Integrating Response to Intervention in an Inquiry-Based Math Classroom

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Response to Intervention (RtI) is a practice of academic and behavioral interventions designed to provide early, effective assistance to underperforming students. Research-based interventions are implemented and frequent progress monitoring is conducted to assess student response and progress. When students do not make progress, increasingly more intense interventions are introduced. In this paper, we will discuss Response to Intervention (RtI), inquiry-based mathematics, and how these can work together for the benefit of students and educators.

Introduction

Response to intervention (RtI) is a way for classroom teachers to determine which students need intervention and which interventions are needed. RtI is based in the general education classroom where teachers routinely implement a strong and rigorous standards-based learning environment. The tiered approach to providing layers of intervention for students needing support requires a school wide common understanding performance standards, assessment practices, and instructional pedagogy (Georgia Department of Education, 2008). Of the different "Tiers" or levels of intervention, which will be discussed later in this paper, we believe that inquiry-based instruction in K-6 grade mathematics integrates well into Tiers 1 and 2, and can be used to show growth. Research-based strategies can be used to help students fill gaps and create a deeper understanding, and can give students the tools to become more successful in mathematics. In this paper we will discuss RtI, inquiry-based mathematics, and how these can work together for the benefit of students and educators. We end with an example of how these are put into practice in a mathematics classroom.

Features of RtI

The National Joint Committee on Learning Disabilities (2005) reported that the focus of RtI is on the accountability of the teaching and learning process in general education. Having a specialist work one-on-one intensively with a student in a special education room is typically a myth. The reality is, "Most intervention specialists are attempting to serve a wider range of high-needs students than the general education teachers" (Searle, 2007, p. 10). In addition, often the type of support is help with assignments, homework, and testing, rather than specific interventions targeting the root cause of a student's problems. The classroom teacher can get involved. A key component is early intervention at the first sign of difficulties, with the result being the improvement in achievement of all students, including students who may have a specific learning disability (Mentoring Minds, 2010).

The intent of RtI is to provide a database for making instructional decisions for particular students. These identified students respond to evidence-based interventions using a multitiered model (IDEIA, 2004). This differs from past practice of using an IQ-discrepancy model to identify students with potential learning disabilities. Torgensen, et. al. (2001) states that, "The IQ-discrepancy criterion is potentially harmful to students as it results in delaying intervention until the student's achievement is sufficiently low that the discrepancy is achieved" (p. 35). Donovan and Cross (2002) argue that the "wait to fail model does not lead to closing the achievement gap for most students placed in special education."

Recent RtI-related literature (Bradley, Danielson & Doolittle, 2007; Canter, 2004; Fletcher et al., 2002) suggests that a central advantage of RtI over the IQ-achievement discrepancy model is that RtI provides information directly relevant to the design, delivery, and monitoring of student progress to appropriate instruction. Currently, states are shifting from categorizing and labeling students to focusing much more on the instructional needs of students, "with the goal of basing instructional decisions on how students are progressing. It is anticipated that this shift will help integrate general and special education, streamline resources, and promote greater inclusion of students with special needs (Georgia Department of Education, 2008, p. 17).

While procedures are important, conceptual development and ways of thinking are also important areas to support.

It appears, then, that RtI is needed to intervene with students who may have potential learning disabilities, or for students who fall into the "gap" between general education and special education. RtI can also benefit the general education student who simply has trouble in a specific content area, for example, multiplication of double-digits in mathematics. In fact, many researchers affirm that there is evidence to support RtI as a means of monitoring the progress of students with or without disabilities (Fuchs & Fuchs, 2006; Vaughn, Linan-Thompson, & Hickman, 2003). Specifically in mathematics, researchers have noted positive findings for students who received interventions (Butler, Miller, Crehan, Babbitt, & Pierce, 2003; Cass, Cates, Smith, & Jackson, 2003). In Fuchs, et. al (2006) study on third graders in mathematics, it was found that the RtI approach had a favorable impact; students were provided interventions at different tiers to improve their problem solving skills.

Tiered Interventions

"Tiered" systems of interventions, which are adjustments to the type and intensity of instruction in order to address individual student needs, appear necessary when implementing RtI. There is no universal RtI tiered system, but it is generally understood that multiple tiers provide the proper services that are needed to support the diverse academic difficulties. For example, Tier 1, may be good classroom practices: grouping students to work together, classroom management, and providing clear directions. Tier 2, may include: providing a math "tool" such as base 10 blocks or a calculator, or spending more time with a specific student or group of students. Table 1 illustrates what one state, Georgia, has created as their tiers of interventions.

Teachers' concerns, though, often involve "time." Where will this time come from to implement these interventions? What will be given up so that interventions can be provided to certain individuals? This is a very real concern. Our stance is that by using a sound, research-based, pedagogical approach such as inquiry-based mathematics, extra time is not required. In the following section, we will explore inquiry-based mathematics, and then follow with an example of how RtI connects with the pedagogical approach.

Inquiry-Based Mathematics

Inquiry-based mathematics, requires both teachers and students to think differently about the nature of mathematics (Lampert, 1990). If taken on, this can be a challenging approach for teachers who have spent years learning and teaching in a more traditional manner. For teachers, this transition

	Tiers of Intervention	Example in Action
Tier 1	Universal screenings are used for reading, math, and/or behavior for all students at all levels. Classroom teachers use frequent common formative assessments to measure progress. Teams of teachers use the data to collaboratively discuss instructional approaches, and design learning opportunities to address individual needs. Progress monitoring data is purposefully collected and organized, shared with students and parents, and is the driving force of the instructional program.	Fifth grade mathematics teachers use short term flexible grouping to support students struggling with function tables. Students are identified based on a common assessment. Students move between rooms during a class period for a predetermined amount of time. Further common assessments are used to determine progress.
Tier 2	Students identified for Tier 2 interventions are regularly assessed to measure understanding and transfer of learning to core classrooms. Benchmarks for expected progress are set, and student progress toward these benchmarks is closely monitored through assessments. Graphs of these purposeful data points are needed to illustrate the progress toward benchmark goal.	Mathematics Support Class implemented with dedicated time for Support Class teacher and classroom teacher to routinely collaborate. Fourth grade small group math students take frequent assessments. Data is used to show student growth or lack of growth. Continued use of a particular intervention is based on student performance.
Tier 3	Students identified for Tier 3 interventions will be closely monitored based on the interventions designed by the Student Support Team during the problem solving process. At this level, clear documentation of progress monitoring data is needed to support the deep focus on the individual. Graphs of assessment trends are required to show progress and identify transfer of learning to the core classrooms.	Student homework notebook is created with sections for assignments, teacher signatures, parent signatures. Student is assigned a mentor who checks notebook at school each morning and at end of day. Mentor instructs student in the use of an organizational tools for classroom work and homework. Protocol shared with parent. Together, student, teacher and mentor progress the effectiveness of the intervention.
Tier 4	Students identified for Tier 4 interventions will be involved in deep, systematic, and formalized progress monitoring, data collection, and targeted instruction. Tier 4 interventions are individualized based on student assessment data. Documentation of progress is comprehensive and robust. (Georgia Department of Education, 2008)	Tier 4 is for students who need additional supports and meet eligibility criteria for special program placement including gifted education and special education. Tier 4 does not represent a location for services, but indicates a layer of interventions that may be provided in the general education class or in a separate setting.

Asking students to write open-number and true-false sentences to pose to classmates also supports the development of their relational reasoning.

includes "knowledge of mathematical ideas, skills of mathematical reasoning and communication, fluency with examples and terms, and thoughtfulness about the nature of mathematical proficiency" (Ball, Hill, & Bass, 2005, p. 17). Mathematics teaching practice is more than what the teacher knows or does not know in the content area, it is also about the teaching practice itself: being able to hear and interpret what the students are saying, being able to skillfully probe when the student is not clear, designing and posing a question, or pointing out a connection (Ball, Lubienski, & Mewborn, 2001). Teaching practice means planning and reflecting, as well as the moment-to-moment work of enactment in class.

In inquiry-based mathematics, the teacher clearly communicates student roles and classroom expectations. Problems will be presented without an explanation of how to do them, and solutions are not what is expected, rather a justification of the strategies. In order for the classroom environment to create these high-level thinkers, teachers must communicate clear expectations about what students will learn, how they will learn it, and what qualifies as good work (Resnick & Hall, 2003). Without this bigger picture of classroom culture, students become dependent on someone else to tell them what is good or not, and what to do next. "Only when children know what is expected and are able to assess their progress toward a set goal can they take responsibility for their own learning" (Resnick & Hall, 2003, p. 17).

Many students will not have much experience in an inquiry-based classroom; it is important for teachers to guide the students in communicating their justifications, and to learn to talk mathematically. This may be using questioning techniques, such as, "Can someone explain Johnny's thinking?" or "Why would it make sense to do that?" This is a way of modeling thinking from the teacher, so that the students will eventually follow suit and share their thinking. When teaching a third grade classroom while researching, Ball (1993) suggests, "I am trying to model my classroom as a community of mathematical discourse, in which the validity for ideas rests on reason and mathematical argument, rather than on the authority of the teacher or the answer key" (p. 388).

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An important aspect of the mathematics teacher's practice in an inquiry-based classroom is to find those rich problems that will encourage a range of student thinking and questioning. "The most important criteria in picking a problem is that it be the sort of problem that would have the capacity of engaging all of the students in the class in making and testing mathematical hypotheses … setting the stage for the kind of zigzag between inductive observation and deductive generalization" (Lampert, 1990, p. 38).

Rich problems are "structured problems requiring productive thinking" (Lampert, 1990, p. 39). They are not problems that students can simply solve with an algorithm, although one may be discovered along the way. They are problems that allow for multiple routes to a solution, or multiple solutions. It is the strategies that are used and the justifications that are discussed, rather than the answers, which provide the mathematical growth. "It is these strategies that reveal assumptions a student is making about how mathematics works" (Lampert, 1990, p. 40). The content of the lesson is the arguments that support or reject the solution strategy, it is not the teacher giving mathematical knowledge to the recipient students. Teachers who have been successful in implementing rich problems and student inquiry into their mathematics classroom have beliefs that are characterized by the acceptance of the idea that children can solve problems without direct instruction and that the mathematics should be based on children's abilities (Fennema & Carpenter, 1996). Additionally, if posed properly, rich problems can cover a great deal of curriculum (often these problems cover unintended curriculum). The real challenge for teachers is to integrate rigor of content, through rich problems with high-level thinking. Not only do they want to do this because that is the way that real learning takes place, but also because of time (Resnick & Hall, 2003).

In traditional classrooms, children are expected to tell the class what the teacher wanted them to learn rather than expressing their own thinking (Voigt, 1995). In a classroom where rich problems are explored and followed by children sharing their thinking in class discussions, the intention is that children are reconstructing their solutions and justifying them to others. This creates opportunities for learning in which children not only express their mathematical thoughts but also listen to strategies and justifications of solutions of others. "These settings would provide opportunities for children to reflect on their activity and reorganize their current conceptual level of thinking" (Wood, Cobb, & Yackel, 1991, p. 599).

An Example in Action

As we implemented RtI and inquiry-based mathematics into our weekly teaching, it appeared that these two classroom approaches complimented each other. Searle (2007) suggests that there are universal interventions that have been shown to be effective with 80-90% of learners. These interventions include: creating a safe and welcoming environment, focusing on the learners' attention, pacing lessons, chunking material, planning practice and rehearsal, and providing feedback and reinforcement. These "interventions" are simply good teaching practices which can readily be used in a mathematics classroom where inquiry-based learning is occurring.

Let's take a look at a scenario where RtI is integrated into an inquiry-based mathematics classroom. Mrs. Smith wants to work on patterns. She finds a rich problem that allows for multiple answers, and this problem will likely touch on many other mathematical indicators or standards along with patterns. She presents this problem to her class, "2, 3, 5 ...... List as many different ways as you can to continue this pattern." Mrs. Smith has thoughtfully grouped students, she is rotating from group to group to encourage all to participate, she is offering feedback if a student or group seems "stuck," she is allowing plenty of time for students to think outside the box and come up with multiple solutions, and she may provide a 100s chart to a student who needs an extra tool. Mrs. Smith has a pedagogical approach that allows her to put extra time in before the lesson even began (grouping students, finding a rich problem, thinking of tools that might be needed by individuals), but then gives her time to work with small groups or individuals during the lesson.

After group work, Mrs. Smith returns to a whole group setting to share answers, strategies, and justifications. The students communicate their answers, they hear different answers and approaches, and they connect their learning of patterning to many other areas of mathematics, depending on what strategies and content were discussed during group work. For example, one group's strategy is "multiply by two, then subtract one, so the next numbers would be 9, 17, 33." Multistep problems and creating algorithms can now be discussed, or at least mentioned by the teacher or student. Another group recognized that these first three numbers are prime, and continued, "7, 11, 13...." A third group found a pattern of even, odd, odd; and shared this answer, "6, 7, 9, 10, 11, 13." By allowing the two groups to share their strategies, the entire class has now been exposed to prime and composite numbers, as well as odd and even numbers.

Along with the class experiencing benefits of a rich problem in an inquiry-based setting (group work, communication skill, problem solving, connecting mathematics, reasoning), the teacher has also implemented RtI interventions. Mrs. Smith's universal interventions of providing feedback, reinforcement, chunking material, pacing the lesson, and focusing the learner's attention, applied to 80-90% of her learners. How does this help our students, especially those at risk with learning disabilities? "If every teacher in a school system would put universal research-based strategies in place, the number of students who appear to be 'at risk' would drop dramatically .... Intervention plans built on these universal designs will not only help the student in question but also benefit other students in the class at the same time" (Searle, 2007, p. 67).

According to Searle (2007), 5-10% of the learners need a targeted intervention. This can be initially addressed by asking, what are the most intensive services a student might require, and what is the least invasive level that makes sense for this case? This might take longer than traditional interventions, but the idea is "not to jump into a testing

Finding a connection between the figure number and the number of dots was encouraged and emphasized.

process with the intent of qualifying a student for an intensive special education program" (p. 80). The new RtI way of thinking is to assess a student and immediately start with mild interventions, which may become incrementally stronger until one finally works.

This next targeted level of intervention might require Mrs. Smith to observe a student more closely and make a list of academic and/or behavior concerns. It might mean collecting samples of student work, making anecdotal notes of student participation in group work, talking to the parents, or talking with other teachers. Without going into great detail on this process, a baseline data and planning form can begin. This can initiate the process of developing targeted interventions, which can readily be applied in an inquiry-based mathematics classroom.

Later in the year, different warm-up formats were used to develop and/or strengthen the connection between the visual patterns, the rule and the graph.

Going back to our rich "2, 3, 5...." problem, Mrs. Smith now needs to implement some targeted interventions. Because of the nature of this type of pedagogical approach to teaching mathematics, she now has the time to apply these interventions. She has noted that Abby gets angry easily with Chloe. She purposefully does not group them together. Mrs. Smith has also noted that Abby needs to be encouraged when she makes good choices; praising and being a helper have worked in the past, while time-out and scolding has not worked. Mrs. Smith sits with Abby's group a bit longer than most, and purposefully praises Abby when she contributes to the group. She also noted that Brandon struggles with multiplication. This might place a road block in his thinking about solutions to the pattern problem. She provides Brandon with a multiplication chart, which may alleviate his stress and may also help him to see some patterns in the problem. Both of these targeted interventions can be applied in this inquiry-based mathematics classroom simply because of the nature of the teaching approach.

Summary

Early intervention in general education at the first sign of difficulties is necessary to address the needs of all students, especially those with possible learning disabilities. When these interventions are implemented, which we refer to as Tiers 1 and 2, the results are an improvement in achievement of all students, including students who may have a specific learning disability. Eighty to ninety percent of learners simply need universal interventions (Tier 1) from the general education teacher, including: providing feedback and reinforcement, chunking material, pacing the lesson, creating a safe learning environment, and focusing the learner's attention. Another five to ten percent of students need a more targeted intervention (Tier 2): anecdotal notes to help create a plan, strategies, learning tools, and parental involvement, just to name a few. If these first two Tiers of interventions are not successful, special education would be the next step, but it would not be the initial step.

Our stance is that in an inquiry-based mathematics classroom, these universal and targeted RtI strategies, implemented in the first two Tiers , can be readily put into practice in the regular education classroom. In fact, RtI and inquiry-based mathematical strategies simply go hand-in-hand. The teacher's preparation time is put in up front, before the class arrives, which means less time spent in front of the classroom telling the students how to do the mathematics. Instead, the use of rich problems allows for multiple standards and indicators to be covered, provides a constructive learning environment, and allows the teacher time to implement interventions and better study her students. In other words, by approaching math instruction with an inquiry-based pedagogy, time doesn't need to be "found," it is already built in.

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Warm-ups can serve as a vehicle for building new ideas. Ways of thinking can be developed across time and not take time away from an already full pacing guide.

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Think about it!

"The fact of the matter is that your brain was simply not built to store unrelated bits of information, such as lists of names and numbers."

Buonomano, D. (2011). *Brain bugs: How the brain's flaws shape our lives, 3.* W. W. Norton & Company, NY.

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Do you remember?

"What does or does not get stored in memory depends heavily on context, significance, and attention. ... The purpose of human memory is ultimately not to store information but to organize this information in a manner that will be useful in understanding and predicting the events of the world around us."

Buonomano, D. (2011). *Brain bugs: How the brain's flaws shape our lives, 68.* W. W. Norton & Company, NY.