Best Practices for 1st Grade Mathematics Education

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Abstract

This paper explores the importance of early mathematics instruction and best-practices for first-grade mathematics education according to research. Moreover, it explores how first-grade educators can incorporate effective evidence-based practices to maximize student learning and enhance mathematical development. Research suggests that prioritizing early mathematics instruction is pivotal in building foundational mathematical skills that affect subsequent learning, and establishing students' attitudes towards the subject and their beliefs about their mathematical capabilities. Highly effective practices to ensure students receive the adequate early instruction they deserve include building students’ mathematical vocabulary knowledge so that students can successfully engage in mathematical conversations, implementing Child-centered learning opportunities, and providing students with or at-risk of mathematics difficulty with explicit instruction. I use my observations to consider how technology and teachers can set students up for long-term success and provide students positive and effective early mathematical learning experiences.
Introduction

Fostering children’s early mathematical abilities is essential. An abundance of research suggests that it has a lasting impact on later academic success and forming children’s attitudes towards the subject (Hachey, 2013). Researching the best practices will remain an ongoing process as our knowledge about children, their early needs, and effective classroom practices continues to improve. However, we can learn much from current studies suggesting that teachers and technology can maximize student learning and potentially improve future academic outcomes. Current research emphasizes increasing students’ exposure to mathematics talk and building vocabulary knowledge, implementing Child-centered tasks, and supporting students with or at-risk for mathematics difficulty with explicit instruction. Ultimately, exploring and implementing these best practices in early childhood is pivotal in creating strong foundations for mathematics achievement and setting students up for long-term success.

By employing evidence-based practices, being responsive, and addressing students’ early needs, teachers have the unique and profound ability to set students up for long-term achievement and having positive experiences with mathematics. Teachers can develop student’s foundational mathematical skills instrumental in subsequent learning, provide students positive learning experiences that improve their beliefs about the subject and their abilities, and prevent students from experiencing the adverse consequences of early mathematical difficulty. Students must be intentionally and fully supported by teachers, the classroom environment, and instructional practices they employ so that they have positive experiences with mathematics as soon as possible, and master foundational skills. All students deserve nothing less from their early educators and educational experiences.
Fortunately, technology can be instrumental in aiding teachers as they incorporate effective practices in their classrooms. Technology is highly promising for its ability to individualize, personalize, and differentiate content and instruction. In addition, incorporating technology into early mathematics instruction can increase engagement and motivation. Thus, I contend that technology is a powerful tool for early childhood educators because of the many ways it can facilitate effective learning and align with research-backed best practices for early mathematics education. Within this paper, I will explain the importance of fostering early mathematical abilities, best practices and critical components of instruction for young learners, and how teachers can use technology to facilitate meaningful learning. I will also connect my personal experiences observing in a general education first-grade classroom with findings from research.

**Importance of Early Mathematics**

The significance of prioritizing early childhood mathematics education cannot be understated. Growing and supporting mathematical ability during this period has significant long-term and lasting effects on academic achievement (Hachey, 2013). Indeed, several longitudinal studies show that mathematical ability in early childhood is the strongest predictor of later academic success (Duncan et al., 2007). Thus, it is just as important to develop children’s mathematical abilities in early childhood as it is to enhance reading skills to give young children a meaningful and effective early education.

Moreover, adequate early childhood mathematics instruction may be critical because deficits often emerge when students are young. If left unchecked, difficulty may persist throughout children’s school careers and adversely affect later academic achievement. For instance, in a study examining students’ individual differences in mathematical performance from
pre-k to second grade, students who did not possess higher level mathematical skills early on showed slower improvement over time than students who had been equipped with mathematical skills before entering school (Aunola et al., 2004). Thus, even before children enter school, their mathematical experiences have a significant and long-term impact on their later achievement.

Unfortunately, students who exhibit slower mathematical growth are also likely to fall further behind their typically developing peers in subsequent years. This trajectory can be seen in several longitudinal studies examining the effects of early mathematical difficulty. Within these studies, students who had initial low achievement scores often experienced slower growth compared to their typically developing peers, resulting in even lower achievement scores in later grades compared to peers without mathematical difficulty (Geary et al., 2013; Kiss et al., 2012; Vukovic, 2012). For example, in the studies by Vukovic (2012) and Kiss et al. (2021) students who experienced low achievement scores in first grade, experienced slower or parallel growth compared to their typically developing peers as they progressed through school. Students with low initial achievement were just as behind or or more, compared to their peers by 3rd grade (Vukovic, 2012; Kiss et al., 2021). Similarly, in a five-year perspective study conducted by Geary et al. (2013), compared to typically developing peers, students with mathematical learning disabilities and initial low achievement experienced slower mathematics achievement growth and had slower addition fact retrieval, used decomposition strategies less frequently, and exercised less attention, compared to typically developing peers (Geary et al., 2013). These studies point to early mathematical difficulty creating persistent gaps in achievement between students with low initial achievement compared to typically developing peers.

This persistent gap in achievement scores likely results from the nature of mathematical learning in school. After all, starting in as early as first grade, learning is affected by the skills
and knowledge children obtained from the year prior as lessons build from each other (Entwisle et al., 2005). Thus, these findings are concerning as they suggest that children who start behind, whether because their education began later or they receive inadequate instruction, may struggle to catch up to their peers (Moffett & Eaton, 2017). Priority to early mathematics education may prevent students from falling behind, allow teachers to notice deficits and implement early interventions, and help students build strong foundations for mathematical learning.

Adequate early mathematics instruction may also have a lasting impact on students' outcomes by shaping student's beliefs towards the subject. According to Hachey (2013), children are born with an innate and natural curiosity about mathematics. This is likely the root cause of children’s early positive attitudes towards mathematics (Philippou & Christou, 1998). However, as children progress through school and experience negative encounters with the subject, such as pressure, inadequate instruction, and negative teacher attitudes, and do not recognize the significance, importance, or relevancy of content to their personal lives, students often lose interest, motivation, and their positive attitudes towards mathematics (Cooper, 2014; Philippou & Christou, 1998). Thus, students' early encounters with math must be positive, meaningful, relevant, and interesting to foster strong foundations and positive attitudes towards mathematics and their own mathematical abilities (Cooper, 2014; Hachey, 2013). After all, beliefs may improve performance by improving student’s motivation to persist through challenging tasks (Philippou & Christou, 1998). Ultimately, this early period is critical. Adequate instruction has long-term implications on students' attitudes toward mathematics and the development of essential mathematical skills. Moreover, adequate instruction that students recognize as meaningful and relevant, motivates students and helps teachers sustain engagement.
Negative experiences with the subject or mathematical difficulty may also lead to the development of math anxiety, which has significant impacts on children and adult’s academic performance (Pantoja et al. 2020). Math anxiety is a phenomenon in which people experience fear when doing or thinking about mathematical tasks or activities (Pantoja et al., 2020). Unfortunately, math anxiety can manifest in children and have persisting effects through adulthood (Pantoja, 2020). Math anxiety has even been shown to negatively affect performance for even 1st-graders (Pantoja, 2020). For instance, in the study by Pantoja (2020) examining children’s early math anxiety about the foundational skill of number line estimation, it was found that when the task related to number line estimation was challenging but not too difficult, math anxiety hindered student’s performance from 1st through 3rd grade. Moreover, math anxiety has been shown to consistently predict later math anxiety for students from middle school through 12th grade, specifically, it has been shown to interfere with problem-solving ability in various contexts, which indicates that math anxiety may also affect later performance (Pantoja, 2020). Because students may be at-risk for developing math anxiety in first-grade, it is critical that teachers build positive foundations for math learning and build student’s foundational skill knowledge, like number line estimation, to prevent students from experiencing the phenomenon (Pantja, 2020).

Prioritizing adequate early mathematics instruction is essential. At 1st-grade, learning experiences have the power to positively shape student’s beliefs towards the subject and their own abilities. Moreover, positive learning experiences based on evidence-based practices are instrumental in equipping young learners with foundational skills imperative for subsequent learning. Unfortunately, many students do not receive the adequate instruction they deserve early on, which can have devastating consequences on a student's mathematical experience and later
learning. For example, if a student enters kindergarten having barely been exposed to critical mathematical concepts, that student may struggle increasingly to catch up to their peers because subsequent learning depends on foundational mathematical skills. What’s more, if teachers fail to support that student and provide positive mathematical experiences, he or she may have difficulty fully participating and excelling in group and individual practice opportunities, and developing proficient mathematical skills. In addition, the student may develop math anxiety because of these negative experiences, hindering their problem solving performance and negatively impacting their student’s beliefs about themselves and their mathematical ability. Sadly, many students enter first grade with low initial ability, and do not receive the adequate support that they need to avoid the adverse consequences of early mathematical difficulty and starting behind, having long-term and significant implications on their learning. Teachers must take their position seriously by employing evidence-based practices that help students succeed, believe in themselves and their abilities, and develop the skills they need to thrive in subsequent learning environments. Teachers must ensure that early instruction serves students and has the most profound positive impact, because with adequate support, all students can succeed.

**Best Practices in 1st Grade Mathematics**

To ensure successful mathematical learning and help students develop foundational mathematical skills that affect all subsequent learning, teachers must prioritize building student’s mathematical vocabulary knowledge and equipping students with the skills to verbalize their thought processes and engage in knowledge-building mathematical conversations. Teachers should also implement Child-centered learning tasks to motivate and engage students in meaningful learning activities driven by students strengths and interests. In addition, it is imperative that teachers support students with or at-risk of mathematical difficulty by providing
explicit instruction to ensure that students receive the support they need to successfully understand critical mathematical concepts and skills, and engage in skill-building practice opportunities.

**Mathematics Vocabulary**

Building early mathematical vocabulary knowledge should be one major focus for early educators because of its several positive implications. First, this type of knowledge improves students’ abilities to engage in mathematical conversation. This ability is imperative as the ability to discuss, explain, and justify material becomes an increasingly required task of students (Moffett & Easton, 2017). After all, mathematical vocabulary is routinely implemented in education through several modes including, textbooks, story and word problems, and computation (Barnes & Stephens, 2019; Moffett & Easton, 2017). In addition, understanding and exercising knowledge of mathematics vocabulary allows students to describe their thinking processes during more complex tasks, which can enhance problem-solving ability and other skills (Nelson & Carter, 2022). Similarly, the ability to leverage mathematical language helps students as they make meaning of important concepts (Barnes & Stephens, 2019). In particular, engaging in mathematical conversations and using subject-specific language helps students better engage in mathematical processes, like solving word-problems, and understand symbolic representations, like operation signs (Barnes & Stephens, 2019). In essence, building and supporting vocabulary knowledge will improve student’s abilities to engage in mathematical conversation, which becomes increasingly important as students progress through school and increasingly helpful as students engage in higher-level thinking skills, like analyzing multi-step word problems.
Prioritizing vocabulary instruction may also be instrumental to preventing or minimizing achievement gaps. After all, limited vocabulary knowledge is associated with difficulty solving word problems (Barnes & Stephens, 2019), learning mathematics concepts (Nelson & Carter, 2022), and accessing content (Barnes & Stephens, 2019). Thus, teachers must target vocabulary knowledge to prevent students from falling behind their peers, and help each student develop pivotal vocabulary knowledge that will help them as they engage in higher level thinking skills, and with more challenging content and concepts.

Lastly, strong vocabulary knowledge may have long-term benefits as it predicts later academic achievement (Moffett & Eaton, 2017; Nelson & Carter, 2022). This is because mathematical vocabulary knowledge is linked with important numeracy skills like counting and cardinality (Aunola et al., 2004; Nelson & Carter, 2022), which have been found to be linked with later academic success. For example, Aunola et al. (2004) found that students with higher level counting skills at the beginning of preschool, exhibited better performance and showed faster development in subsequent math skills. Ultimately, foundational mathematical vocabulary knowledge allows students to develop important skills that help them as they increasingly engage in higher-level thinking processes (Kiss et al., 2019; Nelson & Carter, 2022). Thus, dedication to building vocabulary knowledge is critical as it gives students better access to mathematical content, improves their ability to engage in mathematical conversation, and develops skills necessary in years to come.

Teachers can help students build vocabulary knowledge by incorporating effective research-based practices in their instruction. Early and repeated exposure to subject-specific vocabulary is one strategy that has been shown to improve students’ understanding of mathematical concepts in context, prepare students for learning more complex vocabulary in
later grades, and help students engage in accurate, precise, and advanced mathematics talk
(Barnes & Stephens, 2019). Subject-specific vocabulary refers to terms that are primarily used in
the context of a specific discipline, such as mathematics. For instance, terms like “perimeter,”
“addition,” and “orientation,” can be considered subject-specific as they are most frequently used
in mathematics, rather than in everyday conversation (Barnes & Stephens, 2019). Therefore,
because students typically have less frequent encounters with significant subject-specific
vocabulary words, explicit instruction must be used to help students make connections between
the new terms and prior knowledge.

Before engaging students in explicit instruction, teachers must be sure to introduce terms
strategically. Specifically, teachers must identify subject-specific terms when planning lessons
and consider how they might introduce students to the term, so they can clarify, correct
misconceptions, and offer scaffolding for students who may need additional support (Carter &
Nelson, 2022). Planning also allows teachers identify opportunities to help students make
connections between the vocabulary term and prior knowledge (Nelson & Carter, 2022). For
example, to help students activate background knowledge, teachers can have students first
brainstorm their knowledge about the term to activate prior knowledge (Nelson & Carter, 2022).

After introducing students to the term, teachers should then promote a deep
understanding and mastery of subject-specific terms by enhancing definitional support through
multiple strategies (Nelson & Carter, 2022). Particularly, research supports using a combination
of verbal and non-verbal learning strategies to deliver explicit instruction. Teachers should first
provide students with child-friendly definitions, otherwise considered definitions that consist of
language students are familiar with (Barnes & Stephens, 2019; Moffett & Eaton, 2017). For
example, when introducing students to the word “perimeter,” a teacher could provide a
child-friendly definition by describing “perimeter” as the distance around the outside of a shape. This type of simple language makes it easier for learners to understand the subject-specific word that they likely have had little exposure to. Teachers should then use a mix of verbal and non-verbal strategies by describing the term, acting it out, supplying visual aids, and sharing examples, synonyms, and antonyms (Stephens & Barnes, 2019). These multiple strategies will deepen student’s vocabulary knowledge and ensure that they receive adequate support when learning subject-specific words that they may not hear in everyday conversations.

During and after explicit instruction, teachers must also offer students opportunities to use new vocabulary terms and take action. For instance, teachers can prompt students to turn to their peers and say the word out loud (Nelson & Carter, 2022). They can also encourage young learners to make a real-world connection with the word by sharing their background knowledge or experiences with the term with a classmate (Nelson & Carter, 2022). Moreover, to have students actively engage with word definitions, teachers can ask students to use elaboration strategies like writing the definition in their own words, identifying examples and non-examples (Barnes & Stephens, 2019; Nelson & carter, 2022), and matching pictures to the term (Nelson & Carter, 2022). These practice opportunities are particularly powerful in helping students activate prior knowledge, supporting student’s understanding of concepts, and giving teachers opportunities to clarify and misconceptions about terms with positive feedback (Nelson & Carter, 2022). In addition, providing students with non-examples has been shown to be especially helpful for students struggling to learn mathematics (Nelson & Carter, 2022). Thus, finding ways as a teacher to facilitate connection making throughout lessons is critical in ensuring all student understanding.
Teachers should also promote active engagement with vocabulary words. Game-playing (Nelson & Carter, 2022), mathematical storytelling (Novakowski, 2023), and group-practice (Doabler et al., 2015) offer excellent opportunities for students to practice engaging with subject-specific vocabulary terms and knowledge-building mathematical talk. Play, either facilitated through technology or with physical materials may promote mathematics vocabulary acquisition by giving students opportunities to practice mathematics skills and language in real-life contexts. These types of serious and realistic math games have been also shown to positively impact student’s math fluency (Fraga-Valera et al., 2021). Mathematical story telling, where students create their own mathematical stories based on problems or contexts meaningful to them (Novakowski, 2023), may also promote mathematical talk in real-world contexts. For example, a teacher can share an equation with missing information, and ask students to come up with a story to match it (Novakowski). An equation might look like, “6 + _____ = 11,” and a child who loves basketball might write a story explaining, “this weekend my friends and I played basketball. I scored six baskets, and my friends scored five so we got a total of 11 points.” This little activity gives students the opportunity to express their identity and connect on a personal level to mathematics, which has several other positive implications for students and the classroom community (Novakowski, 2023).

Similarly, engaging students in group-practice allows students to collaborate with peers and the instructor to construct mathematical understanding and use mathematical language and subject-specific vocabulary (Doabler et al., 2015). For example, after introducing a subject-specific term like “perimeter,” and using multiple strategies to provide definitional support, a teacher can engage students in a group activity in which they can use various materials from around the room, like post-it-notes, legos, or yearn to create, map out, and measure the
perimeter of several shapes they created. This activity will give students a hands-on opportunity to explore the term, use it in context with peers, and create a visual representation of it.

Ultimately, providing opportunities for active practice after having received explicit instruction gives students meaningful opportunities to connect with terms and apply words in various contexts (Nelson & Carter, 2022), reinforcing vocabulary knowledge and helping students master important terms.

Teachers must prioritize incorporating each critical component of vocabulary instruction in their lessons to ensure that students develop foundational mathematical vocabulary knowledge that allows them to engage in meaningful math talk. These critical steps for improving vocabulary knowledge include, teaching subject-specific vocabulary (Barnes & Stephens, 2019), using explicit instruction (Barnes & Stephens, 2019; Nelson & Carter, 2022; Moffett & Eaton, 2017), providing verbal and non-verbal learning strategies (Barnes & Stephens, 2019), modeling terms in context (Barnes & Stephens, 2019; Nelson & Carter, 2022), and providing multiple or repeated opportunities to engage with terms (Barnes & Stephens, 2019; Nelson & Carter, 2022). These practices strengthen vocabulary knowledge, which has long-lasting effects on mathematical knowledge and outcomes.

**Child-Centered Tasks**

Incorporating Child-centered learning in first-grade mathematics education is another effective practice for all learners. Child-centered learning is an educational approach in which teachers facilitate learning by providing students with opportunities to explore academic topics that are central to them (Lerkkanen et al., 2016). Thus, teachers in Child-centered classrooms are sensitive to students’ needs, interests, and goals, and act as partners that provide guidance and scaffolding as students actively engage with academic content through various activities that
promote exploration and collaboration (Lerkkanen et al., 2016; Pakarinen & Kikas, 2019). Notably, researchers suspect that these features of Child-centered learning make the educational approach highly motivating and advantageous.

For instance, humanist psychologist Carl Rogers, argued that deep learning is often best facilitated in environments that allow students to take responsibility for their learning, learn by doing, engage with content that is relevant, purposeful, and utilizes student’s innate curiosity (Rogers, 1969). These conditions foster student’s natural curiosity for mathematics, create positive academic experiences, and motivate students to learn and create meaningful learning goals, giving students a stake in their own learning (Rogers, 1969). Moreover, Cooper (2014) found that students are most engaged in learning activities when activities and content is useful, interesting, and relatable to students, making it relevant in their lives. Thus, centering students and incorporating relevant content that children find valuable and interesting is instrumental in increasing their motivation, and improving student’s learning experiences. Teachers can make content relevant by implementing Child-centered learning, which ensures a variety of learning opportunities driven by exploration, hands-on activities, student’s needs and interests, collaboration, and learning goals. When making instructional decisions, teachers can additionally make content more relevant by considering student’s multiple perspectives, creating a classroom learning community that helps students feel represented and connected, and helping students recognize the value of the learning activities students engage in (Ginsberg, 2015). Ultimately, teachers can provide students positive learning experiences by implementing Child-centered learning and employing relevant content.

In addition, Child-centered allows teachers to provide students with valuable opportunities to engage in social constructivism, where learning becomes an active social
activity (Watson, 2001), independent exploration, and exercise autonomy and initiative. After all, students become active participants of learning with this instructional approach, guided by teachers in exploring relevant topics of interest and relevancy. Notably, this social constructivist aspect of the Child-centered approach may be especially important for students with learning difficulties because according to Watson (2001), students with learning difficulties are more likely than typically developing peers to be dependent learners, show less initiative, and have less autonomy over their learning, due limiting beliefs, and the tendency for support to rely too heavily on teacher-dominated interactions. However, Child-centered learning promotes autonomy, as with the approach, students engage frequently in social constructivism through discussions and hands-on learning opportunities.

Child-centered learning also improves students’ mathematical development regardless of initial mathematical ability. For instance, in a study conducted by Lerkkanen et al. (2016), examining the effects of teacher-directed learning compared to Child-centered teaching approaches, the more teachers employed Child-centered learning, the more student’s saw gains in their mathematical abilities, like applied problem solving skills (Lerkkanen et al., 2016). Moreover, Child-centered teaching practices were equally beneficial for students with varying initial abilities in both reading and math (Lerkkanen et al., 2016). These results suggest that Child-centered teaching practices may benefit all students regardless of their initial academic skill (Lerkkanen et al., 2016). Thus, Child-centered teaching may be a pivotal approach in 1st grade classrooms, as students come into this early grade with varying strengths and abilities.

What’s more, Child-centered learning improves mathematical skills and students’ beliefs about their own abilities. In a similar study by Pakarinen and Kikas (2019), examining the effects of Child-centered instruction on the math skills of students in early elementary school, results
corroborated with the findings by Lerkkanen et al. (2016) as Child-centered practices were associated with better arithmetic fluency and problem-solving skills in 1st grade (Pakarinen & Kikas, 2019). The improvements student’s experienced in critical mathematical skills, like problem-solving ability and calculation, align with previous research suggesting multiple advantages of Child-centered practices. For example, an earlier study by Perry et al. (2007) also studied the effects of Child-centered practices on early elementary students’ mathematics development and discovered that when teachers offered instruction and social-emotional support, children exhibited improved behavior and demonstrated more positive perceptions of their own academic abilities. In addition, by incorporating students' interests, providing challenging learning opportunities, and forming positive relationships, students met more academic standards in reading and math (Perry et al., 2007). In combination, these studies indicate that Child-centered teaching approaches have multiple worthwhile and powerful benefits on various skills.

Teachers must employ high degrees of Child-centered teaching practices for their significant influences on children’s early mathematical skills, beliefs, and outcomes. After all, compared to less Child-centered teaching practices, a high degree of Child-centered teaching promotes greater skill development throughout the school year (Lerkkanen et al., 2016). Teachers can do so by being sensitive to students' interests, incorporating opportunities for peer engagement, individualizing content, and scaffolding learning according to each student's needs (Lerkkanen et al., 2016). Similarly, teachers should opt for Child-centered teaching approaches that challenge students and offer students to approach tasks in various ways (Linder, 2012). Teachers should be sure to allow students to explore problems and multiple solutions on their own and prioritize giving social-emotional and instructional support when needed (Perry et al.,
2007; Linder, 2012). These actions ensure that students get to deeply explore tasks independently and get critical opportunities to collaborate and engage in question making (Linder, 2012). Implementation is entirely worthwhile. However, some may argue that the demands of teaching make Child-centered learning difficult to implement because of its emphasis on individualization.

Fortunately, Child-centered apps may make it easier for teachers to implement Child-centered instruction and for students to reap its benefits. For example, Outhwaite et al. (2019) examined the effects of interactive apps with Child-centered learning components on the mathematical ability of students and discovered that they may be a highly effective tool. Specifically, apps that engage students in active, meaningful, and social learning opportunities, provide feedback, repetition, and rewards, enable students to participate in Child-centered in beneficial scaffolded learning environments (Outhwaite et al., 2019). These Child-centered and curriculum-based learning environments positively influenced student’s mathematical development, and made incorporating Child-centered teaching more efficient and easier for teachers. Students in this study who used interactive apps in combination with normal math instruction were found to be 4 months ahead of their peers, who in comparison, only received standard instruction (Outhwaite et al., 2019). Of course, these results indicate that technology should not substitute small-group learning activities or standard instruction. Instead, they suggest that platforms can be used as a tool to enhance learning and provide students with enriching Child-centered tasks. After all, combining Child-centered technology with standard teaching practices had the most significant effect on student achievement (Outhwaite et al., 2019). In addition, these interactive apps are highly efficient because they allow teachers to meet the needs of students without additional teaching demands (Outhwaite et al., 2019). Thus, it would seem as
though incorporating Child-centered learning through technology is instrumental for both teachers and students, making it entirely worth exploring for educators.

While conducting my observations in a 1st grade general education classroom, I noticed that students experienced these described benefits of Child-centered learning through technology platforms. Specifically, students at my site used a program called “iready mathematics” (Curriculum Associates), which was designed to provide children with responsive and personalized instruction to meet their individual needs and promote deep learning by presenting real-world problems (“iready math”). In addition, the program seeks to build student’s confidence and boost engagement by having students master skills and embrace challenges with learning games to receive rewards (“iready math”). Moreover, to support learners, the program employs positive and immediate feedback and helps teachers assess student’s growth, so that they can target instruction and identify individual student’s learning needs (“iready math”). By centering students, offering specific instruction and feedback based on students needs, and creating a fun learning environment with various opportunities for exploration and practice, students were able to develop and build upon foundational mathematical skills and find joy in mathematics, which is critical.

Particularly, students appreciated the platforms engaging mathematics games, and its features, like rewards for mastering skills, which made students feel like they were capable and growing as learners. “We love iready math, it's really fun,” two students told me when I asked them what they thought of the program. Moreover, students seemed to enjoy the differentiated instruction that it provided as the program met them where they were. Indeed, students always worked happily with the program, engaged, motivated, and excited to collect rewards, play games, and try new pathways.
The program was also especially helpful because it allowed the teacher to administer the personalized education students deserve, efficiently. Students received individualized questions suitable for them and their skill level, and were challenged enough to promote growth. This allows the teacher and I to walk around the room and provide support if necessary. Notably, its engaging features and ability to differentiate instruction makes the platform an incredibly efficient means of practice and administering differentiated instruction with targeted feedback. Moreover, this Child-centered learning platform reflected how early mathematics learning should be, fun, supportive but challenging, and based on improving student’s confidence and foundational skills.

**Supporting Students With or at Risk for Mathematics Difficulty**

Teachers must utilize explicit instruction to support students with or at-risk for mathematics difficulty. Explicit instruction is an instructional approach in which teachers craft purposeful instructional interactions centered around academic content to increase student understanding and facilitate mathematical development (Doabler et al., 2015). Explicit instruction is a highly effective and instrumental practice for improving the mathematical performance and skills of students with or at-risk of developing mathematical difficulty (Doabler et al., 2021; de León et al., 2021). Specifically, when targeting basic math skills, explicit instruction has been shown to improve student’s understanding and skills related to place value, quantity discrimination, and finding a missing number (de León et al., 2021). This suggests that explicit instructions designed to meet the needs of students may be used to improve students' mathematical skills, which may be pivotal in establishing stronger foundations for learning.

Teacher-directed explicit instruction may also be powerful for this student population because children with mathematics difficulty often struggle with low task-persistence.
Task-persistence refers to the ability to consistently apply effort even when engaging with difficult and challenging tasks (Kikas et al., 2014). Indeed, compared to students with high initial skills, students with mathematics difficulty often experience low-task persistence and experience adverse consequences on their achievement as a result (Kikas et al., 2014). For instance, for young students, low task-persistence is associated with quitting, and low reading, spelling, and math scores (Kikas et al., 2014). Thus, the guidance and direction that teachers provide students during explicit instruction may be critical in preventing students from developing low-task persistence, which could potentially worsen academic performance as students engage in less stable effort when engaging with the subject. Moreover, teachers should be sure to be encouraging of students (Kikas et al., 2014) and to offer positive, constructive feedback in all types of instructional interactions, to give students direction, and help them persist through challenges.

Notably, the quality of explicit instruction also significantly influences student gains as well as the nature of supporting interactions that help students through all stages of learning, from teacher-directed instruction to engaging successfully in independent practice (Doabler et al., 2015). Thus, it is critical that students at-risk or with mathematical difficulties receive high-quality explicit instruction. After all, first-grade is a pivotal time for mathematical development, and not receiving targeted support may have significant implications on a student's later mathematical achievement (Kiss et al., 2019; Moffet & Eaton, 2019).

High-quality instruction includes several steps to support students throughout the learning process. These critical components include clear and concise demonstrations from the teacher, the modeling of skills and concepts, and the explicit explanation of thought processes. For instance, as a teacher approaches a word problem, they can support learners by thinking-out loud
and explaining why they make decisions like circling the numbers in the word problem and re-writing a simple equation. These initial components allow teachers to give students clear step-by-step demonstrations aimed to improve their understanding and content knowledge (Doabler et al., 2015; Doabler et al., 2021). In addition, teachers must ask individual and group questions to gauge understanding, provide timely, corrective, and positive feedback, and students in independent practice (de León et al., 2021; Doabler et al., 2021). These instructional interactions have been shown to improve performance and help students make connections between background knowledge and new content (Doabler et al., 2015). Moreover, practice engages students, allowing them to become active participants of their learning while they practice to master academic content and skills (Doabler et al., 2015). Notably, both group-practice and independent practice improve student’s understanding and allow teachers to administer critical feedback.

Group-practice also plays a pivotal role in explicit instruction. Particularly in the early grades, group-practice facilitates mathematical conversations and allows students to verbalize their thought processes, which is instrumental in successfully engaging in discussions with peers, and has been shown to enhance problem-solving skills (Nelson & Carter, 2022). Moreover, group-practice opportunities allow students with learning difficulties, who often show more dependence than typically developing peers, to show initiative and take active ownership of their learning by engaging in discussion (Watson, 2001). In addition, students get to learn from other perspectives, listen to other student’s cognitive processes (Linder, 2012), and engage with the instructor (Doabler et al., 2015). This may help students explore other possible solutions that they might not have considered, and allows for the teacher to clarify misconceptions, guide students, and offer positive feedback (Doabler et al., 2015).
A group-practice opportunity in a first-grade classroom might look like an instructional interaction where after students receive explicit instruction about coin combinations, a teacher breaks students into small groups to practice representing money using coin combinations (Linder, 2012). While in small groups, students get to learn from each other, practice verbalizing their thought processes and explaining their reasoning, and engage in collective problem-solving to find various coin combinations (Linder, 2012). After students work together, the teacher could then facilitate a whole-class discussion where groups explain their problem-solving process and the methods they used (Linder, 2012). This activity would help students use content-specific language, verbalize their thinking, and hear other possible solutions. In addition, it would allow for the teacher to assess student’s mathematical understanding, and to use that knowledge to provide corrective feedback to ensure that all students develop a deep understanding of coin combinations (Doabler et al., 2015; Linder, 2012). Ultimately, teachers can employ group-practice opportunities to facilitate meaningful discussions, engage students with learning difficulties in active roles, assess student’s understanding, and to insert positive corrective feedback.

Independent practice allows teachers to understand the knowledge and understanding of individual students. Thus, students solve problems, answer questions, and ask questions, which gives teachers critical information about a student’s unique understanding and needs (Doabler et al., 2015). This then allows teachers to monitor the progress of students, differentiate instruction, and provide positive academic feedback (de León et al., 2021). This positive academic feedback extends learning opportunities, helps students correct responses and learn from their mistakes, and allows teachers to correct any student misconceptions (Doabler et al., 2021).
In essence, teachers set students up for success with high-quality instruction by intentionally and systematically building student’s knowledge related to specific content and in a logical order, and teach students direct skills and concepts to improve understanding and target student’s needs (de León et al., 2021). Each component of explicit instruction serves as a critical instructional interaction that helps teachers demonstrate, explain, and clarify relevant skills and strategies, and students get closer towards independent practice (Doabler et al., 2021).

Furthermore, teachers must focus on supporting students in developing specific skills related to first-grade achievement. These pivotal steps include developing and mastering basic numerical skills like counting, number comparison, magnitude, and place-value (de León et al., 2021). Competencies in these domains of mathematics are critical for first-graders (de León et al., 2021). Moreover, teachers should use explicit instruction to ensure that students can solve addition and subtraction problems relying on counting procedures as these skills are fundamental for arithmetic development (de León et al., 2021). Teachers can use explicit instruction to teach these skills central to first-grade curriculum by conducting think-alouds for students, verbalizing each step involved in completing a simple word problem, or even providing a demonstration for counting to solve addition and subtraction problems (Doabler et al., 2015). In addition, teachers can model lower-level skills, such as solving number combinations, as well as higher-order content. For example, a teacher might provide a vivid, step-by-step demonstration of the counting-up and the counting-down strategies to solve subtraction problems. Then, teachers should provide sufficient opportunities for group-practice, and administer positive and corrective feedback and targeted instruction to support struggling learners, and finally, have students engage in independent practice to achieve mastery.
While observing at my internship site I noticed that explicit instruction is pivotal in supporting students with mathematical difficulty. Students who had not yet mastered concepts or critical mathematical skills like place-value or basic arithmetic struggled during individual and group practice opportunities. It was only after I worked with them one-on-one, assessed their needs and provided targeted explicit instruction in these areas that students were able to achieve independent practice. Moreover, these students increasingly fell behind when they weren’t given targeted support or corrective academic feedback and the opportunity to fix their mistakes when there was not enough support in the classroom. My observations align with current research emphasizing the importance of each step of explicit instruction from the modeling and verbalization of the teacher’s through practices, to the group and individual practice opportunities followed by positive corrective feedback. I noticed that by engaging in each step sequentially, students with mathematical difficulty saw the most improvement. This is because without initial explicit instruction, students did not know how to initiate practice activities. However, once students received targeted instruction based on their needs, they were much more likely to engage successfully in practice and experience better performance.

**Conclusion**

Early on, students develop foundational mathematical skills and attitudes towards the subject that have lasting impacts on their academic success. It is critical that first-grade educators fully support students’ mathematical development and incorporate evidence-based practices to help all students develop deep understandings of important mathematical concepts. After all, this period of early childhood is pivotal in setting students up for long-term success, and shaping student’s attitudes about their abilities and future mathematics endeavors. Moreover, teachers can prevent students from falling behind and experiencing the adverse consequences of early
mathematical difficulty and math anxiety by identifying student’s early needs and targeting explicit instruction to provide student necessary support.

To create optimal learning conditions and ensure that students receive adequate early instruction, teachers must prioritize building and strengthening student's vocabulary knowledge and abilities to engage in mathematical conversations, incorporating Child-centered tasks, and supporting students with or at-risk for mathematics difficulty with targeted explicit instruction. In addition, teachers can and should use technology and exploration activities to make learning fun, meaningful, and effective. Similarly, teachers must be responsive, attentive, and supportive, so that their feedback, lessons, and instructional decisions not only improve student’s academic skills, but align with student’s mathematical development. Education must foster curiosity, spark interest, and help students engage in deep thinking about learning and math. When teachers can truly support students, make learning meaningful, include relevant content, and incorporate student’s interests, students will not only see academic improvements, but be highly motivated to continue their learning journey and embrace the challenges that come their way.

Ultimately, teachers play a pivotal role in student’s early mathematical development. Technology is a valuable tool that can help teachers have an even greater impact on student’s early mathematics education. It is essential that we as future educators understand how to use technology to support students and how to structure instruction to help students reach their fullest mathematical potential.
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