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A review of measures aimed at low-performing students in mathematics—What to do?

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This review article investigates measures aimed at low-performing students in mathematics in general classroom settings in primary and middle school education, as described by 24 empirical studies published after The Organization for Economic Co-operation and Development (OECD)'s 2016 report on low performance in mathematics. The article identifies how low performance in mathematics is defined, what measures have been studied, and the implications both for teaching and for future research. The results show considerable variation in the way low performance is defined as well as a predominance of quantitative intervention studies. Four key areas in which measures have been taken were identified: teaching organization and structure, the use of tools and aids, students' own learning strategies, and in specific mathematical content. The review highlights that measures aimed at individual students often yield limited outcomes and suggests a need to shift toward more inclusive and collaboratively-oriented teaching practices. Further, it underscores the importance of teacher competence, classroom stability, and content-specific didactics for enhancing learning outcomes. Finally, the article argues for increased focus on qualitative studies relating to inclusive teaching practices that also include those students who struggle with mathematics.

KEYWORDS

low-performing students, low-achieving students, mathematics, measures, teaching

1 Introduction

This article focuses on measures aimed at low-performing students in mathematics in general classroom settings in primary and middle schools. Student performance in mathematics has been registered and analyzed through various national and international tests for a number of years (Bew, 2011; Rambøll, 2013; OECD, 2016, 2023; Vestheim and Sem, 2019; Reynolds et al., 2024; von Davier et al., 2024). The Programme for International Student Assessment (PISA) has measured the performance of 15-year-old students in mathematics, reading and science triennially since 2000, and analyzes students' competence and skills to meet real-life challenges (OECD, 2023). PISA uses a baseline proficiency to identify a level of necessary performance in mathematics "required to participate fully in society" (OECD, 2016, p. 37). OECD (2016) defines low-performing students as those students who score below Level 2, on the PISA test, where the proficiency scales are divided into six levels. The levels span from level 1 (lowest achievement) to level 6 (highest achievement) (OECD, 2016). There are also other definitions of low performance, for instance Geary (2011) defines low-performing students as those students who score

between the 11th and 25th percentile on at least two consecutive standardized tests. If a student performs at or below the bottom 10th percentile, Geary (2011) states that they are likely to have learning disabilities in mathematics. These definitions do not include specific topics or skills that the students struggle with, or any reason why students are low performers in mathematics. The definitions state that the low performers are those students who perform below a certain number of points on specific tests.

Our frame of reference is the Norwegian context regarding low-performing students. In Norway, students have 10 years of compulsory school, and start in 1st grade the year they turn 6 years old, and finish 10th grade the year they turn 16. First grade to 7th grade equals primary school, and 8th grade to 10th grade equals middle school. The PISA testing is conducted for students being 15 years old. The 2022 PISA results for Norway showed that the number of low-performing students increased to 31% from 19% in 2018. This result places Norway at the mean of low-performing students in mathematics. Part of this increase may be attributable to 2 years of extraordinary circumstances during the COVID-19 pandemic, although there are also other factors that contribute to these low scores, for example bullying and mathematical anxiety (Jensen et al., 2023). In Norway, students are tested in multiple ways to register their level of performance during primary and middle school. In addition to international tests such as PISA and TIMSS (OECD, 2023; von Davier et al., 2024), Norwegian students are tested using three different national tests.

First, the students have a mandatory screening test in 3rd grade, which teachers use to decide where to put extra effort in the early years (Norwegian Directorate for Education Training, 2024). Second, there are mandatory national tests in calculation in 5th, 8th and 9th grades, developed by the Norwegian Directorate of Education and Training. Eighth and 9th grade students take the same test. The national tests are used to establish whether a student needs extra help in mathematics, and municipalities and schools use the results to develop the quality of teaching at their schools. The results can also be used by researchers (Norwegian Directorate for Education Training, 2023). The results of the 2024 national test for 5th graders showed that 28.7% of students scored at the lowest level of achievement out of three levels of achievement defined for the specific test (Norwegian Directorate for Education and Training, n.d.-b). The third and last test is a written mathematics exam after the students have completed middle school (10th grade). The exam is assessed with grades ranging from 1 to 6, where grade 1 is defined as very low competence and is regarded as a fail, and grade 2 is defined as low competence (Norwegian Directorate for Education Training, 2025). According to the Norwegian Directorate for Education and Training (n.d.-a), 6.6% of students achieved grade 1 on the exam in 2024 and 20.7% of students achieved grade 2. The results indicate that in 2024, 27.3% of the students completed 10 years of compulsory school with low competence in mathematics. The number of students achieving grade 1 and grade 2 on the written mathematics exam increased from 21.2% in 2023 to 27.3% in 2024 (Norwegian Directorate for Education and Training, n.d.-a).

The different tests of Norwegian students reveal an increase in the number of low-performing students in mathematics, leading

to a challenging situation with many low-performing students in Norwegian classrooms. Many teachers who encounter low-performing students in their classrooms report that they would like to learn more about how to help these students (Brennhaug, 2020). What happens when so many students are low performers in mathematics? A report from the Norwegian Directorate for Education Training (2015) showed a strong relationship between students who scored at the lowest level of achievement on the national tests in calculation in 5th grade and completing high school within the standard time frame. As many as one in four students who scored within the lowest level of achievement on the national test in calculation in 5th grade did not complete their first year of high school within the standard time frame as expected. The Norwegian Ministry of Education responded to this report with a revision of the national curriculum (Ministry of Education Research, 2017, 2019). The new curriculum comprises a core curriculum that contains values and principles for primary and secondary education in Norway. In mathematics, practical application, relevance and variation in the teaching and learning are emphasized as measures in order to attempt to reduce the number of low-performing students in mathematics (Ministry of Education Research, 2017, 2019; Meld St. 6, 2019–2020; Meld St. 34, 2023–2024).

The situation with low-performing students is not confined to the Norwegian educational system, and other countries have experienced similar developments. This has resulted in widespread international focus on measures to alleviate this problem (United Nations Educational Scientific Cultural Organization Institute for Statistics, 2017; Dir, 2020:24; Shimizu and Vithal, 2023). Thus, there is no question about the severity of the alarmingly high numbers of low-performing students in mathematics. However, less apparent are the measures that have been presented since the alarming report on low-performing students in mathematics from the OECD in 2016 (OECD, 2016). The implications of these measures for primary and middle school teaching and future research on low performance and low achievement in school mathematics are also less clear. This is why this review article is concerned about the established interpretation of students' low performance in mathematics, not why some students are low-performing students, *per se*. The article brings attention to measures that have either been proposed by, reported on or evaluated by educational research as part of the joint quest of stakeholders such as politicians, bureaucrats, researchers, school leaders, and teachers to increase the learning in mathematics of such students.

Thus, through a systematic selection of empirical research studies reported on in international peer-reviewed journals, this review addresses the following four research questions:

1. How is *low-performing students in mathematics* defined?
2. What methodologies have been used to examine the measures applied in primary and middle school mathematics in order to increase the learning of low-performing students?
3. What is the focus in research on measures applied in primary and middle school mathematics in order to increase the learning of low-performing students?
4. What are the implications for primary and middle school teaching, and for future research on the measures applied

to increase the learning of low-performing students in mathematics?

2 Method

2.1 Review parameters

This literature review was conducted in three phases, with the aim of identifying research on measures aimed at low-performing students in general mathematics education in primary and middle school. In the first phase, several different search terms and keywords were tested to get a better understanding of which combinations best fit the research questions. Keywords included “low-perform*,” “low-achieve*,” “student” or “pupil,” “mathematics,” “measure,” “teaching” and “elementary school.” After testing different combinations, a few search strings that had proved effective were decided on, including:

- “*mathematics AND (“low perform” OR “low-perform*”) AND (student* OR pupil*)*”
- “*low achievement AND student OR pupil AND mathematics AND teaching AND education AND school*”

To ensure the review reflected recent developments in the field, and to investigate research activity following the 2016 OECD report on low-performing students (OECD, 2016), the search was limited to articles published from 2016 onward. Only articles written in English were included for the sake of accessibility to an international research audience.

In the second phase, the keywords found in the first phase were applied to five academic databases: ERIC, Scopus, ScienceDirect, Web of Science, and SpringerLink. These databases were chosen for their wide influence on educational research. The search was limited to peer-reviewed empirical studies.

In the third phase, the search results were screened based on their relevance to the research questions. Duplicates were removed, i.e., articles found by either two or all three authors. Then, articles that did not include empirical research or did not focus on low-performing students in primary or middle school mathematics education were excluded. Studies that solely focused on students with diagnosed learning disabilities or studies situated outside the primary or middle school education context were also excluded. Articles were included if they:

- Focused on primary or middle school students
- Addressed low-performing students in general mathematics education, and not students with specific learning disabilities
- Recorded the effects of a measure in mathematics education targeting low-performing students
- Emphasized students’ outcome of a measure and not solely the teachers’ perceptions, as the focus of this review is on individual students

After completion of the three phases, 24 articles remained for closer analysis. The transparency of the three phases should make it easy to replicate the search, which was concluded in mid-February 2025 (Figure 1).

2.2 Analysis

With the aim of conducting a systematic analysis of the selected studies, a summary table was created (our analysis protocol) in which key features from each article was recorded. The four key features were the research setting (number and type of informants), the methods used, the focus of attention, conclusions and implications for teaching, and implications for future research. The articles were initially divided among the three authors, who conducted an initial review and completed the table individually. The first author then reviewed all entries for consistency and clarity. No further adjustments were required at this point.

With the four research questions in mind, the protocol was used to guide our analysis. For each article, how low performance was defined and conceptualized, the methodology employed, and the primary focus of the research was identified. Any reported implications for teaching, as well as directions for future research were extracted. This made it possible to identify trends and patterns across the literature. The summary table is available as [Supplementary material](#) linked to the article on the journal’s website.

3 Results

3.1 Definition of low-performing students in mathematics

The term *low-performing student in mathematics* is defined in various ways in the articles recorded in our protocol. Even though the articles define low-performing students in different ways, all the articles, like Geary (2011) and the OECD (2016), describe low-performing students as the lowest performers in the group in one way or another.

Fourteen of the articles defined low-performing students in relation to a percentage, either to the percentage of a test score, or as the percentage of the number of students. Nine of the articles defined low performers as those students who scored below a certain percentage of a test score. Four articles set the line at the lowest quartile (Mononen and Aunio, 2016; Oudman et al., 2022; de Barros and Ganimian, 2024; Lindström-Sandahl et al., 2024), while Hellstrand et al. (2020) and Koponen et al. (2021) set the line at the 20th percentile. Other articles defined low performers as the lowest decile of achievements (Herbst et al., 2023), students who scored below the 35th percentile of the test (Fuchs et al., 2016), or below 40% (Suseelan et al., 2023). Herrmann et al. (2022) divided the informants into three equal parts and defined the lowest part as low-performing students, while Spitzer (2022), Pedersen et al. (2023) and Lopez-Pedersen et al. (2022) defined low performers as 20%, 25% and 32%, respectively, of the number of students. One article defined low performers as the lowest 15%–20% of the students who were identified by their school as struggling with numeracy (Hodgen et al., 2023).

Of the remaining 10 studies, one study defined the low-performing students as -1 standard deviation on a test (Hotulainen et al., 2016), while Yeo et al. (2023) described them as students without significant achievement or growth rate. In four studies, the low-performing students were selected or nominated by their



FIGURE 1
Flow chart of the search and screening process.

teachers (Burns et al., 2019; Schueler, 2020; Kovalčíková et al., 2021; Xin et al., 2023) and in two studies, low-performing students were defined as those students with lower academic grades (Malola, 2020; Fernández-Company et al., 2023). Finally, the remaining two articles did not give a precise definition of the term *low-performing students* (Casler-Failing, 2018; Hulse et al., 2019).

3.2 Methods used in the reviewed studies

Our subject of interest, low performance in mathematics, is commonly measured using quantitative methods (OECD, 2023). This trend is reflected in the research articles. Of the 24 articles, three of them described mixed methods studies (Casler-Failing, 2018; Malola, 2020; Suseelan et al., 2023) while the remaining 21 articles were quantitative studies.

As shown in Table 1, the methods used in the research vary. A common approach was found to be an intervention study with

TABLE 1 Types of methods used in the research of the articles reviewed.

Type of method	Number of occurrences*
Pre- and post-testing during the intervention (test designed by the researchers)	14
Analyzing test scores from standardized tests or other data	8
Interview or conversation	2
Self-assessment	1

*Some articles employed more than one of these methods, such as Malola (2020), in which pre- and post-testing was conducted along with the interview sessions. Thus, the number of occurrences in this table exceeds the number of articles reviewed.

TABLE 2 Number of studies involving students from the given grade.

Grade	Number of occurrences*
1–2	8
3–4	13
5–6	6
7–8	6
9–10	3

*Several studies (e.g., Fernández-Company et al., 2023; de Barros and Ganimian, 2024) included a range of different grades. Thus, the number of occurrences in this table exceeds the number of articles reviewed.

a control group and an experiment group together with pre- and post-testing. Of the 24 research articles, 14 articles defined their research as an intervention study (e.g., Fuchs et al., 2016; Burns et al., 2019; Hellstrand et al., 2020; de Barros and Ganimian, 2024), one as design research (Malola, 2020), one as a case study (Casler-Failing, 2018). Five articles (Herrmann et al., 2022; Spitzer, 2022; Herbst et al., 2023; Pedersen et al., 2023; Yeo et al., 2023) were classified as large longitudinal studies analyzing test results or data collected nationwide from Denmark (Pedersen et al., 2023), Germany (Herrmann et al., 2022), Poland (Herbst et al., 2023), South Korea (Yeo et al., 2023), or across The Netherlands, Uruguay and Germany (Spitzer, 2022). Interview sessions were conducted in two studies (Malola, 2020; Suseelan et al., 2023), while self-assessment was conducted in Oudman et al. (2022).

The articles included in this review were limited to studies involving primary or middle school students with low performance in mathematics. Table 2 shows the number of articles that included students from the given grade in their research. There is a slightly higher number of studies focusing on the earlier grades, a trend (e.g., Hulse et al., 2019; Lindström-Sandahl et al., 2024) that emphasizes the need for early interventions to mitigate the effects of low performance in mathematics.

3.3 Focus of research attention on measures aimed at low-performing students in mathematics

The research articles studied in this review show that quantitative approaches are dominant in research regarding measures taken to improve the performance of low-performing students. The articles may be classified into four main categories of attention.

First, *measures taken regarding organizing teaching, and measures taken regarding priorities in teaching* were studied. This comprised quantitative-based research on class structure (Herrmann et al., 2022), group size (Herbst et al., 2023), increased use of teaching assistants (Hodgen et al., 2023), increase in study time, and the use of intensive study sessions (Schueler, 2020; Spitzer, 2022), as well as different teaching styles (Yeo et al., 2023). In summary, these studies highlighted several key points for researchers, politicians, school leaders, and teachers. First, Herbst et al. (2023) show that low-performing students in mathematics benefited from being in stable heterogeneous groups. Second, increasing the use of teaching assistants did

not always lead to a positive outcome according to the results of [Hodgen et al. \(2023\)](#). Finally, low-performing students in mathematics can improve their results if they make more effort. These results are of interest to the practice field. The use of dialog instruction seems to be more beneficial for low-performing students than direct instruction ([Yeo et al., 2023](#)), and they seem to benefit from more stable student groups ([Herbst et al., 2023](#)). However, addressing the challenges faced by low-performing students by highlighting their perseverance and willpower does seem to be more valuable for the research field than the practice field.

Second, the research community is concerned about *measures relying on certain aids or equipment*. The focus of attention was mainly on quantitative studies regarding the impact of different types of computer-based software ([Xin et al., 2023](#)) or hardware ([Casler-Failing, 2018](#)), but also on the use of analog, concrete teaching and learning aids such as flashcards ([Burns et al., 2019](#)) and music ([Fernández-Company et al., 2023](#)). Also, some articles had chosen or included a qualitative approach, for instance, [Casler-Failing's \(2018\)](#) mixed-methods study on the development of reasoning skills using Lego robotics. The results of the studies that focused on computer-based aid were spread quite widely. Some research suggests that individual instruction influenced by computer-based adaptive measures ([de Barros and Ganimian, 2024](#)) and the use of computer games for learning algebra ([Hulse et al., 2019](#)) might have a positive effect. In contrast, other studies highlighted that certain computer-based games showed no positive effect at all ([Hellstrand et al., 2020](#); [Kovalčíková et al., 2021](#)).

Third, the research community seemed concerned about the *focus on the student's own role in paving the way for learning and improved performance*. This became apparent through a quantitative study of the effects of self-assessment ([Oudman et al., 2022](#)), and quantitative studies that emphasized students' self-regulation and self-efficacy ([Koponen et al., 2021](#); [Spitzer, 2022](#); [Fernández-Company et al., 2023](#)). According to [Oudman et al. \(2022\)](#), low-performing students need support when conducting self-assessment activities. The studies on students' self-regulation and self-efficacy were more concerned about registering the effect, rather than how to achieve such an effect.

Fourth, and finally, the review showed that 20 of the 24 reviewed articles focused on *mathematical content*. The exceptions are [Casler-Failing \(2018\)](#), [Herrmann et al. \(2022\)](#), [Fernández-Company et al. \(2023\)](#), and ([Herbst et al., 2023](#)) focusing respectively on the effect of implementing Lego robotics in mathematics teaching; Matthew effects; the effect of music; and peer group stability. The remaining 20 articles studied the effects of low-performing students' work in a variety of mathematical topics. This included topics such as algebra ([Hulse et al., 2019](#)), functions ([Kovalčíková et al., 2021](#)), early numeracy ([Lopez-Pedersen et al., 2022](#); [Lindström-Sandahl et al., 2024](#)), the use of array in multiplication ([Malola, 2020](#)), counting ([Mononen and Aunio, 2016](#)), as well as word problems ([Suseelan et al., 2023](#)). Additionally, it covered more general subjects such as problem solving ([Xin et al., 2023](#)) and thinking skills ([Hotulainen et al., 2016](#)). Among these topics, fractions stood out as a core topic to study regarding low-performing students in mathematics, due to its complex relation to arithmetic, pre-algebra and algebra ([DiTom, 2023](#)). [Fuchs et al. \(2016\)](#) and [Pedersen et al. \(2023\)](#)

examined the approach to working with fractions from both the student's and the teacher's perspective. They reached a similar conclusion in their findings of there being a connection between mapping the understanding of fractions and the understanding of other mathematical topics, and that low-performing students are more dependent on quality teaching than other students. However, this does not rule out research related to other mathematical topics. [Lindström-Sandahl et al. \(2024\)](#) and [Lopez-Pedersen et al. \(2022\)](#) found that emphasizing early numeracy can have a positive impact on the mathematical performance of young, low-performing students. [Malola \(2020\)](#) also conducted a small mixed-methods study that revealed strong indications that learning certain techniques can serve as a powerful aid for low-performing students in mathematics.

3.4 Implications for teaching

Research on measures aimed at low-performing students in mathematics is very broad, but two similarities stand out as important motivational powers in this research. There seems to be a genuine desire to help low-performing students in mathematics have a better school experience, and a desire to achieve this by testing whether or not the proposed measures work. The latter focus is reflected in the majority of effect studies, with the intention of studying the outcome of measures aimed at low-performing students. The reason for helping these students improve their performance differs depending on the perspective. International socio-economic perspectives may entail changes to the national curriculum and usually take a more general perspective than school leaders. At the forefront of this are teachers encountering students who are confused, unmotivated, and maybe even desperate when it comes to learning mathematics. Through this review, the research community has shown interest in all three levels of intervention: the systemic, the institutional and the classroom level. The research in the reviewed articles was conducted on large volumes of national data ([Herrmann et al., 2022](#); [Herbst et al., 2023](#)), as well as measures aimed at the development of a national curriculum (e.g., [Lopez-Pedersen et al., 2022](#)). However, such research does not find its way to schools or enter classrooms on its own. It needs to be interpreted and cultivated by researchers and teachers in order to reach the students. Even though several studies appear to focus on what teachers might or might not do, or what students ought to do, it seems that less attention is being paid to how teachers and students accomplish this through joint effort. This review contains research projects that report on qualitative approaches that have harvested qualitative experiences on how students and teachers can work together to achieve improvements (e.g., [Casler-Failing, 2018](#); [Malola, 2020](#)). Both the qualitative and quantitative results indicate that low-performing students in mathematics share one feature in particular: *Their challenge with mathematics is individualized and their situation does not necessarily apply to other low-performing students*. However, more structural results have been highlighted, such as the important role of the teacher ([Pedersen et al., 2023](#); [Yeo et al., 2023](#)), structural stability in the classroom ([Herrmann et al., 2022](#); [Herbst et al., 2023](#)), ambiguous

impression of the influence of the use of computer software (e.g., [Hellstrand et al., 2020](#); [de Barros and Ganimian, 2024](#)), and mixed results from the emphasis on self-assessment. These findings demonstrate that research is a powerful resource for didactical development, particularly in relation to classroom practices aimed at supporting low-performing mathematics students and conscientious mathematics teachers.

4 Discussion and conclusions

This review of research about measures aimed at low-performing students in mathematics in general classroom settings in primary and middle school is based on empirical research. The reviewed studies can be hard to compare because the participants were selected based on different criteria, but also due to the definition of low-performing students in each study. The variation in definitions of low-performing students in the reviewed articles implies that one student would have been considered as low-performing in one study and not in another one and vice versa. When many countries use the OECD reports and the PISA results to report on the high number of low-performing students ([Dir, 2020:24](#); [Shimizu and Vithal, 2023](#); [Meld St. 34, 2023–2024](#)), it is not certain that the reports and the research addresses the same students. The definition of low-performing students in mathematics by the [OECD \(2016\)](#) only applies to students who have reached an age where the PISA test is conducted, i.e., 15 years of age. When identifying younger students as low-performing students, assumptions, and expectations have to be included based on locally developed assessments and other parameters. Using Geary's definition of low-performing students ([Geary, 2011](#)) is one option, although it is still necessary to know the results from two consecutive standardized tests, which may be hard for researchers to access. This lack of information could lead to the development of other definitions, as seen in the reviewed articles where the definitions varied a lot. There could be various reasons for being identified as low-performing students in mathematics that are not explicitly related to mathematical ability. It is important to remember that the reviewed articles are based on a careful selection of participants, and that the participants are students with both strengths and limitations. All students are unique, meaning it could be hard to treat students as a homogenous group. It is appropriate to acknowledge the careful selection and definitions made by the researchers, as they aim to propose effective measures to help low-performing students improve their performance in mathematics.

4.1 Low achievement and the pursuit of developing mathematical proficiency

Individual focus on low-performing students in mathematics will provide opportunities for individual adaptations, adjusted in accordance with the reason for the low performance. For example, this could relate to lack of knowledge, reduced learning capabilities, lack of motivation, and numerous other features of influence. The reviewed research mainly focused on what could be offered to these students, and what they could be urged

to do. However, there were a few exceptions that focused on teachers' competence (e.g., [Schueler, 2020](#); [Pedersen et al., 2023](#)). [Pedersen et al. \(2023\)](#) and [Yeo et al. \(2023\)](#) primarily relied on quantitative-based research aimed at testing the effect on performance of one or more specific measures. The results of the review identify that the attention was focused on organizing teaching, priorities in teaching, the use of equipment, addressing low-performing students, and focusing on mathematical content. The focus, and to some extent the results, seemed to vary considerably. In itself, this indicates that this area of research is far from exhausted.

However, the main problem for the students, their teachers, schools, and other stakeholders seems to be about these students finding and maintaining motivation and interest in a subject. This occurs when they have either fallen behind in the curriculum or because they have never mastered the subject enough to develop the knowledge, skills, and self-confidence to face new mathematical challenges. A persistent reminder of being marginalized in mathematics impacts the potential motivation and joy of working on the subject. Focus on such matters was somewhat concealed in some of the reviewed articles (e.g., [Koponen et al., 2021](#)). This highlights the need for research to investigate how teachers can facilitate teaching that makes all students motivated and also able to experience mastery in mathematics. It is also important to explore how to avoid low-performing students from being constantly reminded of their lack of mastery of the subject, especially when the school system emphasizes control and individual test performance.

4.2 Moving from individual measures to inclusive teaching practices

The results from the review confirm that different features and priorities appeal to low- and high-performing students in mathematics. High-performing students are more comfortable with organizational and structural changes ([Herrmann et al., 2022](#); [Herbst et al., 2023](#)), appreciate individual work more (e.g., [Mononen and Aunio, 2016](#)), and respond better to direct instruction ([Yeo et al., 2023](#)). In contrast, low-performing students seem to benefit from predictability in structure, collective work with teachers and their peers, and dialog instruction. Low-performing students in mathematics seem to prefer to be part of a shared learning community. However, prioritizing this aspect alone does not appear to significantly enhance their motivation or perceived sense of mastery. This conclusion has been reached by several researchers in mathematics education, for example, [Smith and Stein \(2018\)](#), [Liljedahl \(2021\)](#) and [Boaler \(2022\)](#). The thinking classroom methodology, suggested by [Liljedahl \(2021\)](#), stems from identifying those student activities in a mathematics classroom that obstruct learning, such as stalling, faking, and mimicking. Such behavior may rapidly become the solution for low-performing students or lead them into such a position. The question is how to prevent this from happening. An overarching solution proposed by researchers such as [Smith and Stein \(2018\)](#) or [Liljedahl \(2021\)](#) is to actively engage all students in a constructive and inclusive manner. This

approach would provide them with a genuine experience of participation and co-determination in a joint effort by students and teachers to develop mathematical concepts, connections, and results.

The movement from individually-oriented measures to more collectively-oriented measures appears to be both emerging and consistent with the teaching implications identified in this review. In our opinion, such a development may influence three levels of practice: at the policy level, providing schools with frameworks and conditions that emphasize students' collective development, rather than individual testing. On the school level, the schools will have more autonomy on how to make learning mathematics a more collective and process-oriented task, and a less individual and product-oriented task. At the classroom level, grasping such autonomy at the school level will provide teachers and students with more room for combining emphasis on the development of knowledge and skills in core elements in mathematics. Teachers will be able to emphasize the experience of relevance, authenticity, creativity, and influence for their students. When offering inclusive teaching practices as an alternative to individual measures, the students will be active participants, experiencing co-determination and influence in a collective effort to achieve learning and mastery. Of course, the options depend on the teacher's didactical knowledge of mathematics (e.g., [Loewenberg Ball et al., 2008](#)), as such knowledge is crucial for student learning. The importance is in the joint, experience-oriented interaction between the content, the student, and the teacher (e.g., [Dewey, 1938/2008](#)).

4.3 Implications for future research

The articles that form the basis of this review mainly concern quantitative studies. This is no surprise, given the decision to review empirically-based research articles that focus on the effect and outcome of measures aimed at low-performing students in mathematics. Registering and evaluating learning outcomes by studying effect is both necessary and commendable for the mathematics education research community and for stakeholders at the three levels of practice highlighted above. This work must continue, but there is also other work that must commence. This review shows that qualitative studies that focus on understanding and explaining of how to define low-performing students in mathematics at a young age, and why they might be characterized as such, need to be prioritized. Such research will prove valuable for both qualitative and quantitative studies focusing on the experiences of low-performing students who, for some reason, struggle in mathematics, when they become part of an inclusive teaching practice environment. These research priorities are necessary because such measures should be for the benefit of the students when they are quite young. Being able to offer measures for the teaching and learning environment for primary and middle school students, for example, through the use of methodologies such as [Smith and Stein's \(2018\)](#) five practices, or [Liljedahl's \(2021\)](#) thinking classrooms, might even obviate the need to define who the low-performing students actually are. Of course, these results and conclusions can only be achieved through classroom

experiences. They should be investigated and interpreted through qualitative research and confirmed quantitatively through both small-scale intervention studies and through large-scale results on tests that allow for comparisons to be made with existing results, such as the PISA tests for 15-year-olds (e.g., [OECD, 2016](#)).

5 Closure

This review is based on 24 empirically-based articles, and the search criteria and selection of articles have resulted in articles and other kinds of literature on low-performing students being excluded. Other criteria could possibly offer more suggestions on what to try out. However, this review establishes what the empirical research on measures that aim to improve the results of low-performing students in mathematics actually tells us. Even though the range of focal points in the reviewed articles appears somewhat diverse, the overarching pattern is nonetheless quite clear. Individual measures do not work. In communities of mathematics education, it seems that the emphasis on individual measures is now ready to give way for the benefit of research on didactic measures aimed at joint student groups. This calls for research with two goals. The first goal is to understand and explain why some students may be regarded as low-performing students in mathematics at a young age. The second goal is to explore why inclusive teaching practices are proposed as an alternative to individual measures. The future endeavor for research on how to reach out to low-performing students in mathematics, with the joint goal of improving each of these students' results and prospects in mathematics, is not a leap of faith, but it may well represent a paradigmatic shift.

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Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/feduc.2025.1705140/full#supplementary-material>

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