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Perception of the elementary mathematics teachers about assessment for learning: a case study of Sukkur IBA community colleges, Sindh, Pakistan

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This study aims to explore the perceptions of elementary mathematics teachers regarding assessment for learning (AfL). The participants of this study included three elementary mathematics teachers, each with over 5 years of teaching experience at Sukkur IBA community colleges and schools in Sindh, Pakistan. These participants were selected using purposive sampling techniques. A qualitative exploratory case study research approach was used, with data collected through semi-structured interviews and observations. To ensure the trustworthiness of the study, the interview guide and observation checklist were reviewed by experts. The data were analyzed using thematic analysis. The findings of this study revealed that teachers had a limited understanding of the concept of assessment for learning. Based on these results, the study recommends several measures: the initiation of an assessment literacy program, an increase in class time, reducing the number of students per class, using moveable chairs to enhance classroom flexibility, and making amendments to the assessment policy.

KEYWORDS

assessment for learning, qualitative case study, qualitative exploratory case study approach, elementary mathematics, and perceptions of teachers

Introduction

In recent years, education has undergone a tremendous transformation. The focus has shifted from a teaching paradigm to a learning paradigm, where students have moved from being passive recipients of knowledge to active constructors of it.

The shift from teaching to learning has made students more active participants in the educational process (Wong et al., 2018), placing them at the center of the learning experience (Morkūnienė, 2008). This change has brought experience fundamental transformations in various educational activities, including teaching and assessment. Specifically, the purpose of assessment has evolved from merely testing to promoting learning (Dwyer, 1998; Reinholz, 2016; Suurtamm et al., 2010).

For many years, assessment has been transitioning from summative to formative techniques, with a growing emphasis on learning (Abosalem, 2016; Menéndez et al., 2019).

After 1990, researchers increasingly focused on student learning rather than only measuring academic performance (Dwyer, 1998; Saeed et al., 2018).

In this context, highlights recent changes in Singapore's educational assessment system, such as the elimination of exams in primary grades. By doing so, Singapore aims to implement a more holistic approach to support learning (Wong et al., 2018). In current times, students in Singapore are assessed through classroom participation (Bergmark and Westman, 2018), homework, quizzes, and so on, reflecting modern trends in educational assessment.

One of the most widely recognized trends in educational assessment is Assessment for Learning (AfL), which has gained considerable prominence in the field of education. AfL has become a highly debated topic, with many educationists arguing that traditional testing methods negatively affect student learning (Dwyer, 1998; Reinholz, 2016). In current times, there is a growing global recognition of the true purpose of assessment, which is not merely to measure learning, but to enhance and support students' learning processes.

In Pakistan, some educational institutions have recognized the importance of assessment methods that support student learning by adopting modern assessment types and tools designed to promote student learning. A notable example, as highlighted by Rehmani, is the Agha Khan school system, which has implemented an assessment system similar to those used in advanced countries such as Finland, the United Kingdom, the United States of America, Canada, Australia, and New Zealand.

In this regard, both the National Educational Policy (2017) and the Government of Pakistan (2006) have greatly emphasized the need for AfL. The Government of Pakistan (2006) encourages teachers to use assessment strategies that enhance and support student learning, performance, and active participation (Bergmark and Westman, 2018), though the term "AfL" is not explicitly mentioned. Moreover, the National Educational Policy (2017) strongly recommends using assessments that promote student engagement, learning, and interest in the classroom.

In this context, AfL has proven to be a powerful tool for improving student learning (Wong et al., 2018) in mathematics, focusing on guiding students through problem-solving, critical reasoning, and logical thinking processes. Research has shown that AFL significantly enhances student learning in mathematics (McIntosh, 1997). Students tend to learn more effectively when the primary goal of assessment is to improve learning rather than simply measure it.

Teachers can help students improve their mathematical skills by engaging them in peer assessment, using affective questioning techniques, sharing success criteria, and providing meaningful feedback.

This study aimed to explore the practices of mathematics teachers regarding AfL at the elementary level. In Pakistan, teachers generally tend to focus on assessment strategies that test students' knowledge rather than helping them learn more effectively (Khattak, 2012). Several reports show the poor performance of students in mathematics at the elementary level in Sindh province (SAT Report, 2017). Various factors contribute to this issue, with assessment being one of the most important factors. Assessment cannot be separated from teaching, as the two are inherently integrated. However, in Pakistan's education system, they are often treated as distinct entities.

Most schools focus on assessments that test students' memory rather than supporting their learning (Khattak, 2012). This focus on memorization rather than on enhancing learning contributes to poor performance in mathematics and other subjects. The National Educational Policy (2017) emphasizes that the goal of assessment should be to promote higher-order learning (application, analysis, and evaluation), rather than simply obtaining good grades through rote memorization (Wong et al., 2018).

It has been observed that there is very little ongoing assessment in schools in Pakistan, and the strategies used mainly focus on testing students' memory. Moreover, assessments are conducted sporadically, offering little or no feedback to students (Khattak, 2012), which further hinders their learning progress.

In schools, mathematics is mostly taught using the lecture method, where teachers explain concepts or solve problems on the board (Westwood and Westwood, 2008). After demonstrating a few examples, they assign more problems for students to solve in their notebooks, encouraging rote memorization of procedures rather than fostering a true understanding of the material (Willingham, 2021). As a result, students miss out on developing critical mathematical skills such as problem-solving, critical thinking, and logical reasoning (Hmelo-Silver, 2004; Sachdeva and Eggen, 2021; Yayuk and As'ari, 2020).

Mathematics, however, can be taught through engaging students in different activities and novel pedagogies. Abdulwahed et al. (2012) suggest that mathematics teachers can involve students in collaborative learning, inquiry-based learning, problem-solving, and discovery-based learning. By incorporating these strategies, teachers can foster curiosity and deeper understanding in their students. To support this shift, assessment strategies should align with teaching methods that encourage active learning and exploration.

Wiliam et al. (2004) argue that the effective use of AfL or formative assessment can not only help students improve their performance in internal exams but also enhance their results in externally mandated assessments (Menéndez et al., 2019), such as the General Certificate of Secondary Education (GCSE).

This study holds significant importance for several reasons. First, it helps teachers understand the true purpose of assessment, moving beyond the traditional focus on memory recall to a more supportive role in student learning. As Khattak (2012) noted, the Pakistani education system tends to test students' memory rather than their actual potential to enhance learning (Ahmad et al., 2013; Hoodbhoy, 2009). Second, this study aligns with the National Educational Policy (2017), which emphasizes the use of assessment strategies that promote student learning. Given that few studies on this topic have been conducted in Pakistan, particularly in rural Sindh, this research makes a valuable contribution to the existing literature.

Additionally, this research serves as a foundation for in-service and pre-service teachers, as well as educators and teacher educators, to better understand the purpose of AfL.

This study is designed to achieve the following objectives: (a) to explore the practices of mathematics teachers regarding AfL and (b) to identify the challenges faced in the implementation of AfL in mathematics classrooms. It seeks to answer the following research questions: (a) What are the practices of mathematics teachers regarding assessment for learning? (b) what teaching strategies do mathematics teachers use?, and (c) What challenges do mathematics teachers face in implementing AfL?

Assessment for learning

Generally, teachers use three types of assessment in their daily routines: assessment as learning (AaL), assessment for learning (AfL), and assessment of learning (AoL). AoL focuses on measuring student achievement at the end of a learning process to assign final marks and grades. In contrast, AfL is an ongoing intervention that provides feedback and suggestions during the learning process, helping students improve before final grades are assigned. AaL occurs when students reflect on their own progress and performance, enabling them to focus on future learning goals to achieve better grades and marks.

The researchers of this study believe that prevention is better than cure, emphasizing the importance of addressing learning needs during the educational process rather than waiting until the end. Thus, this study focuses specifically on *AfL* in mathematics, exploring the perceptions of elementary teachers on this approach.

AfL is defined by the Assessment Reform Group as the process of seeking and interpreting evidence for use by learners and teachers to determine where learners are in their learning, where they need to go, and how best to achieve their predetermined objectives. Further elaborates on AfL, describing it as a process in which teachers, students, and peers actively seek and respond to information gathered from daily interactions and observations in ways that promote and support their learning. Most studies have concluded that AfL is an approach integrated into teaching that directly supports student learning (Dwyer, 1998; Ninomiya, 2016; Swaffield, 2011).

Although AfL is often used synonymously with formative assessment, they are not identical (Dwyer, 1998; Ninomiya, 2016; Swaffield, 2011; Wiliam, 2011). The literature suggests that there is no clear distinction between the two, and there is no consensus on the terms, definitions, and meanings of formative assessment and AfL.

However, Swaffield (2011) highlights key differences. First, AfL is an ongoing process embedded in teaching and learning, while formative assessment serves a specific purpose within a given assessment. Second, AfL focuses on immediate and near-term learning, whereas formative assessment may have a long duration.

In addition, AfL is directed toward particular teachers and students, while formative assessment may involve other students and teachers in different contexts. In AfL, students play an autonomous role in their learning, whereas, in formative assessment, they are often passive participants, following the teacher's decisions. Finally, AfL is part of the learning process itself, while formative assessment provides feedback to guide future learning (Menéndez et al., 2019).

Ninomiya (2016) suggests that AfL is not entirely distinct from formative assessment but represents an evolution or extension of it. Bennett (2009) suggests that assessments designed primarily for summative purposes can also serve formative functions, just as assessments designed for formative purposes can serve summative roles.

In this context, several key principles of AfL have been discussed and highlighted by various studies (Swaffield, 2011; Wiliam, 2011). These principles, outlined by the Assessment Reform Group (ARG, 2002), include the following: (a). AfL is a crucial element in planning teaching and learning; (b) AfL must consider how students learn; (c) AfL is central to classroom practices; (d). AfL should be seen as a key professional skill for teachers; (e) AfL has an emotional impact, so it should be applied sensitively and constructively; (f) AfL must motivate students to learn; (g) Success criteria must be shared with students in AfL so they understand expectations and can work accordingly; (h) learners must receive guidance on how to improve; (i) AfL develops students' capacity for self-assessment, enabling them to become self-managing and reflective; and (j). AfL should recognize the full range of student potential and achievement.

Elements of assessment for learning

Studies on AfL identify four fundamental elements (Black et al., 2003; Black and Wiliam, 1998; Dwyer, 1998; Pollard et al., 2014): (a) questioning; (b) effective feedback; (c) sharing criteria; and (d) self-assessment.

Questioning is a key component of teaching, allowing teachers to discover what students already know and to identify gaps in their knowledge and understanding. Pollard et al. (2014) argue that questioning is an effective strategy that helps students enhance their learning by fostering classroom dialog. When teachers engage students in questioning, it promotes discussions that help students make sense of what they are learning. Classroom dialog helps students to make sense of what they are going to do. Black et al. (2003) emphasize that asking questions encourages students to think critically, engage in discussions, and learn more effectively.

Additionally, if teachers ask questions that address various cognitive levels, such as knowledge, comprehension, analysis, synthesis, and evaluation, students become more creative, develop problem-solving skills, and improve their logical thinking (Bloom et al., 1956). The way questions are asked can make a significant difference; superior questioning can encourage students to think beyond recalling facts and help them construct deeper meaning (Kamii and Warrington, 1999).

Recent research has shown a growing interest in the relationship between teacher questioning and students' knowledge levels. Teacher questioning strategies can be used as an assessment tool to evaluate students' level of understanding. When open-ended questions are used, leading to multiple correct answers, the learning environment becomes complex and less predictable, as teachers must interpret and understand a range of student responses.

Many action research studies indicate that when teachers ask questions, they gain insight into where students currently stand in their learning, helping teachers understand how students learn. However, effective questioning can also impact teachers' own instructional practices (Buschman, 2001).

Research has identified four key themes for effective questioning strategies in the classroom. First, teachers must have confidence in their questions and ensure that these questions support learning and recognize students' contributions. Second, teachers should ask conceptual questions that are aligned with curriculum goals and focus on enhancing student learning. Third, questions should be organized in a way that fosters students' engagement and encourages effective questioning. Finally, teacher guidance is strengthened when the questioning process is made visible on a collective platform, allowing students to engage more fully with the process (Stokhof et al., 2017).

Wiliam (1999) described effective feedback as one of the most significant factors in learning, comparable in importance to the quality and quantity of instruction.

Effective feedback, as defined by Hattie and Timperley (2007), is a powerful tool that enhances and supports student learning (Wong et al., 2018). Valuable feedback lies at the heart of AfL, as research consistently highlights its role in improving student learning. Feedback helps guide students in understanding their performance and learning strategies (Boud and Dawson, 2023; Watling and Ginsburg, 2019). Moreover, effective feedback provides students with a clear path for improvement, enabling them to perform better and more efficiently.

Wiliam (1999) described effective feedback as one of the most significant factors in learning, comparable in importance to the quantity and quantity instruction.

However, research by Hugener et al. (2009) found that feedback in many classrooms tends to be superficial, often limited to generic praise such as "very good," which offers little guidance for improvement. Given the critical role feedback plays in enhancing learning, it is particularly important to investigate which types of feedback interventions are most effective in improving learning and which are less beneficial. In addition, it is worth examining which feedback interventions that are likely to enhance learning are being used by teachers in their daily interactions with students, and how often (Voerman et al., 2012).

Feedback is also an integral part of the assessment process that teachers use in the classroom. It provides both teachers and students with information on how students are progressing toward classroom goals (Black and Wiliam, 1998). Effective feedback is most impactful when it is clear and actionable. Furthermore, valuable feedback offers information that students can use to incorporate into their learning processes (Black and Wiliam, 1998).

When providing effective feedback, teachers should focus on the "why" and "how.

For example, explaining why an answer is right or wrong and identifying what specific point the students missed in a question. This approach helps students understand their mistakes and encourages deeper learning.

Effective feedback provides a comprehensive summary of student's progress, highlighting their current standing, outlining necessary steps for improvement, and guiding them toward achieving their goals. Such feedback is crucial for students because it provides clear direction, helping them work more effectively and improving their likelihood of success (Carless et al., 2023). Ultimately, effective feedback serves as a vital tool in creating a more conducive learning environment (Chappuis and Stiggins, 2002).

Sharing success criteria with students can have positive effects on their learning. Pollard et al. (2014) suggest that sharing success criteria helps students become more engaged in the learning process and perform according to clearly communicated expectations. However, they also caution that sharing success criteria purely for the sake of formality can negatively impact student learning and engagement. Pollard et al. (2014) highlight both sides of the issue, emphasizing that success criteria should be used effectively and efficiently to achieve the desired results.

When students are aware of the learning outcomes and understand where they currently stand, they can better plan their learning, leading to improved outcomes. O'donovan et al. (2004) stress the importance of teachers having a clear understanding of the intended outcomes, as this clarity maximizes student learning. In addition, teachers must ensure they have clear goals for what students should learn on a given day, and afterward, they must check if these goals have been met.

Success criteria provide students with a clear understanding of what success looks like. This knowledge encourages students to plan and predict, set goals, and develop a stronger ability to judge their progress. It also allows students to assess their own learning. Sharing success criteria clarifies learning objectives for both teachers and students, enhancing the learning process. Moreover, AfL strategies, such as sharing success criteria, are widely recognized as effective in the teaching and learning process (Crichton and McDaid, 2016).

Self-assessment is a process through which students reflect on their learning by using various techniques and strategies (Panadero et al., 2016). It involves self-monitoring where students take note of their actions and abilities (Boud and Falchikov, 1989). Self-assessment occurs when students make judgments about their learning, particularly regarding their achievements and learning outcomes. This process can range from simple activities, such as asking students to grade their own work without much reflection, to more complex tasks that require them to analyze their performance in detail (Boud and Falchikov, 1989).

Self-assessment fosters greater autonomy in the learning process, encouraging students to become more critical thinkers, problem solvers, and reflective learners. Logan (2009) explored how self-assessment can enhance teaching while also making learning more effective. Research suggests that self-assessment has a greater impact on students learning, as it promotes self-dependence and critical thinking. Through self-assessment, students learn how to improve their skills and become more adept in specific areas (Ndoye, 2017).

These definitions highlight that self-assessment helps students improve their learning by creating an environment where they take internal responsibility for their education (Yorke and Longden, 2004). Additionally, research shows that peer assessment, where students assess each other's learning, plays a complementary role (Cheng and Warren, 2005). According to some of the studies, self-assessment promotes self-regulated learning, allowing students to compare their work with predetermined standards and make necessary adjustments. In simple words, self-assessment is a strategy that teachers use to motivate students to become more responsible for their own learning.

Use of assessment for learning in teaching and learning mathematics

AfL is a powerful approach to enhancing and promoting students learning (Black and Wiliam, 1998; Boyle and Charles, 2010; Ninomiya, 2016; Swaffield, 2011). AfL is a creative strategy that actively supports student learning. A study conducted by Suurtamm et al. (2010) finds AfL to be a highly effective and impactful form of assessment. According to Suurtamm et al. (2010), AfL plays a vital role in both teaching and learning processes. Promoting skills such as problem-solving, critical thinking, and reasoning (Suurtamm et al., 2010). Wiliam (1999) emphasizes that effective questioning is key to students' conceptual understanding. In mathematics, when students engage in thoughtful questioning, they develop a deeper grasp of concepts. Questioning also helps teachers capture students' attention and keep them on their learning.

Mathematics is generally perceived as a difficult subject, and this perception has been shaped by various reasons. One contributing

reason, according to the National Educational Policy (2017), is the nature of assessment. Implementing AfL can increase students' interest in mathematics (Suurtamm et al., 2010), highlighting the importance of AfL as a powerful toll to enhance learning in this subject.

AfL is regarded as one of the most effective pedagogical approaches for enhancing student learning outcomes. Many researchers suggest that AfL not only improves student achievement but also develops metacognitive skills and fosters support motivation, leading to positive learning outcomes (Young, 2008).

However, several barriers hinder the use of AfL in classrooms. The current focus on accountability and standards in educational systems has led to an increased reliance on summative assessments, both at the classroom and large-scale levels (Adams and Kirst, 1999). Teachers and principals often prioritize the use of assessment data to guide school improvement efforts and tailor instructional practice. Shute (2008) argues that most teachers still rely on traditional, summative assessment methods in the classroom.

Moreover, current research identifies significant barriers to the integration and implementation of AfL within classroom teaching and learning. Specifically, these barriers include the following: (a) time constraints and large class sizes; (b) conceptual confusion surrounding AfL; and (c) a perceived misalignment between system-wide priorities and classroom assessment practices (Rahman, 2018). Additional barriers include discrepancies between educational and assessment priorities, misunderstandings of AfL's intent, and practical challenges related to its integration. These barriers are often interconnected, complicating the assessment process and presenting significant challenges for teachers in the implementation of AfL in the classroom.

AfL is hindered by factors such as large class sizes, unsuitable classroom settings, and limited class time. While AfL encourages students to take greater control of their learning through assessment, the teacher's role is to provide structure and support for engaging in AfL (Young, 2008). However, teachers face challenges in implementing AfL due to the multiple roles they are required to fulfill simultaneously. These overlapping responsibilities make it difficult for teachers to consistently integrate AfL into their teaching practices.

Research methodology

To conduct this study, a qualitative exploratory case study approach (Alam, 2021; Priya, 2021) was utilized, as it allows for a deeper understanding of the topic (Farquhar et al., 2020; Almås et al., 2023) through classroom observations and interviews, providing in-depth knowledge (Baskarada, 2014; Creswell, 2007; Osgerby, 2013) of the subject, phenomenon, or problem. Another rationale for selecting this approach is its ability to offer insights into real-life situations (Creswell, 2007, 2009). As highlighted by Neuman (2007), qualitative case research helps simultaneously measure and create new concepts during the data collection process.

The qualitative case study research design was selected for several reasons, as suggested by Yin (2018). Case studies are particularly suitable when the main research questions begin with "how" or "why," allowing for an in-depth exploration of complex social issues (Crowe et al., 2011) and a detailed analysis of the data (Zainal, 2007).

The role of the researcher(s) was to carefully collect and analyze the data while remaining objective and unbiased. Data were gathered from two different sources—semi-structured interviews and classroom observation—to explore the phenomenon from multiple perspectives. The trustworthiness of data was ensured through member checking of the interview transcriptions (Sahakyan, 2023; Ritter et al., 2023) and validation of the observational data by the participants (Enworo, 2023). Furthermore, the study's results and instruments were reviewed and validated by field experts to further ensure accuracy and reliability.

The study was conducted in semi-government schools in the Khairpur district of Sindh. These recruited schools offered classes from kindergarten (KG) to grade XII, following the National Curriculum of Pakistan, and were affiliated with local boards, the Agha Khan examination system, and the Cambridge School system.

Three classes (grade VI, grade VII, and grade VIII) in the elementary/middle section were observed, and data were collected from them. The seating arrangement was fixed, and the average class size ranged from 40 to 50 students. Moreover, due to the large number of students, teachers were unable to assess individuals properly and scientifically. Although some teaching and learning resources were available, they were not used effectively, as most teachers relied heavily on the traditional "chalk and talk" methods. Were highly used by the majority of the teachers in their classrooms. Despite this, the schools were well-equipped with facilities such as airy classrooms, clean washrooms, a canteen, electricity, a security system, and access to clean drinking water.

The participants of this study were three mathematics teachers, selected through a purposive sampling technique for specific purposes and contexts (Ishak et al., 2014), all of whom were teaching mathematics in various classes within the middle/elementary section. In the first phase, 3–4 classes per teacher were thoroughly observed (Xu and Harfitt, 2019), followed by semi-structured interviews (DeJonckheere and Vaughn, 2019) to cross-validate the data collected (Kallio et al., 2016) through classroom observations (Jones and Moreland, 2005) and semi-structured interviews (Drever, 1995).

The data collection instruments were based on the Attribution Theory of Assessment for Learning (Daly, 1998; Graham, 1991; Weiner, 1986), which posits that individuals explain their successes or failures to themselves in various and different ways (Holmes et al., 2017). For example, learners may focus on their homework assignments but shift their attention to other subject(s) to review, edit and improve their performance (Jones et al., 1972).

The collected data were analyzed using thematic analysis, a widely recognized method in qualitative research. Thematic analysis helps researchers to identify patterns and themes that emerge from the data, enabling them to decode and draw meaningful insights. (Castleberry and Nolen, 2018; Nowell et al., 2017). Throughout the study, ethical research guidelines were strictly followed, including obtaining participants' consent and ensuring the confidentiality of their identities.

Findings and discussion

The results and the discussion of this study are based on the data collected through classroom observation and semi-structured interviews (Drever, 1995). The primary aim of the study was to explore mathematics teachers' perceptions of AfL. The collected data were analyzed using thematic analysis techniques to explore scientific

patterns and themes. The following four comprehensive themes were identified from the collected data:

a. **Teachers' Perceptions about Assessment for Learning (AfL)**: This theme explores how teachers view AfL and its role in the teaching and learning process.
b. **AfL as a Tool to Assess Students' Knowledge, Understanding, and Disposition**: This theme highlights how AfL helps teachers gage students' knowledge, comprehension, and attitudes.
c. **AfL as a Guide for Students' Execution, Engagement, and Problem Solving**: This theme discusses how AfL supports students by guiding their learning, fostering engagement, and enhancing problem-solving skills.
d. **AfL as a Tool to Improve the Learning Environment, Enhance Student Learning, Satisfaction, and Success**: This theme focuses on how AfL contributes to creating a conducive learning environment that promotes student satisfaction and success.
e. The following sections provide a detailed description of these themes.

Teachers' perceptions regarding AfL

The perceptions of MTs about AfL were found to be deeply rooted in their personal and professional experiences, which were further shaped by classroom practices, management experiences, and expertise. For example, one mathematics teacher (MT 01) said, "*The AfL is the crucial part of teaching and learning, which indicates that all learners can improve well in their education life.*"

This view aligns with research literature that highlights teachers' perception of AfL as a powerful tool for both learning and teaching (Mui So and Hoi Lee, 2011; Sach, 2012; Warsi and Shah, 2019). AfL is seen as directly impacting students' lives (Arthur et al., 2018) by fostering 21st-century skills and readiness (Soulé and Warrick, 2015). The main purpose of AfL is to motivate students, ensuring learning satisfaction (Brown, 2019), which, in turn, helps them improve in their respective learning environments (Black et al., 2003) and supports future sustainability (Kopnina, 2020).

The teachers' perspectives on implementing AfL highlight how it supports classroom practices (Brown, 2019; Soulé and Warrick, 2015). As one teacher (MT 10) noted, "*Through learning outcomes and the results of the students, it is known how much understanding of a concept a student has gained during their classroom teaching.*" Furthermore, another teacher (MT 07) emphasized the role of questioning, saying, "*the use of questioning technique helps to know how much the students have understood the contents and materials.*" Similarly, MT 04 stated,

Similarly, MT 04 stated, "*When a student speaks more or answers the questions, it helps in estimating how much percent of concept student has understood correctly.*" These statements indicate that AfL is instrumental in helping teachers assess students' understanding through questioning (Kulasegaram and Rangachari, 2018).

Furthermore, the data explain how a teacher should support students in learning (Lavoie et al., 2018; Leong et al., 2018; Muijsenberg et al., 2023), particularly in mathematics (Arthur et al., 2018). As MT 03 stated, "*In mathematics class, a teacher should not help students quickly, however, he should give some time to students to solve their problems on their own.*" Instead, the teacher should motivate them by offering encouragement and kind words (Den Haan and Van der Voort, 2018). As MT 02 explained, "*Teachers always try to make students self-dependent. If a teacher helps students instantly, the students become dependent on the teacher.*"

AfL as a tool to check students' knowledge, understanding, and disposition

The revealed data indicate that AfL helps teachers assess students' understanding through questioning. In this regard, MT (11) noted, "*The whole process of AfL is a process that explains how a teacher should support students in learning mathematics, depending on the processes and procedures of learning.*" These processes and procedures of AfL assist teachers (Arnold, 2022) in guiding their students effectively through socialization (Bolden and DeLuca, 2022; Lee, 2007). AfL also helps students grasp concepts more thoroughly in their classrooms (Marshall and Jane Drummond, 2006), relying on their self-regulation (Hawe and Dixon, 2017) and the social and cultural contexts (Abbasnasab and Mohd Saad, 2013) of their classes and schools (Xu and Harfitt, 2019).

Another teacher, MT 14, added, "*In mathematics class, a teacher should give some time to students to solve the problems on their own, instead of providing quick help to them.*" This view was supported by MT 07, who stated, "*The teacher should motivate the students by giving them some task by saying that 'you can do it' easily, just try yourself.*"

This type of strategy helps students (Mumm et al., 2016) become self-reliant, analytical, and proactive (Hawe and Dixon, 2017) in their class routines (Abricot et al., 2022), fostering in their later lives autonomy (Willis, 2011). This approach validates their learning processes well (Pat-El et al., 2013) using tools, techniques, processes and procedures (Swaffield, 2011) within a structured scientific teaching–learning process (Willis, 2007).

Assessment for learning (AfL) as a tool for guiding students through execution plans, engagement, and problem-solving

The data revealed MTs clearly understood the role of AfL in guiding their students through execution plans, engagement, and problem-solving in their respective classes (Jonsson et al., 2015). Another teacher MT 15 mentioned, "*The majority of the teachers have a basic know-how about AfL that they try their level best to use during their lesson designing and implementation.*" This observation was also confirmed by the researchers during the data collection process.

Student engagement activities (Heitink et al., 2016; Rands and Gansemer-Topf, 2017) were seen to be highly effective. For example, MT 13 noted, "*I used to engage my students in questioning and answering activities to listen, think and answer properly and scientifically to promote self-dependent learning among them.*"

This engagement extended to activities such as drawing geometric figures on the board for practice (Mukhtar and Ahmad, 2015) and guiding students (Leirhaug and Annerstedt, 2016) to solve problems individually or with group mates (Smith, 2016).

Moreover, the teachers monitored the students' work to gain insights (De Vries et al., 2023). After 2 min, the teachers asked the

students who had completed the task to raise their hands (Willis et al., 2023). Some students raised their hands, signaling that they had completed the activity (Baas et al., 2015), appearing actively engaged in their groups, subjects, and classes (MacPhail and Halbert, 2010).

Most of the time, teachers called students to the blackboard to solve mathematical problems (Yeworiew, 2022). In this context, MT 15 stated, "*I use to call active or intelligent students to solve the problems given in the exercise to maximize the students' engagement, which brings, increases, and improves the appreciation and motivation of the class.*" This kind of student engagement (Xiang et al., 2022) also provides valuable data for AfL (Yeworiew, 2022), which teachers use to assess students (Zhang, 2022), identify intervention needs, and select group leaders for activities and assignments (Vattøy and Gamlem, 2023).

As MT 08 noted, "*I used to observe students' interest in mathematics subject and when I confirm the competency, knowledge, and skills of the students', then I make them a group leader and assign him or her a group to engage for further learning through group discussions, sharing and caring techniques too.*" Cooperative learning, where students are grouped for activities, supports faster learning and helps minimize student anxiety (Acar, 2023; Triswidrananta et al., 2022; Vattøy and Gamlem, 2023).

Assessment for learning (AfL) as a tool to improve the learning environment, student learning, student satisfaction, and success

The data revealed insightful perspectives from MTs on how AfL can improve the learning environment, enhance student learning, and boost student satisfaction and success. MT 03 shared, "*I believe that AfL is a good strategy and every teacher should implement it in his or her class. It helps teachers to make a conducive learning environment. In my class, sometimes I start the lecture with a story related to mathematics. Or, I also use an application related to the topic to acquire the attention of all students.*" These comments indicate that MT 03 had a strong understanding of AfL, using various strategies to create a conducive learning environment (Cayubit, 2022; Quadir et al., 2022) and increase student interest (Siddiqua et al., 2022). His method of starting lessons shows his emphasis on gaining full student attention (Tolgfors et al., 2022) to foster an engaging and productive atmosphere.

While teachers shared their perceptions and positive experiences with AfL in mathematics classrooms (Stovner and Klette, 2022), classroom observations revealed that their understanding of AfL might be limited, potentially missing its broader application. In some classes, for example, teachers did not ask students how they arrived at their answers, especially in terms of logical reasoning and problem-solving (Wolterinck et al., 2022). Logical reasoning and problem-solving are essential components of learning mathematics (Bransford et al., 1986; Nunes et al., 2007).

The focus of teachers was to enable students to solve their given problems by using particular procedures and connecting them to real-life situations (Arthur et al., 2018). This approach reflects the teachers' intent to improve their students' performance (Mahlambi et al., 2022; Majoros et al., 2022) by fostering a comprehensive understanding of every aspect of AfL (Arnold, 2022; Lee, 2007). AfL promotes and encourages a student-centered approach (Abdigapbarova and Zhiyenbayeva, 2023; Capone, 2022; Dada et al., 2023), which continuously supports students' performance and progress in all subjects, especially mathematics (Nieminen and Atjonen, 2023). This process is sometimes bolstered by parental involvement (Williams and Williams, 2022).

AfL was found to be an essential tool for enhancing student learning, satisfaction, success, and achievement (Harmeni and Talib, 2022). As MT 05 explained, "The *AfL process and procedures help teachers and students to identify the hurdling and hindering factors on the spot and modify them before they reach out of control.*" AfL processes help teachers better understand their students and facilitate their learning (Chen, 2023) promoting student growth and improvement (De Vries et al., 2022; Kao, 2023). MT 09 added, "*If a teacher gives his or her students homework, he or she must check that homework daily and provide them with constructive feedback. Because timely constructive feedback also helps the students to modify their learning style, techniques, and activities for further learning and achievement.*"

Classroom observations (Vlachou, 2018) revealed that the majority of teachers solved problems solved on the board without offering any detailed explanations and support (Nishizuka, 2022), especially for lengthy problems that took approximately 15 min to complete. After solving the question (Oo and Alonzo, 2023), the teacher asked, How many of you have understood this?" (Yang et al., 2023), encouraging students to support their peers. In response (Westaway and Graven, 2019), only a few students raised their hands to confirm their understanding (Poortman and Schildkamp, 2016).

The teacher then instructed students to open their books and solve the remaining problems from the exercise (Mokhtar et al., 2022). Following these instructions (Rajendran, 2022), most students opened their books and began working (Pang, 2022). However, during this observational process for authentic assessment (Swaffield, 2011), it was noted that some students were inactive, possibly due to misunderstanding the instructions, lack of motivation, or shyness (Peeters et al., 2020; Mazana et al., 2020).

Subsequently, the teacher asked a student to solve a problem on the board (Soulé and Warrick, 2015) to aid the learning of other students (Willis, 2007). This method was intended to foster autonomous learning (Willis, 2011) by validating students' assessment tools and techniques (Pat-El et al., 2013).

Conclusion and implications

The purpose of this study was to explore the perceptions of mathematics teachers regarding AfL. The findings of this study revealed that while teachers had a limited understanding of how to explain the term AfL, they still perceived it as a good tool for enhancing student learning. However, despite having a general understanding of it through the available feedback system, they did not implement AfL effectively or efficiently in their classrooms. MTs faced several challenges while implementing AfL in their classes, including overcrowded classrooms, rigid seating arrangements, a lack of assessment training, and difficulties with time management.

Based on the findings, the study proposes several recommendations for teachers, school administration, and policymakers. These include reducing the number of students per class, increasing the session duration from 40 min to 60 min, revising assessment policies, and using moveable chairs in classrooms to enhance student participation. Additionally, the study suggests implementing an assessment literacy program to help teachers become

familiar with different types of assessments and understand their specific purposes in their daily routines.

Limitations of the study

This study is limited to exploring AfL in elementary mathematics classrooms within schools of a single organization dedicated to providing quality education in the northern region of Sindh, Pakistan. It focuses on a qualitative case study approach and involves a small number of elementary mathematics teachers.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the participants was collected to participate in this study in accordance with the national legislation and the institutional requirements.

Author contributions

ZS: Conceptualization, Data curation, Formal analysis, Writing – original draft. ÖÖ: Methodology, Project administration, Supervision, Writing – review & editing. GA: Data curation, Investigation, Resources, Writing – review & editing. KJ: Validation, Visualization, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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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.2024.1430318/full#supplementary-material

References

Abbasnasab, S., and Mohd Saad, M. R. (2013). Defining assessment for learning: A proposed definition from a sociocultural perspective. *Life Sci. J.* 10, 2493–2497. doi: 10.7537/marslsj100213.345

Abdigapbarova, U., and Zhiyenbayeva, N. (2023). Organization of student-centered learning within the professional training of a future teacher in a digital environment. *Educ. Inf. Technol.* 28, 647–661. doi: 10.1007/s10639-022-11159-5

Abdulwahed, M., Jaworski, B., and Crawford, A. R. (2012). Innovative approaches to teaching mathematics in higher education: a review and critique. *Nordic Stud. Mathematics Educ.* 17, 49–68.

Abosalem, Y. (2016). Assessment techniques and students' higher-order thinking skills. *Int. J. Secondary Educ.* 4, 1–11. doi: 10.11648/j.ijsedu.20160401.11

Abricot, N., Zúñiga, C. G., Valencia-Castañeda, L., and Miranda-Arredondo, P. (2022). What learning is reported in social science classroom interventions? A scoping review of the literature. *Stud. Educ. Eval.* 74:101187. doi: 10.1016/j.stueduc.2022.101187

Acar, A. S. (2023). Genre pedagogy: A writing pedagogy to help L2 writing instructors enact their classroom writing assessment literacy and feedback literacy. *Assess. Writ.* 56:100717. doi: 10.1016/j.asw.2023.100717

Adams, J. E., and Kirst, M. W. (1999). New demands and concepts for educational accountability: striving for results in an era of excellence. *Handbook of Res. Educ. Admin.* 2, 463–487.

Ahmad, I., Rauf, M., and Rashid, A. (2013). Analysis of the problems of primary education system in Pakistan: critical review of literature. *Academic Res. Int.* 4:324.

Alam, M. K. (2021). A systematic qualitative case study: questions, data collection, NVivo analysis and saturation. *Qualitative Res. Organiz. Manag.* 16, 1–31. doi: 10.1108/QROM-09-2019-1825

Almås, H., Pinkow, F., and Giæver, F. (2023). Reimagining how to understand learning game experiences: a qualitative and exploratory case study. *Smart Learn. Environ.* 10:14. doi: 10.1186/s40561-023-00234-0

Arnold, J. (2022). Prioritising students in assessment for learning: A scoping review of research on students' classroom experience. *Rev. Educ.* 10, 1–36. doi: 10.1002/rev3.3366

Arthur, Y. D., Owusu, E. K., Asiedu-Addo, S., and Arhin, A. K. (2018). Connecting mathematics to real life problems: A teaching quality that improves students' mathematics interest. *IOSR J. Res. Method Educ. (IOSR-JRME)* 8, 65–71. doi: 10.9790/7388-0804026571

Baas, D., Castelijns, J., Vermeulen, M., Martens, R., and Segers, M. (2015). The relation between assessment for learning and elementary students' cognitive and metacognitive strategy use. *Br. J. Educ. Psychol.* 85, 33–46. doi: 10.1111/bjep.12058

Baskarada, S. (2014). Qualitative case studies guidelines. *Qual. Rep.* 19, 1–25. doi: 10.46743/2160-3715/2014.1008

Bennett, R. E. (2009). A critical look at the meaning and basis of formative assessment. Princeton: Educational Testing Service.

Bergmark, U., and Westman, S. (2018). Student participation within teacher education: emphasising democratic values, engagement and learning for a future profession. *High. Educ. Res. Dev.* 37, 1352–1365. doi: 10.1080/07294360.2018.1484708

Black, P., Harrison, C., and Lee, C. (2003). Assessment for learning: Putting it into practice. UK: McGraw-Hill Education.

Black, P., and Wiliam, D. (1998). Assessment and classroom learning. *Assess. Educ. Principles, Policy Prac.* 5, 7–74. doi: 10.1080/0969595980050102

Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H., and Krathwohl, D. R. (1956). Taxonomy of educational objetives: The classification of educational goals: Handbook I: Cognitive domain. New York, US: D. Mckay.

Bolden, B., and DeLuca, C. (2022). Nurturing student creativity through assessment for learning in music classrooms. *Res. Stud. Music Educ.* 44, 273–289. doi: 10.1177/1321103X211054793

Boud, D., and Dawson, P. (2023). What feedback literate teachers do: an empirically-derived competency framework. *Assess. Eval. High. Educ.* 48, 158–171. doi: 10.1080/02602938.2021.1910928

Boud, D., and Falchikov, N. (1989). Quantitative studies of student self-assessment in higher education: A critical analysis of findings. *High. Educ.* 18, 529–549. doi: 10.1007/BF00138746

Boyle, W. F., and Charles, M. (2010). Leading learning through assessment for learning? *School Leader. Manag.* 30, 285–300. doi: 10.1080/13632434.2010.485184

Bransford, J., Sherwood, R., Vye, N., and Rieser, J. (1986). Teaching thinking and problem solving: research foundations. *Am. Psychol.* 41, 1078–1089. doi: 10.1037/0003-066X.41.10.1078

Brown, G. T. L. (2019). Is assessment for learning really assessment? *Front. Educ.* 4, 1–7. doi: 10.3389/feduc.2019.00064

Buschman, L. (2001). Using student interviews to guide classroom instruction: an action research project. (research, reflection, practice). *Teach. Child. Math.* 8, 222–227. doi: 10.5951/TCM.8.4.0222

Capone, R. (2022). Blended learning and student-centered active learning environment: A case study with STEM undergraduate students. *Can. J. Sci. Math. Technol. Educ.* 22, 210–236. doi: 10.1007/s42330-022-00195-5

Carless, D., To, JKwan, C., and Kwok, J. (2023). Disciplinary perspectives on feedback processes: towards signature feedback practices. *Teach. High. Educ.* 28, 1158–1172. doi: 10.1080/13562517.2020.1863355

Castleberry, A., and Nolen, A. (2018). Thematic analysis of qualitative research data: is it as easy as it sounds? *Currents in Pharmacy Teach. Learn.* 10, 807–815. doi: 10.1016/j.cptl.2018.03.019

Cayubit, R. F. O. (2022). Why learning environment matters? An analysis on how the learning environment influences the academic motivation, learning strategies and engagement of college students. *Learn. Environ. Res.* 25, 581–599. doi: 10.1007/s10984-021-09382-x

Chappuis, S., and Stiggins, R. J. (2002). Classroom assessment for learning. *Educ. Leadersh.* 60, 40–44.

Chen, P. P. (2023). Interactions between self-regulated learning and assessment for learning in an undergraduate introductory computer science course. *New Dir. Teach. Learn.* 2023, 49–56. doi: 10.1002/tl.20548

Cheng, W., and Warren, M. (2005). Peer assessment of language proficiency. *Lang. Test.* 22, 93–121. doi: 10.1191/0265532205lt298oa

Creswell, J. W. (2007). Qualitative inquiry and research design: Choosing among five approaches. *2nd (ed.)* Edn. Thousand Oaks, California: Sage Publication, Inc.

Creswell, J. W. (2009). Research design, qualitative, quantitative and mixed methods approaches. *3rd (ed.)* Edn. Thousand Oaks, California: Sage Publication, Inc.

Crichton, H., and McDaid, A. (2016). Learning intentions and success criteria: learners' and teachers' views. *Curriculum J.* 27, 190–203. doi: 10.1080/09585176.2015.1103278

Crowe, S., Cresswell, K., Robertson, A., Huby, G., Avery, A., and Sheikh, A. (2011). The case study approach. *BMC Med. Res. Methodol.* 11:100. doi: 10.1186/1471-2288-11-100

Dada, D., Laseinde, O. T., and Tartibu, L. (2023). Student-centered learning tool for cognitive enhancement in the learning environment. *Procedia Computer Sci.* 217, 507–512. doi: 10.1016/j.procs.2022.12.246

Daly, D. (1998). Attribution theory and the glass ceiling: career development among Federal Employees. *Public Admin. Manag. Interactive J.* 1, 93–116. doi: 10.1108/IJOTB-01-01-1998-B005

De Vries, J. A., Dimosthenous, A., Schildkamp, K., and Visscher, A. J. (2022). The impact on student achievement of an assessment for learning teacher professional development program. *Stud. Educ. Eval.* 74:101184. doi: 10.1016/j.stueduc.2022.101184

De Vries, J. A., Dimosthenous, A., Schildkamp, K., and Visscher, A. J. (2023). The impact of an assessment for learning teacher professional development program on students' metacognition. *Sch. Eff. Sch. Improv.* 34, 109–129. doi: 10.1080/09243453.2022.2116461

DeJonckheere, M., and Vaughn, L. M. (2019). Semi structured interviewing in primary care research: a balance of relationship and rigour. *Family Med. Community Health* 7:e000057. doi: 10.1136/fmch-2018-000057

Den Haan, R. J., and Van der Voort, M. C. (2018). On evaluating social learning outcomes of serious games to collaboratively address sustainability problems: A literature review. *Sustain. For.* 10:4529. doi: 10.3390/su10124529

Drever, E. (1995). Using semi-structured interviews in small-scale research. New York: A Teacher's Guide. ERIC.

Dwyer, C. A. (1998). Assessment and classroom learning: theory and practice. *Assess. Educ. Principles, Policy Prac.* 5, 131–137. doi: 10.1080/0969595980050109

Enworo, O. C. (2023). Application of Guba and Lincoln's parallel criteria to assess trustworthiness of qualitative research on indigenous social protection systems. *Qual. Res. J.* 23, 372–384. doi: 10.1108/QRJ-08-2022-0116

Farquhar, J., Michels, N., and Robson, J. (2020). Triangulation in industrial qualitative case study research: widening the scope. *Ind. Mark. Manag.* 87, 160–170. doi: 10.1016/j.indmarman.2020.02.001

Government of Pakistan. (2006). *National Curriculum for Mathematics, Grades I – XII.* Islamabad: Ministry of Education. Available at: https://bisep.edu.pk/downloads/curriculum/Grades-I-XII/pk_al_mt_2006_eng.pdf

Graham, S. (1991). A review of attribution theory in achievement contexts. *Educ. Psychol. Rev.* 3, 5–39. doi: 10.1007/BF01323661

Harmeni, H. A., and Talib, R. (2022). Construct validity analysis: assessment for learning primary mathematics questionnaire. *J. Educ. Teachers and Trainers* 13, 54–72. doi: 10.47750/jett.2022.13.02.006

Hattie, J., and Timperley, H. (2007). The power of feedback. *Rev. Educ. Res.* 77, 81–112. doi: 10.3102/003465430298487

Hawe, E., and Dixon, H. (2017). Assessment for learning: a catalyst for student self-regulation. *Assess. Eval. High. Educ.* 42, 1181–1192. doi: 10.1080/02602938.2016.1236360

Heitink, M. C., Van der Kleij, F. M., Veldkamp, B. P., Schildkamp, K., and Kippers, W. B. (2016). A systematic review of prerequisites for implementing assessment for learning in classroom practice. *Educ. Res. Rev.* 17, 50–62. doi: 10.1016/j.edurev.2015.12.002

Hmelo-Silver, C. E. (2004). Problem-based learning: what and how do students learn? *Educ. Psychol. Rev.* 16, 235–266. doi: 10.1023/B:EDPR.0000034022.16470.f3

Holmes, Y. M., Collins, J., and Rutherford, J. (2017). Active learning and generation next perceptions of engagement and motivation: an attribution theory approach. *J. Higher Educ. Theory Prac.* 17, 111–114.

Hoodbhoy, P. (2009). Pakistan's higher education system—what went wrong and how to fix it. *Pak. Dev. Rev.* 48, 581–594.

Hugener, I., Pauli, C., Reusser, K., Lipowsky, F., Rakoczy, K., and Klieme, E. (2009). Teaching patterns and learning quality in Swiss and German mathematics lessons. *Learn. Instr.* 19, 66–78. doi: 10.1016/j.learninstruc.2008.02.001

Ishak, N. M., Bakar, A., and Yazid, A. (2014). Developing sampling frame for case study: challenges and conditions. *World J. Educ.* 4, 29–35.

Jones, E. E., Kannouse, D. E., Kelley, H. H., Nisbett, R. E., Valins, S., and Weiner, B. (1972). Attribution: Perceiving the causes of behavior. Morristown, NJ: General Learning Press.

Jones, A., and Moreland, J. (2005). The importance of pedagogical content knowledge in assessment for learning practices: A case-study of a whole-school approach. *Curric. J.* 16, 193–206. doi: 10.1080/09585170500136044

Jonsson, A., Lundahl, C., and Holmgren, A. (2015). Evaluating a large-scale implementation of assessment for learning in Sweden. *Assess. Educ. Principles, Policy Prac.* 22, 104–121. doi: 10.1080/0969594X.2014.970612

Kallio, H., Pietilä, A., Johnson, M., and Kangasniemi, M. (2016). Systematic methodological review: developing a framework for a qualitative semi-structured interview guide. *J. Adv. Nurs.* 72, 2954–2965. doi: 10.1111/jan.13031

Kamii, C., and Warrington, M. A. (1999). Teaching fractions: fostering children's own reasoning. *Develop. Mathematical Reason. Grades* K-12, 82–92.

Kao, Y. T. (2023). Exploring assessment for learning: assessment tools and approaches in Taiwanese CLIL classes. *Lang. Learn. J.* 1-15, 1–15. doi: 10.1080/09571736.2023.2217435

Khattak, S. G. (2012). Assessment in schools in Pakistan. *SA-EDUC* 9, 1–13.

Kopnina, H. (2020). Education for the future? Critical evaluation of education for sustainable development goals. *J. Environ. Educ.* 51, 280–291. doi: 10.1080/00958964.2019.1710444

Kulasegaram, K., and Rangachari, P. K. (2018). Beyond formative: assessments to enrich student learning. *Adv. Physiol. Educ.* 42, 5–14. doi: 10.1152/advan.00122.2017

Lavoie, P., Michaud, C., Belisle, M., Boyer, L., Gosselin, E., Grondin, M., et al. (2018). Learning theories and tools for the assessment of core nursing competencies in simulation: A theoretical review. *J. Adv. Nurs.* 74, 239–250. doi: 10.1111/jan.13416

Lee, I. (2007). Assessment for learning: integrating assessment, teaching, and learning in the ESL/EFL writing classroom. *Can. Mod. Lang. Rev.* 64, 199–213. doi: 10.3138/cmlr.64.1.199

Leirhaug, P. E., and Annerstedt, C. (2016). Assessing with new eyes? Assessment for learning in Norwegian physical education. *Phys. Educ. Sport Pedagog.* 21, 616–631. doi: 10.1080/17408989.2015.1095871

Leong, W. S., Ismail, H., Costa, J. S., and Tan, H. B. (2018). Assessment for learning research in east Asian countries. *Stud. Educ. Eval.* 59, 270–277. doi: 10.1016/j.stueduc.2018.09.005

Logan, E. (2009). Self and peer assessment in action. *Practitioner Res. Higher Educ.* 3, 29–35.

MacPhail, A., and Halbert, J. (2010). 'We had to do intelligent thinking during recent PE': students' and teachers' experiences of assessment for learning in post-primary physical education. *Assess. Educ. Principles, Policy Prac.* 17, 23–39. doi: 10.1080/09695940903565412

Mahlambi, S. B., van den Berg, G., and Mawela, A. S. (2022). Exploring the use of assessment for learning in the mathematics classroom. *J. Educ. (University of KwaZulu-Natal)* 89, 1–24. doi: 10.17159/2520-9868/i89a02

Majoros, E., Christiansen, A., and Cuellar, E. (2022). Motivation towards mathematics from 1980 to 2015: exploring the feasibility of trend scaling. *Stud. Educ. Eval.* 74:101174. doi: 10.1016/j.stueduc.2022.101174

Marshall, B., and Jane Drummond, M. (2006). How teachers engage with assessment for learning: lessons from the classroom. *Res. Pap. Educ.* 21, 133–149. doi: 10.1080/02671520600615638

Mazana, M. Y., Montero, C. S., and Casmir, R. O. (2020). Assessing students' performance in mathematics in Tanzania: the teacher's perspective. *Int. Electronic J. Mathematics Educ.* 15, 1–28. doi: 10.29333/iejme/7994

McIntosh, M. E. (1997). Formative assessment in mathematics. *Clearing House* 71, 92–96. doi: 10.1080/00098659709599333

Menéndez, I. Y. C., Napa, M. A. C., Moreira, M. L. M., and Zambrano, G. G. V. (2019). The importance of formative assessment in the learning teaching process. *Int. J. Soc. Sci. Human.* 3, 238–249. doi: 10.29332/ijssh.v3n2.322

Mokhtar, M., Adnan, W. A. W., Harithuddin, A. S. M., Jamaludin, D., Zan, Z., and Ahmad, F. A. (2022). Students' and lecturers' perception on the use of introductory engineering mathematics Putra MOOC. *Asean J. Eng. Educ.* 6, 11–17. doi: 10.11113/ajee2022.6n2.106

Morkūnienė, V. (2008). Shift in conceptualizing student assessment in the process of education paradigm change. *Socialiniai Mokslai* 4, 51–58.

Mui So, W. W., and Hoi Lee, T. T. (2011). Influence of teachers' perceptions of teaching and learning on the implementation of assessment for learning in inquiry study. *Assess. Educ. Principles, Policy Prac.* 18, 417–432. doi: 10.1080/0969594X.2011.577409

Muijsenberg, A. J. L., Houben-Wilke, S., Zeng, Y., Spruit, M. A., and Janssen, D. J. A. (2023). Methods to assess adults' learning styles and factors affecting learning in health education: A scoping review. *Patient Educ. Couns.* 107:107588. doi: 10.1016/j.pec.2022.107588

Mukhtar, M. I., and Ahmad, J. (2015). Assessment for learning: practice in TVET. *Procedia Soc. Behav. Sci.* 204, 119–126. doi: 10.1016/j.sbspro.2015.08.124

Mumm, K., Karm, M., and Remmik, M. (2016). Assessment for learning: why assessment does not always support student teachers' learning. *J. Furth. High. Educ.* 40, 780–803. doi: 10.1080/0309877X.2015.1062847

National Educational Policy. (2017). Ministry of Federal Education and Professional Training Government of Pakistan. Available at: https://pbit.punjab.gov.pk/system/files/National%20Educaton%20Policy%202017.pdf

Ndoye, A. (2017). Peer/self-assessment and student learning. *Int. J. Teach. Learn. Higher Educ.* 29, 255–269.

Neuman, L. W. (2007). Social research methods, 6/E. India: Pearson Education.

Nieminen, J. H., and Atjonen, P. (2023). The assessment culture of mathematics in Finland: a student perspective. *Res. Math. Educ.* 25, 243–262. doi: 10.1080/14794802.2022.2045626

Ninomiya, S. (2016). The possibilities and limitations of assessment for learning: exploring the theory of formative assessment and the notion of “closing the learning gap&rdquo. *Educ. Stud. Japan* 10, 79–91. doi: 10.7571/esjkyoiku.10.79

Nishizuka, K. (2022). How can assessment for learning be useful for self-regulated learning? Four approaches to change of assessment conceptions from individualistic to contextualistic. *Pedagogy Human Sci.* 8, 1–22.

Nowell, L. S., Norris, J. M., White, D. E., and Moules, N. J. (2017). Thematic analysis: striving to meet the trustworthiness criteria. *Int J Qual Methods* 16:160940691773384. doi: 10.1177/1609406917733847

Nunes, T., Bryant, P., Evans, D., Bell, D., Gardner, S., Gardner, A., et al. (2007). The contribution of logical reasoning to the learning of mathematics in primary school. *Br. J. Dev. Psychol.* 25, 147–166. doi: 10.1348/026151006X153127

O'donovan, B., Price, M., and Rust, C. (2004). Know what I mean? Enhancing student understanding of assessment standards and criteria. *Teach. High. Educ.* 9, 325–335. doi: 10.1080/1356251042000216642

Oo, C. Z., and Alonzo, D. (2023). Developing pre-service teachers' skills in assessment for learning (AfL): A plan using design-based research. *Issues Educ. Res.* 33, 693–712.

Osgerby, J. (2013). Students' perceptions of the introduction of a blended learning environment: an exploratory case study. *Acc. Educ.* 22, 85–99. doi: 10.1080/09639284.2012.729341

Panadero, E., Jonsson, A., and Strijbos, J.-W. (2016). "Scaffolding self-regulated learning through self-assessment and peer assessment: guidelines for classroom implementation" in Assessment for learning: Meeting the challenge of implementation. The Enabling Power of Assessment, eds. D. Laveault and L. Allal vol 4. (Springer), 311–326.

Pang, N. S.-K. (2022). Teachers' reflective practices in implementing assessment for learning skills in classroom teaching. *ECNU Rev. Educ.* 5, 470–490. doi: 10.1177/2096531120936290

Pat-El, R. J., Tillema, H., Segers, M., and Vedder, P. (2013). Validation of assessment for learning questionnaires for teachers and students. *Br. J. Educ. Psychol.* 83, 98–113. doi: 10.1111/j.2044-8279.2011.02057.x

Peeters, A., Robinson, V., and Rubie-Davies, C. (2020). Theories in use that explain adolescent help seeking and avoidance in mathematics. *J. Educ. Psychol.* 112, 533–550. doi: 10.1037/edu0000423

Pollard, A., Black-Hawkins, K., Cliff-Hodges, G., Dudley, P., and James, M. (2014). Reflective teaching in schools: Evidence-informed professional practice. New York, USA: Bloomsbury Publishing.

Poortman, C. L., and Schildkamp, K. (2016). Solving student achievement problems with a data use intervention for teachers. *Teach. Teach. Educ.* 60, 425–433. doi: 10.1016/j.tate.2016.06.010

Priya, A. (2021). Case study methodology of qualitative research: key attributes and navigating the conundrums in its application. *Soc. Secur. Bull.* 70, 94–110. doi: 10.1177/0038022920970318

Quadir, B., Yang, J. C., and Chen, N. S. (2022). The effects of interaction types on learning outcomes in a blog-based interactive learning environment. *Interact. Learn. Environ.* 30, 293–306. doi: 10.1080/10494820.2019.1652835

Rahman, M. (2018). Exploring science teachers' perception of classroom assessment in secondary schools of Bangladesh. *European J. Educ. Stud.* 4, 139–160. doi: 10.5281/zenodo.1296835

Rajendran, M. (2022). Sociocultural perspective on assessment for learning: exploring pre-service teachers' understanding. *Int. J. Soc. Sci. Human Res.* 5, 4567–4570. doi: 10.47191/ijsshr/v5-i10-21

Rands, M. L., and Gansemer-Topf, A. M. (2017). The room itself is active: how classroom design impacts student engagement. *J. Learn. Spaces* 6:26.

Reinholz, D. (2016). The assessment cycle: a model for learning through peer assessment. *Assess. Eval. High. Educ.* 41, 301–315. doi: 10.1080/02602938.2015.1008982

Ritter, C., Koralesky, K. E., Saraceni, J., Roche, S., Vaarst, M., and Kelton, D. (2023). Qualitative research in dairy science: A narrative review. *J. Dairy Sci.* 106, 5880–5895. doi: 10.3168/jds.2022-23125

Sach, E. (2012). Teachers and testing: an investigation into teachers' perceptions of formative assessment. *Educ. Stud.* 38, 261–276. doi: 10.1080/03055698.2011.598684

Sachdeva, S., and Eggen, P. O. (2021). Learners' critical thinking about learning mathematics. *Int. Electronic J. Mathematics Educ.* 16:em0644. doi: 10.29333/iejme/11003

Saeed, M., Tahir, H., and Latif, I. (2018). Teachers' perceptions about the use of classroom assessment techniques in elementary and secondary schools. *Bull. Educ. Res.* 40, 115–130.

Sahakyan, T. (2023). Member-checking through diagrammatic elicitation: constructing meaning with participants. *TESOL Q.* 57, 686–701. doi: 10.1002/tesq.3210

SAT Report. (2017). Annual Report 2016–17. Available at: https://www.iba-suk.edu.pk/Content/pdf/publications/Books/Annual%20Report%202017-2018.pdf

Shute, V. J. (2008). Focus on formative feedback. *Rev. Educ. Res.* 78, 153–189. doi: 10.3102/0034654307313795

Siddiqua, N., Khan, M., and Ansari, H. (2022). Teachers' concept about strategies of assessment for learning and its application: A descriptive study of undergraduate teachers of education. *Pakistan Lang. Human. Rev.* 6, 647–662. doi: 10.47205/plhr.2022(6-II)55

Smith, K. (2016). "Cooperative learning about assessment for learning" in Assessment for learning: Meeting the challenge of implementation. The enabling power of assessment. eds. D. Laveault and L. Allal, vol. *4* (Cham: Springer).

Soulé, H., and Warrick, T. (2015). Defining 21st century readiness for all students: what we know and how to get there. *Psychol. Aesthet. Creat. Arts* 9, 178–186. doi: 10.1037/aca0000017

Stokhof, H. J. M., De Vries, B., Martens, R. L., and Bastiaens, T. J. (2017). How to guide effective student questioning: a review of teacher guidance in primary education. *Rev. Educ.* 5, 123–165. doi: 10.1002/rev3.3089

Stovner, R. B., and Klette, K. (2022). Teacher feedback on procedural skills, conceptual understanding, and mathematical practices: A video study in lower secondary mathematics classrooms. *Teach. Teach. Educ.* 110, 103593–103512. doi: 10.1016/j.tate.2021.103593

Suurtamm, C., Koch, M., and Arden, A. (2010). Teachers' assessment practices in mathematics: classrooms in the context of reform. *Assess. Educ. Principles, Policy Prac.* 17, 399–417. doi: 10.1080/0969594X.2010.497469

Swaffield, S. (2011). Getting to the heart of authentic assessment for learning. *Assess. Educ. Principles, Policy Prac.* 18, 433–449. doi: 10.1080/0969594X.2011.582838

Tolgfors, B., Quennerstedt, M., Backman, E., and Nyberg, G. (2022). Enacting assessment for learning in the induction phase of physical education teaching. *Eur. Phys. Educ. Rev.* 28, 534–551. doi: 10.1177/1356336X211056208

Triswidrananta, O. D., Pramudhita, A. N., and Wijaya, I. D. (2022). Learning management system based on assessment for learning to improve computational thinking. *iJIM* 16, 150–158. doi: 10.3991/ijim.v16i04.28979

Vattøy, K. D., and Gamlem, S. M. (2023). Students' experiences of peer feedback practices as related to awareness raising of learning goals, self-monitoring, self-efficacy, anxiety, and enjoyment in teaching EFL and mathematics. *Scand. J. Educ. Res.* 68, 904–918. doi: 10.1080/00313831.2023.2192772

Vlachou, M. A. (2018). Classroom assessment practices in middle school science lessons: A study among Greek science teachers. *Cogent Educ.* 5:1455633. doi: 10.1080/2331186X.2018.1455633

Voerman, L., Meijer, P. C., Korthagen, F. A. J., and Simons, R. J. (2012). Types and frequencies of feedback interventions in classroom interaction in secondary education. *Teach. Teach. Educ.* 28, 1107–1115. doi: 10.1016/j.tate.2012.06.006

Warsi, L. Q., and Shah, A. F. (2019). Teachers' perception of classroom assessment techniques (CATs) at higher education level. *Pakistan J. Soc. Sci. (PJSS)* 39, 189–199.

Watling, C. J., and Ginsburg, S. (2019). Assessment, feedback and the alchemy of learning. *Med. Educ.* 53, 76–85. doi: 10.1111/medu.13645

Weiner, B. (1986). An attributional theory of motivation and emotion. New York: springer-Verlag.

Westaway, L., and Graven, M. (2019). Exploring grade 3 teachers' resistance to 'take up 'progressive mathematics teaching roles. *Math. Educ. Res. J.* 31, 27–46. doi: 10.1007/s13394-018-0237-7

Westwood, P. S., and Westwood, P. (2008). What teachers need to know about teaching methods. Australia: Australian Council for Ed Research.

Wiliam, D. (1999). Formative assessment in mathematics part 1: rich questioning. *Equals: Mathematics Special Educ. Needs* 5, 15–18.

Wiliam, D. (2011). What is assessment for learning? *Stud. Educ. Eval.* 37, 3–14. doi: 10.1016/j.stueduc.2011.03.001

Wiliam, D., Lee, C., Harrison, C., and Black, P. (2004). Teachers developing assessment for learning: impact on student achievement. *Assess. Educ. Principles, Policy Prac.* 11, 49–65. doi: 10.1080/0969594042000208994

Williams, H., and Williams, K. (2022). Parental contributions and assessment for learning as a component of mathematics homework. *Education* 50, 211–224. doi: 10.1080/03004279.2020.1842480

Willingham, D. T. (2021). Why don't students like school?: A cognitive scientist answers questions about how the mind works and what it means for the classroom. New Jersey, USA: John Wiley & Sons.

Willis, J. (2007). Assessment for learning–why the theory needs the practice. *Int. J. Pedagog. Learn.* 3, 52–59. doi: 10.5172/ijpl.3.2.52

Willis, J. (2011). Affiliation, autonomy and assessment for learning. *Assess. Educ. Principles, Policy Prac.* 18, 399–415. doi: 10.1080/0969594X.2011.604305

Willis, J., Arnold, J., and DeLuca, C. (2023). Accessibility in assessment for learning: sharing criteria for success. *Front. Educ.* 8:1170454. doi: 10.3389/feduc.2023.1170454

Wolterinck, C., Poortman, C., Schildkamp, K., and Visscher, A. (2022). Assessment for learning: developing the required teacher competencies. *Eur. J. Teach. Educ.* 1-19, 1–19. doi: 10.1080/02619768.2022.2124912

Wong, T. K. Y., Tao, X., and Konishi, C. (2018). Teacher support in learning: instrumental and appraisal support in relation to math achievement. *Issues Educ. Res.* 28:202.

Xiang, X., Yuan, R., and Yu, B. (2022). Implementing assessment as learning in the L2 writing classroom: A Chinese case. *Assess. Eval. High. Educ.* 47, 727–741. doi: 10.1080/02602938.2021.1965539

Xu, Y., and Harfitt, G. (2019). Is assessment for learning feasible in large classes? Challenges and coping strategies from three case studies. *Asia Pac. J. Teach. Educ.* 47, 472–486. doi: 10.1080/1359866X.2018.1555790

Yang, J., Özbek, G., and Cho, S. (2023). Teachers' beliefs and their influence on math instructions for gifted English learners. *Educ. Sci.* 13, 1–28. doi: 10.3390/educsci13070728

Yayuk, E., and As'ari, A. R. (2020). Primary school Students' creative thinking skills in mathematics problem solving. *Eurasian J. Educ. Res.* 9, 1281–1295. doi: 10.12973/eu-jer.9.3.1281

Yeworiew, L. B. (2022). Assessment for learning knowledge, skills, and practices of mathematics teachers in Ethiopian primary schools (Doctoral thesis, University of Calgary, Calgary, Canada).

Yin, R. K. (2018). Case study research and applications. London, United Kingdom: Sage.

Yorke, M., and Longden, B. (2004). Retention and student success in higher education. UK: McGraw-Hill Education.

Young, D. B. (2008). On the impact of formative assessment on student motivation, achievement, and conceptual change. *Appl. Meas. Educ.* 21, 335–359. doi: 10.1080/08957340802347845

Zainal, Z. (2007). Case study as a research method. *J. Kemanusiaan* 5, 1–6.

Zhang, X. (2022). The role of teacher patience in the implementation of assessment for learning (AfL): vignettes from a writing classroom. *Human. Soc. Sci. Commun.* 9, 1–9. doi: 10.1057/s41599-022-01398-9