The Influence of Assessment on Students' Experiences of Mathematics

Helena Roos

Abstract The empirical material and results presented in this paper come from an ongoing ethnography-inspired study of inclusion in mathematics as seen from a student perspective. This study did not initially focus on assessment, but when investigating what influences students' experiences of school mathematics, assessment came out as a result. The research participants are not ordinary students, but students who need some degree of special education in mathematics, either as gifted or as low-performing students. For these students, traditional assessment in mathematics does not provide any relevant feedback to support them. On the whole, assessment primarily influences either how they write solutions to tasks, but not exactly how they solve them, or else how they feel about themselves as low performers in mathematics.

Keywords Special educational needs in mathematics • Assessment • Discourse analysis

Introduction

An important question in mathematics education asks how students experience mathematics in school and what influences how they develop mathematics knowledge. In response, the main purpose of this paper is to investigate students' experiences and perceptions of mathematics at school. The students investigated are not any ordinary students, but ones who need some degree of special education in mathematics (SEM), either as gifted or as low-performing students.

H. Roos (✉)
Linnaeus University, Växjö, Sweden
e-mail: Helena.roos@lnu.se

H. Palmér, J. Skott (eds.), *Students' and Teachers' Values, Attitudes, Feelings and Beliefs in Mathematics Classrooms*,
https://doi.org/10.1007/978-3-319-70244-5_10

SEM is about students in need of something else other than what is typically offered in mathematics education in order to be able to optimise their learning of mathematics (Magne, 2006). In this study, SEM is identified as an educational initiative that may occur if a student is a high or a low achiever either in general or in specific areas of mathematics. In this paper, the phrase *student in need of SEM* is used to imply that a student is *in* need of something from his or her surroundings in order to appropriately develop his or her mathematical knowledge (Bagger & Roos, 2015).

Across and even within countries, schools deal differently with SEM. One way is to work in inclusive settings (Persson & Persson, 2012), although that method invariably raises the question of what working inclusively means exactly. From a broad perspective, working inclusively means being able to accommodate all differences among students within normal classrooms and create opportunities for all students to participate meaningfully in their education (Barton, 1997; Persson & Persson, 2012). Its aims are to organise schools around the fact that students are different and to ensure every student's participation in relevant learning activities (Nilholm, 2006). Accordingly, participation is an important aspect of inclusive education, yet one that invariably raises another question: Participation in what?

This study of inclusion in mathematics as seen from the perspectives of the students was conducted in a lower secondary school in Sweden. Its aim is to investigate what these students perceive themselves to be participating in and how that perception influences their experiences with mathematics in school. Their experiences are described as discourses, among which the discourse of assessment is the primary focus of the paper.

Assessment

This paper concerns how assessment influences students' experiences of mathematics in school. The Swedish primary school curriculum (Swedish National Agency, 2011) stipulates that teaching needs to be examined and evaluated. Another aspect of evaluation in Swedish schools is assessment of students' knowledge and the responsibility to inform students, parents, and school principals about the knowledge development of individual students. The Swedish National Agency for Education provides both oral and written tests, the stated purpose of which is to provide a standard assessment of pupils and increase the achievement of learning goals.

Of course, assessment is a broad, complex concept, and many situations in a student's school day can be regarded as forms of assessment, such as day-to-day communication with teachers, tests, and class work (Björklund-Boistrup, 2010). In any case, assessment can come in two types: formative and summative. On the one hand, *formative assessment* encompasses all 'activities undertaken by teachers, and/or by their students, which provide information to be used as feedback to modify the teaching and learning activities in which they are engaged' (Black & Wiliam, 1998, p. 7). On the other, *summative assessment* is performed with tests on a local or national level and summarises students' performance in relation to stated goals (Björklund-Boistrup, 2010).

Lyon (2011) explains that research on assessment at the classroom level usually takes an assessment-, teacher-, or student-centred approach. The most studied of those three types is the assessment-centred approach, whereas the student-centred approach, which focuses on motivation and achievement, receives less attention (Lyon, 2011; Wiliam, 2007). Boaler (1998) investigated mathematics assessment from a student-centred approach to show that the form of assessment influenced student's knowledge and the ways in which students applied school-learned mathematical methods in situations outside the mathematics classroom. In this paper, the student-centred approach is applied to examine how assessment influences students' experiences of mathematics in school.

Theoretical and Methodological Perspectives

This study has used discourse analysis (DA). Although some research applies DA as an analytical tool only, other research applies it as a theory, while still other studies, such as this one, apply it as both. Common to all of those approaches is a focus on language and text: what we can actually see, hear, and read. Such a focus can be applied with different approaches, since the field of DA makes many routes of application available. Similar to all approaches, however, is that DA concerns studying language in use and examining language beyond its use in sentences (Trappes-Lomax, 2006)—that is, the meaning of language in interaction. By extension, from a DA perspective, when we create texts, we are active reproducers of culture (Gee, 2005). One way to capture students' perspectives on inclusion in mathematics education is therefore to grasp how students perceive the ways in which they are included in mathematics taught in different situations, which can be done by identifying the ways in which students talk about, act, and produce items in school mathematics.

This study applies DA as described by Gee (2005, 2011). From his perspective, DA encompasses all forms of interaction, both spoken and written, and he provides a toolkit for analysing such interaction. The toolkit consists of 28 tools of inquiry and stresses the fact that speakers and writers are active designers in reproducing culture (Gee, 2011). Although limited space prevents the tools from being fully described here, they generally focus on communication and ask questions of texts.

Gee (2005, 2011) also distinguishes two theoretical notions, big and small discourses, henceforth referred to as *Discourse* and *discourse*, respectively. On the one hand, Discourse represents a wider context, both social and political, and is constructed upon ways of saying, doing, and being. In any case, recognition is critical. Such Discourses are always simultaneously embedded in various social institutions involving various sorts of properties and objects. For example, Discourse can be mathematics in school, although any Discourse encompasses language plus 'other stuff' (Gee, 2005, p. 52), including actions, interactions, values, symbols, objects, tools, and places. When language and the other stuff are combined in a way that makes them recognisable, the result is Discourse, and the persons engaged in that Discourse are recognised as a particular type. On the other hand, discourse focuses

on language in use: the 'stretches of language' that we can see in conversations or stories that we investigate (Gee, 2011). In this study, Discourses and discourses inform the theoretical perspective, which is applied by using the abovementioned toolkit as a methodological instrument.

Text was analysed with the help of the tools of inquiry provided by Gee (2011). While examining the text, I asked certain questions depending on the type of text being examined. For example, when using the subject tool, I asked, 'What are they talking about here, and why?' When using the deictic tool, I asked, 'What is pointed out in the text, and what is the listener assumed to already know?' When applying the fill-in tool, I asked, 'What needs to be filled in to achieve clarity? What is not being said overtly, but is nevertheless assumed to be known or inferable?'

When students were addressing the same aspects, different themes emerged—or to use Gee's (2011) terminology, different 'stretches' of language appeared. Thereafter, Discourses were identified by how the speakers constructed the stretches of language and if such stretches could be seen in classroom observations and, if so, then how.

This study also draws upon ethnography, meaning that the researcher has sought to understand a phenomenon through interpersonal methods over time by collecting data via social interactions (e.g., interviews, discussions, and visual representations). Social interactions (Aspers, 2007) and in-depth studies (Hammersley & Atkinson, 2007) prescribed by ethnography can be used to follow certain processes in a particular case. In this study, ethnography was applied together with DA in order to make students' perspectives of mathematics teaching and learning visible. However, it is important to recognise that conflicts can arise when using ethnography and DA together (Hammersley, 2005). Such conflicts can emerge both in ways of conducting empirical investigations and in the roles, if any, that researchers play in their research. Nevertheless, in this research, DA and the ethnographic approach complement each other; DA provides theoretical and analytical notions, while ethnography provides a methodology for conducting research.

Setting the Scene

I examined a municipal lower secondary school (Grades 7–9) in Sweden that has roughly 500 students and that has set out to implement inclusive work. The goal of applying inclusive work implies that the school does not typically apply special education in small groups, that all teaching occurs in the regular classroom, and that there are nearly always two teachers for each lesson—for mathematics lessons, one SEM teacher and one regular mathematics teacher. The school is an urban one, albeit on the outskirts of a city, and has a varied catchment area of both apartment blocks and villa districts. As such, the students examined have different socioeconomic backgrounds.

Two classes (i.e. Grade 7 and Grade 8) selected by the school's teachers were examined via observations and interviews. The classes were selected according to how long the students had been participating in inclusive classrooms. In Grade 7,

inclusive settings were rather new, whereas in Grade 8, students had engaged in inclusive learning for at least a year and planned to continue it for another year. Another criterion was that the classes could handle having a researcher in the classroom. Teachers also identified students in need of SEM in the two classes based on the definition presented in the introduction; their selection included both students struggling with mathematics and students who needed additional learning challenges.

Since this research focuses on students and special education needs, ethical considerations were taken into account before, during, and after the research process. Both the students and their guardians have provided their written consent. Furthermore, as the researcher, I reflected on the ways in which I could have affected the students and the study. Above all, I did not want to put students in any uncomfortable situations or make them feel exposed. Floyd and Arthur (2012) highlight the importance of researchers' being aware of both external and internal ethics. Here, the external ethical issues were the visible aspects—for example, written consent—whereas the internal ones related to my possible ethical and moral dilemmas as a researcher in relation to the research conducted. In that sense, preventing students' exposure and my being an unfamiliar adult in their classrooms were important to consider.

Several methods were used for data collection. All students involved completed a written self-evaluation. Observations of mathematics lessons were conducted in order to study the context, and after the observations close in time student interviews were conducted. For this paper, two students—Edward and Ronaldo—were selected as examples because they both attended the same class, but Edward is perceived to be a gifted student in mathematics, whereas Ronaldo is perceived to be a low performer. The students chose their pseudonyms.

Edward and Ronaldo

Edward and Ronaldo are both 15 years old and in the same class in year 8. They also both attend the same mathematics class, have the same mathematics teachers, and, by that, receive 'the same' mathematics teaching. Edward is perceived to be a gifted student in mathematics and has earned A marks, the highest mark on a scale from A (high aptitude) to F (fail) in which A–E marks are passing. By contrast, Ronaldo is perceived as a low performer in mathematics and has earned roughly E marks. The special education teacher in mathematics describes the two boys as follows:

> Edward needs more challenges. He cracks the codes and such things at an entirely different level from the rest of the class. So, he needs to be challenged. He has a pretty clear focus of what he wants in the future. He wants to be prepared for upper secondary school, so we [the teachers] must be better at challenging him.
>
> He [Ronaldo] has an approved grade, but we feel that it's probably pretty much thanks to the adjustments that he receives . . . adapted materials, he gets introductions of lessons and stuff in a small group . . . . He gets a lot of directed support, which has enabled him to reach the [educational] goals.

For this paper, the first two interviews with each of Edward and Ronaldo were analysed using of DA (Gee, 2011). The four interviews were conducted by the same researcher at the school in a small room next to the classroom. The first interview was based on a written self-assessment that the students completed and that contained claims about how they perceive their mathematics teaching and learning—for example, how they feel (i.e. *sure*, *pretty sure*, *unsure*, or *very unsure*) when they are going to tell a friend how they have solved a task or when they are going to choose a method to solve a task. The second interview was based on a task used in a previous lesson about the circumference of a bicycle wheel. The focus of the results is assessment, even though assessment was not expressly addressed in the self-assessments or interview questions. On the contrary, the students introduced assessment as a topic in the interviews.

Analysis and Results

In the four interviews, stretches of language-addressing assessment appeared several times, although assessment was not an expressed focus of the interview questions. These stretches are presented in what follows.

In the first interview, Edward was asked about how he writes in mathematics:

Edward: Well, it mostly takes place in my head, but then when it's a test, you write everything.

Interviewer: Okay. Why do you do it [write] then [on the tests]?

Edward: Otherwise. .. you cannot be assessed on what you have done, but when I do the calculations in my workbook, then it is mostly mental arithmetic.

Later in the interview, Edward described an ordinary mathematics lesson.

Edward: They [the lessons] are kind of good. […] well, they [the teachers] have lesson introductions on the blackboard, then we [the students] are supposed to do the calculations in the book. And then on the blackboard, they do different E, C, and A tasks. Or not [A tasks], but they make up C [tasks] on the board anyway.

Interviewer: And then you mean the grading [A, C, and E]?

Edward: Yes, the grade levels, because they show approximately how difficult the task we did [on the blackboard] was.

Interviewer: mm … ah, right, would you like it to be done any differently?

Edward: No, it's too complicated to pick up an A task on the blackboard, because it's so much to write, and often, it's problem solving.

Here, Edward referred to how he performs arithmetic mostly in his head. However, when he takes a test, he writes out his calculations on paper so that he can be assessed, even though when he has a regular math lesson, he mostly uses mental arithmetic. If using the fill-in tool, Edward thinks that he has to do mathematics differently in different situations, and he introduces assessment into the discussion, thereby making assessment a topic that was not expressly addressed. He also

described the mathematics lesson from the perspective of assessment, in which he refers to grades to describe the different tasks done on the blackboard by teachers. When referring to an A task, he does not say that he wants an A task on the blackboard, but he indirectly says that he wants a more difficult task. Although A tasks are not defined, they are often referred to as problem-solving and tasks that need to be explained with 'so much' writing.

In Ronaldo's first interview, he discussed taking tests:

Ronaldo: Well, it always feels pretty good when I take the tests, but then … it becomes a little like—when you get the result and then I think that it will get better next time. Like struggling, like struggle more and more like that ….

Interviewer: mm .. How was it then, this test?

Ronaldo: Well, I got like one point away from a D or something ...

Interviewer: But it did not feel good?

Ronaldo: Well, yeah ….

When Ronaldo talked about 'it' here, he referred to how he generally feels about assessment and how well he performs on tests. He also used vocabulary that relates to his feelings; he says that he will be 'struggling more', and when he talks about how it feels, his intonation is hesitant and uses ambiguous language—'Well, yeah'—which indicates that he does not feel exactly pleased about the result of the test, even though the question was more or less guiding him towards a positive answer.

In the second interview, the focus was a geometry lesson in which the students needed to calculate the circumference of a bicycle wheel and then how far the bicycle had gone when the wheel had made 1000 revolutions. I observed the lesson and conducted the interviews a few days later. As shown in the following, Edward explained his thinking when facing the task and explained that although he does not need to perform all of the small steps in the calculations, he feels as if he has to show how he performs them anyway.

Edward: It's just that you have to do it [write out the steps].

Interviewer: To show?

Edward: Really, it's just a burden to do that.

Interviewer: (*Laughing.*)

Edward: (*Laughing.*) To make and write all that, because it takes such a [long] time.

Interviewer: Otherwise?

Edward: Otherwise I just do it so quickly.

Interviewer: So you really don't have to do all of those calculations?

Edward: No, no. I would have done it in very few calculations.

[. . .]

Interviewer: But you can't not do that?

Edward: No, I can't.

Interviewer: Because?

Edward: Then I can't be assessed.

[. . .]

Edward: It's that you have to do it on the tests or you won't pass. But in the math book, I don't do it. . . . It's the writing that takes such a long time on tests.
Interviewer: Yes, that's right.
Edward: Because I take the entire time [when taking tests].
Interviewer: You do?
Edward: To *have time* to write everything.
Interviewer: Ah.
Edward: I mean, pure physically.

In this excerpt, Edward discussed having to write out calculations. He used the words 'have to' and 'burden', thereby indicating that he does not need or want to write out the mathematical steps. He also talked about mental calculations versus written ones and said that writing them out 'takes such a long time', but mentally, he can do the arithmetic 'just like that'. However, he has to write out the steps or else he 'cannot be assessed'. Edward especially stressed the burden of writing everything on tests by emphasising that he is given time to do so. He also pointed out that it is not a burden mentally, only 'physically'.

Also in the second interview, Ronaldo discussed completing geometry tasks in the mathematics book:

Ronaldo: I think that Level 1 [referring to tasks at Level 1 in the book] has begun to be a little easier now, because it feels like I've started to get a little better at maths. So I start, like, with Level 2.
Interviewer: You have started at the second level now?
Ronaldo: Yes, and then Level 3.
Interviewer: Nice. How does it feel?
Ronaldo: Good. Like progress.

Here, Ronaldo addressed the levels of tasks in the mathematics book, among which Level 1 has 'easy tasks while the tasks at Level 4 provide real challenges', according to the book. He referred to his feelings about the levels of the tasks and indirectly said that to be good at maths, one has to be able to do the higher-level tasks. He assessed himself in relation to the levels of tasks, and since starting with Level 2 tasks, he has become a 'little better at maths'. He used the word 'progress' to describe the feeling.

Taken together, the discourses in the analysed interviews exhibit strong stretches of assessment in mathematics introduced directly by the students and not the interview questions or interviewer. Arguably, the stretches about assessment indicate the Discourse of assessment in mathematics, for the students indeed position themselves as being assessed in mathematics, which clearly influences their experiences of the subject. Interestingly, the students are categorised by their teachers as either gifted or low performing in mathematics, yet both are greatly influenced, albeit differently, by the Discourse of assessment in mathematics. On the one hand, assessment influences Edward at the level of actions, such as his writing out solutions to tasks in a way that will earn him good grades. That way of writing is not how he actually solves the tasks but merely a construction for assessment; as such, tension exists between writing solutions for him and for others. On the other hand, Ronaldo

is influenced by assessments at the level of feelings, particularly his feelings about himself as someone who is not very good at mathematics. However, it is premature to say whether the differences relate to the different needs of the two students—one gifted and one low performer—or not.

Discussion

Mathematics teaching in Swedish primary schools varies considerably, which creates differences in students' experiences of the subject and how it is taught (Swedish Schools Inspectorate, 2009). The different social and cultural contexts within which children learn mathematics influence what they learn, what they think mathematics is, and how they think about mathematics learning (Perry & Dockett, 2008). Based on the results presented in this paper, assessment seems central to both Edward's and Ronaldo's experiences of mathematics at school, but in different ways, as seen in how they talk and reproduce culture (Gee, 2005). Consequently, assessment is a Discourse instead of a discourse. On the one hand, Edward is influenced by the Discourse by feeling as though he has to write out even the smallest of steps in solving mathematical problems in order to be assessed well. For him, doing so is a burden that he nevertheless assumes because he has learned that not doing it is to his disadvantage in assessment. This result indicates that assessment and learning do not always go hand in hand. Edward also indirectly indicated that he wants to discuss more difficult tasks during mathematics lessons but that the form of A tasks is too challenging, thereby suggesting that he needs another level of mathematics to be challenged in assessments. Ronaldo, on the other hand, is influenced by assessment at a level of feelings. When he got one point away from a D mark, he said that he feels as if he struggles more, thereby indicating he is not pleased with his result. He also talked about his knowledge in mathematics in relation to levels in the mathematics book, thereby suggesting he is assessing his own knowledge in relation to the levels and that he has made progress since beginning at a higher level.

In general, it is apparent that assessment affects students' experiences of mathematics. In this case, written assessments (i.e. tests) were the most obvious means of assessment to students, even though many other situations involved the assessment of students' knowledge in mathematics (Björklund-Boistrup, 2010). Formative assessment was not visible in the interviews, meaning that the students did not view other situations as being assessments, but only the written tests.

In sum, it seems as though assessment does not provide relevant input to support the SEM students in this study in developing their mathematical knowledge, as the Swedish National Agency (2011) prescribes, to increase students' achievement of goals. On the contrary, assessments seem to exert other kinds of influence on the students: in Ronaldo's case, his feelings about mathematics and how he perceives himself to be a low performer, whereas in Edward's case, the burden he feels about having to present his knowledge. In that sense, it seems that assessment is even an obstacle for Edward, a gifted student, in developing his knowledge of mathematics.

References

Aspers, P. (2007). *Etnografiska metoder: att förstå och förklara samtiden. [Ethographical methods: to understand and explain contemporary life]* Malmö: Liber. ISBN: 978-91-47-08648-1.

Bagger, A., & Roos, H. (2015). How research conceptualises the student in need of special education in mathematics. I O. Helenius, A. Engström, T. Meaney, P.Nilsson, E. Norén, J. Sayers, & M. Österholm (red.), *Development of mathematics teaching: Design, scale, effects.* (pp. 27–36). Proceedings from MADIF9: The Ninth Swedish Mathematics Education Research Seminar, Umeå, February 4–5, 2014. Linköping: SMDF. ISBN: 978-91-973934-9-2.

Barton, L. (1997). Inclusive education: Romantic, subversive or realistic? *International Journal of Inclusive Education, 1*(3), 231–242. https://doi.org/10.1080/1360311970010301

Björklund-Boistrup, L. (2010). *Assessment discourses in mathematics classrooms: A multimodal social semiotic study [Doctoral dissertation]*. Stockholm: Stockholm University. ISBN: 978-91-7447-116-8.

Black, P., & Wiliam, D. (1998). Assessment and classroom learning. *Assessment in Education: Principles, Policy & Practice, 5*(1), 7–73. Englewood Cliffs, NJ: Prentice Hall. https://doi.org/10.1080/0969595980050102

Boaler, J. (1998). Alternative approaches to teaching, learning and assessing mathematics. *Evaluation and Programming*. *Planning, 21*, 129–141. https://doi.org/10.1016/S149-7189(98)00002-0

Floyd, A., & Arthur, L. (2012). Researching from within: External and internal ethical engagement. *International Journal of Research & Method in Education, 35*(2), 1–10. https://doi.org/10.1080/1743727X.2012.670481

Gee, J. P. (2005). *An introduction to discourse analysis: Theory and method*. New York, NY: Routledge. ISBN: 978-415-72125-7.

Gee, J. P. (2011). *How to do discourse analysis: A toolkit*. London, UK: Routledge. ISBN: 978-0-415-72557-6.

Hammersley, M. (2005). Ethnography and discourse analysis: Incompatible or complementary? *Polifonía, 10*(10), 1–19.

Hammersley, M., & Atkinson, P. (2007). *Ethnography: Principles in practice* (3rd ed.). London, UK: Routledge. 978-0415396059.

Lyon, E. G. (2011). Beliefs, practices, and reflection: Exploring a science teacher's classroom assessment through the assessment triangle model. *Journal of Science Teacher Education, 22*, 417–435. https://doi.org/10.1007/s10972-011-9241-4

Magne, O. (2006). Historical aspects on special education in mathematics. *Nordic Studies in Mathematics Education, 11*(4), 7–34.

Nilholm, C. (2006). *Inkludering av elever 'i behov av särskilt stöd': Vad betyder det och vad vet vi? [Incluision of students in need of 'special support'; what does it mean and what do we know?] Forskning i Fokus 28*. Stockholm, Sweden: Myndigheten för skolutveckling. ISSN:1651-3460.

Persson, B., & Persson, E. (2012). *Inkludering och måluppfyllelse: Att nå framgång med alla elever [inclusion and goal achievement: To reach success with all students]*. Stockholm, Sweden: Liber. ISBN: 9789147100880.

Perry, B., & Dockett, S. (2008). Young children's access to powerful mathematical ideas. In L. D. English (Ed.), *Handbook of international research in mathematics education* (pp. 75–108). New York, NY: Routledge. ISBN: 978-0415832045.

Swedish National Agency. (2011). *Läroplan för grundskolan, förskoleklassen och fritidshemmet 2011. [Curriculum for elementary school, pre-school-Class, and leisure Centre 2011]*. Stockholm, Sweden: Fritzes. ISBN: 978-91-38325-42-1.

Swedish Schools Inspectorate. (2009). *Undervisningen i matematik: Utbildningens innehåll och ändamålsenlighet [teaching mathematics: The content and effectiveness of education]. Kvalitetsgranskning rapport 5*. Stockholm, Sweden: Skolinspektionen.

Trappes-Lomax, H. (2006). Discourse analysis. In A. Davies & C. Elder (Eds.), *The handbook of applied linguistics* (pp. 133–164). Malden, MA: Blackwell. ISBN: 9780631228998.

Wiliam, D. (2007). Keeping learning on track: Classroom assessment and the regulation of learning. In F. K. Lester (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 1051–1098). Charlotte, NC: National Council of Teachers of Mathematics & Information Age. ISBN: 978-1593115869.