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BENEFITS OF ADDING PRECISION TEACHING TO BEHAVIORAL INTERVENTIONS FOR STUDENTS WITH AUTISM

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Students with autism have a variety of learning characteristics that can provide challenges to teachers. Precision Teaching, a method providing frequent assessment of performance, facilitation of curricular decisions, and techniques for developing fluency, can help teachers enhance educational outcomes for students with autism. Teachers can use the techniques found in Precision Teaching to augment their current instructional methods. This article purposes to examine the potential benefits of adding Precision Teaching to behavioral interventions for children with autism. This paper will define Precision Teaching, and review its guidelines within the context of a hypothetical case study. Copyright © 2002 John Wiley & Sons, Ltd.

INTRODUCTION

Educating students with autism can pose a formidable task for teachers. Students with autism have learning characteristics that vary considerably from typical learners. The demanding learning characteristics, such as problems with generalization, 'stimulus overselectivity', and prompt dependency, means that teachers must have powerful tools at their disposal to produce effective learning outcomes (Scott, Clark, & Brady, 2000). Choosing the most powerful teaching intervention, however, does not prove an easy task.

Choices range from empirically derived treatments to controversial interventions (Simpson & Zionts, 2000), and with the diversity of intervention options available to teachers, almost all therapeutic programs claim some type of efficacy. Maurice (2000) describes an unfortunate outcome that sometimes occurs with competing interventions. In her words, '"The autism wars" refer to the fierce infighting and conflicting claims of individuals or groups, each of whom claims to know how best to

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treat children with autism and derides the theories and methods of the other camps' (p. 496).

With conflicting messages and disdain levied to alternative theories of treatment, how can teachers decide which intervention will help their students most? Regardless of the interventions teachers choose, methods that evidence a rigorous scientific approach would seem a wise selection. In Green's (1996) words,

> The vast majority of the child's time and other resources ought to be invested in treatments that have been shown, through scientific research, to produce the most lasting beneficial effects on the broadest range of behavioral deficits and excesses that constitute autism (p. 17).

Science has a distinguished history as it has helped facilitate the discovery of natural laws of the Universe (Sagan, 1993). In like manner, science has also uncovered the natural laws and principles of behavior (Skinner, 1953). With carefully controlled experiments and precise measurements, science has consistently yielded valuable information. A scientific approach to treatment (Bernard, 1957) set the foundation for fundamental changes in the other professions such as medicine. The scientific approach also holds great promise for those working with students with autism.

Undoubtedly, teachers of students with autism would welcome changes to the field of education if they produced the same tangible results as in medicine. By incorporating the scientific approach into educational interventions, like our counterparts in other professions, favorable developments can occur. A method called 'Precision Teaching' exemplifies one such evidentiary-based scientific system designed to measure behavior, facilitate curricular decisions, and promote independence. This article will introduce Precision Teaching, share its guidelines and contributions to the understanding of learning, and discuss the benefits of adding Precision Teaching to existing educational programs. Although the term 'teachers' appears throughout this article, 'teachers' can apply to any adult who teaches a new skill—general education teachers, special education teachers, para-professionals, behavior analysts, speech and language clinicians, parents, and anyone else who interacts with a student with autism.

CHARACTERISTICS OF PRECISION TEACHING

Lindsley (1964) wrote 'Children are not retarded. Only their *behavior* in average environments is sometimes retarded. In fact, it is modern science's ability to design suitable environments for these children that is retarded' (p. 62, italics in the original). Lindsley's bold pronouncement planted the seeds of what would become

Precision Teaching. Contemporary Precision Teachers still share the strong commitment to arranging suitable learning environments so each student can strive to reach his or her potential.

The name 'Precision Teaching' may sound like a curriculum and a set way to teach students. Precision Teaching, however, better exemplifies an overlay procedure that compliments existing curricula with a set of systematic procedures for measuring behavior and facilitating decision-making (Binder & Watkins, 1990; Lindsley, 1990; Maloney, 1998; West & Young, 1992; West, Young, & Spooner, 1990; White, 1986). Precision Teaching works best when combined with effective curricula or educational or therapeutic approaches (Lindsley, 1997). For example, the curriculum Direct Instruction, a research-based approach for teaching children academic skills, becomes even more effective when combined with Precision Teaching (see e.g. Desjardins & Slocum, 1993; Morrell, Morrell, & Kubina, 1995; Maloney, 1998).

The advantage of adding Precision Teaching to a curriculum like Direct Instruction originates from two features of Precision Teaching. The first feature, adding a responsive measurement system, calls for daily, direct, and continuous measures of a specific curricular skill. Teachers who engage in systematic formative evaluation of students produce higher levels of student achievement than teachers who do not (Fuchs & Fuchs, 1986). Precision Teaching has developed a measurement approach that embraces Skinner's powerful laboratory discoveries (e.g., cumulative response recorder) and makes the scientific method available to teachers (Binder, 1988).

Skinner (1938) developed the cumulative response recorder to produce a standard view of real time changes in behavior. The cumulative response recorder produced a standard frequency chart (i.e. the cumulative response record, Lindsley, 1994). The standard frequency chart facilitated experimental discoveries that resulted in descriptions of elementary principles of behavior (Skinner, 1956). The Standard Celeration Chart (Figure 1) used in Precision Teaching represents the next derivative from Skinner's standard frequency chart. The Standard Celeration Chart allows a standard view of how frequencies (i.e. count per unit of time) multiply or divide in real calendar time. The standard frequency chart allows a standard view of how behavior counts change in real time.

Teachers who use Standard Celeration Charts can do the following: (i) interpret standard slopes; (ii) see major changes in behavior displayed; and (iii) produce objective and reliable data displays (Lindsley, 1991). Stated differently, Standard Celeration Chart readers will:

(i) View changes in frequency of behaviors represented by celeration courses that have standard values. A celeration course with a doubling of performance per celeration period on the daily chart will have an identical celeration course as a doubling of performance per celeration period on the weekly, monthly, and

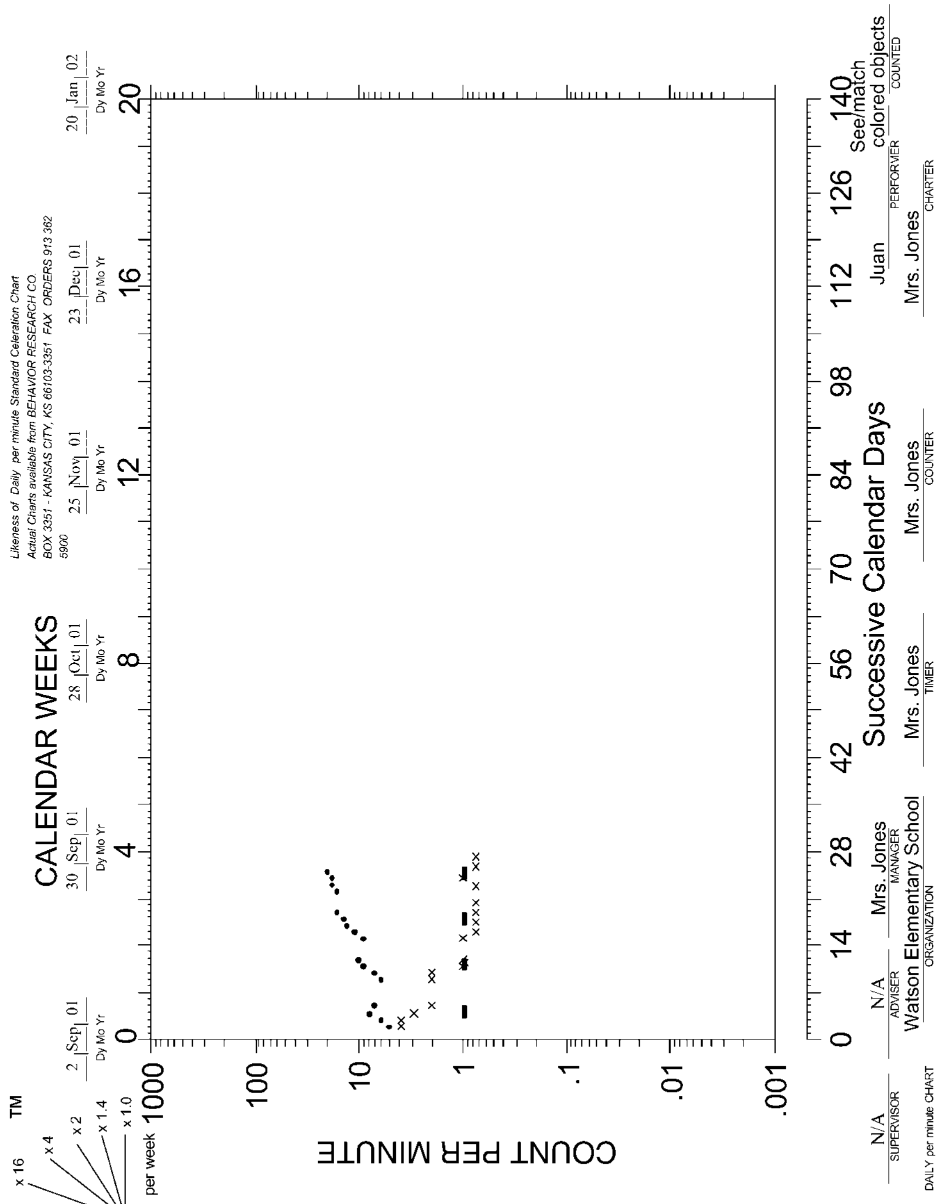

Figure 1. A Standard Celebration Chart showing Juan's learning progress on a discrimination task.

yearly Standard Celeration Charts. For example, the celeration period for the daily chart is per calendar week, per calendar month for the weekly chart, per calendar year for the monthly chart, and per calendar decade for the yearly chart. A $\times$ 2.0 celeration on the daily chart means that frequencies have doubled per calendar week, from the beginning to the end of the acceleration course. Again, a $\times$ 2.0 acceleration on the weekly chart means that the frequencies have doubled per calendar month, from the beginning to the end of the acceleration course.

(ii) Large changes and small changes show up because the chart show proportional changes (e.g. a change from 1 to 2 represents a doubling or ' $\times$ 2.0' and will look the same as a change from 10 to 20, another doubling or ' $\times$ 2.0').

(iii) Like the cumulative response recorder, Standard Celeration Chart data displays do not require appeals to complex statistical formula. As Skinner (1938) described the cumulative response recorder, 'Records of this sort are easily classified and filed, and they supply a permanent first-hand account of the behavior' (p. 60).

Many social and physical scientists and certainly persons who work in service delivery may assume intuitively that science and application have developed many standard views for measurements. This belief may represent an incorrect assumption. Lindsley (1994) wrote

> Our chart [standard celeration chart] is also based on a standard view which is not old, but very new. There are only a few standard view charts. The standard audiogram . . . for displaying hearing loss is one of the rare examples. Another rare example is Skinner's standard 'cumulative response record' . . . Standard charts are so rare that there is not yet a standard videogram for displaying visual loss (p. 103).

The second beneficial feature of Precision Teaching, or as Lindsley (1997) states the 'core of Precision Teaching', presents itself as a unique focus on building fluency. Binder (1996) characterizes fluency, or 'true mastery', as 'the fluid combination of accuracy plus speed that characterizes competent performance' (p. 164). Further, Binder suggests fluency 'is a metaphor . . . referring to a collection of observations about relations between response frequency and critical learning outcomes' (p. 164). Binder's definition corresponds to many definitions of fluency or automaticity (Binder, 1988, 1993, 1996; Bloom, 1986; Ericsson, Krampe, & Tesch-Römer, 1993; Haughton, 1980; Johnson & Layng, 1992, 1996) yet it adds a functional component. Namely, fluent performances consist of behavior distinguished by speed, pace, and accuracy or quality.

Fluency, as functionally defined in Precision Teaching, relates to three learning outcomes associated with automatic, or fluent behavior: retention, endurance, and application (Binder, 1993, 1996). Retention or the relationship 'between behavior frequencies at two points in time, between which the individual has had no opportunity to emit the behavior' (Binder, 1996, p. 164) constitutes the first outcome. The necessity of retention comes forth each time a student attempts to learn something. Without adequate retention, the ability to perform a behavior for any significant period of time after the intervention has ended diminishes.

Malabello and Leach (1998) reported an example of retention with Dennis, a five-year old boy diagnosed with autism. Dennis said phonemes when presented with the visual stimulus of a letter. After Dennis reached a criterion of saying 57 correct phonemes per minute, the researchers administered a follow-up seven weeks after practice had ended. During the follow-up, Dennis answered 57 correct and zero incorrect phonemes in one minute. In other words, he retained the phonic skill for seven weeks without practice.

Precision teachers have also identified 'endurance' as another critical result of fluency. Endurance refers to the ability to perform a behavior at a given level over time (Binder, unpublished doctoral dissertation; Binder, 1996; Binder, Haughton, & Van Eyk, 1990). An analogy to the physical act of running helps understand endurance. A runner who can run a mile at the same pace and does not fatigue for that interval has endurance. Students who can fluently write digits have endurance to perform at the same quick pace without fatigue for extended periods of time (e.g. 10 seconds, 30 seconds, 1 minute, 2 minutes). Consequently, students who cannot write digits fluently for extended periods of time lack endurance. Students deficient in endurance may stop performing desired behaviors or sometimes engage in escape behaviors (Binder et al., 1990).

Students who do not have endurance for a particular skill may have difficulty performing for intervals as short as 30 seconds to 1 minute. For teachers of students with autism, assessing endurance can further help functionally define problem behaviors. As Binder (1996) indicates, the addition of reinforcement to a learning assignment for which a student does not have endurance will not necessarily enhance performance. Therefore problems associated with underdeveloped endurance help define 'can't do' behaviors as opposed to 'won't do'. By pinpointing and addressing endurance problems teachers can help students develop functional skills that persist across time.

The last effect of fluency, 'application', appeals to a critical result of many interventions. Application refers to the combination of 'element' or component behaviors to a 'compound' or composite behavior (Binder, 1996; Johnson & Layng, 1996). One of the first examples showing application came from Haughton (1972). Haughton consulted with a school principal to determine why some elementary school students could not achieve instructional aims in math. The students practiced daily and did not make many errors but still could not meet the aim. Haughton observed that the math problems required students to write digits very quickly but the students wrote digits very slowly, 20 digits per minute or below. Because the element skill of handwriting speed occurred at a low frequency, application of the compound behavior, answering written math facts quickly, could not occur.

Students with autism have difficulty applying what they have learned to novel situations. Problems with such applications have led some researchers to emphasize fluency building 'Given the acknowledged generalization problems facing students with autism, developing fluent performances should be considered absolutely essential' (Scott et al., 2000, p. 312).

GUIDELINES CAN PROVIDE DIRECTION

Precision Teachers follow four guidelines: (i) a focus on observable behavior, (ii) the use of frequency as data metric, (iii) graphing student performance data on a Standard Celeration Chart, and (iv) making decisions based on performance data (Cooper, 2000). In the following section, a case study of a student with autism illustrates Precision Teaching's guidelines.

Juan, a 12 year old with autism and moderate mental retardation, does not communicate verbally, but often makes requests by grabbing or gesturing for objects that he wants. Mrs. Jones, Juan's teacher, currently works with the school's speech/language pathologist (SLP) to help Juan develop a more appropriate method of communication. Mrs. Jones also reports that Juan has a difficult time in social situations, partly because he lacks nonverbal communication skills and can not 'read' the other children's cues. Juan does attend some general education classes with an aide, but spends most of his time in a self-contained classroom.

Juan's parents, like most every parent, want their son to succeed and have become very involved in his education. After only a brief conversation with them it seems apparent that they want to learn as much about autism as they can. In an effort to help their son, they have tried a variety of interventions purported to help individuals with autism. Unfortunately, many of these interventions did not have scientific support and, although implemented for long periods of time, the interventions produced little success. Choosing the most effective teaching interventions for Juan and other students with autism does not prove an easy task. Juan's teacher and his parents have decided to augment his present academic curriculum by adding Precision Teaching.

The first guideline of Precision Teaching, 'focus on directly observable behavior' (White, 1986), dictates what the teacher will measure. Precision Teachers often use the term 'pinpoint' when identifying directly observable behaviors. A pinpoint accurately delineates an action/object (e.g. writes answers to math facts) specifying where instruction begins regarding academic and social skills. The pinpoint helps teachers avoid using imprecise terms such as 'knows', 'understands', and 'is able' (Haughton, 1980).

For example, in Juan's previous Individual Education Program (IEP) the short-term objectives were stated in very ambiguous terms (e.g. 'Juan will be able to communicate more effectively'). As a result of this ambiguity, teachers had difficulty measuring Juan's progress toward various goals. Juan's current teacher, Mrs. Jones, decided to revise his goals and objectives to include directly observable behavior as pinpoints. Mrs. Jones changed the previous goal of, '. . . being able to communicate' to 'Juan will activate his communication device in response to a teacher requests'.

Objectively defined observable behaviors allow for more consistent measurement of behavior across time and individuals than do subjective broader definitions of student responding. Specifically, the behavior that Juan's teacher has selected to observe and teach in September will remain the same behavior that she observes and teaches in June. Similarly, Mrs. Jones and the IEP team can feel confident they will document and work toward the same specific goals.

The second guideline states that Precision Teachers use the frequency of correct and incorrect responses for making curricular decisions. A count per unit of time defines frequency (Johnston & Pennypacker, 1993). Examining frequency, also called rate, within a unit of time has advantages over other metrics used for making instructional decisions. A commonly used measure, percentage correct, appeared throughout Juan's IEP. Relying exclusively on percentage correct can inadvertently mislead a teacher when determining the effectiveness of an educational procedure.

For example, Juan and Mary may both achieve 100% accuracy on a discrimination task. Mary may complete ten trials with no errors in one minute and Juan may complete five trials with no errors in one minute. If Mrs. Jones had only examined the percentage correct she would not have discovered that Mary could perform the discrimination task more fluently than Juan. Mrs. Jones may have made the decision to move both Mary and Juan forward in curriculum and that could result in problems for Juan because he can not make the discriminations fluently even though he can do so at 100% correct. Frequency gives teachers a sensitive metric for measuring a variety of behaviors and does not create measurement-imposed ceilings (Binder, 1996).

The third guideline holds that Precision Teachers display student performance data graphically. Research shows that teachers who use graphic displays of student performance data shows increase student achievement more than teachers who use data recorded in grade books (Fuchs & Fuchs, 1986). Precision Teachers display student performance data using a Standard Celeration Chart (Pennypacker, Koenig, & Lindsley, 1972).

Juan's performance data for a discrimination task show the advantages of displaying data graphically. Figure 2 shows Juan's daily performance collected and recorded in a grade-book by a previous teacher. Figure 1 shows data that Mrs. Jones has collected and graphed on a Standard Celeration Chart. Note how the chart quickly simplifies data interpretation for teachers. Johnston and Pennypacker (1993) note,

SUBJECT TIME

	MONTHS	MARCH					MARCH					MARCH				
	DAYS OF MONTH	4	5	6	7	8	11	12	13	14	15	18	19	20	21	22
	NAMES	M	T	W	T	F	M	T	W	T	F	M	T	W	T	F
1	Andrea	7	9	5	5	8	9	7	10	12	11	5	12	·	15	8
2	George	4	4	3	5	·	7	·	8	4	5	9	5	6	4	4
3	Juan	5	6	8	7	6	7	9	10	9	11	13	14	16	18	18
4	Michael	·	12	15	15	16	10	·	13	13	14	15	18	17	15	16
5	Sharon	9	15	14	16	16	15	10	3	5	·	15	·	17	16	12
6																

Figure 2. Sample gradebook from Mrs. Jones' class.

after relevant features of a performance emerge in a visual configuration, the reader interprets the data display which in turn affects decision making. Standard displays allow for consistent interpretations of performance data.

The phrase 'the learner knows best' provides the fourth and final guideline of Precision Teaching. The 'learner knows best' does not mean that the student selects what, when, and whether to practice and learn (Cooper, 2000), but rather *how* to practice and learn. For example, through data collection Mrs. Jones has determined that Juan learns to label objects better using more concrete rather than abstract instructional strategies. Data from Juan show that he performed a labeling task faster and more accurately when taught with the actual objects than when pictures of objects were used. Through his response patterns Juan has essentially told Mrs. Jones that using actual objects benefit him the most for learning label tasks. Mrs. Jones then developed a program that built upon Juan's strengths while addressing his areas of need.

ADDING PRECISION TEACHING

With a host of interventions available, when confronted with the prospect of adding a new component to an overall academic or therapeutic program for a student with autism teachers must ask themselves whether the new method has scientific merit and social validity. Precision Teaching offers scientifically derived attributes from Skinner's experimental analysis of behavior (Lindsley, 1991) that make it eminently valuable for teachers of students with autism. Precision Teaching offers the following.

(i) Frequency as a standard and universal measure of behavior.
(ii) The Standard Celeration Chart, which permits a standard visual display of data.
(iii) Procedures for building fluency, specifically retention, endurance, and application of instructional content, that all address specific learning characteristics of students with autism.

Table 1. Daily Standard Celeration Chart-based decision rules (Cancio & Maloney, 1994)

Make a change to instruction or practice procedure when the following occurs
Data at aim or goal level for 2 out of 3 days
Three days of flat data
Minimum celeration line less than $\times$ 1.25
Correct responses decelerating
Celeration line less than previously projected celeration line
Error responses accelerating

(iv) Precise descriptions of behavior.
(v) Guidelines for making daily Standard Celeration Chart-based decisions (Table 1; readers may refer to Eaton, 1978, for a more elaborate discussion regarding chart-based decisions).

In addition, teachers will find the principles of Precision Teaching flexible because it accommodates almost any curriculum, program, or instructional intervention.

The use of Precision Teaching has resulted in many effective academic interventions for students with and without disabilities, in whole school implementations and in individual studies (Beck & Clement, 1991; Johnson & Layng, 1992; Kubina & Morrison, 2000). For teachers who educate students with autism the guidelines hold promise for augmenting educational programs and fostering vital learning environments. Although a large database for the application of Precision Teaching with students with autism has yet to develop, an increase of published literature (e.g. La Porte & McLaughlin, 1996; Malabello, 1998; Scott et al., 2000; Simmons, Derby, & McLaughlin, 1998) and professional presentations (e.g. Ali-Rosales & Rosales-Ruiz, 2000; Bedient, 1999; Carbone, 2000; Kubina, 2000; Lindsley, 2000; Malabello & Leach, 1998; McGreevy, 2000; Moors & Fabrizio, 2000) indicates teachers and professionals have begun exploring Precision Teaching's application for children with autism.

Resources exist for teachers who wish to add Precision Teaching to their educational programs. A variety of articles and books clearly explain how to use Precision Teaching and further discuss its technical adequacy (see Binder, 1996; Kubina & Morrison, 2000; Lindsley, 1971, 1990, 1992, 1997; Maloney, 1998; McGreevy, 1983; Potts, Eshleman, & Cooper, 1993; Pennypacker et al., 1972; West & Young, 1992; White, 1986; White & Haring, 1980). In addition, the *Journal of Precision Teaching and Celeration* has existed for more than 20 years and contains a variety research articles and technical information. Teachers can also join or search the archives of the SClistserv, a discussion group originated in 1997 devoted exclusively to Precision Teaching (http://lists.psu.edu/archives/sclistserv.html). Last, for information pertaining to materials, contact people, public schools, leaning centers, and universities and colleges that use Precision Teaching, or joining the Standard Celeration Society, teachers can read the Standard Celeration Society web page http://www.celeration.org/ or the Association for Behavior Analysis Special Interest Groups web page http://www.wmich.edu/aba/sigs.html

A number of intriguing research questions emanates from Precision Teaching. For example, does a relationship exists between 'joint attention' and 'endurance'? What performance standards, or fluency aims, do students need for specific social and academic skills? What effects does Precision Teaching have for very young or much older students with autism? Does fluency promote generalization? What accelerations will various procedures produce?

Although researchers may ask and explore many other questions, applications of Precision Teaching also have immediate benefits. For example, Strain, Wolery, and Izeman (1998) draw attention to the fact that 'children with autism are children' and not only deserve the highest quality programs obtainable, but also need strategies that promote fun. Lindsley (1995) lists 'fun' as a product of fluency. Going fast and beating one's previous score has gamelike qualities and motivates children to do better. For children who do not understand the concept of beating their score teachers use differential reinforcement to make accelerated performance natural and entertaining. Precision Teaching has long maintained that teachers celebrate success with their students and make learning individual, positive, and exciting (Johnson, 1971; Lindsley, 1971, 1997). As long as teachers maintain a vigilant eye on researched-based programs and keep in mind 'children with autism are children', methods such as Precision Teaching may soon help many students with autism greatly accelerate their learning.

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