

Sustainable assessment in mathematics: a matter of access and participation

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This paper explores aspects of sustainable assessment in mathematics for students with disabilities. Specifically, it looks at the levels of and production of participation in the actual situation of test-taking and how this relates to the students' opportunities to display knowledge. The purpose of the paper is to investigate if and how this model for evaluating and reflecting on participation might be useful for evaluating the assessment situation and, through this, promote sustainable assessment for all students.

Nora, a third-grade student, has difficulty focusing and concentrating in the mathematics classroom. She is often reluctant to do assignments and has stated that she will *not* take the national test. Nora sometimes works in the special education teacher's room with mathematics, where she manages to focus on the tasks and participates in the mathematics activity. Importantly, this room is silent, has no other students in it, and Nora has an adult to help her focus. In order to support Nora to participate in test-taking, the teachers planned for her to take the test with this setting as the major part of the adaption of the test situation. The present article trials a model for evaluating and reflecting on participation in actual test situations. There is a lack of research from the mathematics educational research community regarding students with disabilities, participation in mathematics, and showing knowledge during assessment. The overall discourse of segregating and excluding the value of some students and their knowledge, without even recognising them as legitimate mathematics students, is troublesome. The article may provide valuable insights into how to promote sustainable test-taking in mathematics for Nora and other students with disabilities or those in need of similar support. The results can be used to reflect on, and the model hopefully to evaluate the sustainability of test-taking in mathematics when participation is put at risk. The questions asked in this study are: What form of participation takes place in the assessment of mathematics? And, What are the prerequisites for the form of participation that takes place? The results might provide a tool for planning, evaluating, and carrying out sustainable assessment, for every student.

Participation in mathematics assessment for students with disabilities

Mathematics education has various theories on participation, such as the sociocultural understanding of learning as participation in communities of practice (Lave & Wenger, 1991). However, this theory was not specifically developed for evaluating actual situations of assessment and is not focused in particular on students with disabilities. In those moments and situations, the initial prerequisites and needs in terms of adaptations are core, as is the way in which various functions meet the environment and create the possibility to display knowledge, or not. Sfard (2019) described how learning as acquisition and learning as participation has both its legitimacy and pitfalls in research on mathematics education. Both are required, especially since theories of participation have the potential to investigate external factors, while the acquisition theories have the potential to capture internal factors for learning. However, I argue that this becomes even more true when it comes to students with disabilities. What content or knowledge a student with disabilities can access externally or retrieve internally will impact both the participation and acquisition in the learning and assessment of mathematics. Heyd-Metzuyanım (2013) proposed a model to analyse how the co-construction of the disabled learner is created, though using Sfard's commognition framework. Although this framework is about disabled students' identities and combines both learning as acquisition and learning as participation, the model has its limits in terms of scrutinising how participation is constructed and conditioned in the actual situation. Instead, the model aims to display the identity building of the learner. With this said, there is a need for a theoretical and practical model that allows for an evaluation of the prerequisites for participation, and in turn the sustainability of the assessment situation for the disabled student.

Although these and other theories of participation in mathematics education have been well elaborated, there is a lack of focus on students with disabilities. On the other hand, when turning towards disability studies instead, they often lack the explicit perspective of mathematics assessment (see, for example, Lambert, Padilla, & Wieman, 2018). To exemplify how scarce research on the combination of mathematics education, assessment and participation for students with disabilities is, I use the example of a search in the educational database Eric and what the research is about. The search was limited to peer-reviewed articles within the last 20 years, and the keywords were participation *and* disability *and* assessment *and* math*. Only 20 hits were generated and of these, only half concerned assessment in mathematics for students with disabilities. The purpose and focus of those studies was often about whether students with disabilities attended class and how that could be understood or increased (Bouck, 2013; Goldstein & Behuniak, 2012; Ketterlin-Geller, 2005; Thurston, Shuman, Middendorf & Johnson, 2017). Participation beyond just attending and taking the test was lacking. The research focused on specific disabilities such as emotional disturbance (Temple-Harvey & Vannest, 2012) or intellectual disabilities and how participation relates to accountability (Bouck, 2013) or the subject being assessed. For example, Cawthon (2011) showed that accommodations and recommendations depend on the subject

being assessed. Furthermore, participation was labelled as participation assessment, but the study addressed the amount of participation rather than the mechanisms and levels of participation for the individual in the assessment situation. In this research, no theory or model of participation could be found. The study that came closest to presenting a model or theory of participation was a study of Universal Design for Learning (Ketterlin-Geller, 2005), which analysed disabilities and students' participation in mathematics assessment. In that study, meaningful participation and accommodations that improve the results were highlighted. Furthermore, Schuelka (2013) confirmed the need to research participation beyond "taking the test", showing how students with disabilities are actually excluded from the achievement and testing discourse:

The shape and power of such a myopic view of learning, coupled with a testing discourse devaluing the learning and participation of students with disabilities, creates a discourse of achievement that excludes students with disabilities (p. 226).

The governing of sustainable assessment

The United Nations' sustainability development goals (SDGs) express sustainable education and assessment as being closely connected to participation. In order to be able to participate in a practice, a student must be given access to this practice (United Nations, 2019). The UN's sustainability goal of education harmonises with how participation and access to education and materials in education are keys in Swedish steering documents. All students are supposed to be stimulated according to their needs and prerequisites, and the first step of securing this is to adapt and adjust learning environments, approaches and materials so that the content of education is accessible and the student can participate (SFS 2010:800). Students with disabilities have guaranteed access to the educational content, hence the testing situation and materials, through the Discrimination Act (SFS 2008:567). This was reinforced in January 2015. If a student is not provided access to the content, this is considered discrimination. There have recently been a couple of judgements following from this law regarding students with disabilities who were not given the necessary adaptations and thereby access to the national test. The School Act has also been reinforced regarding the right to grades for students who are attending the special school for intellectually disabled students. Moreover, students are supposed to participate in the assessment of their knowledge and to understand the process (SFS 2010:18).

Theory and framework

In this article, I use three core concepts that are interrelated with regard to assessment in mathematics for students with disabilities: sustainable assessment, participation and access. I derive from Bouds (2002) definition of sustainable learning and assessment as something: 'that meets the needs of the present and

[also] prepares students to meet their own future learning needs’ (Boud 2000, 151). In order for assessment of knowledge to be sustainable for students with disabilities, it is essential to understand that support to participate, learn and communicate supports and presupposes each other (Ahlberg, 2013). Hence, when participating in assessment, there is a need to ensure that the students have the support they need to access the mathematical content and to communicate their knowledge. What this support should consist of will vary greatly depending on the individuals’ and the environment’s prerequisites. With that said, I stress that the participation in assessment cannot take place without proper support to access the communication and the content in the test- situation. This perspective on the learner and the environment is also prevalent in the Nordic and Swedish research context on special needs in mathematics through a model developed by Magne (2006). Achievement is then understood as deriving from the intersection of the students, the mathematics at hand and the environment’s prerequisites.

Jansson (2005, 2010) stressed that participation is essential in order for teaching—and learning to be meaningful. The model of participation can be divided into three basic levels that the school must afford to the individual:—(1) Belonging is when a pupil is given the opportunity to take the test. (2) Accessibility exists if a student has the access and the opportunity to take the test. (3) Co-action is when it is possible for the pupil to do what the other pupils are doing. It is only after the three basic levels have being granted that the three advanced levels of participation can be conquered by the pupil: acceptance, commitment and autonomy. This means that if a student’s autonomy or commitment is not working, there is a need to first interrogate whether the student is belonging, has accessibility to the assessment situation and can co-act. Although participation follows from the interplay between individual and environment, participation is not understood as merely a social aspect of learning. The model makes it possible to scrutinise how participation does or does not take place from each individual’s unique situation and agency in the lived situation. The model is universal and might be used for different ages, activities and individual functionalities (Szönyi & Söderqvist Dunkels, 2018).

	Level	Kind of Participation
Advanced levels	6. Autonomy	Existential, to experience meaning
	5. Commitment	Psychological, to be motivated and make a good try
	4. Acceptance	Interpersonal, to accept to take the test
Basic levels	3. Co-action	Social, to be able to act and cooperate
	2. Accessibility	Functional, to be able to access the content
	1. Belonging	Physical, to be included in the activity

Table 1: Jansson’s (2005) model of aspects of participation

The data presented in this article exemplify and explore how the model might come into use for reflecting on levels of participation in a complex and highly individualised test situation, for a specific individual. A moment of national

assessment in the third grade is presented through three representative vignettes that follow each other and in which participation is challenged. The first is a snapshot from the actual test occasion in which Nora, 9 years old, takes the test together with Karin, the special education teacher. This is followed by a vignette created from a video-stimulated recall dialogue with Karin. Last, but not least, Nora's own reflections on taking the test are displayed. This is represented through a short video-stimulated recall dialogue after the test. During this process, Nora did not remember much and had a hard time concentrating on questions while looking at the video. Her perspective is also represented in the actual test-taking through her statements and multimodal communication. The vignettes are followed by a deconstruction of what kind of participation can be interpreted in the vignettes, which explores how the model works. Two questions were posed during the exploration of the model: What form of participation takes place in the assessment of mathematics? And what seem to be the prerequisites for the form of participation that takes place?

Vignette 1: National test-taking with the special education teacher

Karin begins by welcoming Nora and states that Nora's teacher thought that those two had worked well together and had asked if Nora could take her test with Karin. Karin expressed how much she enjoys this, that they like each other, and that this will go very well. She introduces some concepts: the equals sign and number patterns. The pencil breaks and is put aside, hidden behind the bear, and another pencil is used instead. Karin says: "I will begin by giving you an easy pattern: 3, 6, 9, 12. What comes next?" Nora guesses 13, and looks and sounds proud. Karin gives her lots of praise and then quickly says: "Now, I will give you something harder; are you ready?" Nora then replies "NO" and Karin starts writing: 26, 24, 22 and, 20. "What is next? Can you figure it out?" Nora rapidly answers "23". Karin then asks, "How did you think?". Nora explains her way through the sequence – "it is going down..." – and then states that it should be 18. Karin praises her again and asks how much less it becomes at each step. Karin sums up that Nora now knows what a pattern of numbers is. Karin then asks: "Do you know what the equals sign is?" Nora shakes her head. Karin opposes: "Yes, I think you know!" Karin continues to explain. Meanwhile, Nora loses her attention and starts to play with the pencil that had been put aside. Karin calmly takes Nora's attention back to their joint focus and puts the pencil away; she also tells Nora that this is to help her, since the pencil is disturbing her. Karin reminds Nora what they have talked about and concludes that the test will now begin. Karin praises Nora at the very beginning of the test for having it in focus: "Really good, you have already written your name".

Nora is eager to read the tasks herself, first silently and then aloud: "I will read it like a book [reads the tasks aloud]". Nora is mostly engaged and looks at the paper; she sometimes sits for several minutes at a time and looks at the tasks, like she is thinking about them. When finishing a task, Karin directs Nora's attention towards the next task. She also checks if Nora feels ready and is

following. Karin touches Nora with her hand when Nora fades in energy, slumps in her seat or stops working. Karin asks Nora throughout the test if she needs anything explained to her. In the middle of the test, Karin decides that a break is needed. Nora gets to stretch out and take deep breaths. Karin puts Nora's focus on how the air feels and they stretch the arms and legs. They also talk about the lunch and the scent from the kitchen. At one occasion Karin stops and says: "Before you continue, I want to explain one thing – that is what area is. It is how much of the surface something takes up. This is area [points to the desk]. Do you understand?" Nora answers, "Yes". Karin also explains how Nora is supposed to respond to the task at hand: "You are to put a cross besides the statement that you think is correct". Nora reads the task and Karin praises her: "You read very well". When reading the sentence, Nora stops at the word "area". The actual word area seems hard to pronounce and Nora does not recognise it, even though they have just talked about it. They laugh together and Karin says that that this was what she just explained. Several times throughout the test Karin gives back the answer Nora has made and checks if she is satisfied. Such feedback includes sentences like: "What do you think...", "So then you think that..." "What do you think about...?" or "Do I understand you correctly...?" Karin also monitors Nora's perceived level of difficulty – "Is this complicated?" – and her perceived focus or energy: "Are you up to it?–Otherwise we can take a break and do it later." She also compensates if Nora fades in energy or motivation: "I can write, since you are tired." This is done completely without blame and Karin is very clear that it is to help and unload. Karin also puts a hand on Nora's shoulder to help her keep going. Karin's praise of Nora is continuous, specific, encouraging and positive: "You can do it", "Well done", "You know it!" As they move towards the end of the test, she tells Nora how much she has already done and how much is still to go: "Only one task to go. Now you have done the national test in mathematics!"

Vignette 2: Karin's reflections on the video

Karin talks while looking at the video and comments on what happens. She starts by commenting on the warm welcome that she gives the girl, saying "girls need a lot of love". She also comments on how this occasion is different from her ordinary positioning in the classroom: "We sat for almost an hour. She has never done that before" and "She is not used to listen for this long". "Now she looks like any other schoolgirl". She follows her attempts to push Nora forward and several times she identifies that Nora actually says no, but Karin keep her going and Nora then looks relieved and committed to their joint task to work through the test: "It is like I say, well then we will do this ... and then the girl is with me again and looks happy".– Karin talks about and recognises that Nora gets tired after a while and sometimes gets tense or stops: "She cannot concentrate and is tired. She does not want to do more of the test. Karin also talks about this when saying: "She cannot concentrate and is tired, Nora does not want to do more of the test but I keep on". She also comments on the mathematical knowledge, working memory and Nora's lack of confidence in mathematics: "She is supposed to do a pattern, but do not know how and gets tense. She starts to bite her lips. Generalisation is hard for her. She just

did the same kind of task and directly after, it is gone from the working memory”. Karin finds it hard to give Nora positive feedback but without revealing anything about the test: “It is hard to give praise but without giving things away. If it had been an ordinary maths class, she would have been given more feedback. Now she knows that she will not be given that”. To sum up, Karin says that: “Nora is calm and she wants to take the test. Part of my work to make this happen is to build a good relation to the teacher. This is remarkable work she is doing and she cooperates all the time. It was important that it was only the two of us and I could encourage her”.

Vignette 3: Nora’s reflections on the video

While Nora did not remember much from the test, she said: “The tests are important since you need to know them as an adult”. About the test-taking itself, Nora said: “I usually do not work when I am in the classroom when everybody is there. So, I usually get to work with Karin”. When Nora looked at the video of the test-taking, she focused mostly on how she and Karin made things. In a very attentive way, she talked about the physical things actually took place: “Look, she is putting the pencil back” or “Why I did you zoom in here?” I then answered that: “I tried to record what you wrote, but that was not so easy”. Nora then giggled and said: “Yes, nothing can be seen! Four plus ten equals three plus one ... Seven plus three – that is ten!” Seeing those numbers made her remember and pay attention to the test itself: “I worked with, what is it called ... like a thin book. There you are supposed to divide, to use plus and minus and so on.”–Nora sums up by stating that she thinks that the test is similar to an ordinary session with Karin. She could not say whether she thought the test was hard, but she did feel it was boring and she was not nervous.

Advocating the model of participation

In order to explore the model of participation on the test situation for a student with major support needs, I have compiled a table including text from all three vignettes (see Table 2). The teacher’s and the student’s reflections are represented together and the actual test situation is connected to their statements thereafter.

Table 2: Advocating Jansson’s (2005) model of participation on a situation of national testing in mathematics in the third grade.

	Level	Examples from vignettes 2 or 3
Advanced	6. Autonomy	Karin: “Now she looks like any schoolgirl.” Nora guesses 13, and looks and sounds proud.
	5. Commitment	Karin: “Nora is calm and she wants to take the test.” “This is remarkable work she is doing, and she cooperates all the time”. Nora: “I want to read it myself.”
	4. Acceptance	Karin: “It is like I say, well then we will do this ... and then the girl is with me again and looks happy.” Nora: “The tests are important since you need to know them as an adult.”

Basic	3. Co-action	Karin: “We sat for almost an hour. She has never done that before.” “Now you have done the national test in mathematics!” Nora: “I worked with, what is it called ... like a thin book. There you are supposed to divide. To use plus and minus and so on.”
	2. Accessibility	Karin: “It was important that it was only the two of us and I could encourage her”. Nora: “I usually do not work when I am in the classroom when everybody is there. So, I usually get to work with Karin”.
	1. Belonging	The student is considered a test-taker

Regarding the autonomy level where existential aspects of participation is activated, the student is self-sufficient at times, but there are also moments of friction and resistance when Nora does not wish to continue. The participation then drops down to the basic level of access. At the same time, Nora does not access the mathematics. She no longer has access to the test and Karin quickly responds accordingly. The commitment level of participation is shown, for example, when Nora takes on the test with interest and focus and makes her best effort. According to Karin, this opportunity to commit also requires that the class teacher be committed to building good relations with the special education teacher and vice versa. Participation as acceptance is displayed when Nora follows the rules and routines of test-taking. In order to be able to follow rules and routines, she must be aware of them and also needs to be able to do some self-monitoring; this is closely connected to adaptations since Karin has to remind Nora and keep track on the situation and Nora’s current state regarding what she remembers or how tired or restless she is. Nora cannot remember everything that was said, but is highly cooperative and listens to Karin. This level of participation emanates from mutual attention on the mathematics tasks and also that the teacher monitors Nora’s needs and functions constantly. –Helping Nora to accept taking the test, is closely connected to her needs of adaption and reconciliation. Part of the adaptation is also to push Nora and show trust in her managing, when she herself does not. Karin signals that the mathematics is actually Nora’s space and that that she should manoeuvre the numbers. One moment that might include all of the levels is when Nora is given a harder task in the number line. At this moment it becomes obvious that the mathematical content and the higher levels of participation pre-suppose each other and require communication and adaptation in order to be realised.–She opposes (belonging is put at risk) but the support given is that Karin guides her and strengthens her working memory (gives access and supports co-action), diminishing the tension and resistance (making it possible to accept and commit). This gives Nora access and provides another way to access the task through reading aloud:

Nora then replies “NO” and Karin starts writing: 26, 24, 22 and, 20. “What is next? Can you figure it out?” Nora rapidly answers, “23”. Karin then asks, “How

did you think”. Nora explains her way through the sequence: “It is going down...” and then states that it should be 18.

To sum up: Nora is given access to the mathematics test and content through the explanation of language and symbols, help with writing, concentration, focusing on the right place in the test, taking away distractions, being calmed or encouraged, helped to monitor the test occasion and the answers and to self-correct.

Concluding remarks

The liminal space between the three basic levels and the three advanced ones becomes blurred in the test situation. There is a need to further develop the model to include the subject content and to make the levels more nuanced. The most important factors are the relationship between Karin and Nora, if and how they can communicate and what kind of response is given on different adaptations or reactions to the test. Karin constantly evaluates whether Nora is at the participial level of commitment or at the level regarding access to mathematical content, in her choice of ongoing adaptations or support. Through this, there seem to be a fluency of movement between aspects of participation. They happen simultaneously and presuppose each other, similar to how the actual counting and doing the mathematics is fluent and presupposes the constant adaptation and adjustment that the teacher is making. The same action or statement can be categorised in several of the levels. In order to actually know which level of participation is engaged, it would have been necessary to ask the student in real time how Nora felt or what she thought. This is not possible in a test situation and certainly not with students who are easily distracted. Still, using this model to reflect might raise issues regarding if and how commitment or acceptance is even possible for a student. A real challenge to simply handle the number line could be overcome. In addition, it seems that this model could be used to learn about the adaptations needed and what could even be considered an adaptation.–If these circumstances are possible to detect and work with before and during a test situation, the test has the possibility to lead to sustainable assessment, both for the teachers and the students. In order for the model to be helpful in promoting the SDG, further studies of why and how it works are needed in real-time situations, as are studies of which students and teachers get the opportunity to reflect on the actual levels before, during and after test taking.

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