Enacting assessment accommodations in an inclusive formative classroom practice: The case of color-coding

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This study explores how a Special Education Teacher in Mathematics (SETM) implements the assessment accommodation of color-coding in a Parallel Support setting. SETM's goal is to support a student with learning disabilities in a grade 8 mathematics classroom. We view formative assessment as a unified classroom practice that involves teachers' actions and students' responses to these actions. The results indicate that the main SETM's actions while enacting color-coding accommodation are a*) repeating and extending student's short answers; b) asking student to justify his responses; c) evaluating and validating student's correct responses; d) honoring student's contribution by maintaining his mathematical idea and e) creating a positive and engaging learning environment by frequently rewarding student's responses.*

Keywords: Inclusive formative classroom practices, Assessment accommodations, Color-coding, Special Education Teacher's actions.

Introduction.

The potential of using formative assessment in mathematics classrooms to raise students' learning is well documented in many studies (Andersson, 2020; Heritage & Wylie, 2018). Even though, many studies argue that adapting formative assessment practices could be more effective and inclusive for specific group of learners such as learners with autism (e.g., Ravet, 2013), there is a limited number of studies that explore formative assessment in mathematics classrooms from a special education perspective.

In special education settings, teachers usually implement assessment accommodations to support students with special learning needs (Maccini & Gagnon, 2000). Assessment accommodations are changes made to an assessment procedure (e.g., scheduling, timing, task presentation), that aim to remove barriers and allow students to fully demonstrate their competencies and their abilities (Elliott et al., 1998). Maccini and Gagnon (2000) determined the type of assessment accommodations that special and general education teachers reported while enacting assessment practices. These types of accommodations may include visual tools for task presentation; reference materials such as cue cards or charts of strategy steps; or time extensions on tests.

The current study explores how a Special Education Teacher in Mathematics (SETM) implements a specific type of visual tools such as color-coding in order to support a student with autism. The research question (RQ) is: What are SETM's teaching actions while enacting the assessment accommodation of color-coding in a formative assessment practice?

Color-coding is the use of colors to represent data values on a task. This means that every data value is associated with exactly one color, and vice versa i.e. every color represents a fixed range of data values (Tominski, Fuchs & Schumann, 2008).

Theoretical Background.

Socio-cultural perspective.

We adopt a socio-cultural perspective since we view teaching and learning as a joint labor process where teachers and students are laboring together to produce knowledge (Radford, 2014). Thus, it is important to explore teachers' in-the-moment responses to student mathematical contribution. In this study, we analyze SETM's actions through the Teacher Response Coding (TRC) framework (Van Zoest et al., 2022). Some of the actions included in this framework are: *allow* (creates an open space for interaction); *check-in* (elicits student's self-assessment or understanding); *clarify* (asks the student to make more precise answer); *justify* (gives the student the opportunity to reason on his mathematical idea) and *evaluate* or *validate* students' responses. Another important aspect of the TRC framework is the degree to which the teachers' response aligns with students' ideas and mathematical contributions.

Inclusive formative assessment practice.

Practice in a classroom, is formative to the extent that evidence about student achievement is elicited, interpreted, and used by teachers, learners, or their peers, to make decisions about next steps in instruction (Black & Wiliam, 2009). Thus, all studies share the defining characteristic of formative assessment: agents in the classroom collect evidence of students' learning, and based on this information, adjust their teaching and/or learning (Andersson & Palm, 2017). In this study we use the term of 'inclusive formative assessment' (Andersson, 2020, p. 75) where inclusion means that students' diversity and differences are seen as something natural and valuable. Based on this perspective, students with mild learning disorders are now taught in mainstream classrooms and not in special units and schools. To achieve inclusive formative assessment is a challenging issue. Ravet (2013) argues that "inclusive formative assessment can be more successful when teachers abstract themselves from the straitjacket of normative thinking about learning, in order to understand the minds of students who function differently" (p. 961).

In this study, we view formative assessment as a unified practice that involves teachers' actions and students' responses to these actions. We analyze SETM's actions while enacting a specific assessment accommodation in a Parallel Support environment as well as the outcome of these actions on students' learning.

Literature review.

A limited number of studies suggest empirically validated approaches for assessing students with learning disabilities in mathematics classrooms. Tay and Kee (2019) study mainstream teachers' effective questioning and feedback in primary and secondary math and science classrooms that include high-functioning students with autism spectrum disorder (ASD). They identified three important characteristics of effective questioning and feedback for these students: *addressing students' cognitive needs of* (e.g., precise and direct questions); *taking*

into consideration their socio-emotional needs (e.g., affirmative feedback); and *using of supporting structures* (e.g., visual cues). Andersson (2020) documented 39 special education teachers' views while implementing formative assessment practices in mathematics classrooms. Participants, referred to the potential of formative assessment for students with learning disabilities as well as to the challenges they faced, while trying to adjust the learning environment according to students' individual needs.

Methodology.

The Greek educational system.

The Greek educational system, based on the current legislation (Law 3699 of 2008, article 6) provides inclusive teaching support programs, such as the Parallel Support (PS) program, for students with learning disabilities (e.g., students with Autism Spectrum Disorder (ASD) or students with intellectual disability). Parallel Support is a co-teaching program where two teachers, a general education teacher and a special education teacher share the instruction for a single student in a single classroom setting. Mavropalias and Anastasiou (2016) explored the features of the Greek co-teaching model of Parallel Support (PS) in several Greek educational regions. Their study revealed that the PS program is similar to the One Teach, One Assist approach where the special education teacher typically sits next to the student with a disability, while the general education teacher delivers the lesson in the traditionally arranged classroom setting. The Special education teachers provide individualized support for these students during lessons in a regular classroom, not only to support them to follow the general education system curriculum, but also to reach their educational needs.

The context of the study.

The research was carried out in a general education junior high school, during the 2023-24 school year, where one of the researchers works as SETM in a PS program and is responsible for implementing individualized instruction in mathematics, for students with learning disabilities. In this study the research data concerns one of these students, who attends the 8th grade mathematic classes, with an ASD diagnosis. For the needs of this research ethical issues were taking into consideration. SETM from the beginning of the school year had knowledge about important characteristics of the student's learning profile, through the official written diagnosis. This diagnosis, among others, provided useful instructive suggestions that were estimated to favor student's understanding. Specifically, some of these suggestions were that SETM should conduct a combined review of acquired knowledge and implement applications of mathematical skills; systematically pursue student's understanding of mathematical concepts; use information coding (e.g., acronyms, highlighting or color-coding) and positive reinforcement by rewarding student's effort.

Research data and data analysis.

Research data is drawn from the research diary kept by the SETM, concerning her everyday actions as special education teacher. Data derived from the research diary included written notes of her daily schedule; photographic material from the student's notebook; short indicative dialogues with the students and the classroom teacher, written on field notes during the lesson

or during the breaks; her teaching goals and her reflections after the lesson enactment; short reports/updates about the students' learning progress; information about students' daily homework tasks and the difficulties they faced. It also included short discussions with general education teachers, concerning assessment tools. The above information supports SETM to gain a better perception of the student's learning profile, learning needs as well as types of assessment accommodations that appeared to have a positive learning outcome for them.

The analysis of research data was carried out in three steps. Step 1: We traced all episodes in SETM's Research Diary where she implemented the specific assessment accommodation of color-coding in a number of lessons. Step 2: Two episodes were selected in which, the color-coding played a significant role in a problem-solving process. Step 3: In these episodes, SETM's actions were analyzed through the TRC framework (Van Zoest, et al., 2022).

Results.

The following two episodes are from the same teaching hour and the teaching chapter covers the calculation of the area of known geometric shapes. The color-coding method was used during the problem-solving process.

1st episode.

The 1st episode was concerning a textbook homework task (Task 1) assigned by the general education teacher to all students. The problem was asking students to calculate the area of the two roads (brown rectangles) and the lawn (green areas) as presented in Figure 1.

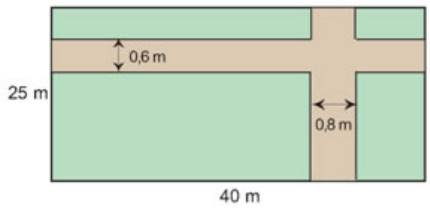

Figure 1: The textbook task (Vlamos et al., 2017, p. 125)

At first SETM checked student's notebook to make sure that homework was done. From this check, SETM realized that there was a mistake in student's following response: 1000 - (24 + 20) = 1000 – 44 + 0,48 = 956.48. In the area calculation solution, student added 0,48 (the crossroad area) without any explanation. This prompted SETM to ask student to justify his answer. The student seemed to face difficulties in justifying his answers. SETM decided to copy the shape on student's notebook by using different colors for each road and the lawn area (Figure 2). Specifically, she took the following color-coding steps as appears in her new version Figure 1 (see Figure 2). Step 1: SETM drew the main rectangle (25W x 40L) and defined with green color all the areas that supposed to be planted with lawn, keeping the book's initial color coding, specifying that this was the area to be calculated. Step 2: Orange color was used to mark the horizontal road. Even though student pointed out correctly the largest and the smallest dimension of the orange rectangle, seemed to struggle when was asked to calculate this area. Step 3: Purple color was used for the vertical road. The main purpose of color-coding was to make the magenta rectangle visible to the student. Then, SETM asked again the student to

calculate this area where similar difficulties appeared once more. Then SETM started to discuss with the student about the colors that appeared in the final design.

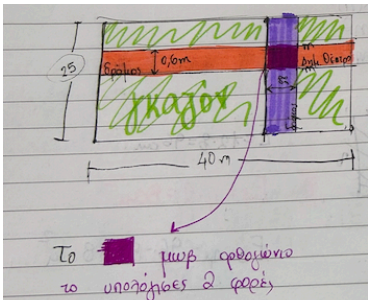

Figure 2: Modifying the textbook task by using color-coding accommodation.

1 SETM:	So far, we have calculated the area of the orange road and the area of the purple road. Can you see what is happening with that little rectangle with the different color? Why do you think the color changes?
2 Student:	Because is the purple above the orange. It has two colors [purple and orange]. This [rectangle] is part of the two roads!
3 SETM:	Very nice! So practically what does this mean for us? When we calculated the orange area, we calculated the area of the little magenta rectangle for the 1st time, but we calculated the area of this exact same rectangle for the 2nd time when we calculated the area of the purple road. So, in the end it's like we have calculated magenta's rectangle area twice.

SETM *summarizes* what was done so far and asks student to focus on the color change that appears in the Figure 2 (Line 1). SETM *allows* student to respond and asks him to *justify* through the two colors. Student realized that the magenta area appeared twice in calculations during the solution (Line 2). Student came to this conclusion through the observation that the different color in the crossroad rectangle is due to the overlapping of the two colors. Then, SETM gives supportive feedback to student for the observation made, *repeats* and *extends* the whole solution process in detail (Line 3) and finally she relates the solution with the color-coding accommodation and presents it in mathematical terms by *evaluating* and *validating* student's response. Furthermore, she *honors* and *rewards* student's mathematical contribution.

2nd Episode.

The 2nd episode concerned a geometrical problem that the general education teacher gave to the students as homework. This geometric task (Task 2) referred to the calculation of the area of a specific geometric shape. Student drew the shape in the notebook and solved the problem as appears in Figure 3. Then, the general education teacher asked students to provide an alternative solution. Student could not think of a different way to solve the task. The SETM decided to use color-coding to support student to identify another way to solve the problem.

SETM redesigned the geometric shape and filled with pink color the inner rectangle appeared, as shown in Figure 4.

1 SETM:	So, can you tell me what is the geometric shape that you see here?
2 Student:	A large rectangle.
3 SETM:	What's the area of this large rectangle?
4 Student:	12x8

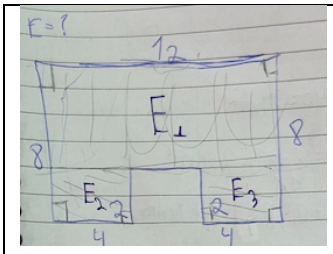

Figure 3: Students' initial solution of Task 2

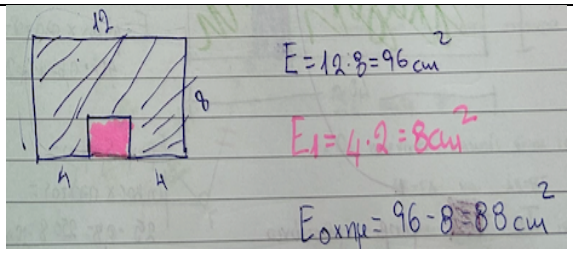

Figure 4: The modification of Task 2, indicating the alternative solution and the use of color-coding accommodation

In Lines 1, SETM starts with *check-in* student's understanding of the geometrical figure. Student possibly identifies two rectangles in the drawing, the large one and the small one colored in pink (Line 2). Then, SETM asks student to *clarify* his answer and make the relevant calculations. SETM wrote "E1 = …" on the notebook to *allow* him to move to the next step i.e. to calculate the area of the small pink rectangle.

5 SETM:	So, can you tell me what is the length and the width of this little pink rectangle that was formed?
6 Student:	4 [points out the length of the rectangle].
7 SETM:	Oh, nice! And how did you find it?
8 Student:	At the left and at the right is also 4. There are 3 pieces that makes us 12.
9 SETM:	That is because our shape is rectangle, so the opposite sides are… [let the student finish her argument]
10 Student:	Equal.
11 SETM:	Perfect! So, you made the calculations 4+4=8 and then 12-8=4. And what a nice observation that in this case we have indeed 3 equal parts of 4, that makes us 12. What about the other dimension? Look at the shape above and then calculate the area of this pink rectangle.
12 Student:	2. So the area is 2x4.
13 SETM:	Finally, to calculate this area [outlines the shape with purple lines], what shall we do?
14 Student:	96-8.
15 SETM:	Very nice! So, from the area of the large rectangle we will subtract the area of the small one.

In line 5 SETM starts focusing on the small pink rectangle, asking him to *name* the dimensions of the small rectangle. In lines 6 to 8 student responds correctly and SETM asks him to *justify* his responses. It seems that color-coding facilitated student to reach the conclusion that the length is divided into 3 equal pieces (Line 8). SETM *validates* this response while mentioning the relevant theory (Line 9). In line 11 SETM provides positive feedback to the student and then *extends* and *repeats* the mathematical process leading to student's correct answers in lines 6, 8 and 10. Finally, in lines 12 and 14 student gives the correct numerical solution to the problem while SETM *validates* student's answer and keeps *honoring* and *rewarding* student's mathematical contribution (Line 15).

Conclusions.

In this paper we explore SETM's actions while enacting a color-coding assessment accommodation in a PS program in a Grade 8 mathematics classroom. These actions constitute parts of an inclusive formative assessment classroom practice. The outcome of SETM's actions was leading to student's understanding. The main SETM's actions while enacting color-coding

accommodation are a) repeating and extending student's short answers; b) asking student to justify his responses; c) evaluating and validating student's correct responses by underlining the mathematical reasoning behind these answers; d) honoring student's contribution by maintaining his mathematical idea. In this way the student could easily follow the whole discussion (Van Zoest, et al., 2022); and e) creating a positive and engaging learning environment (Hill & Seah, 2023) by frequently rewarding student's responses and focused observations on the color-coding task presentation. SETM's actions seems to satisfy aspects of Tay and Key (2019) effective questioning and feedback. Specifically, SETM poses direct questions when she was asking student to *name* the dimensions of the rectangle; she provides affirmative and constructive feedback; and uses visual cues in color-coded form.

From our perspective, it is the dynamic nature of formative assessment, that makes this process challenging for special education teachers, as it requires continuous adjustments to create the appropriate inclusive conditions for students with learning disabilities (Andersson, 2020). The assessment accommodations -such as color-coding- create opportunities for the learners to demonstrate their mathematical competence and open ways to assess their abilities and not their disabilities (Elliott et al., 1998). Furthermore, despite the institutional limitations that the Greek educational system poses to SETM's teaching activities, as addressed by Mavropalias and Anastasiou (2016), SETM managed to overcome these limitations and to deliver a positive outcome for the student she is responsible for.

Finally, the limitations of this study include, the limited number of participants, one SETM and one student, and the small and by convenience selected sample of episodes does not allow us to generalize our conclusions. More research is needed concerning the enactment of assessment accommodation in inclusive formative assessment practices.

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