

Formative assessment – from the view of special education teachers in mathematics

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The potential of using formative assessment is well demonstrated, but studies about the use of formative assessment from a special education perspective are lacking. This study adds to this gap by investigating the view of formative assessment in a group of 39 special education teachers in mathematics (SETMs) who had learned about formative assessment within the SETM-program 2–6 years earlier. Five respondent interviews were used to design a questionnaire answered by the rest of the group. The SETMs had perceived formative assessment beneficial and useful in all their common sub-responsibilities and reported experiences of benefits as well as challenges. The article discusses the importance of reaching an inclusive formative assessment practice in mathematics education.

Formative assessment was chosen as an essential part of the content in a pre-service program for special education teachers in mathematics (SETMs) in order to set focus on the options for changing the mathematics classroom practice, and in that way avoid a deficit approach focusing the shortcomings of the students. This article reports the views of formative assessment of these SETMs after using formative assessment in their professional responsibility. The potential for using formative assessment to raise student learning (e.g. Black & Wiliam, 1998a; Hattie, 2009), in mathematics (e.g. Andersson & Palm, 2017b; Palm, Andersson, Boström & Vingsle, 2017) and for low-performing students (e.g. Black & Wiliam, 1998b; Fuchs & Fuchs, 1986) is well proven. The core principle in formative assessment is the process of eliciting information about student learning and a subsequent use of this information to adapt teaching and learning in the classroom practice. In recent conceptualizations

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both teachers and students are seen as urgent agents in this process (e.g. Brookhart, 2007; Black & Wiliam, 2009).

This article will suggest that a qualified use of formative assessment can afford an adapted learning environment that also is inclusive. Students who underperform in mathematics will never be a homogenous group and support in mathematics needs adaption to differences in student needs as well as to the mathematical content (Lewis & Fischer, 2016). Formative assessment assumes such differences. A formative assessment classroom practice should continuously identify and target particular misconceptions and incorrect strategies, and by building on specific strengths and weaknesses of the students, such practice may reduce the need of other intensive interventions and at the same time avoid marginalizing students whose learning trajectories deviate from what is considered normal (see discussion in Scherer et al., 2016). The use of formative assessment in the mathematics classroom has the potential to avoid that some students do not get access to full curricula and/or full participation in the learning environment, but also to empower students by affordances for their active agency and learning (see Björklund Boistrup, 2010).

Formative assessment in special education – opportunities and risks

Already in 1986 a research review, showing an effect size of .70 for students in need of special education support, was used to argue for the use of formative assessment as a replacement for the traditional way of categorizing students' specific needs and for improving the use of resources in classroom (Fuchs & Fuchs, 1986). Avoidance of categorization and a focus on the condition of the classroom practice characterise inclusive pedagogy (see Florian & Spratt, 2013), where *inclusion* connotes that student diversity and differences are seen as something natural and valuable. Formative assessment can facilitate inclusion (Bourke & Mentis, 2013; Hayward, 2013), but assessments include risks of leading to sorting, categorisation and exclusion (Hayward, 2013; Hollenweger, 2011) when used to judge who will receive special education resources (Isaksson et al., 2010). Within the project *Assessment in inclusive settings*, the *European agency for special needs and inclusive education* (EADSNE, 2009) argues for using formative assessment in special education, but points out that *how* formative assessment is applied still needs considerations. If the assessment becomes a barrier to inclusion depends on the adopted view of assessment, including what is assessed and how the assessment is carried out. More specific, the adopted view of assessment decides

whether shortcomings of the student or further learning opportunities come into the foreground (Bourke et al., 2011). The definition of formative assessment has developed and is now, in common with more general trends in education, often seen as a collective endeavour. From a socio-cultural perspective, curriculum, pedagogy, learner and community are linked together, and the engagement of all agents in the classroom and the roles of the teacher and learners becomes crucial (Hayward, 2013). Hereby, the access to the joint engagement will be vital for reaching an inclusive classroom practice.

To reach an *inclusive formative assessment*, Ravet (2013) points out avoidance of normative thinking and understandings of inclusion and formative assessment as crucial:

I have made the further case that inclusive formative assessment can be more successful where teachers can abstract themselves from the straightjacket of normative thinking about learning in order to understand the minds of children who function differently [...] Logically, if we want inclusive classrooms, we need teachers who can grasp the necessary inter-relationship between inclusion for all (Florian and Black-Hawkins 2011) and authentic formative assessment (Swaffield 2011). (Ravet, 2013, p. 961–962)

Formative assessment in special education teacher training

Formative assessment is recommended for special education (EADSNE, 2009; Watkins, 2007) and for support of struggling students in mathematics (National Mathematics Advisory Panel, 2008), but it cannot be expected that all ways of using formative assessment will have the same effect on students' learning in mathematics (see Palm et al., 2017). The conceptualisation of formative assessment and the quality of implementation will affect the outcome. In the framework by Wiliam and colleagues used in this paper (see below), high quality formative assessment means a competent and integrated use of five key strategies. Using formative assessment as a unit of integrated strategies can lead to extended learning opportunities (Andersson & Palm, 2017a) and enhanced student performance in mathematics (e.g. Andersson & Palm, 2017b; Balan, 2012). This potential, as well as the practice oriented origins and characteristics of the framework (see the KMOFAP project, e.g. Black et al., 2003), motivates the use of this framework in teacher training to support translation of theories of formative assessment into classroom practice.

Formative assessment – a framework

Formative assessment is based on the assumption that the outcome of the instruction cannot be predicted. This uncertainty leads to the need of collecting evidence of the students' learning to be used for adjustment of the teaching and learning in the classroom, which can be made by the teachers and/or the students. Two dimensions of formative assessment are shown when putting three processes in teaching and learning horizontally (*Where the learner is going; Where the learner is right now; How to get there*) and three agents in the classroom vertically (*Teacher; Peers; Learner*), simultaneously constructing the five key strategies (see Black & Wiliam, 2009; Wiliam & Thompson, 2008) that teachers can use to operationalize formative assessment.

1. Clarifying, sharing and understanding learning intentions and criteria for success.
2. Engineering effective classroom discussions, questions and tasks that elicit evidence of learning.
3. Providing feedback that moves learners forward.
4. Activating students as instructional resources for one another.
5. Activating students as the owners of their own learning.

These five key strategies (KS) are connected and can influence each other's performance. For example, clear learning intentions guide the teacher to choose questions or tasks that elicit relevant information about students' learning and help the teacher to provide goal directed feedback. In addition, learning intentions clear to the students enhance their opportunities to be engaged and involved in the learning process of their own or their peers'.

The complexity of putting formative assessment into practice

A study of Swedish mathematics teachers' use of the five key strategies showed that the teachers did use such strategies in classroom, but also ample room for improvement (Andersson et al., 2017). Using this kind of formative assessment is complex (e.g. Vingsle, 2014). Consequently, teachers need implementation support (Black & Wiliam, 1998b; Lee & Wiliam, 2005), with training that is formative and process oriented and provide the teachers with productive motivational beliefs (Andersson & Palm, 2018). In other words, support that is: "structured strongly enough

to afford teacher growth, but flexible enough to allow different teachers to take their practice in different ways” (Lee & Wiliam, 2005, p. 265).

Collaborative learning is found especially supportive for teachers’ learning about formative assessment (Young & Kim, 2010), offering opportunities to broaden teachers’ views of formative assessment (Black et al., 2003). The conceptualisation of (see e.g. Marshall & Drummond, 2006) and attitudes towards (see e.g. Torrance & Pryor, 2001) formative assessment need consideration because they will influence the implementation thereof (Brown, 2004; Sach, 2012; Young & Kim, 2010).

The literature in the area in-between special education and formative assessment makes up an optimistic but complex image that implicates teachers’ need of knowledge about both advantages and risks involved in formative assessment processes, an issue seldomly discussed in literature (Lin & Lin, 2015). Knowledge and guidance about how to implement assessment in inclusive terms need improvement (Watkins, 2007). Even so, it is suggested that the special education teacher has a unique position at school to coordinate formative assessment (Dorn, 2010). How such work is completed will depend on what this position means. Below, the conditions for and the responsibility of SETMs in Sweden are presented to illuminate what this position means in the Swedish context.

Context and responsibilities of special education teachers in Sweden

Swedish policy documents point out the responsibility of schools to provide all students inspiration and guidance for optimal learning and development, and to compensate for differences in students’ prerequisites. The ”school for all”-vision in Sweden is old and sometimes used as a reference model for inclusion, but the vision is not always reached in practice. Still, school failure and problems are often sought on an individual level rather than on a group or an organizational level (Giota et al., 2009; Göransson et al., 2015), students are defined and categorized from their weakness and student diversity is seldomly seen as positive (Göransson et al., , 2011).

There are two kinds of professionals with a responsibility directed to special education in Sweden, the special educators and the special education teachers. Both are well-educated and the latter has a specialization in mathematics, reading and writing or intellectual disorder. The present study is completed in a group of special education teachers with the specialization in mathematics. The skills and competences expressed in the degree ordinance of the Examination acts describe six *sub-responsibilities* in their profession:

- *School development*: to monitor and evaluate, as well as lead the development of the pedagogical work at school to meet the needs of all students
- *Adjustment of learning environments*: to initiate, analyse and contribute in preventive work of eliminating barriers and difficulties
- *Consultation*: to be a qualified partner and advisor in questions related to students' mathematical development
- *Educational evaluation*: to analyse difficulties for the individual student in the learning environment
- *Individual educational plan* (IEP, in Swedish Åtgärdsprogram): to, in collaboration with other involved actors, design and use IEPs for individual students to support students and develop learning environments
- *Instruction and assessment*¹: to provide individualized instruction for students in special education needs and to critically examine and apply methods for assessing students' learning and development in mathematics

Aim and research questions

By examining the view of formative assessment held by teachers having certain responsibilities within special education in mathematics, this study aims at contributing to the understandings about how formative assessment can be used in special education. The study intends to answer the following research questions:

1. To what extent and for what reasons do the SETMs consider formative assessment as beneficial and useful in their professional responsibility?
2. How is formative assessment considered beneficial and useful in the SETMs' different sub-responsibilities?
3. What challenges have the SETMs experienced in using formative assessment?

Methods

This explorative survey used interviews in combination with a questionnaire. The themes generated from five interviews was examined in

a questionnaire to the rest of the SETMs. The author of this paper conducted all data collection and data analysis, and was also the teacher for the respondents' training in formative assessment in four of five occasions of annual training programs.

Sample

The sample of 46 SETMs consisted the total number of teachers who had learnt about formative assessment in their training to become special education teachers in mathematics at the same university in Sweden between spring 2010 and spring 2014, and also taken their degree.

Five of the SETMs were selected as respondents for an interview. A stratified selection was made to reach respondents who worked with different age groups, from preschool class (6 years old students) to upper secondary school. The remaining 41 SETMs constituted respondents to the questionnaire. In the end 34 respondents, working from preschool class to upper secondary school, answered the questionnaire.

Table 1 shows an overview of the number of SETMs for each school level for: SETMs in total, those interviewed and those responding the questionnaire. Because of many different combination alternatives, the table is not fully consistent. For example, SETMs working in preschool class (P)–grade 2, P–grade 5 or grade 4–grade 6 are included in the group P–6 (i.e. non of them work in grade 7 and higher).

Table 1. The distribution of respondents working at different school levels

School level	P-6	1-9	4-9	7-9	7-US	US	Special school (2-18 years)	Tot
Number in the population	20	4	4	9	2	6	1	46
Number answering the interview	2	1		1		1		5
Number answering the questionnaire	14	2	4	6	2	3	1	34

Note. P = Preschool, US = Upper secondary school.

Data collection

All respondents were asked for participation via a telephone call. The interviewees were before the interview informed by email about the content to give them opportunity to prepare themselves. The interviews, conducted by telephone, were recorded and lasted between 45 and 80

minutes. The information about the questionnaire and a link to a web questionnaire were e-mailed to the respondents of the questionnaire.

Both the interview guide and the questionnaire included questions about the use of formative assessment activities in different sub-responsibilities (School development, Adjustment of learning environments, Consulting, Educational evaluation, IEP, Instruction, and any other responsibility); opportunities and/or barriers for using formative assessment; and the respondent's opinions about design of training about formative assessment for becoming special education teachers in mathematics. Data from the last question was excluded in this article due to limit of space. The interview was semi-structured, by supplementing the interview guide with control questions, clarifying questions, and questions about further information, details and examples. The questionnaire used close-ended questions and two types of open-ended questions.

The close-ended questions (designed based on the information obtained during the interviews) asked respondents to rate their degree of agreement on a scale of 1 (Not at all) to 5 (High degree), e.g. for experiencing the following obstacles when using formative assessment. One type of open-ended question gave the respondents the opportunity to add their own response alternative and the second type asked the respondent to give a descriptive answer. When respondents were asked to describe the ways formative assessment was found beneficial and useful in different sub-responsibilities, one separate question concerned *Instruction*, while another question compiled the other sub-responsibilities. The principle in the design of the questionnaire was to create a questionnaire with: quickly responded close-ended questions, the ability to add alternative answers and open questions in which the respondents could use their own words to express their thoughts, experiences and opinions.

Data analysis

Based on the design of the study the analysis of data from the questionnaire was completed after the analysis of data from the interview. The interviews were first transcribed verbatim. Then a grounded theory approach (Strauss & Corbin, 1990) was taken to analyse the responses by performing open coding, axial coding, and selective coding. In more detail, using meaning condensation (Kvale & Brinkmann, 2009), each main question response was coded and then categorized into sets of similar statements, two steps that were iterative (data, codes and categories were revised to become more sophisticated). The categories were examined to reach core statement categories that did not overlap each other. For example, these statements: "I have changed my way of looking

at teaching and learning in general on the basis of formative assessment” and “[...] changed my perception of development and learning, reflection about how the instruction has worked”, express a common theme that led to the core category *changed view of teaching and learning*, constituting one of the given response alternatives to the question about the ways formative assessment can be beneficial and useful.

The questionnaire, examining the core categories in the rest of the sample, generated quantitative data from the close-ended questions. Mean and standard deviation were calculated for all quantitative data. The qualitative data from open-ended questions were compared to the default response alternatives of the close-ended questions (generated from the interview) to distinguish responses consistent with default category (common theme) and responses adding a new theme. All descriptive responses were analysed according to key strategies in formative assessment and sub-responsibilities for special education teachers.

Findings

The findings derive from the questionnaire, with the number of responses (n), mean and standard deviation for the core categories presented in tables 2–4 (the range of answers to all items are 1–5). Data from one respondent who rated 1 (not at all) on all responded questions was removed since there was reason to believe that this respondent did not respond seriously. The findings are amplified by references to responses from the open-ended questions. To increase transparency, the number of SETMs who provided a certain type of response is reported.

Formative assessment – beneficial and useful

A mean of 4.06 from 33 responses (SD .83; range 2–5) shows that the SETMs in this study viewed formative assessment as beneficial and useful in their professional responsibility.

The reasons for viewing formative assessment as beneficial and useful from the interviews were confirmed in the survey (see table 2). At a general level, the SETMs express that formative assessment is beneficial because it increase the quality of teaching and learning in the classroom. More specifically, the use of formative assessment helps teachers to meet student differences and is particularly favourable for students in special educational needs. Moreover, most of the SETMs say that their view of teaching and learning has changed in an advantageous way, and many of them mean that formative assessment provides a structure useful for analysis of and discussions about teaching and learning. The vast

majority have also changed their own teaching, which in turn may be linked to their perceived change in their dialogue with the students.

Table 2. *The reasons for viewing formative assessment as beneficial and useful*

Reason	<i>n</i>	Mean	Standard deviation
Increase the quality of teaching and learning in classroom	33	4.30	.81
Is particularly beneficial for students in special education needs	33	4.18	.92
Help the teacher meet student differences	33	3.94	1.03
Has changed my view on teaching and learning	33	3.76	.94
Provides a structure for how to analyse and discuss teaching and learning	33	3.73	.94
Changed my own teaching	32	3.72	.63
Changed my dialogue with the students I teach	32	3.72	.85

The responses to the open-ended question largely corresponded to the default response alternatives (i.e. column 1 in table 2). Increased quality of teaching and learning (5 statements) expressed as: "Many students reach further than before" and the benefits of formative assessment as a structure for analysis of and discussion about teaching and learning (3 statements) as: "Has made me more conscious and analytical". One statement describes a new view on teaching and learning:

I have changed my way of looking on how you can learn. I use to think that using the students as recourses only was a way of exploiting the students. But if they [the students] put words on their learning then knowledge becomes more fortified.

Six statements not related to the default core statements in table 2, are instead related to the special education teacher's profession, as: "May evaluate the teacher's instruction" and "an instrument to mentor the teachers", and therefore touches upon the findings presented in the next section.

Formative assessment in different sub-responsibilities

The response rate to this item was slightly lower because some respondents did not have all sub-responsibilities. Even so, table 3 indicates that

formative assessment was viewed beneficial and useful in all the sub-responsibilities those special education teachers in mathematics commonly have. *Instruction and consultation* are favoured, but the differences between different sub-responsibilities are small.

Table 3. *Usefulness of formative assessment in different sub-responsibilities*

Sub-responsibility	<i>n</i>	Mean	Standard deviation
School development	29	3.48	1.02
Adjustment of learning environment	30	3.23	1.04
Consultation	31	3.77	.92
Educational evaluation	30	3.33	.96
Individual education plan (IEP)	30	3.23	1.17
Instruction	31	4.06	.73

No additional sub-responsibility was added in the open-ended question except for four SETMs using formative assessment in municipal mathematics education reform programs. The summary and examples below show ways in which formative assessment was seen as beneficial and useful in SETMs’ different sub-responsibilities. The findings about *Instruction*, which was separated from the other sub-responsibilities in the questionnaire, are presented first.

Formative assessment in SETMs’ own instruction

Responding the item asking them to describe how formative assessment had been beneficial and useful in their instruction, 27 SETMs see advantages for: (i) their students and (ii) themselves; (iii) how formative assessment give them theoretical support in form of a structure that is useful for them; and expressed as (iv) experiences from using formative assessment.

Six SETMs describe an increased efficiency of the instruction when the students notice and reflect on their own development, or by students’ enhanced engagement and motivation, e.g.: ”Reoccur in so many situations. What does the student know now? What is the next step? How do we get there? Students are involved and motivated when they know exactly what is required.”

Five SETMs articulate that formative assessment focuses on teaching, as a tool for the evaluation of the instruction and to help the teacher to quickly assess the needs of the group so that the instruction becomes

more efficient, e.g.: "By clarifying and focusing on the instruction, what you as a teacher can influence."

Five SETMs specify formative assessment as a model helping them to design instruction based on the students' needs, e.g.:

It has given me a theory to link to what [methods/instruction] I so often applied. A structure that has given me a kind of checklist of important aspects to use to increase participation and give a high degree of intrinsic motivation. The concrete tools have expanded my store of strategies, which I see as important in the "craftsmanship profession" that the job as a teacher is.

Eleven SETMs describe using aspects of formative assessment, e.g. creating classroom discussions, gathering student knowledge information and adjusting teaching and learning; and/or the instructional benefits e.g. communication of learning expectations or appropriated challenge for students, leading to enhanced meaningfulness, engagement or students' self-confidence as in: "Planning teaching on the right difficulty level and provide students in difficulties the opportunity to discover that they have skills even though they have not reached all the goals – increasing their self-confidence."

Formative assessment in other sub-responsibilities

Twenty-four SETMs describe how they find formative assessment beneficial and useful in different sub-responsibilities: (i) School Development; (ii) Adjustment of learning environments; (iii) Consultation; (iv) Educational evaluation; and (v) IEP.

Four SETMs describe how formative assessment has been used when they, together with colleagues, worked with development of the pedagogical work (School development), e.g.:

As I said, I think that it's rather obvious things, but it has helped us to put words on our tacit knowledge. We have worked a lot with, among others Dylan William, and it's great with a common language among us teachers.

Seven SETMs describe how they work to analyse and act to remove barriers in learning environments (Adjustment of learning environments) by (a) effective instruction or adjusting instruction based on identified students' need:

[...] to focus on teaching and learning and ask questions based on it [formative assessment]. Is the instruction visible? Do the students

know where they're going, where they are and how they should do to get further? To draw the attention of the colleagues to the importance of starting from the student and where he or she is [in their learning] and to build from there, instead of only conclude that the student cannot keep up with the teaching and learning in the classroom

or by (b) increasing students' participation in their own learning: "... it is the structure in order to increase participation and ownership of a shared responsibility I have had greatest benefits from. When the pattern became apparent to me, it was also easier to apply in other contexts."

Five SETMs describe the development of their role as a SETM, where formative assessment becomes a resource in the dialogue with and guidance of others, foremost with colleagues but also parents (*Consultation*) used to initiate, demonstrate and discuss various formative activities; and to support teachers' learning by building on the teachers' knowledge and help them find appropriate methods by letting the teachers themselves determine how to do in their own class:

Consultation. I have worked at my current school in four years; we are constantly trying to develop the special education teacher role in the school organisation. If this would work better then I think I to a greater extent would be able to convey and support the teachers to a more formative approach to teaching and learning.

The sub-responsibilities of the special education teacher sometimes overlap each other. Therefore statements (eight in total) relating to *Educational evaluations* and design and implementation of *IEPs* are here presented together (also *Consultation* is involved). The SETMs find formative assessment useful when they evaluate the adjustments of ordinary classroom practice, and in communication with the teachers and students about Educational evaluations:

Through the logbooks that the students work with each week and of course in conversations with students, it provides information to evaluations, an insight into where the students are in their learning based on short-term goals etc. in consultation with others, we have often discussed task design, material presentation, etc.

Formative assessment is also used in the monitoring of goal attainment and found well suited to the purpose of the IEP: "In guidance and discussion when the individual education plan is done, there is time to think about the student' next step in learning and development and how we get there." Several SETMs mention the importance of concrete goals: "Clarification of goals for students and parents has improved the efficiency of

individual education plans and short-term goals become relevant and linked to the teaching and learning.”

The next section, presenting challenges the SETMs had experienced, deepens the understandings about the contexts in which the SETMs work. The reported challenges for using formative assessment relate to SETMs’ different sub-responsibilities and somewhat to specific aspect of formative assessment.

Challenges related to SETMs’ different sub-responsibilities

The reported challenges related to SETMs’ different sub-responsibilities regard organisation, time, communication and collaboration (see table 4). However, noticing the negation in the question design and the standard deviation in the table, it is indicated that the experiences of the SETMs are varied.

Table 4. *Challenges for using formative assessment in different sub-responsibilities*

Challenge	<i>n</i>	Mean	Standard deviation
I have no class to practice formative assessment in.	33	3.15	1.68
My colleagues have not been interested in learning more about formative assessment.	33	2.45	1.33
My colleagues have not had the same understanding of formative assessment.	33	2.94	1.25
Lack of time to discuss formative assessment with colleagues.	33	3.33	1.19
Lack of time to plan for the use of formative assessment.	33	3.15	1.30

Additionally, three SETMs brought up: the difficulty of creating the basic social safety needed for formative assessment because the classes are constantly changing, difficulties in communication with non-native Swedish speaking students and lack of compliance with national assessment support. Another SETM describes obstacles on a general level:

The work as a special education teacher often becomes large urgent problems and consequently often long-term plans with mathematics teachers on how to use formative assessment are not given priority. Often my time is used to individual students or small group who need extra instruction because the math teacher often has worked too long alone teaching and eventually becomes completely exhausted.

The challenges related to cooperation with colleagues in the core categories are complemented in four open ended responses bringing up the overload and tiredness of their colleagues, misunderstandings among colleagues and the need of basic understandings of formative assessment, e.g.:

All teachers should have a basic knowledge [about formative assessment], then it is easier that we agree to prioritizing both the discussions and changes in instruction methods. Even the principal needs to understand what it is all about so that it is prioritised in the school organisation.

Challenges related to formative assessment

For challenges related to formative assessment key strategy 4 (students as learning resources for each other) is the strategy brought up as challenging by most (nine) SETMs. Students who support each other require a supportive classroom climate, which can be socially complicated or otherwise difficult to create. Six SETMs indicated that using rubrics/clarifying learning goals is challenging. Both the time for planning and limited lesson time are given as problematic. Other challenges, raised by a few respondents, are to handle students' mistakes, self-assessment and to provide feedback to students that the special education teacher only meets once a week. In total was given 18 responses in the open-ended questions that touched upon all five key strategies (KS) in formative assessment.

Discussion

Reaching inclusive school mathematics and defining characteristics of education that recognize and value student diversity, rather than treating differences as evidence of a deficiency (see Scherer et al., 2016) should be a prioritised aim of research and practice in school mathematics. The avoidance of a deficit approach motivated formative assessment as a content in the training for the special education teachers in mathematics (SETMs) in this article. Their views of formative assessment after using this practice in their professional responsibility have been reported here. These findings do not provide evidence of *inclusive formative assessment* (see above), but they underpins the motives for using formative assessment from a special education perspective and show benefits as well as challenges for doing so. The findings also provide implications for how to reach and secure a use of formative assessment that is inclusive. These implications will be outlined after a discussion of the main findings.

Main findings

In summary, formative assessment is viewed as beneficial and useful in general with reference to raising the quality of the teaching and learning, the framework structure advantaging the dialogue with colleagues, a changed view of teaching and learning, changes in the SETMs' own instruction and dialogue with student, helping teachers to meet student differences and particularly favourable for students in special needs in mathematics. The respondents in this study found formative assessment useful in all SETM common sub-responsibilities. However, the reported challenges in using formative assessment depict the complexity of working with these sub-responsibilities. Organisational and time issues as well as communicational issues are addressed and generally there seems to be room for improvement regarding the cooperation between SETMs and regular teachers. Challenges related to formative assessment highlight the dimension of student involvement as an issue and the need of social safety in classroom.

Above, the findings from qualitative data are given ample space to complement the quantitative data. The findings based on quantitative data are not straightforward. At the general level the respondents agree on formative assessment as beneficial and useful, but at more detailed levels the means and standard deviations indicate a more varied view. The variation regarding sub-responsibilities and work situations affects what benefits the SETMs will experience and make conclusions difficult in small samples as this.

Nevertheless, the findings confirm the motive for formative assessment as a content in SETM training programs to set the options for changing mathematics classroom practice in focus. All reasons for benefits and usefulness reported by the SETMs more or less regard raising the quality of the instruction in mathematics. Moreover, the findings confirm literature saying that implementation of formative assessment is challenging and implicate a need of cooperation between SETMs and regular teachers, with the possibility of using the framework in such cooperation.

Cooperating to reach and secure an inclusive formative assessment

Cooperation is favorable in implementation of formative assessment (Young & Kim, 2010), but reaching an inclusive formative assessment adds another demand. Special education teachers and regular teachers working together can raise consciousness and broaden the views of formative assessment (Black, et al., 2003) to keep focus on the

development of the classroom practice conditions as suggested by Florian and Spratt (2013, p. 122):

[...] encouraged to view difficulties in learning as dilemmas for themselves as teachers (rather than deficits in children) and to seek new approaches to support children. Following this approach, teachers work with specialists in order to find ways of providing meaningful learning experiences for all children within the classroom community. In common with children, teachers are encouraged to learn from working with others.

The findings implicate that the framework of formative assessment could be used in such cooperation to analyse, evaluate and talk about the classroom practice to identify barriers for learning and find ways of raising the quality of classroom practice. For example, reaching a common understandings of learning goals (KS 1), frequent and reliable information of student learning (KS 2) or enough time and support to use feedback (KS 3) could be favourable for all students in the class. As a result, categorization of students and risks of exclusion may be avoided. In addition, risks of exclusion may be reduced by enhanced and secured involvement of the students as agents in formative assessment (KS 4 and 5), which at the same time can improve the use of resources in classroom (Fuchs & Fuchs, 1986). It is hard to see how this kind of development work could be done without a cooperation between the special education teachers in mathematics and the regular teachers.

Using formative assessment for an inclusive school mathematics

The need of communication and cooperation is reflected in the sub-responsibilities of SETMs, viewing the unique position that they have (Dorn, 2010) in striving towards *a school for all*. Using formative assessment will never be the one and only way to build an inclusive school mathematics, but its potential deserves attention. The immovable need of adaption to differences in student needs and the mathematical content (Lewis & Fischer, 2016) equals the core idea in formative assessment that calls for the need of eliciting evidence of student learning to be used for adjusting the teaching and learning in the classroom. In addition, the use of formative assessment in the mathematics classroom can empower students by affordances for their active agency and learning (see Björklund Boistrup, 2010). This article may contribute to the understandings about the inter-relationship between inclusion and formative assessment vital for reaching the use of inclusive formative assessment (see Ravet, 2013).

Limits of the study

The novelty of the questionnaire, the small and by convenience collected sample and the relation between the researcher and respondents threaten the trustworthiness of the study. However, the exploratory approach of the study makes the methodology reasonable, the sample appropriate, and the consistency of the data obtained strengthen the trustworthiness. The researcher has deliberately tried to handle all challenges arisen from previous relation to the respondents. An advantage has been that the communication between the researcher and the respondents was facilitated by the common reality (including the common conceptualisation of formative assessment).

Future studies and concluding remarks

Generally, more knowledge is needed concerning assessment practices in special education (Lin & Lin, 2015) and how to implement formative assessment in inclusive terms (Watkins, 2007). This study highlights the need of studies on what special education teachers need to know about formative assessment from an inclusive perspective and studies on how collaborative work between regular and special education teachers can be conducted and supported. In future research more sophisticated frameworks, combining theories of formative assessment and inclusion, may be developed to provide more specified guidance. Unless the use of formative assessment in schools leads to more inclusive classroom practices it is important to pay attention to this issue.

References

- Andersson, C., Boström, E. & Palm, T. (2017). Formative assessment in Swedish mathematics classroom practice. *Nordic Studies in Mathematics Education*, 22(1), 5–20.
- Andersson, C. & Palm, T. (2017a). Characteristics of improved formative assessment practice. *Education Inquiry*, 8(2), 104–122.
- Andersson, C. & Palm, T. (2017b). The impact of formative assessment on student achievement: a study of the effects of changes to classroom practice after a comprehensive professional development programme. *Learning and Instruction*, 49, 92–102.
- Andersson, C. & Palm, P. (2018). Reasons for teachers' successful development of a formative assessment practice through professional development – a motivation perspective. *Assessment in Education: Principles, Policy & Practice*, 25(6), 576–597. doi.10.1080/0969594X.2018.1430685

- Balan, A. (2012). *Assessment for learning: a case study in mathematics education* (PhD thesis). Malmö University.
- Björklund Boistrup, L. (2010). *Assessment discourses in mathematics classrooms: a multimodal social semiotic study* (PhD thesis). Stockholm University.
- Black, P., Harrison, C., Lee, C., Marshall, B. & Wiliam, D. (2003). *Assessment for learning: putting it into practice*. Open University Press.
- Black, P. & Wiliam, D. (1998a). Assessment and classroom learning. *Assessment in education: Principles, policy & Practice*, 5 (1), 7–74.
- Black, P. & Wiliam, D. (1998b). Inside the black box: raising standards through classroom assessment. *Phi Delta Kappan*, 80 (2), 139–144.
- Black, P. & Wiliam, D. (2009). Developing the theory of formative assessment. *Educational Assessment, Evaluation and Accountability*, 21 (1), 5–31. doi.10.1007/s11092-008-9068-5
- Bourke, R. & Mentis, M. (2013). Self-assessment as a process for inclusion. *International Journal of Inclusive Education*, 17 (8), 854–867. doi.10.1080/13603116.2011.602288
- Bourke, R., Mentis, M. & Todd, L. (2011). Visibly learning: teachers' assessment practices for students with high and very high needs. *International Journal of Inclusive Education*, 15 (4), 405–419.
- Brookhart, S. M. (2007). Expanding views about formative classroom assessment: a review of the literature. In J. H. McMillan (Ed.), *Formative classroom assessment: theory into practice* (pp. 43–62). Teachers College Press.
- Brown, G. T. L. (2004) Teachers' conceptions of assessment: implications for policy and professional development. *Assessment in Education: Principles, Policy & Practice*, 11 (3), 301–318. doi.10.1080/0969594042000304609
- Dorn, S. (2010). The political dilemmas of formative assessment. *Exceptional Children*, 76 (3), 325–337.
- EADSNE (2009). *Assessment for learning and pupils with special educational needs*. European Agency for Development in Special Needs Education. <http://www.european-agency.org/publications/flyers/assessment-materials/assessment-for-learning/assessment-for-learning-graphic-en.pdf>
- Florian, L. & Spratt, J. (2013). Enacting inclusion: a framework for interrogating inclusive practice. *European Journal of Special Needs Education*, 28 (2), 119–135. doi.10.1080/08856257.2013.778111
- Fuchs, L. S. & Fuchs, D. (1986). Effects of systematic formative evaluation: a meta-analysis. *Exceptional Children*, 53 (3), 199–208.
- Giota, J., Lundborg, O. & Emanuelsson, I. (2009). Special education in comprehensive schools: extent, forms and effects. *Scandinavian Journal of Educational Research*, 53 (6). doi.10.1080/00313830903302083
- Göransson, K., Lindqvist, G. & Nilholm, C. (2015). Voices of special educators in Sweden: a total-population study. *Educational Research*, 57 (3), 287–304. doi.10.1080/00131881.2015.1056642

- Göransson, K., Nilholm, C. & Karlsson, K. (2011). Inclusive education in Sweden? A critical analysis. *International Journal of Inclusive Education*, 15 (5), 541–555. doi.10.1080/13603110903165141
- Hattie, J. (2009). *Visible learning. A synthesis of over 800 meta-analyses relating to achievement*. Routledge.
- Hayward, L. (2013). Assessment for learning and the journey toward inclusion. In L. Florian (Ed.), *The Sage handbook of special education* (pp. 523–535). Sage.
- Hollenweger, J. (2011). Teacher's ability to assess students for teaching and supporting learning. *Prospects*, 41 (3), 445–457. doi.10.1007/s11125-011-9197-3
- Isaksson, J., Lindqvist, R. & Bergström, E. (2010). "Pupils with special educational needs": a study of the assessments and categorizing processes regarding pupils' school difficulties in Sweden. *International Journal of Inclusive Education*, 14 (2), 133–151. doi.10.1080/13603110802504176
- Kvale, S. & Brinkmann, S. (2009). *InterViews: learning the craft of qualitative research interviewing* (2nd ed.). Sage.
- Lee, C. & Wiliam, D. (2005). Studying changes in the practice of two teachers developing assessment for learning. *Teacher Development*, 9 (2), 265–283. doi.10.1080/13664530500200244
- Lewis, K. E. & Fisher, M. B. (2016). Taking stock of 40 years of research on mathematical learning disability: methodological issues and future directions. *Journal for Research in Mathematics Education*, 47 (4), 338–371.
- Lin, P.-Y. & Lin, Y.-C. (2015). Identifying Canadian teacher candidates' needs for training in the use of inclusive classroom assessment. *International Journal of Inclusive Education*, 19 (8), 771–786, doi.10.1080/13603116.2014.970669
- Marshall, B. & Drummond, M. J. (2006). How teachers engage with assessment for learning: lessons from the classroom. *Research Papers in Education*, 21 (2), 133–149. doi.10.1080/02671520600615638
- National Mathematics Advisory Panel. (2008). *Chapter 6: report of the task group on instructional practices*. <http://www.ed.gov/about/bdscomm/list/mathpanel/report/instructional-practices.pdf>
- Palm, T., Andersson, C., Boström, E. & Vingsle, C. (2017). A review of the impact of formative assessment on student achievement in mathematics. *Nordic Studies in Mathematics Education*, 22 (3), 25–50.
- Ravet, J. (2013). Delving deeper into the black box: formative assessment, inclusion and learners on the autism spectrum. *International Journal of Inclusive Education*, 17 (9), 948–964. doi.10.1080/13603116.2012.719552
- Sach, E. (2012). Teachers and testing: an investigation into teachers' perceptions of formative assessment. *Educational Studies*, 38, 261–276. doi.10.1080.03055698.2011.598684
- Scherer, P., Beswick, K., DeBlois, L., Healy, L. & Opitz, E. M. (2016). Assistance of students with mathematical learning difficulties: How can research support practice? *ZDM*, 48 (5), 633–649.

- Strauss, A. L. & Corbin, J. (1990). *Basics of qualitative research: grounded theory procedures and techniques*. Sage.
- Torrance, H. & Pryor, J. (2001). Developing formative assessment in the classroom: using action research to explore and modify theory. *British Educational Research Journal*, 27 (5), 615–631. doi.10.1080/01411920120095780
- Vingsle, C. (2014). *Formative assessment: teacher knowledge and skills to make it happen* (Licentiate thesis). Umeå University.
- Watkins, A. (Ed.) (2007). *Assessment in inclusive settings: key issues for policy and practice*. European Agency for Development in Special Needs Education.
- Wiliam, D. & Thompson, (2008). Integrating assessment with learning: What will it take to make it work? In C. A. Dwyer (Ed.), *The future of assessment: shaping teaching and learning* (pp. 53–82). Lawrence Erlbaum.
- Young, V. M. & Kim, D. H. (2010). Using assessments for instructional improvement: a literature review. *Education Policy Analysis Archives*, 18 (19), 1–40.

Note

- 1 This sub-responsibility will be called Instruction because the study sees assessment as embedded in instruction (i.e. in teaching and learning).

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