacher interpretations, and analyze different characteristics of hearing and their possible sources. We also discuss the important role that context plays in teacher hearing and interpretations.

INTRODUCTION

The purposes of student assessment have expanded in recent years. Previously, student assessment has served mainly for evaluating students' achievement at the end of instruction. But today it is argued that, in addition to that, teachers should use assessment of students' learning as an integral part of everyday instruction: to design better learning tasks, to adapt the pace of instruction, to choose wisely among various materials, to conduct discussions, to challenge and extend student thinking, and so on (e.g., Ball, 1997; Even & Tirosh, 2002; NCTM, 2000). Indeed, a meta-analysis of more than two hundred research studies (Black & Wiliam, 1998) indicates that the latter kind of assessment contributes to the enhancement of student learning.

This expansion in the purposes of assessment, the conditions imposed by making assessment part of the on-going everyday instruction, combined with the dissatisfaction from the limited information received by traditional paper-and-pencil mathematics tests, lead to the development of alternative assessment methods, tools and techniques. These include projects, portfolios, journals, conversations, observations, etc. (e.g., NCTM, 2000; Romberg, 1995). Teachers are expected now to assess student understanding not only by a separate activity specifically designed for this purpose, but rather as part of the regular instruction. For example, by observing students solve mathematics problems in class, by listening to their mathematical discussions during the lesson, by attending to the nature of their participation in class activities, and by being sensitive to their feelings. It is commonly claimed that collecting varied information from multiple sources would allow the teacher to formulate more valid inferences about their students' mathematical understanding.

What do teachers need to learn in order to assess student understanding in new ways? Among other things, if student assessment should be a significant source for the on-going daily instructional decision-making then observing students working on mathematics becomes an important teaching practice. Yet, not much attention has been given to the question whether teachers need to learn this practice. To begin to answer this question we need to know, for example, what teachers learn when they

observe a small group work; or what a teacher learns about her students' understanding when she listens to their discussion of an open-ended problem.

Recent studies (e.g., Ball, 1997; Morgan & Watson, 2002) have begun to reveal the complexity associated with teacher attempts to understand what students are saying, showing, feeling and doing — what Ball (1997) calls “to hear students”. These studies illustrate how different factors influence teacher hearing students and discuss challenges that teachers face when trying to hear children. Our research extends this line of research. The study reported here is part of a larger study that aims to unpack what it might mean for a teacher to hear students and interpret their talk and actions. In this paper we use the case of Ruth, an elementary school teacher, to classify types of teacher interpretations, and to analyze different characteristics of hearing and their possible sources.

METHODOLOGY

Ruth was one of 25 elementary school teachers who participated in a weekly four-month-long in-service workshop, led by the second author at a regional teacher center. Ruth had 11 years of teaching experience in upper elementary grades. In the year of the study she taught fourth grade. Like most elementary school teachers in Israel, she taught all subjects, among them mathematics.

The workshop activities were designed specifically for this study. After solving several mathematics problems and discussing their solutions in small groups, each teacher was asked to choose one of the problems and to present it to a pair of students from her own class. The teachers observed and videotaped the students as they worked on solving the problems. The teachers were instructed not to intervene by giving comments, hints or advice to the students. Then, each teacher summarized and reflected on her observations in writing and met with the workshop leader to discuss episodes from the students' videotape.

Data collected for the larger study include: video-tapes of all workshop sessions; the workshop leader's (second author) journal; written work prepared by the teachers; videotapes of the pairs of students' problem-solving sessions; video-tapes of individual interviews with each teacher that centered on episodes that the teacher chose from the videotape of her students; video-tapes of two focus-group interviews, one at the beginning of the workshop to discuss the teachers' own solutions and how they expected their students to solve the problems, another toward the end of the workshop to discuss the work of an unfamiliar pair of students on the same problem that the teachers chose for their students.

Data analysis is based on the “Grounded Theory” method (Glaser & Strauss, 1967). For the study reported in this paper we transcribed the data related to Ruth, coded them using utterances as the unit of analysis, and generated initial categories. We constantly compared new data with the current categories, refined them and identified core categories, looking for integration and hierarchy among the categories, and used them as a source for theoretical constructs.

TYPES OF INTERPRETATION

Our analysis reveals four types of teacher interpretation of students' talk and action: (a) *Describing* — the teacher describes students' talk, thoughts, feelings and actions by direct (or almost direct) “quotation” or portrayal, (b) *Explaining* — the teacher explains the students' talk or actions. This includes ideas about the students' thoughts, reasoning, knowledge, and assumptions. The explanation is the meaning the teacher attributes to students' talks and actions, (c) *Criticizing* — the teacher criticizes the students' talk and actions, based on the meanings she assigns to them, (d) *Justifying* — the teacher justifies her criticism of, or the meaning she attributes to, students' talk and actions. The latter type of interpretation differs from the other three, because it involves the teacher's reflection on her own interpretation rather than on the students' talk and actions. Illustrations of the different types appear in Wallach and Even, 2002.

The first two types of interpretation, describing and explaining, are, in a way, a teacher's attempt to propose an objective interpretation of the students' talk, actions, thoughts, and feelings. In contrast, the other two types, criticizing and justifying, are subjective interpretations. In other words, the teacher communicates explicitly her own view of what the students did. The four types of interpretation are interrelated. Each type depends on the ones preceding it. Explaining students' talk or actions is based on the teacher's description of them. Likewise, criticizing is based on the teacher's description and explanation of the students' work. Justification is related to the three types preceding it in different ways. The teacher justifies her criticism of the students' work, based on her description and explanation of them.

Other kinds of relations among these interpretation types are connected to their nature. Both the describing and criticizing types involve the actions of portraying something whereas explaining and justifying are concerned with assigning meaning to this portrayal. Explaining involves assigning meaning to the (description of) actions, talks, thoughts, and feelings of the students. Justifying involves the teacher assigning meaning to her own criticism.

CHARACTERISTICS OF HEARING STUDENTS

Our analysis indicates four characteristics of Ruth's hearing her students.

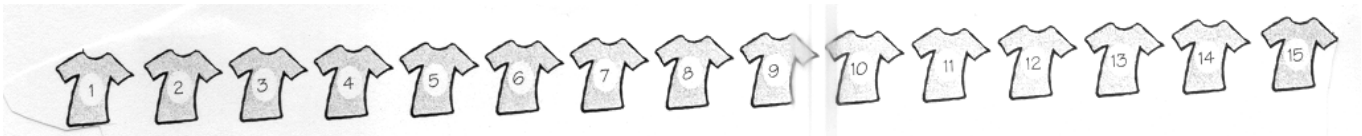
Overhearing. Teachers may “hear” things that were not said by the students. For example, when working on part (a) of the “Shirts and Numbers” problem (Figure 1) Sigal, one of the students said, “Because the number 15 is odd and the number 4 is even, then it's impossible”.

During the interview Ruth “quotes” Sigal's explanation (describing) as “...If you take away an even number from an odd number, then you are left with an odd number, which you cannot divide by 2”. However, Sigal did not say all that. Sigal refers only to the two numbers, 15 and 4, and indicates that they are odd and even, respectively. She does not mention any operation on these numbers nor on the difference between them. Still, what Ruth hears is different. Ruth hears Sigal talking in generalizations,

without mentioning any specific number. She hears her discussing odd and even numbers, the difference between an even and an odd number, and the difference's divisibility by 2. Interestingly, overhearing is reflected even in the relatively simple type of interpretation — describing — which we would expect to be an accurate representation of what the students said.

The following task does not have a solution:

Divide the 15 children in the line into two groups, so that in one group there are 4 players less than in the other group.



- Explain why there is not such a division _____
- Change the number of players, so that there will be a solution.

Demonstrate the solution.

Figure 1. The “Shirts and Numbers” Problem

Under-hearing. Teachers may “not hear” things said or done by the students. For example, Sigal suggested the solution of 10 players for part (b) of the “Shirts and Numbers” problem. She reached this solution by actually building up the two groups. She circled first four shirts (of the 15 shirts on the worksheet). Then she added three shirts and created one group of seven players. Finally, she built another group of three. However, Ruth’s responses (explaining) do not attribute reasoning to finding the 10-players answer. “Ignoring” the actual building of the two groups, Ruth claims that “the solution just came out of the blue”.

Unhearing. Unhearing and under-hearing differ in magnitude. Under-hearing denotes hearing where some parts are missing whereas unhearing implies that the whole is missing. For example, in her initial attempt to change the number of players from 15 to a number that would satisfy the conditions, Ore, the other student, suggested: “...instead of 15 we will put 16.” She later rejected this suggestion and the students tried the solution of 12, rejected it too and finally suggested to change the number of players to 10. However, when describing their work Ruth said that the girls tried to change the number of players to 12, that they did not see how to divide the groups so that one would have 4 less than the other, and that finally they changed the number to 10. She also repeatedly stated how surprised she was that they did not immediately remove one player. But she never mentioned Ore’s suggestion of 16, as if she did not hear it.

Biased-hearing. Teachers may be “biased” in their hearing. For example, when describing their work, Ruth claimed that Sigal and Ore are different from each other in that “Ore, until she understands things deeply won’t answer” whereas “Sigal takes a lot of risks, she volunteers answers without much thought.” Still, an analysis of the two girls’ ways of participating in the collaborative solution of the problem shows different things. For example, it was Ore who was the first to immediately suggest numerical answers for part (b) of the problem without supporting them with adequate reasoning, whereas Sigal’s suggestions came only after experimentation with drawing, circling, erasing, and counting shirts on the worksheet.

The first three characteristics of hearing: overhearing, under-hearing and unhearing – are, in a way, more straightforward and objective. They parallel the “describing” type of the researchers’ interpretation. Biased-hearing is more subjective and parallels the “criticizing” type of the researchers’ interpretation. Biased-hearing involves an assessment of the teacher’s understanding and interpretations of the students’ talk and actions based on the researchers’ understanding and interpretation of what has happened as well as what dimensions may be attended to (such as cognitive, social or affective).

POSSIBLE SOURCES FOR HEARING AND INTERPRETATION

Why does Ruth “hear” what was not said or done by the students? Why does she “mishear” what was said or done by them? Why does Ruth totally neglect parts of what was said or done by the students? Why is her hearing biased? Possible sources of the teachers’ hearing their students are the teachers’ own knowledge of mathematics, conceptions of the solution of the problem at stake, beliefs about the nature of mathematics learning and knowing, understanding the nature of mathematics teaching, dispositions toward the teacher’s role, feelings about their students, expectations from their students, and so on. In the following we analyze possible sources for Ruth’s hearing.

Ruth’s concern for her students’ success. Throughout the interview Ruth clearly expressed her desire to see Sigal and Ore succeed in solving the problem. While watching the videotape of them working, she looked happy and satisfied when they said what she considered was good, and she was upset and disappointed when it seemed to her that they were not on the right track. This concern to see her students succeed may have emerged simply from her liking them. It may also be related to her role as their classroom teacher, where Sigal and Ore’s success may be regarded as her own success.

Ruth’s own conception of the problem and its solution. Ruth (and the other teachers) solved the “Shirts and Numbers” problem at the beginning of the workshop. To explain why it is impossible to divide 15 players into two groups as required (part (a)) Ruth subtracted 4 from 15 and got 11. Then she stated that the division of the result by 2 does not give a whole number, which means that the problem has no solution. Ruth emphasized that it is enough to state that “15 is odd and 4 is even. It is not

possible to divide 11 by 2". This short version includes for her a claim about the impossibility of solving a more general problem when the group size is odd and the difference between the sizes of the two groups is even. Furthermore, when discussing the solution with her colleagues, Ruth was willing to accept even a shorter version, where only two components are mentioned: "15 is odd and 4 is even". For her, such a statement represents the more elaborated solution.

When solving part (b) of the problem, Ruth changes the number of players to 14. Her solution strategy was to *remove a minimal* number of players to reach an even number of players. For Ruth, as indicated by her assessment of the students' attempts, the answer is a number that satisfies the following attributes: it is even, smaller than 15, but close as possible to 15.

Ruth's view of mathematical knowledge. Analysis of instances in which Ruth expressed surprise and disappointment with the ways the girls worked and the time it took them to solve the problem suggests that Ruth views mathematical knowledge in an unproblematic way. For her, if students know anything, then they also know how to use this knowledge. Ruth does not distinguish between inert and active knowledge, between knowing that something is so and knowing to act in the moment (Mason & Spence, 1999). Nor does she differentiate between specific and general knowledge. She sees knowledge as uncontextualized, ready to be generalized, transferred and used in all circumstances. For example, Ruth assumes that if Sigal and Ore know how to solve the "Shirts and Numbers" problem, they also know that division is impossible for any odd number of players and furthermore that they know that the division exists whenever the number of players is even. Moreover, Ruth assumes that knowing how to explain why there is no solution in the case of 15 implies knowing how to use this knowledge to change the number of players and therefore suggest a solution.

Ruth's acquaintance and familiarity with Sigal and Ore. Both Sigal and Ore are students in Ruth's fourth grade class. Naturally, based on her acquaintance and familiarity with the two girls at school, Ruth developed an impression of the girls' abilities, characters, dispositions, motivations, collaboration skills, etc. When asked to write down her expectations of the girls' work before their actual problem-solving session, Ruth described the two students as good, attentive, thoughtful, but not extraordinary. She also anticipated that they would try to solve the problem very quickly with some hastiness. Ruth described Ore as a hard worker, a student who aims to understand things thoroughly, who does not leave a problem until she is sure she understands it entirely. Sigal, on the other hand, Ruth claims, is less thorough; sometimes she provides good answers but sometimes she fails to do so.

HEARING THROUGH

Ruth hears Sigal and Ore "through" various factors. Wanting to see Sigal and Ore succeed, Ruth is receptive to interpret their talk and actions emphatically. When combined with her own conception of the problem and its solution, her unproblematic

view of mathematical knowledge, and her previous acquaintance with Sigal and Ruth as good students, Ruth overhears in Sigal and Ore's statement that "15 is odd and 4 is even" the answer she expects. She then assumes that they know how to solve the problem.

However, when Ore suggests the solution of 16 players, Ruth does not hear it. Her own understanding of the solution as an even number *smaller than 15*, which does not correspond to Ore's suggestion, hampers her hearing. Ruth's view of the solution as *an even number* is in accord with her strategy of *changing the total number of players* from the given odd number to an even number. But Sigal and Ore understand the solution to be *two groups of children* so that one has four children more than the other. This view of the solution is in accord with their strategy of *building up the two groups*. When Sigal and Ore propose the solution of 10 players, which they found by actually *building up* two groups, Ruth's under-hears them. The discrepancy between Ruth's "remove the minimum possible number to reach an even number" strategy and the girls' "build up two groups" strategy, as well as between Ruth's solution of 14 and the girls' solution of 10, interferes with Ruth's hearing how they reached a solution. Even after watching this part of the videotape several times, Ruth did not understand how the students' reached the solution and claims that "The solution [10] just came out of the blue".

In addition to the above sources for Ruth's hearing and interpretations, which are teacher characteristics, context also plays a major role. Our findings suggest that the focus of Ruth's hearing and interpretation is context-bound. In her interview she describes, explains, and criticizes cognitive aspects of Sigal and Ore's work: the strategies they choose, the explanations they provide, the solutions they suggest, their thought processes, and so on. During the interview Ruth rarely refers to social and affective aspects unless the interviewer asks her explicitly about these aspects (e.g., about Sigal and Ore's motivation or cooperation). Only then does Ruth refer to social and affective characteristics, such as their listening to each other, Sigal's attempts to dominate Ore, Ore's desire to understand thoroughly before acting, and the girls' confidence. In contrast to the interview, Ruth's written work, which preceded the interview and also dealt with her interpretations of Sigal and Ore's work, does focus on social and affective aspects. More specifically, in her written work, Ruth describes the cooperation between Sigal and Ore, their need to explicate their reasoning, and their hastiness. Moreover, Ruth's written work focuses almost entirely on the social and affective aspects, and nearly completely ignores cognitive issues: the methods used by the girls, their arguments, and so on – the exact features on which she focused in the interview.

CONCLUSION

Contemporary views on student assessment consider the teacher hearing and interpretation as fundamental. Based on how the teacher interprets students' talk and actions, she assesses students' understanding and makes instructional decisions. Our study reveals the complexity of teacher hearing and interpretation, even in the rather

simple case where a teacher observes only two students for less than one hour. The discrepancies found between what students say, do and mean, and what the teacher hears are highly important for teacher instructional decision-making. These findings point to the need to design learning experiences for teachers that will improve their ability to assess student learning and understanding.

Our examination of the various types of interpretation, characteristics of hearing, and sources of hearing and interpretation provide useful information for the design of such learning experiences. Our study also suggests other issues that need research attention: Questions such as to whom or to what does the teacher refer (e.g., herself, specific students, the problem to be solved)? What aspects are the center of attention (e.g., cognitive, social, affective)? Does the interpretation focus on meaning? Valuing? What is being interpreted: Talk? Actions? Body gestures? How are teacher interpretations connected with various contextual factors? We believe that research that focus on questions that are related to the complexity of what it means to assess students in new ways and for new purposes could assist teacher educators in making informed decisions regarding the design of effective learning experiences for teachers.

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