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Picturing student progress : teachers' comprehension of curriculum-based measurement progress graphs

Bosch, R.M. van den

Citation

Bosch, R. M. van den. (2018, November 22). *Picturing student progress : teachers' comprehension of curriculum-based measurement progress graphs*. Retrieved from <https://hdl.handle.net/1887/67118>

Version: Not Applicable (or Unknown)

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Note: To cite this publication please use the final published version (if applicable).

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Author: Bosch, R.M. van den

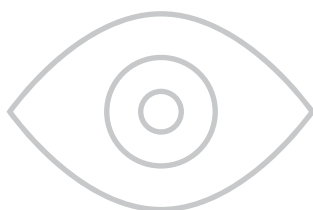
Title: Picturing student progress : teachers' comprehension of curriculum-based measurement progress graphs

Issue Date: 2018-11-22

BACKGROUND ON CURRICULUM-BASED MEASUREMENT: CONTEXT, RESEARCH, AND CHALLENGES

Based on:

Espin, C. A., van den Bosch, R. M., & Sikkema-de Jong, T. M. (2016). Behandeling van onderwijsleerproblemen: Interventies en voortgangsmonitoring [Remediation of learning disabilities: Interventions and progress monitoring]. In M. H. van IJzendoorn & L. van Rosmalen (Eds.), *Pedagogiek in beeld. Een inleiding in de pedagogische studie van opvoeding, onderwijs en hulpverlening* (pp. 327-338). Houten, The Netherlands: Bohn Stafleu van Loghum.



CHAPTER 2

BACKGROUND ON CURRICULUM-BASED MEASUREMENT: CONTEXT, RESEARCH, AND CHALLENGES

To illustrate how curriculum-based measurement (CBM) can be used within educational settings, we begin this chapter with a case study of a teacher (Mr. Kees) and a student with reading difficulties (Sander). CBM is built upon a *problem-solving approach* to addressing the needs of students with learning difficulties. We return to the concept of *problem solving* following the case study.

Case Study: Mr. Kees and Sander

Mr. Kees is a 4th-grade (groep 6) teacher. One of his students, Sander, is having difficulty with reading. Sander's reading scores on a national, standardized progress-monitoring test (the "Cito LVS-toets") are far below those of his peers. Sander reads slowly and haltingly, has difficulty sounding out words, and does not always understand what he reads. Sander does not like to read. He never volunteers to read in class and he does not read at home unless he has to. During independent reading time (the time when students read silently from books of their own choosing), Mr. Kees gives Sander extra instruction. However, based on Sander's scores on the Cito LVS-toets and on his in-class reading assignments, the extra instruction is not enough to improve Sander's reading.

Mr. Kees is concerned about Sander's reading difficulties. He thus asks the school psychologist ("orthopedagoog" in Dutch) and lead teacher ("intern begeleider" in Dutch) for advice. Together they decide to implement a small-group reading intervention called the Systematic Teaching and Recording Tactic (S.T.A.R.T) for Sander and three other 4th-grade students with reading difficulties. S.T.A.R.T. is an intervention that combines evidence-based approaches for word reading, fluent reading, and comprehension (Rogers, Deno, & Markell, 2001). S.T.A.R.T. is designed as a supplemental intervention program for students who struggle in reading and is easy to implement. The team also agrees to closely monitor the progress of Sander and the other students in order to evaluate the effects of S.T.A.R.T. on the students' reading progress.

A group of parent volunteers already come to the school twice a week to read for a half hour with struggling students. Mr. Kees, the school psychologist, and the lead teacher decide to train the parent volunteers to implement S.T.A.R.T. in that time. The school psychologist creates a scripted version of S.T.A.R.T., and does a

brief training with the parents. After the training, the parents implement S.T.A.R.T. under the supervision of Mr. Kees and the lead teacher, who offer encouragement to the students and advice to the parents. The school psychologist and Mr. Kees collect CBM progress data to evaluate the effects of the S.T.A.R.T. intervention via an online program called Mazonline® (www.mazonline.nl). Once a week students complete a 2-minute CBM maze-selection task. The online system automatically scores the maze tasks and graphs the data, and after a certain number of data points, generates a slope line (line of growth) through the data.

After 10 weeks of intervention and monitoring, Mr. Kees inspects Sander's CBM progress graph. He wants to share the graph with Sander's parents at an upcoming parent meeting ("10-minuten-gesprek"/"ouderavond" in Dutch). In preparation for the meeting with the parents, Mr. Kees inspects Sander's graph to determine whether Sander is making adequate progress and whether the S.T.A.R.T. intervention is effective for Sander. However, there is a lot of information on the graph and Mr. Kees is unsure about how to read and interpret the graph, and he is especially unsure as to how to describe the graph to Sander's parents.

Problem-solving Approach to Addressing the Needs of Students with Learning Difficulties

The case study of Mr. Kees and Sander illustrates the use of CBM within a *problem-solving approach* to specialized education. A problem-solving approach is in contrast to a more traditional diagnostic-prescriptive approach.

Diagnostic-prescriptive approach

Traditionally, when the learning characteristics of a student appear to be very different than those of peers – as they are in the case of Sander – the student is referred to a specialist (such as a school psychologist) for assessment. Based on the results of the assessment, a diagnosis may be made, providing a name for the constellation of characteristics exhibited by the student. For example, if Sander were to be assessed, he might receive a diagnosis for dyslexia. After a diagnosis has been made, a specialized program of remediation is designed. This program might be individualized instruction provided by the teacher, specialized instruction provided by a specialist in- or outside of the school, or placement of the student in a different school. The diagnosis of a problem followed by the prescription of a treatment is referred to as a *diagnostic-prescriptive approach* to addressing the learning needs of students (Deno, 1990, 2013).

The diagnostic-prescriptive approach assumes that a diagnosis (label) is a necessary prerequisite to receiving extra help, and that a particular diagnosis indicates a particular type of treatment or intervention.

There are several drawbacks associated with the diagnostic-prescriptive approach (Vaughn & Fuchs, 2003). First, it is a “wait-to-fail” approach; that is, there often is a delay between the time that a problem is noticed and the time that specialized interventions are begun because the student must wait for assessment and diagnosis. Second, there is the potential for a disconnect between assessment, diagnosis, and instruction because assessment and diagnosis occur in one setting (e.g., outside of school) while instruction occurs in another (e.g., in school). Third, students can easily “fall through the cracks”. That is, students might experience serious learning difficulties, but if they do not receive a diagnosis, they are not provided with additional instruction.

Problem-solving approach

An alternative approach to the diagnostic-prescriptive approach is a *problem-solving approach* (Deno, 1990, 2013). In a problem-solving approach, a learning problem is defined within the educational context, and then various interventions are tested to determine whether the interventions “solve” the problem that has been defined. More specifically, in the problem-solving approach, the “problem” is defined in terms of a discrepancy in performance between what a student can do and what he or she is expected to do (Deno, 2013). For example, a teacher may notice a discrepancy between a student’s reading performance and the performance of same-aged peers. This discrepancy might be confirmed via the student’s scores on informal assessments and/or standardized tests. As soon as a discrepancy is identified, additional specialized interventions are implemented in an attempt to improve the student’s performance and progress. Furthermore, data are collected to evaluate the effects of the additional interventions.

In a problem-solving approach, the aforementioned drawbacks to the diagnostic-prescriptive approach are addressed (Vaughn & Fuchs, 2003). First, in a problem-solving approach there is less time between “diagnosis” of the problem and intervention because as soon as a discrepancy in performance is identified, interventions can begin. Second, because both the “diagnosis” of the problem and the design of the intervention take place within the school setting, there is less of a chance for a disconnect between diagnosis and treatment, and between regular and specialized instruction. Third, students are less likely to “fall through the cracks” because a discrepancy in performance signals the need for additional, specialized instruction, regardless of whether or not the student receives a diagnosis.

An important aspect of the problem-solving approach is that interventions are seen

as “hypotheses to be empirically tested” (Deno, 2013, p. 31). That is, it is assumed that one can never say with certainty that a given intervention will be effective for a given student; thus, the effectiveness of each intervention must be empirically tested for each individual student (Deno, 2013; Deno & Mirkin, 1977). As such, the added value of the problem-solving approach is that the effectiveness of an intervention is not assumed but evaluated, and if an intervention is not effective a new intervention is implemented until an effective intervention has been found to “solve” the student’s problem. One psychometrically sound and practically feasible progress-monitoring system often used to empirically test the effectiveness of interventions for individual students in the context of problem solving is CBM (Deno, 1990, 2013).

Problem Solving at a School Level

Up to this point, we have described problem solving for individual students with learning difficulties, but a problem-solving approach also can be implemented at a school-wide level. One specific school-wide problem-solving model widely implemented in the United States, and beginning to be implemented in Europe and in the Netherlands, is called *Response to Intervention* (RTI; Grosche & Volpe, 2013; Schölvinck & Jansen, 2014; Vaughn & Fuchs, 2003), also sometimes referred to more generally as a Multi-tiered System of Supports (MTSS). Within RTI, a student’s “response” to instruction is used to determine the need for additional/more specialized instruction (Vaughn & Fuchs, 2003). Response to instruction is evaluated on the basis of data such as CBM data that reflect the individual student’s level of performance and rate of progress.

An RTI approach to intervention typically involves three tiers or levels of instruction (e.g., see D. Fuchs & Fuchs, 2006; D. Fuchs, Fuchs, & Compton, 2012; Grosche & Volpe, 2013; Vaughn & Fuchs, 2003). Tier 1 is the general education classroom, where the emphasis is placed on implementation of evidence-based interventions to ensure that poor performance of students is not attributable to poor education or poor instruction. Students are screened three times a year to identify students who are potentially at risk for failure. If a student’s scores on the screening measures are below pre-specified criteria or far below those of peers, as was the case for Sander in the case study, it indicates that the regular classroom instruction is not sufficient for the student to improve, and the student is moved to Tier 2.

In Tier 2, the student receives regular classroom instruction as well as additional, more intensive small-group instruction, and the student’s progress is closely monitored using an ongoing progress-monitoring system such as CBM. In the case study presented earlier, Mr. Kees provided Sander with extra reading instruction in a small-group setting via the S.T.A.R.T. intervention. If after receiving Tier 2 interventions, the student’s performance remains low and the progress is slow, the student is moved to Tier 3. In the

case study, the Tier 2 interventions had not yet been evaluated for Sander.

In Tier 3, the student receives additional intensive, individualized instruction, and the student's progress continues to be monitored. If the intensive, individualized instruction is not effective, the instructional program is changed until an effective program is built for the student. In Tier 3, additional diagnostic assessment may be done to provide a more in-depth insight into the student's problems and to inform the design of an effective instructional program for the student.

In sum, within RTI, students are identified for additional, specialized instruction on the basis of educational needs rather than on the basis of a diagnosis (Vaughn & Fuchs, 2003). Further, as illustrated in the case study of Mr. Kees and Sander, the responsibility for specialized instruction begins with the "home school", and remains with the home school, or at least within the partnership ("samenwerkingsverband" in Dutch) between the home school and other schools.

RTI provides a framework that can be used to address the challenge of implementing *Passend Onderwijs* (tailor-made education) in the Netherlands. The law *Passend Onderwijs* came into force in 2014, and states that every student must receive tailor-made education, and that extra instruction provided for students is not dependent on a "medical indication" (Nationaal Regieorgaan Onderwijsonderzoek, 2014). *Passend Onderwijs* also states that schools are responsible for meeting the educational needs of all students in the school, including those with learning and/or behavioral difficulties or disabilities. This means that schools are supposed to provide tailor-made education for all students, and that this education should be provided as much as possible within the school itself (rather than outside the school). The ideas of *Passend Onderwijs* fit seamlessly with the ideas of RTI. Furthermore, the use of CBM to collect and evaluate student progress data to make data-based instructional decisions is in line with the Dutch ministry for Education, Culture, and Science's (Ministerie van Onderwijs, Cultuur en Wetenschap, 2007, 2011) call for elementary schools to adopt a data-based instructional approach – referred to as *Opbrengstgericht Werken* (Results-oriented Instruction) – in order to improve student achievement.

To summarize, CBM can be used to closely monitor the progress of students with learning difficulties and to evaluate the effectiveness of instruction for those students. RTI and CBM can be implemented in the Netherlands to address the challenge of *Passend Onderwijs*, and to meet the government's call for teachers to adopt a data-based instructional approach. But what is known about the technical adequacy of scores from CBM measures and the effects of the use of CBM on student achievement?

Overview of Research on CBM

Technical adequacy of CBM scores

A large body of research supports the reliability and validity of CBM scores as indicators of the performance and progress for students in several academic areas, including math, written expression, and reading (see reviews by Foegen, Jiban, & Deno, 2007; McMaster & Espin, 2007; Wayman, Wallace, Wiley, Tichá, & Espin, 2007). The studies in this dissertation focus on CBM use in reading. In reading, two different types of measures have been used to monitor student progress: Reading aloud and maze selection (Hosp, Hosp, & Howell, 2016). For the *reading-aloud measure*, students read aloud from text for 1 minute, and the number of words read correctly is scored and graphed. For the *maze-selection measure*, students read from a text in which every 7th word has been deleted and replaced with three choices – one clearly correct and two clearly incorrect choices. Students read silently for 2-3 minutes, selecting choices as they read. The number of correct choices is scored and graphed.

Scores for both the CBM reading-aloud measure and maze-selection measure have been found to be reliable and valid indicators of general reading performance, with alternate-form reliability coefficients typically above $r = .85$ and validity coefficients representing the relation between the CBM scores and scores on other measures of reading performance typically above $r = .65$ (see Espin, Wallace, Lembke, Campbell, & Long, 2010; Marston, 1989; Reschly, Busch, Betts, Deno, & Long, 2009; Wayman et al., 2007).

Effects of CBM use on student achievement

Research also has demonstrated that using CBM leads to improved student achievement (Stecker, Fuchs, & Fuchs, 2005). More specifically, *when* teachers use CBM data to monitor student progress *and* to evaluate the effects of instruction, student performance and progress improves. For example, in one of the earliest randomized control studies to address the effects of CBM use on student achievement (L. S. Fuchs, Deno, & Mirkin, 1984), it was found that students of CBM teachers improved significantly more in reading performance than did students of control teachers. As an example, a description of this study is provided in the following paragraph. Details of other studies addressing the effects on student achievement are outlined in Chapters 3 and 5.

L. S. Fuchs and colleagues (1984) randomly assigned 39 teachers to either a CBM progress-monitoring (experimental) condition or to a control condition. CBM teachers monitored the reading progress of 3-4 students with reading difficulties two times a week for a period of 18 weeks using a CBM reading-aloud measure, and used the data to guide their instructional decision-making. Control teachers also monitored the

reading progress of 3–4 students with reading disabilities for the same 18 weeks using traditional methods such as teacher-made tests, teacher observation, and workbook exercises. Dependent variables in this study were performance on decoding and reading comprehension subtests of a standardized achievement test, teacher instruction, and teacher evaluation of student progress. Teacher was the unit of analysis. Results revealed that students of CBM teachers improved significantly more in both decoding *and* reading comprehension over the 18 weeks than did students of control teachers. In addition, observations of teacher instruction during the study revealed that CBM teachers increased their use of high-quality instructional practices over time, whereas the control teachers decreased use of such practices over time. Finally, CBM teachers were more realistic and specific in describing student progress than were control teachers. These results thus supported the effects of CBM progress monitoring on student achievement as well as teacher instruction and teacher evaluation of student progress.

L. S. Fuchs and colleagues (1984) attributed the effects that they found in part to the fact that CBM teachers used the CBM data to make instructional changes; however, later studies revealed that teachers often do not use CBM data to make instructional decisions (see Stecker et al., 2005, for a review). The majority of studies that have been done to examine the effects of the use of CBM on student achievement were carried out in the 1980s /early 1990s. Unfortunately, since that time, little research has focused on teachers' use of CBM data, and it is only recently that research has been done to examine precisely *why* teachers do not use CBM data to make instructional decisions. This oversight is somewhat surprising given the fact that the success of CBM relies on teachers' use of the data to make instructional decisions (Stecker et al., 2005).

Teachers' Comprehension of CBM Graphs

As described in Chapter 1, one potential reason for teachers' non-use of CBM data might be that teachers have difficulty reading and interpreting – “comprehending” – the CBM progress graphs. Although CBM graphs are designed to be simple, and although the graphs are supposed to be easy to read and interpret (Deno, 2003), until recently, no one had examined whether it actually was the case that the graphs were easy or difficult to read and interpret. Given that research on general graph comprehension demonstrates that reading and interpreting graphs often is *not* as simple as is often thought (see reviews by Friel, Curcio, & Bright, 2001; Glazer, 2011; Shah & Hoeffner, 2002), it is reasonable to assume that reading and interpreting CBM graphs also might be more difficult than presumed.

The first studies conducted to examine teachers' comprehension of CBM graphs were published in 2017. Results of these two small, exploratory, descriptive studies demonstrated

that both inservice teachers (Espin, Wayman, Deno, McMaster, & de Rooij, 2017) and preservice teachers (Wagner, Hammerschmidt-Snidarich, Espin, Seifert, & McMaster, 2017) experienced difficulties with comprehending CBM graphs. In both studies, a think-aloud methodology was used to examine participants' CBM graph comprehension. That is, participants were asked to "think out loud" while reading and describing CBM graphs.

In the Espin et al. (2017) study, inservice teachers' think-alouds of CBM graphs were rated as to the extent to which they reflected knowledge about CBM and were scored on various aspects of CBM graph comprehension (i.e., accuracy, sequential coherence, specificity, and reflectivity). Results revealed that the higher-rated think-alouds were more accurate, coherent, specific, and reflective than the lower-rated think-alouds, showing that some teachers experienced more difficulties reading and describing CBM graphs than others. In addition, and perhaps of most interest, it was found that the CBM knowledge ratings of teachers' think-alouds were *not* related to teachers' years of experience using CBM. This lack of correspondence seems to suggest that experience using CBM and creating CBM graphs does not guarantee adequate understanding and interpretation of the graphs.

In the Wagner et al. (2017) study, preservice teachers' think-alouds were compared to the think-alouds of "gold-standard" CBM experts. Results revealed that the think-alouds of the preservice teachers were less accurate, complete, coherent, specific, and reflective than the think-alouds of the CBM experts, showing that the preservice teachers comprehended the graphs less well than did the CBM experts.

In sum, the results of these first two studies on CBM graph comprehension provide preliminary support for the assumption that reading and interpreting CBM graphs might be more difficult than presumed, but these results should be replicated.

Studies in this Dissertation

The studies presented in this dissertation build upon the two early studies of Espin et al. (2017) and Wagner et al. (2017), and further examine teachers' ability to comprehend CBM progress graphs. First, teachers' ability to describe CBM graphs, and their patterns of graph inspection are examined. Then, instructional approaches for improving teachers' CBM graph comprehension are examined. Throughout the studies, we make use of a framework for the study of graph comprehension developed by Curcio (1987) and Friel et al. (2001). Curcio (1987) and Friel et al. (2001) describe three levels of graph comprehension: *Reading the data*, *reading between the data*, and *reading beyond the data*. *Reading the data* is defined as the ability to extract the data from the graph, and represents the most basic level of graph comprehension. *Reading between the data* is defined as the ability to integrate and interpret the data from the graph, and represents an intermediate level of graph comprehension. Finally, *reading beyond the data* is defined

as the ability to interpret the data from the graph within its context, and represents the most advanced level of graph comprehension.

Curcio's (1987) and Friel et al.'s (2001) framework of graph comprehension often is used in studies of graph comprehension (e.g., Ali & Peebles, 2013; Boote, 2014, Galesic & Garcia-Retamero, 2011; Kim, Lombardino, Cowles, & Altmann, 2014). In the studies in this dissertation, we use this framework to examine (Chapter 3) and improve (Chapter 5) teachers' comprehension of CBM graphs. We do, however, not use Curcio's and Friel et al.'s general terms of *reading the data*, *reading between the data*, and *reading beyond the data* to refer to the three levels of graph comprehension. Instead, we use terms more specific to CBM graph comprehension to refer to these levels, namely *reading the data*, *interpreting the data*, and *linking the data to instruction*. We conceptualize *reading the data* as the ability to describe the CBM data (the data points and the slope lines) as they appear on the graph, *interpreting the data* as integrating and interpreting relations between graph elements (such as the slope line and the goal line), and *linking the data to instruction* as evaluating and interpreting the data within the instructional context (see Chapters 3 and 5 for examples of reading, interpreting, and linking CBM data to instruction).

Summary and Conclusions

As illustrated by the case study of Mr. Kees and Sander presented at the beginning of this chapter, CBM is built upon a problem-solving approach to addressing the needs of students with learning difficulties. CBM can be used to monitor the progress of students with learning difficulties and to evaluate the effectiveness of instruction for these students. A large body of research supports the technical adequacy of CBM scores, and research also demonstrates positive effects of the use of CBM data on student achievement. Importantly, such effects on student achievement are *only* found when teachers use the data to make instructional decisions (i.e., change instruction or raise the goal), but, unfortunately, teachers often do not use the data. Somewhat surprisingly, to date, little research on CBM focused on *why* teachers do not use the data to make instructional decisions. One potential reason that deserves further attention in future research is that teachers might struggle with reading and interpreting – comprehending – CBM progress graphs, which is the first step in using CBM data for instructional decision-making.

