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An Informed Approach to Selecting and Designing Early Mathematics Interventions

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ABSTRACT: The purpose of this article is to discuss techniques, training competencies, and subject content knowledge as it applies to delivering interventions to young children experiencing mathematics problems. Implementing interventions is conceptualized as a complex process that needs to consider a variety of factors having an impact on student performance. Using a model to frame these factors, we use the notion of functional awareness to represent a practitioner's knowledge that alterable variables proliferate in schools and can be combined as tools for learning support. Complementing functional awareness is the need for knowledge in the core subject matter of mathematics. Being that instructionally oriented intervention in early mathematics lags behind reading, we cite both specific and policy-related issues comparing the two areas. Finally, we illustrate the importance of core subject matter knowledge in delivering interventions.

Using information to guide the provision of instructional support is the cornerstone of school psychological practice. This idea pertains to all aspects of establishing and maintaining an effective core set of school-based psychological services (Curtis & Zins, 1986). Regarding the quality of such services, the practitioner should be able to demonstrate how intervention-based psychological services are purposefully employed, empirically supported, and individually impactful. Although school psychologists are expected to use these competencies, practicing within a school system calls upon an extensive continuum of professional knowledge. Such knowledge ranges from carrying out a prescribed set of testing activities to carefully diagnosing and treating a learning problem, whether that treatment is delivered directly or indirectly. As it pertains to individually tailored interventions in the early grades, a more advanced skill set is especially important given that the goal of an early intervention is complex, centering on preventing the development of compounded problems over time.

In schools, problems are often ill-defined and multivariate in nature, thus requiring not only expertise but creativity (Voss, Means, Glover, Ronning, & Reynolds, 1989). Drawing from research on the development of expertise (Bransford, Brown, & Cocking, 1999), three basic forms of knowledge are relevant to the skill set of a school psychologist: declarative, procedural, and conditional. The psychologist with declarative knowledge has an organized set of resources, while procedural knowledge ensures that methods such as functional assessment, behavioral therapy, or curriculum-based assessment can be employed to assist learning. Conditional knowledge, as held by the expert interventionist (Power, 2002), helps practitioners select, design, and evaluate effective interventions

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given different purposes and student needs (Elliott, Witt, Kratochwill, & Stoiber, 2002). Advanced, creative, or expert knowledge is central to an informed approach to educational intervention.

To further illustrate professional competency, let us suppose that a practitioner holds virtually unlimited declarative knowledge and can name, find, and recommend interventions matched to an area of difficulty (e.g., phonemic awareness, reading comprehension, math calculation). Under these conditions, practitioners need only to match interventions to the presenting problem. Common examples of this are Web searches using keywords matched to a broad problem area (e.g., reading decoding, comprehension, math facts). Assuming that these interventions are applied randomly (not considering the unique ecology), practitioners will occasionally find the right intervention; at the same time there is a chance of using the "best" evidence-based intervention (EBI) in an inappropriate situation. Although it is tempting to dismiss this idea, any educational professional can list many cases where EBIs are implemented inappropriately. In such a case where attention is not focused on the fit of the intervention, students who fail to prosper are victims of chance. To be clear, it is important to consider that any chosen intervention carries a likelihood of failure. Thus, picking an intervention, even in light of an extensive evidence base, is the wrong direction for intervention-focused practice. The right direction is ensuring a rationale for its selection based on the problem at hand.

Decisions resulting from the failure of a chosen intervention to produce effects, such as instructional placement or eligibility (Salvia & Ysseldyke, 2004), hold students partially responsible for the failure. Neglecting variables related to instructional management, curriculum, and assessment, the practitioner advocating for the intervention should be held accountable for its failure (Howell & Nolet, 1999). Using an informed approach to intervention selection and design can counter impactful decision errors. The purpose of this article is to discuss a model of intervention selection and design that emphasizes core subject matter knowledge and competency in functional assessment.

EARLY MATHEMATICS: EXPLORING CORE SUBJECT MATTER AND INSTRUCTIONAL ISSUES

Knowing the fundamental subject matter of early mathematics is critical, given the relatively young stage of its development and application in school psychology, as well as the large numbers of students at risk for failure in mathematics (National Center for Education Statistics, 2004a, 2004b). Evidence from the Early Childhood Longitudinal Study confirms the Matthew effect phenomenon, where students with early skills continue to prosper over the course of their education while children who struggle at kindergarten entry tend to experience great degrees of problems in mathematics. Given that assessment is the core of effective problem solving in foundational subject matter (Daly, Chafouleas, & Skinner, 2005), much less is known about the specific building blocks and pinpoint subskills that lead to a numeric literacy, early numeracy, or number sense (Chard et al., 2005; Clarke & Shinn, 2004; Clements, Sarama, & DiBiase, 2004; Gersten, Jordan, & Flojo, 2005; Methe, Hintze, & Floyd, in press). However, numerous researchers in school psychology have begun to tease apart the construct of early numeracy through the development of useful assessment tools (Chard et al., 2005; Clarke & Shinn, 2004; Floyd, Hojnoski, & Key, 2006; Methe et al., in press; VanDerHeyden, Broussard, & Cooley, 2006; VanDerHeyden et al., 2004; VanDerHeyden, Witt, Naquin, & Noell, 2001). With regard to the general idea that an intervention is, at the very least, a subset of instruction, we review (a) early math knowledge, (b) curricular benchmarks, and (c) general instructional principles related to helping children with learning difficulties (Baroody, 2004; Baroody, Ginsburg, & Waxman, 1983; Clements et al., 2004; Griffin, Case, & Siegler, 1994; Kame'enui & Simmons, 1990).

Early Mathematics Knowledge

Following from relevant theory, early mathematics is marked by a set of knowledge transitions temporally converging on the interface of nonnumeric and numeric knowledge (Baroody, 2004). This interface typically occurs during the kindergarten year, where experiences and knowledge children bring from home interact with the formal system of education typically introduced through symbols (numbers and letters). When one conceives of early reading, for example, it is not typically oral reading fluency or comprehension that comes to mind. Instead, it is prereading concepts and subskills that act as markers for readiness. Like the alphabetic principle, where children begin to fluently link natural speech concepts with letters, children who are aware that numerals represent sets of objects are developing what is widely known as number sense. This implies an understanding that a numeral has a set of attributes allowing comparison and combination with other numbers. Mathematical cognition in young children progresses from informal and conceptual to formal and numeral based (Russell & Ginsburg, 1984). Informal knowledge centers around a set of ideas such as enumeration and counting, language concepts pertaining to size, ordinal position, and decomposition (Clements et al., 2004).

To establish a clear knowledge base of core competencies in early math, it is important to understand key differences between children who acquire this knowledge and who do not acquire this knowledge. What appears to separate these groups are differences in (a) early informal experiences with number, (b) strategies used to store and access the knowledge, and (c) fluency with numeric combinations (Gersten et al., 2005; National Mathematics Advisory Panel, 2008). In designing the Right Start instructional program, Griffin et al. (1994) indicated that children who struggle on basic mathematical tasks (e.g., simple addition) lack a conceptual structure to support operations with numerals. When presented with numerals, children who lack a concept fail to demonstrate any useful knowledge beyond the names of numerals. To broaden a child's concept of number, these researchers had children engage in informal play-like activities and measured their knowledge on pretests and posttests. Such activities began with counting using concrete representations (i.e., manipulatives), a numeric line to represent movement and ordinal position, grouping into larger sets, and simple addition and subtraction.

Benchmarks

As emphasized earlier, it is important to identify mathematics problems as they fit within a context of core mathematical knowledge. What becomes necessary is an examination of typical developmental benchmarks. It is important to note that content knowledge provides a setting for the development of curricula, not vice-versa. Considering a basic identification or screening perspective, problems in the timely attainment of these benchmarks can act as markers for mathematics difficulties. Evidence for a set of key big ideas in beginning mathematics is found in Clements et al. (2004) and Baroody (2004). These steps are, respectively, counting, comparing and ordering, equal partitioning, composing and decomposing, grouping and ordering, and adding to/taking away (see Table 1). Numerous researchers and professional organizations have emphasized the positional importance of number sense and basic operations as a curricular cornerstone (National Mathematics Advisory Panel, 2008).

Acting on the behalf of scientific and professional communities, Clements et al. (2004) relate these core competencies to the number and operations strand of many state curricula, and a strand emphasized in the recent rerelease of the National Council of Teachers of Mathematics Focal Points curriculum (National Council of Teachers of Mathematics, 2006). In reference to early child development, Clements et al. refer to this strand as "arguably the most important" (p.16). In this depiction, directionality is implied through a set of arrows pointing either away or toward one of the six areas. These arrows are intended to demonstrate how one specific competency either informs (arrow pointing away; output) or is informed by (arrow pointing toward; input) another specific competency. Competencies that have no inputs are inferred to develop prior to others. Rank ordering the number of inputs and outputs (e.g., counting has 0 inputs, but 5 outputs; adding to/taking away has 0 outputs and 5 inputs) confirms an interesting hierarchy, listed in Table 1 as a task analysis. It is also important to understand that, like any set of skills, perfectly linear development is not implied, per se. However, when identifying and solving educational problems, it is important to understand the key role of prior knowledge (Howell & Nolet, 1999).

Table 1. Task Analysis of Number Sense and Operations Strand

Skill area	Description
Counting	Both nonverbal and verbal enumeration of smaller to larger sets develops. Counting aloud begins with one and progresses accurately. Number words used to identify sets. Important benchmarks are both recognizing and producing numerals accurately (from smaller sets).
Comparing and ordering	Quantities and sets are compared using nonverbal identification progressing to verbal labels (more, equal, less). Ability to recognize and produce ordinal numbers begins with 1–5 and progresses through 30 by age 6. Prerequisite for establishing the idea of movement and change; requires the envisioning of a mental number line (Griffin et al., 1994).
Equal partitioning	Basic ability to equally partition small sets (6 into 3 and 3) develops at 3 years. This basic idea expands and develops into larger sets of items and holds true for word problems.
Composing and decomposing	Children develop more sophistication over time, and can gradually deal with larger numbers in a more abstract fashion, when asked to find subsets embedded within larger sets of items or numbers (7 has 3 and 4, but also has 5 and 2).
Grouping and place value	Typically refers to the progression in abstractly grouping objects into sets of 10 (17 means 10 then 7; 24 means “2-10” and 4). Relates to the prior benchmark in terms of knowing how many are left (or needed) when counting up to 10. Regarding written numbers, knowing that each successive numeral represents larger groups of sets.
Adding to/taking away	Progression in ability to notice increases and decreases in sets of items. Outcome goal is that children know how to make sets larger and smaller (in progressively larger increments) by using accurate strategies that do not rely on laborious enumeration, counting, or equal partitioning.

Note. For an in-depth analysis, see Clements, D. H., Sarama, J., & DiBiase, M. (Eds.). (2004). *Engaging young children in mathematics: Standards for early childhood mathematics education*. Mahwah, NJ: Erlbaum.

Instructional Principles

To illustrate a basic distinction in knowledge form, recognizing the numeral 7 by pointing to it (or saying it) is different from counting on from 6 to 10. Even though both seem to represent a basic skill, it is important to examine the requirements of the task and nature of the response further. The former requires a more basic knowledge form known as discrimination. More specifically, it is a selection-type response using a simple learned association between a number word and a set of relevant features distinguishable from those of the number 5, for example. When a child recognizes numerals, we would like to think that this child has a concept of number. However, given its discrete nature, we may be mistaken, and would thus need to make a *minimal knowledge assumption* (Engelmann, Granzin, & Severson, 1979). This assumption is a careful, mastery-oriented look at an educational response. It assumes that the learner does not know the concept despite the correct response, and has simply either pointed to a 7 by chance, or memorized the number without regard to any distinguishing features.

Counting on from 6 to 10 is an example of both a concept and a strategy. That is, when asked to count up (either in isolation or in response to a given increment, “count up four spaces”), would understand the concept of ordinality, cardinality, relative size, and movement. When beginning this skill, strategy use typically takes the form of using fingers to represent counting and counting numbers. Promoting the use of fingers and concrete objects to assist in the counting process should be undertaken carefully, and considered an instructional prompt or setting-based intervention. Like any prompt, it should be carefully faded as a function of skill development.

Table 2 lists basic examples applied to a subset of the number and operations skills listed in Table 1. Kame’enui and Simmons (1990) adapted both Bloom’s and Gagne’s taxonomies to illustrate the idea that knowledge form progresses from simple to complex. Although we believe this to be an important accomplishment, we find the notion of linearity somewhat misleading for a number of reasons. First, past research has asserted that newborns have a simple number concept, but lack the motor and verbal ability to operate with this knowledge (Canfield & Smith, 1996; D’Mello & Willemsen, 1969; Resnick, 1989). If Kame’enui and Simmons’s model were linear, then a child should have demonstrated verbal chaining ability prior to demonstrating a concept. With this in mind, one does not progress past a conceptual knowledge base when beginning to utilize strategies such as counting on fingers or giving someone another token when asked for “more.” Instead, the ability to use strategies both indicates (a) the presence of a concept and (b) that the concept is widening and branching, indicating that learning is taking place. Such a view is consistent with a cognitive depiction of concept learning. The ineffective use of strategies should inform the practitioner that there is a problem in the learner’s conceptual knowledge, and the effective use of strategies should be a target for intervention (Pressley, Harris, Alexander, & Winne, 2006).

Summarizing the extent of a child’s knowledge is a challenging diagnostic endeavor. At all times, these conclusions should be based upon publicly observable information (Kame’enui & Simmons, 1990), available when the practitioner uses direct assessment strategies in the subject area where the child is struggling. An example of unobservable information is an inference that a child has a math problem because (a) of poor performance on an intelligence test, (b) a practitioner was told by someone else there was a math problem, or (c) a child tends to avoid mathematical activities. When important decisions are under consideration, it is important to use standard measurement techniques and technically sound instruments such as curriculum-based measurement (CBM; Clarke & Shinn, 2004; Floyd et al. 2006; Methe et al., in press).

Functional Awareness

Perhaps the most enduring example of an informed approach to intervention is that of functional analysis. Functional analysis seeks to identify and isolate learning conditions that are consistently associated with the performance of positive educational behaviors. Schools, as venues of such analyses, are dynamic organizations where conditions are rapidly altered. Just as well, decisions regarding instructional needs, progress, and curriculum placement are often as frequent and varied. Consumers of psychological services frequently turn to school psychologists to help with many difficult decisions. We believe that an informed practitioner is inclined to identify and manipulate alterable, proximal, and controllable educational variables while monitoring the variables’ effect on outcomes. Recent studies have extended the functional analysis paradigm toward academic behavior, generally illustrating an informed approach as it links subject matter to a functional awareness under the proxy of specific techniques.

Table 2. Examples of Knowledge Forms in Number and Operations

Knowledge form	Early math skill involved	Example
1a. Simple facts	Counting	Answering "how many" questions related to set of items up to 4.[a]
1b. Verbal chains	Counting	Verbally counting to a specified number.
1c. Discriminations	Counting	Given a set of items, choose the one corresponding to a specific written or verbal number (4 dots equals "four").[b]
	Comparing and ordering	Given an array of numbers, choose the correct one. Given an array of items, choose the one that is "bigger," "smaller," "equal to," or "has more," etc.
2. Concepts	Counting	Producing items (or finger displays) when asked to "show me" a given number.
	Comparing and ordering	Given a set of items in order, choose the one in a given position relative to the others.
3. Rule relationships	Composing/decomposing	Additive, commutative, and relative rules. "Changing the part changes the whole."
4. Cognitive strategies	Counting	Using fingers or objects to help with counting sequence.
	Adding to/taking away	When asked for "more," general use of an "increment" strategy; for "less," use of a decrement strategy. When asked to add, learner begins from the larger addend (7 + 3, begins at 7 and "counts up").

Note. Simple facts, verbal chains, and discriminations are forms of verbal associations. (See Kame'enui, E. J., & Simmons, D. C. (1990). *Designing instructional strategies: The prevention of academic learning problems*. Columbus, OH: Merrill.)

[a]Items to four can be quickly memorized by very young children, known as "subitizing." Typically, answering questions about more than four items, while arguably factual, requires some level of calculation and thus strategy use.
[b]Discrimination is feature driven. While children often can discriminate when they attain a concept, as defined here, discrimination concerns differentiating simple visual or auditory features.

Burke, Hagan-Burke, and Sugai (2003) demonstrated a strong functional link between negative classroom behavior and the form of reading instruction. Using single-case methodology, they examined the link between disruptive disengagement and knowledge form and instructional technique. These researchers correctly guessed that when the student was presented with higher level knowledge forms without the appropriate instructional support, more engagement should be evident. The researchers varied the educational task in terms of knowledge form; negative behavior during a reading comprehension lesson allowed the researchers to test their guess that the student had not attained the higher level knowledge form, and lacked prerequisite knowledge. Further, their methodology allowed negative classroom behavior to be linked directly to instructional form. Changing the level of intervention as it related to knowledge form had a powerful impact on engagement and reduced disruptive behavior. With knowledge of core skills, instructional form (Kame'enui & Simmons, 1990), and functional awareness, practitioners are better equipped to develop a diagnostically based intervention for early mathematics skills.

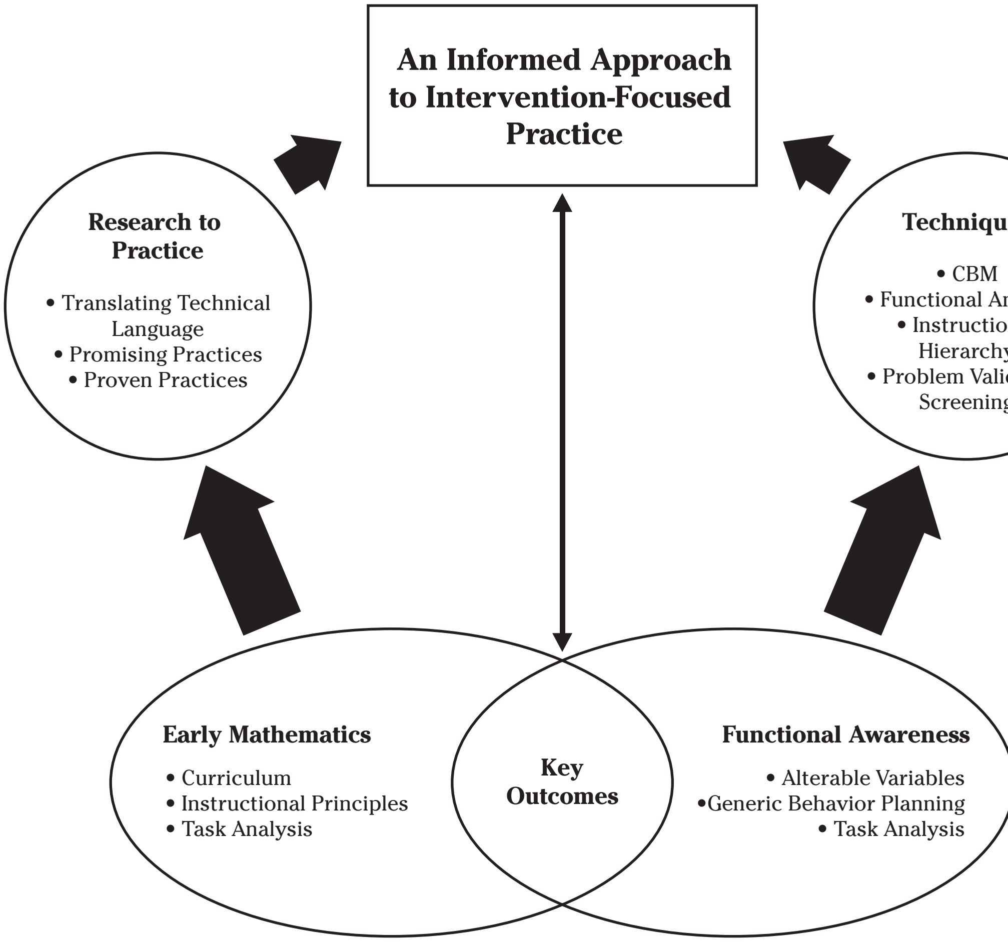
McIntosh, Horner, Chard, Boland, and Good (2006), in an attempt to link subject-matter knowledge to long-term educational outcomes, examined the link between early achievement and later school behavior problems. Using cutoff criteria, these researchers found that students with problems in foundational reading skills in kindergarten (scored below 35 accurately segmented phonemes when verbally presented with a set of decodable words) more than doubled the office discipline referrals of students without these early problems when examined in fifth grade. Although this study has clear implications for early prevention, its major contribution lies in the idea that achievement and behavior problems are not isolated; that is, they act within a series of functional relations over time that persist with immediate and inexorable links to the academic environment. Efforts to treat early achievement or behavior problems must be conceptualized in terms of a prioritized functional relationship: The tendency to act inappropriately is defined in terms of a child's ability to understand and master core subject matter.

Practitioners with an understanding of functional assessment can visualize the topography of an effective instructional landscape and conceptualize three functionally related anchor points when planning interventions: (a) what the student is currently doing, (b) what the student should be doing, and (c) a method for knowing if the student is progressing toward the objectives. When a practitioner establishes a baseline, goals, and a set of assessment activities, these actions prior to intervention implementation can facilitate both natural and planned changes in alterable variables. Instruction and intervention are then appropriately liberated from the idea that materials and prescripted interventions trump an informed approach to their selection. Given the vast array of instructional arrangements, known as alterable educational variables (Howell & Nolet, 1999; Kame'enui & Simmons, 1990), an informed practitioner knows that these variables can be combined to either prohibit or advance learning. As an applied practitioner of educational psychology, the school psychologist must remain informed when recommending how "someone will teach something to someone else in some setting" (Calfee & Berliner, 1996, p. 2).

Applications and Techniques Utilizing Functional Analysis

Through systematically applying the principles of functional analysis, numerous researchers have developed unique ideas that guide the process of instructionally oriented intervention. These models detail the operational plans necessary for building a paradigm of intervention and prevention of early mathematics problems. As such, both application and research into their application is greatly needed. A key feature in each of the models reviewed is the attempt to apply a decision-making rule to observed educational problems using advanced conditional knowledge (if/then knowledge) when generating hypotheses. For example, using logic from the Daly, Witt, Martens, and Dool (1997) study (detailed below), the following thought process is used: *If a child does not want to complete the task, then an incentive should have an impact on completion rates and inform the practitioner about the nature of the deficit*. Such functional and conditional knowledge on the part of the school psychologist characterizes the informed approach to intervention service delivery (Figure 1).

Figure 1. The informed approach model



Daly et al. (1997) proposed a set of five reasonable hypotheses for student failure. Regarding task completion, these five reasons are that the student (a) does not want to complete the task, (b) has not spent enough time doing it, (c) has not had enough help to complete the task, (d) has not had to perform the task that way before, or (e) provides evidence that the task is too difficult. These reasons would only prove useful in targeting a child's difficulty if the practitioner were able to gather relevant data. This notion links the generation of these hypotheses to functional assessment, which is gathering information from multiple sources regarding what happens before, during, and after instruction. Using brief test conditions, Daly et al. indicate that making changes in educational conditions is the primary means for arriving at a diagnosis. For example, assuming that functional assessment indicated that a child appears inconsistent and unmotivated, a practitioner would provide incentives for task completion to examine if the child did not want to complete the task. The case study in the following section details how a practitioner makes further use of this model as applied to early mathematics assessment.

Since Piaget, psychologists have classified knowledge in order to both understand and change what students are able to accomplish in the classroom. One such variation of a classification system is the instructional hierarchy (IH), which sees learning as a process of acquiring, becoming fluent with, maintaining, and applying knowledge outside of the learning environment to novel problems. To validate IH as an instructionally useful tool, it is important to demonstrate that interventions would differentially benefit students as a function of their place in this hierarchy. For example, students who are in the process of acquiring knowledge may not benefit from instruction that focuses on speedy retrieval and generalized use of the knowledge to novel tasks. Examining this assumption, Daly and Martens (1994) predicted that interventions designed for drill and practice (fluency) would be more useful than those designed for acquisition, such as an intervention that plays taped words. The notion of an instructional match was generally supported. Further, Daly and Martens recommended that specifying intervention targets (i.e., building accuracy) a priori allows practitioners to better select approaches geared toward improving that specific dimension.

Focusing in on an important delineation between the accuracy and fluency phases of the IH, VanDerHeyden, Witt, and Naquin (2003) characterized student difficulties at each phase as skills-based versus performance-based deficits, respectively. They emphasized the importance of both validating a problem in terms of its severity and generating hypotheses about its origin. Similar to the aims of the IH, VanDerHeyden et al. proposed a need for analyzing presenting problems that typify referrals for student support. Termed problem validation screening (PVS), their objective was to differentiate students whose problems are motivational in nature from those with true skill deficits. Using PVS, practitioners can readminister commonly available CBM probes, offering students incentives for improving their scores. Typically, students whose scores improve are hypothesized to have problems less mild in nature, and are more readily able to remediate problems independently. Their findings provided support for the idea that PVS can reduce the likelihood that students with environmentally based problems are tested and placed in special education, and increase the likelihood that students who have problems receive intensive and necessary services.

Research to Practice

Research methods make their way to practice with respect to the professional skills of a school psychologist. Outlined by Keith (2002), the practitioner can assume the role of (a) consumer, (b) disseminator, and/or (c) conductor. Our primary assumption and practical direction is to conceptualize the informed practitioner as an outcome-focused intervention agent, somewhere between disseminator and conductor, who nonetheless tests his or hypotheses but may not publish the findings to peer-reviewed journals. The most appropriate definition for an intervention developed by a school psychologist and implemented would be *a set of actions that, when taken, have demonstrated ability to change a fixed educational trajectory*. This definition provides flexibility but focuses on evidence. Although many agencies have developed guidelines as to what *evidence-based* means (some require programs to have randomized controlled trials prior to adoption), we define an informed approach to intervention as inherently experimental by its very nature.

Responding to demands of the accountability movement resulting in "the proliferation of lists of evidence-based prevention programs," Flay et al. (2005, p. 151) describe a set of rigorous criteria necessary to establish an intervention as ready for dissemination. Because interventions will always differ along a continuum of readiness, the actions of a school psychologist in choosing an intervention should similarly differ. As a function of readiness, it seems that the practitioner must decide among four actions: (a) selection, (b) adaptation, (c) translation, or (d) design. Assuming that a specific, targeted intervention is available, a practitioner can simply select the intervention once the student's needs have been identified. When an intervention is available in steps but its intended use differs from its original development or recommendations, the practitioner will likely need to adapt the methods of delivery.

These first two steps assume that an intervention has scientific support and has been translated (almost literally) from its technical language into a user-friendly format. The third step, translation, is exemplified when a practitioner searches for empirical journal articles, and almost literally translates technical language (e.g., differential reinforcement of other behaviors, response cost) into user-friendly language and implementation steps. The final step, design, assumes that no current approach exists, or lacks empirical validation, thus prompting the practitioner to design the intervention itself. In designing an intervention, the practitioner has the opportunity to demonstrate his or her work to a professional audience if clear outcome measures indicate improvement in student skills. It is beyond the scope of this article to discuss factors related to successful implementation following the adoption of an approach.

Case Study in Early Mathematics Intervention

Mike, a first-grade student, is referred to the school psychologist, Dr. M, for problems paying attention during group instructional activities. Aligned with the protocol of the psychological services unit, Dr. M begins a record review and schedules a time for a teacher interview, observation, and brief testing session. Records indicate that Mike was referred to his pediatrician for attention problems but was not diagnosed with any form of psychological or medical disorder. Teacher interview data indicate that Mike tends to act up when the students are gathered for instruction in large groups. More specifically, the teacher notes that Mike is performing relatively well in informal reading assessments, but struggles in virtually all areas of the early math curriculum. Mike was observed during completion of brief mathematics activities in class, and it was found that he made numerous mistakes on basic addition worksheets and struggled with the names of many basic numbers. These observations appear to indicate that Mike is failing to benefit from instruction using numerals, since he struggles to conceptualize the meaning behind the number symbols.

This hypothesis became more likely when Mike was observed in class. He was asked to place a bingo chip on a number plate corresponding to the number of claps the teacher makes. Given 10 opportunities to respond with the numerals 1–10, Mike performed with 60% accuracy. The hypothesis that attention problems were to blame was less likely, given that this instruction occurred in a small group of three students with close teacher supervision, proximity, and at a brisk pace. However, it appeared important to verify the presence of a skill versus performance deficit using the PVS process outlined in VanDerHeyden et al. (2003). Among a large available battery of early numeracy tests, Dr. M. selected a task that presented a group of numbers and collections of dots, requiring a student to accurately and fluently match the numeral with the set (Floyd et al., 2006; Methe et al., in press; VanDerHeyden et al., 2006). Given the opportunity to choose from a small treasure chest described as a mystery prize (Moore, Waguespack, Wickstrom, & Witt, 1994; VanDerHeyden et al., 2003), Mike was asked to do his best to beat his former score on the task. No improvement was noted. Verifying the likelihood of a skills-based deficit was his low level of accuracy (below 80% on three consecutive attempts).

Using the functional hypotheses of the IH, as well as Daly et al. (1997), it appeared that the reason Mike failed on this task was that the fluency required for completion of the task frustrated Mike, who was likely experiencing problems because the task itself was too difficult. Observations, interviews, and records indicated that these hypotheses were feasible, given that prenumeric tasks posed problems for Mike, who appeared to be struggling with basic concepts of counting, especially those requiring the cardinality rule (that small sets of items correspond to a single cardinal number, typically the one counted last). Number bingo required Mike to not only match the number of claps to a numeral, but to discriminate among the numerals 1–10. Referencing Tables 1 and 2, comparing numbers and discriminations appear to be higher order skills and knowledge forms (respectively) than producing simple counting facts and verbal chains. As such, it becomes clear that instruction in these areas can help Mike develop prerequisite knowledge of the informal structure of number. Synthesizing our definition of an intervention (any action demonstrating positive changes in a fixed educational trajectory) with the three critical anchor points (baseline, goal, and method of measuring progress), Dr. M. is moving toward helping Mike better respond to classroom instruction. More specifically, Mike's current skill deficit was observed, identified, and measured, and a measurement task was selected to monitor Mike's progress.

Two more critical activities are necessary: (a) setting a goal to indicate that Mike is learning the intended skill and (b) adopting an intervention approach. Because very little normative information is available for student performance on the number matching task, it is advisable at this step to either gather normative data from the local school building or to reference the original studies to examine growth rates and recommended cutoff scores. It may also be useful to choose a more generalized outcome measure, such as a number recognition fluency task (Clarke & Shinn, 2004). However, in this case, local normative data were collected, and Mike's accuracy and fluency goals were set at above 90% and at or above 45 correct answers per minute. Surveying the research, a number-line intervention that targets directly to Mike's skill deficit was chosen (Fueyo & Bushell, 1998). The intervention needed translation to allow for its readiness for implementation. This intervention was to be delivered by his classroom paraprofessional in a small group of three students three times per week. Over 4 weeks, Mike's response to the intervention was monitored, and he made the gains on the number-matching CBM probe. Important delineations between specific subskill mastery measurement and general outcome measurement should be reviewed, but are beyond the scope of this article (Hintze, Christ, & Methe, 2006).

Notable in this case study was that the practitioner did not spend time testing all available hypotheses, as per Daly et al. (1997). Given the practitioner's knowledge of the core subject matter and the notion that a breakdown in prior knowledge is the most likely culprit, he was able to generate a set of ideas about Mike's skill deficit and quickly rule out performance deficits as the cause (VanDerHeyden et al., 2003). More importantly, the selection of the intervention method was quite straightforward given that methods for measuring student progress were chosen prior to implementation, aligned with a problem-solving model. Although the chosen intervention lacked efficacy research established through randomized controlled group studies (Flay et al., 2005), it did not stifle the practitioner in taking actions likely to improve student responsiveness to instruction.

MATH INTERVENTION IS ROCKET SCIENCE

This article describes a model of practice as a compilation of advanced professional knowledge based on the inclination to act thoughtfully within a sea of dynamic, complex, and alterable educational variables. We propose this model for two primary reasons: (a) to emphasize the complexity of contemporary school psychological practice as it pertains to delivering individual interventions in early mathematics and (b) to deemphasize the perception that contemporary school psychological practice is molded by policies and movements. Although we agree that accountability to the consumer should indeed drive practice, we fail to find a specific methodology, movement, or policy that has colonized this idea. We have first-hand experience indicating that training in responsiveness to instruction and knowledge of evidence-based interventions alone do not reduce the complexity of practice as it pertains to helping needy learners. Instead, the health of the profession as it pertains to its continued provision of effective interventions hinges upon each individual school psychologist and is related to the psychologist's functional competencies (Ysseldyke et al., 2006). Policy-based educational movements cannot define the practitioner; conversely, we believe that the practitioner's actions define and have built these large-scale movements.

On the heels of reading reform lies mathematics. The National Math Advisory Panel has released its final report, and results from this professional consensus advocate content-related proficiencies to guide instruction, intervention, and professional training across disciplines. We borrow our section title from Moats (1999), because the title of her paper reminds the teacher and interventionist that "teaching reading is rocket science," suggesting that significant study and careful analysis is necessary to effectively instruct students with reading problems. This is undoubtedly true for mathematics.

On the precipice of mathematics reform, we urge school psychologists to integrate professional competencies with the core foundational skills necessary to prevent children from failure in mathematics and to use this knowledge to build bridges across professional disciplines that converge within the classroom.

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