Using Assessment to Inform Instructional Decisions: How Hard Can It Be?[1]

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In this article, two problems associated with the expectation that teachers use contemporary assessment techniques are examined. The first problem relates to teachers' sense-making of assessment data. Illustrative cases revealed that teachers' processes of interpretation of students' understanding, knowledge and learning of mathematics draws on a rich knowledge base of understandings, beliefs, and attitudes. Consequently, the process of sense-making of students' mathematical understandings involves ambiguity and difficulty. The second problem relates to ways of helping teachers adopt contemporary assessment approaches. A professional development activity served as the example examined. Three aspects of what the course instructor promoted with respect to contemporary assessment were analysed: (1) the assessment methods and tools advocated in the course, (2) the degree to which the integration of assessment with instruction was promoted, and (3) the purposes for assessment highlighted in the course. It appeared that attention was paid to the use of contemporary assessment tools, but this was associated with traditional assessment purposes. Learning to use the new assessment tool did, however, influence instruction and fostered greater integration of assessment and instruction than before—a characteristic of contemporary assessment. The article concludes with a discussion of the current expectation that teachers use assessment data to improve instruction.

At the heart of the current attempt of the mathematics education community to reform student assessment lies the assumption that assessment data can be a powerful tool to improve learning. Indeed, in their extensive survey of the research literature, Black and Wiliam (2000) concluded that innovations which include strengthening the practice of formative assessment produce significant, and often substantial, learning gains. However, their survey, as well as other recent publications on the issue of assessment (e.g., Shepard, 2001), reveal that little is actually known about what it might mean in practice to use assessment data to improve instruction. Shepard, in her comprehensive overview of the role of classroom assessment in teaching and learning, pointed to a missing link between contemporary ideas about assessment and what is actually known about applying them in practice: "Although contemporary rhetoric implies that a shared understanding exists about what it means to use assessment data to improve instruction, *examples offered suggest considerable ambiguity* [emphasis added]" (Shepard, 2001, p. 1093).

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The aim of this article is to contribute to the current discussion on assessment by examining two problems associated with the expectation that teachers use assessment data to improve instruction. The first problem is related to teachers' sense-making of assessment data; the second with ways to help teachers adopt contemporary modes of assessment. In this article relevant background literature pertinent to the context of contemporary assessment is presented, followed by illustrative data from previous research studies and professional development work to highlight the two problems.

Background Literature: Traditional and Contemporary Assessments

The traditional assessment approach is underpinned by behaviourist learning theory and the psychometric paradigm; contemporary assessment is based on constructivist and socio-cultural learning theories (Shepard, 2001). Traditional and contemporary assessments differ on three main dimensions: the degree of integration of assessment with instruction; the methods and tools used for assessment; and the purposes of assessment (Birenbaum, 1997; Black & Wiliam, 1998, 2000; Clarke, 1997; Clarke, Clarke, & Lovitt, 1990; Lewy, 1996; National Council of Teachers of Mathematics [NCTM], 1995, 2000; Shepard, 1989, 2001). These differences are elaborated below.

Integration of Assessment with Instruction

Traditionally, students are assessed by a separate activity (a test) specifically designed for this purpose. In other words, the activity of instruction and the activity of assessment do not coincide. The teacher assigns students a task either as a learning activity or to evaluate their learning, but not for both. In contrast, an important characteristic of contemporary assessment is that teachers need to derive much of the information on student performance and achievement during the process of regular instruction in order that "assessment that enhances mathematics learning becomes a routine part of ongoing classroom activity rather than an interruption" (NCTM, 1995, p. 13). In such a case, the activities of instruction and assessment often happen simultaneously, and assigning students a task would serve both functions—advancing as well as assessing student learning.

Methods and Tools of Assessment

Traditional assessment aims to provide an accurate account of students' knowledge. The tools and methods used for gathering evidence and for making inferences emphasise positivistic principles such as objectivity, content coverage, precision, and the scientific validity of measurements. The prevailing tool in traditional assessment is paper-and-pencil tests made up of short standard items with closed question formats concentrating mainly on rote recall and mastery of factual knowledge. The methods used for making inferences are formula-based, such as counting miscues, and are aimed at the scientific measurement of ability and the avoidance of subjectivity that might be involved when making a more holistic evaluation.

The contemporary view that assessment should be an integral part of instruction, combined with disappointment from the limited information received from traditional paper-and-pencil mathematics tests, entails the use of assessment methods, tools, and techniques different from those common to traditional assessment. Consequently, in addition to paper-and-pencil tests administered at specified times, contemporary assessment uses a combination of various assessment methods and tools that not only provide a more comprehensive, rich, and multi-dimensional account of what students know and understand, but also serve as powerful instructional tools. Included, for example, are projects, portfolios, journals, conversations, and observations (e.g., Clarke, Clarke, & Lovitt, 1990; NCTM, 2000; Romberg, 1995; Shepard, 2001). Consequently, contemporary-based student assessment draws upon a complex combination of formal-structured and informal-flexible assessment techniques and methods.

Purposes of Assessment

The degree of integration of assessment with instruction, as well as the methods and tools used for assessment, are related to the purposes of assessment. Traditional assessment centres on summative assessment, that is, on evaluating students' achievement at the end of a period of instruction. Its main purposes are: certifying students' attainment at the end of a period of instruction, and classifying or ranking students. Grades are mainly addressed at external authorities such as principals, superintendents, and higher education institutes. Contemporary assessment moves from sole concentration on summative assessment towards an emphasis on formative assessment with the main purposes of advancing students' learning and informing teachers as they make instructional decisions. Advancing students' learning could be based on student self-assessment and peer-assessment, but these do not necessarily include providing teachers with information for instructional decisions. The use of assessment data to make instructional decisions (e.g., adapting the pace of instruction accordingly, choosing wisely among various materials, challenging student thinking, etc.) is aimed, eventually, at advancing students' learning. The following section of this article concentrates on this purpose of contemporary assessment—informing teachers as they make instructional decisions—by focusing on a problematic characteristic of teacher sense-making of assessment data.

Problem 1: Teacher Sense-Making of Assessment Data

Below is a brief analysis of four episodes of teacher-student classroom interactions. For an extended description of these episodes see Even and Wallach (2004). The analysis of the four episodes exemplifies cases when teachers did not understand things said or done by students. For each episode the analysis suggested one resource that could have contributed to the teachers' misunderstanding of their students. Choosing to highlight only one resource was for the purpose of demonstration only, and does not imply that other resources might not have contributed to the nature of the teachers' understandings.

The first two episodes analysed below appear in Robinson (1993). In her study Robinson observed and documented several 7th grade teachers teaching introductory algebra; she also collected lesson plans and interviewed the teachers after each lesson. The third episode appears in Goldenberg (2000). As the instructor of a professional development course for elementary school teachers Goldenberg studied changes in participating teachers' conceptions and practices based on audio-tapes of course sessions, collecting various artefacts produced during these sessions, interviewing the teachers, examining the portfolios the teachers prepared, and keeping a journal in which she described the course sessions and her reflections on them. The fourth episode appears in Wallach and Even (2002). This study examined teachers' interpretations of student talk and actions when solving a mathematics problem, and was based on observations of, and interviews with, primary school teachers who participated in a professional development workshop.

Episode 1: Having a Plan

Benny was a novice teacher who found it overwhelming to pay attention to students' unexpected discussions. He had planned to teach that it is difficult to substitute numbers in a complicated algebraic expression, and that it is therefore worthwhile simplifying the complex expression into a simpler, equivalent one.

He asked the students to substitute $a = \frac{1}{2}$ in each of the two expressions:

$4a + 3$ and $\frac{3a + 6 + 5a}{2}$.

Unexpectedly, the students began to debate how one could decide if two algebraic expressions were equivalent. This, of course, was a different task to that intended by the teacher and the students were not doing as the teacher had planned. However, on their own initiative, they were engaged in a genuine and important mathematical discussion. The teacher, however, adhered to his original plan acting as if he had not heard his students at all, and making a completely unrelated conclusion: "We can conclude that it is difficult to substitute numbers in a complicated expression and therefore we should find a simpler equivalent expression." The teacher ignored the students' discussion entirely, apparently because he was unable to deviate from his lesson plan. He was not tuned into hearing the students beyond the level of whether they were "with him" or not. His hearing of the students seemed to be constrained by the fact that he was listening *for* something rather than *to* the students' discussion. Davis (1996, 1997) defined this mode of listening as *evaluative listening*. In this case, such listening prevented Benny from attending to his students' thinking.

Episode 2: Lacking Knowledge about Students' Ways of Learning Mathematics

Later in the year Benny was teaching his students how to simplify algebraic expressions. In spite of his great effort to explain how to do this correctly, his students kept making mistakes such as "simplifying" 5m + 2 to 7m. The tendency to conjoin or "finish" algebraic expressions is well documented in the literature and is often known to more experienced teachers (Tirosh, Even, & Robinson, 1998). Benny sensed that there was a problem, but not being familiar with students' common conceptions and ways of learning algebra, he could not identify the nature or the source of the problem. Consequently, he did not "hear" some aspects of what his students were doing, and his explanations of the mathematics did not address their difficulties.

Episode 3: Not Valuing Students' Ways of Thinking

Ahuva was an experienced teacher who did not understand the solution to a fraction problem that one of her students had provided on a test. Because she did not expect this particular student to come up with a novel solution, she did not think it worthwhile probing him on his way of thinking. Instead, all the teacher did was to mark his solution as wrong. Only after the student came to tell her that he had checked his solution with his father at home and that both he and his father thought that the solution was correct did the teacher decide to look at the solution more closely and to probe the student about his way of thinking. It was then that the teacher "tuned in" to hear her student and adopted a mode of listening which Davis (1996, 1997) termed *interpretive listening*, moving from not hearing the student to hearing him, and finally understanding his very original way of solving the fraction problem. The teacher needed to believe that there was something to hear, and to become aware of the fallibility of her own sense making of students' work.

Episode 4: Having a Specific Mathematics Solution in Mind

After solving a mathematics problem, Ruth observed two of her fourth grade students solve the same problem. When discussing their solution with an interviewer it appeared that she had "heard" things that were not said by the students, as well as not noticing other things that the students did. Consequently, she described their solution processes in ways that were quite different from what the data had suggested to the researchers who had more time to examine them.

For example, students were asked to show that there was no solution to the problem: "Divide 15 players into two groups, so that in one group there are 4 players less than in the other group." The only thing that the students said was: "Because the number 15 is odd and the number 4 is even, then it's impossible." But the teacher, with great confidence, attributed a specific meaning to this quite vague statement, quoting their solution as if they had said: "…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." This interpretation was very similar to the way she had solved the problem before observing the students.

When the students worked on changing the number of players so that there would be a solution to the problem, the teacher could not understand their solution process. What the students did was to build two groups of player numbers, 3 and 7, that satisfied the specified condition. The teacher, however, had used a different strategy to solve the problem before observing the students solve it. She had removed the minimum number of players to arrive at a number that would satisfy the specified condition and reached the solution of 14 players. Distracted by her own solution strategy, the teacher was unable to "hear" her students.

Hearing Through…

The analyses of the four episodes above were in line with the findings of several other research studies which have suggested that the interpretation of students' understanding, knowledge, and learning of mathematics is a difficult task for teachers (e.g., Ball, 1997; Cobb, Wood, & Yackel, 1990; Coles, 2001; Crespo, 2000; Davis, 1997; Morgan & Watson, 2002; Nicol, 1999; Wallach & Even, 2002; Watson, 2000). The studies have begun to reveal the complexity associated with listening to students and with teachers' attempts to understand what students are saying, showing, feeling, and doing. Ball (1997), for example, showed how a teacher's own ways of understanding the subject matter and her commitment to her students influenced the ways in which she understood the students. Morgan and Watson (2002) argued that when teachers assess students' mathematical performance they rely on various resources, for example, on their personal knowledge of mathematics and the curriculum, on their feelings toward mathematics based on their personal mathematics history, on their expectations of how mathematical knowledge can be communicated, and on their expectations of students and classrooms in general, and of individual students.

Extending this idea, Even and Wallach (2004) introduced the term *hearing through* when claiming that teachers always "hear students through" their personal and social resources. For the sake of clarifying the notion of hearing through, only one resource that contributed to the teachers' misunderstanding of their students was highlighted in the analysis of each of the episodes above: the teacher's plan for the lesson, the limited knowledge about the nature and possible sources of students' tendency to "finish" algebraic expressions, the teacher's low expectation of a specific student, and the teacher's own way of solving the mathematics problems she presented to her students. But research (Ball, 1997; Morgan & Watson, 2002; Wallach & Even, 2002) as well as common sense imply that the interactions of various resources influence the nature of teachers' understandings of their students' talk and actions.

As can be seen, teachers' sense-making of student understanding, knowledge, and learning of mathematics is an active process of interpretation that draws on a rich base of knowledge, beliefs, and attitudes, and can involve ambiguity and difficulties. Thus, understanding what students are saying and doing should not be regarded as unproblematic nor as something certain. This implies that the purpose of contemporary assessment to inform teachers as they make instructional decisions is much more complex than might be anticipated.

Recent research on professional development (Even & Tirosh, 2002) has suggested that teachers can improve their understanding of what their students say, write, and do by learning to be more open to unexpected events in the classroom, by learning about students' common misconceptions, by learning to attribute more value to students' original solutions and paying more attention to their processes of solving problems, and by transforming listening modes from evaluative to interpretive. But does better understanding of students' talk and action necessarily imply use of this information to improve instructional decisions? This leads to the other problem related to current expectations that teachers embrace contemporary assessment: how teachers are helped to adopt and use contemporary assessment. This problem will be examined by analysing an illustrative case.

Problem 2: Ways of Helping Teachers Adopt Contemporary Assessment

The case analysed here is a professional development course for in-service primary teachers who were taught how to incorporate the use of portfolios into their assessment practices. The focus of the analysis is on what the course instructor promoted with regard to contemporary assessment, and not on what the participating teachers learned about portfolio assessment. Three aspects are analysed: the assessment methods and tools advocated in the course; the degree to which integration of assessment with instruction was promoted; and the purposes of assessment highlighted in the course.

The data sources for the analysis were: the comprehensive documentation of the intervention by the course instructor based on the instructor's journal, the portfolios the teachers prepared, individual interviews the instructor conducted with each teacher at the beginning of the course and at the end (Goldenberg, 2000), and numerous conversations the author of this article had with the course instructor during the implementation of the professional development course.

General Description of the Course

The five-month (56 hour) course on Building Portfolios in Mathematics in the Topic of Non-Negative Rational Numbers was part of a larger project aimed at preparing teacher-leaders for primary school mathematics education. The participants were 16 grade 5 and 6 teachers. Each was from a different school and had been chosen by their principal to lead the mathematics education in the school. The course took place in a regional teacher centre.

The course centred on deepening the teachers' mathematical knowledge of non-negative rational numbers, exposing the teachers to mathematics education research in this area, and acquainting them with portfolios in school mathematics. More specifically, the course objectives, as stated by its instructor, were to:

- deepen the teachers' mathematical knowledge in the area of non-negative rational numbers;
- advance the teachers in understanding students' ways of thinking;
- expose the teachers to the existence of students' misconceptions in the area of non-negative rational numbers and possible sources for these conceptions;
- raise the teachers' awareness of the importance and contribution of knowledge of students' ways of thinking in general and students' misconceptions and possible sources for these conceptions;
- raise the teachers' awareness of the contribution, for the student and for the teacher, of incorporating explanations and justifications into the solutions of assessment tasks; and
- guide the teachers in building portfolios in mathematics with their students.

The instructor explained that throughout the course the teachers had solved mathematical tasks, documented their ways of thinking, and explained and justified their solutions. They were also exposed to research findings related to students' ways of thinking about non-negative rational numbers, to students' misconceptions and theories that explain the sources of these conceptions, and to the constructivist approach that views mistakes as an integral part of the learning process that can be used as a springboard to learning. The teachers also learned what a portfolio was, and built portfolios with their students. As a final assignment task for the course, each teacher built a personal portfolio that included a selection of at least three tasks from their students' portfolios including the students' solutions, the teacher's assessment of the students' mathematical knowledge as exhibited in the solutions of the tasks, and the teachers' explanations of the selection of the items included in their personal portfolios.

Assessment Methods and Tools Advocated in the Course

As the title of the course suggests, the main assessment tool advocated in the course was the portfolio. The teachers learned what a portfolio in mathematics might be, its aims, principles and ways of implementing it with students. The course instructor advocated a portfolio that would represent the mathematical profile of the student: his/her efforts, progress, and achievements. The portfolio promoted in the course was composed of two components. One component, which received only minor attention during the course, was a mathematical autobiography of the student owner of the portfolio. The autobiography was to include the student's personal experience in learning mathematics, and past and present supporting and impeding factors in learning mathematics.

Most of the work with the teachers during the course was directed at the other component of the portfolio—a selection of mathematical tasks that the portfolio owner solved during the year. Each task would be accompanied by the reasons for choosing it to be included in the portfolio, and with documentation of the thought process that led the student to the solution. The documentation would also include difficulties encountered, explanations, and justification of the solution, and so on.

The mere idea of using a portfolio as an assessment tool was foreign to the participating teachers. What was most profound for the teachers was the move from assessing the correctness of the *final answer* to assessing the *solution process*, and from expecting students to use the algorithms taught in class to them looking for different and innovative solution processes. Before the course the teachers had assessed students' mathematical knowledge using only examinations and tests that included tasks that required students to use learnt algorithms that produced specific answers. Students were not asked to explain or justify their answers, and the teachers assessed only the use of the algorithm and the degree of correctness (complete, partial, or wrong) of the final answer. During the course, most teachers changed their approaches (to varying degrees) and began focusing on the solution process, accepting as correct solutions that were not based on algorithms learned in class. For example, a teacher gave the following problem in a test: "How many eighths do you need to add to $1\frac{1}{2}$ to get $4\frac{1}{4}$?"

In her personal portfolio the teacher included the following solution from one of her students, Hagai: "I know that to get to 4 you add $2\frac{1}{2}$ and then $\frac{1}{4}$ more and you get $2\frac{3}{4}$ which is 22 eights". In her assessment of this solution the teacher wrote:

> Hagai added verbal explanations instead of exercises. Previously, I would not have accepted this kind of solution as a complete solution. Today I see it as an excellent solution because what is important is that Hagai understands and knows how to solve.

As can be seen, Hagai used a non-conventional method of solution described verbally, and not the taught algorithm for mixed fraction subtraction presented symbolically. Contrary to previous years, she explained, the teacher not only accepted the non-conventional solution, she even thought that it was "an excellent solution" because it showed that "Hagai understands and knows how to solve." What became important was not the use of the taught algorithm, but rather whether the student understood.

Degree of Integration of Assessment with Instruction Promoted

No explicit discussions were conducted during the course on the issue of integration of assessment with instruction. But the mathematical items included in the students' portfolios were to be chosen by the students from tasks conducted in class or at home at different times during the year: examinations, worksheets, personal or group projects, and so on. And indeed, many of the tasks students chose to include in their portfolios were tasks which were part of regular class-work or homework, not tasks that were designed for the purpose of assessment only; nonetheless, some items were from tests. In this regard, instruction and assessment were integrated. For example, one of the teachers got very excited when she learned how to solve the following problem in a systematic way during the course, and decided to bring it to her class.

Pencils and Scissors

Scissors cost $4\frac{1}{2}$ Shekels and pencils cost 3 Shekels each. You can buy at most four pairs of scissors and four pencils.

1. What would be the cheapest purchase?
2. What would be the most expensive purchase?
3. Specify all the other possibilities.
4. Is it possible to buy different items for the same amount of money? If it is, specify all the possibilities.
5. Explain all steps in your thought process.

One of this teacher's students chose to include this problem in his portfolio with two different methods of solution that he used. He explained that he worked very hard to solve the problem. At first he listed all the possibilities of buying pencils only, then all possibilities of scissors only, and finally, pencils and scissors, and scissors and pencils. The student said that in the middle of the work he got confused, became tired, and did not finish the solution. Then the teacher taught the class a systematic way to solve the problem that was based on organising all the data into a table which clearly presented all the buying possibilities for the same amount of money. The student became very excited about the new method. He used it to solve the problem again, and found mistakes that he had made when he first attempted to solve it. In his explanation for including the problem with the two solutions in his portfolio, he said that he chose this task because "I learned an easy and short way for solving it and I like shortcuts."

Another way that assessment and instruction were integrated was related to the quality of the tasks. At the beginning of the year the teachers used only tasks requiring students to use a learnt algorithm that produced a unique numerical answer for class instruction as well as for assessment. Students were not asked to explain or justify their answers. The course emphasised assessment of the process of solution and not of the final answer only. For that, there was the need to present students with open-ended problems allowing for different solution methods—innovative as well as previously learnt—and which required students to explain their thought process. Consequently, quite a few of the teachers modified the tasks they had previously used in class instruction so that they were more open-ended and also required students to explain their solutions. For example, in previous years a teacher had used the following textbook problem for instruction:

> A housekeeper cleaned $\frac{3}{5}$ of the 10 windows in her house. How many windows did she clean?

In the middle of the year of the course, the teacher modified this problem and used the new version for instruction. Note how she changed the context as well:

> A family invited a cleaning company to clean its new apartment. On the first day the company managed to clean $\frac{3}{5}$ of the apartment windows (a whole number of windows).
>
> 1. What part of the total number of windows **was not cleaned** on the first day?
> 2. Suggest three possibilities for the number of windows in the apartment.
> 3. For each possibility calculate the number of windows cleaned on the first day.
> 4. Explain in writing the thought process that led you to the solution.

Assessment items were often also used for instruction. Consequently a qualitative change in the assessment items implied, to some degree, a qualitative change in the instructional items. Yet, the two activities did not happen simultaneously. The teachers' use of the portfolios for assessment did not happen during instruction. Rather, the portfolios were collected and assessed only at the end of the year. In this regard, instruction and assessment were not integrated time-wise.

Assessment Purposes Highlighted in the Course

The use of portfolios for assessment purposes was presented by the course instructor as a better way to assess student achievements. She explained:

> When using a portfolio to *assess achievements* [emphasis added], one assumes that [the use of] several measures is better than one measure. To do this, there is a need to set clear criteria for the teacher and for the student regarding the choice of materials for the portfolio and its assessment. (Goldenberg, 2000, p. xxiv)

She added that it was recommended that the decision on the criteria for assessing the portfolio would be the shared decision of the teacher and students. As the portfolio was to be assessed at the end of the school year, it can be said that it was used for the traditional assessment purpose of certifying students' attainment at the end of a period of instruction. In this regard, there was a mix of a traditional purpose with a contemporary tool. The use of portfolios for assessment enables a more comprehensive and multi-faceted account of students' achievements, and also allows students to have a non-traditional, active role in deciding what and how it would be assessed. Nonetheless, its purpose is consistent with summative assessment.

Yet, the course in which the teachers were taught how to use portfolios for assessing student achievements did more than that. The emphasis on the importance of assessing students' thought processes, and students' (mis)conceptions and their sources did not remain connected only to summative assessment. As mentioned above, in contrast to previous years, during the year of the course teachers started to ask students to explain their solution processes, in addition to providing a final numerical answer. At first, students did not often cooperate, and did not explain how they reached the final answer. Consequently, some of the teachers concluded that this was something they needed to work on in class. For example, one of the teachers said:

> I think that in order for me to get explanations I need to coach them more in giving explanations. I guess I did not work enough in class on explanations and justifications. This way the students will better understand and I will better understand what they know.

And indeed, some of the teachers used the information that students did not explain their solution processes to make the instructional decision to focus on that aspect during instruction—a formative contemporary assessment purpose.

Still, in the course, no explicit focus was put on how to use the information on students' thought processes, and (mis)conceptions and their sources to make appropriate instructional decisions. To illustrate this, a teacher's assessment of the solutions of two of her students (Udi and Anat) to the following problem are examined:

> In March the number of dogs in an animal shelter was $\frac{1}{5}$ more than the number of cats.
>
> - Suggest at least two possibilities for the number of dogs and the number of cats that were in the shelter in March.
> - Explain your thought process.

Udi's solution

> I constructed a table and thought there would be 18 cats. Then I saw that I didn't get a whole number of dogs. I tried with 20 and with 23 and saw that with 23 it is also not a whole number. So I thought that the number of dogs should be a number with a zero at the end.

Dogs	Cats
$18 + 3\frac{3}{5} = 21\frac{3}{5}$	18
$20 + 4 = 24$	20
$23 + 4\frac{3}{5} = 27\frac{3}{5}$	23

The teacher's assessment

> Udi has mastered the operations of addition and multiplication of fractions, knows how to find the value of the part when the whole is known … He was asked to suggest two possibilities for the number of dogs and cats. Didn't do it but reached a generalisation. Although not correct, or better said a partial generalisation: 'the number of dogs should be a number with a zero at the end.' Actually it could also be a number that ends with the digit five.

Anat's solution

> To the number of cats you add $\frac{1}{5}$ and get the number of dogs. For example, 3 cats and $3\frac{1}{5}$ dogs. 10 cats and $10\frac{1}{5}$ dogs.

The teacher's assessment

> Anat understood that the number of dogs is greater than the number of cats, 'if more then you need to add' (addition enlarges—we saw similar conception in research studies). She does not understand the meaning of '$\frac{1}{5}$ more than the number of cats.' She also does not pay attention to the results she reached, the number of dogs must be a whole number, the number $3\frac{1}{5}$ does not have a meaning when we talk about the number of dogs.

As can be seen, the teacher "heard" Anat's solution through her knowledge of research findings in the area. This suggests that children often use verbal hints when solving mathematical problems and, for example, perform addition when the problem they are solving includes the word "more".

But, how might the teacher use her assessment of Udi and Anat's understandings to make instructional decisions? In Udi's case the teacher said, "If Udi forgot the divisibility rule for five, it seems that there is a need to repeat this topic in class." In Anat's case the teacher said, "I will have to work in class on the issue of checking and on the reasonability of answers." Thus, in both cases when the students exhibited a difficulty, the teacher decided to work on this in class. Was that a good instructional decision? Was Udi's real problem that he forgot the divisibility rule for five? It could be that he did know that a number is divisible by five if it ends with a zero or with a five, but did not use this knowledge when solving the dogs and cats problem. If this was the case, would it be useful to repeat the topic in class, as suggested by the teacher? Checking the reasonability of final answers is an important problem-solving strategy. What are the effective ways to teach this strategy? Would this be a difficulty for the whole class or only for Anat who, the teacher said "is a student with difficulties who lacks motivation"? And would it indeed be the main difficulty for Anat in this case? Such information is important for making instructional decisions on appropriate ways to work in class. Nonetheless, the course did not deal with "the next step"—how to use assessment to make instructional decisions.

Conclusions

Current rhetoric portrays a rather ideal picture about the use of assessment data to improve instruction. The literature identifies reading students' mathematical work, and observing and listening to students when they do mathematics as promising assessment means for teachers to improve instruction by making better informed instructional decisions (e.g., Clarke, Clarke, & Lovitt, 1990; Fennema et al., 1996; NCTM, 1991, 1995). In contrast to the ideal picture often portrayed, it was argued in this article that this may be much more complicated in practice than is, perhaps, anticipated.

One problem associated with current expectations that teachers use assessment data to improve instructional decisions is related to teacher sense-making of what students say, write, and do. This is often conceived as unproblematic (e.g., Birenbaum, 1997; Clarke, 1997; Clarke, Clarke, & Lovitt, 1990; Lewy, 1996; NCTM, 1995). But, "hearing through" cannot be overcome—teachers will always hear through their resources. Still, professional development can contribute to improving teacher knowledge and disposition so that they improve their ability to make sense of assessment data. The teachers who participated in the professional development course analysed in this article improved their ability to understand their students' knowledge by learning about: students' ways of learning mathematics; students' common misconceptions; presenting tasks that require students to explain and justify their solutions; and attributing value to students' original solutions and paying attention to their processes of solving problems by transforming their listening mode from evaluative to interpretive (Davis, 1996, 1997). Similar results have been reported in several research studies (e.g., Even, 1999; Even & Markovits, 1993; Even & Tirosh, 2002; Fennema et al., 1996; Goldenberg, 2000; Rhine, 1998; Simon & Schifter, 1991).

Improving teachers' understanding of what their students say, write, and do still leaves the problem of how to use this understanding to make better instructional decisions. In fact, the literature on assessment usually centres on the use of innovative assessment methods and tools, such as open-ended tasks, journals, portfolios, and observations (e.g., Beyer, 1993; Birenbaum, 1997; Carter, Ogle, & Royer, 1993; Clarke & Sullivan, 1992; NCTM, 1995, 2000; Romberg, 1995; Valencia, 1990), but is sparse on how teachers might use assessment data to make instructional decisions. It appears that attention is often given to teaching teachers how to integrate a combination of new assessment methods and tools into their teaching, instead of traditional paper-and-pencil tests administered at specified times. But not as much attention is given to ways of using the richer information acquired about students to make instructional decisions and advance students' learning. Rather, the new tools continue to serve a traditional assessment purpose that focuses on certifying students' attainment at the end of a period of instruction. The use of assessment data to make instructional decisions is treated as unproblematic, as if there is a simple connection between understanding what students know and knowing how to use this knowledge in instruction. Moving to the next step, of helping teachers learn to use assessment data for instructional decision-making is not a simple task, but is, nonetheless, essential.

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