

An Assessment of Beginning Addition Skills Following Three Months Without Instruction or Practice

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This case study reports the effects of Precision Teaching on strengthening and retaining basic computational skills of an elementary student in an urban city school district. The learner attended a university clinic for instruction in arithmetic using repeated practice, review of math rules, guided practice, sprints, and assessments for accuracy. Within 4 weeks, the student demonstrated fluency on the math facts, sums to 10. Fluency with sums to 10 maintained with a slight jump down and no turns more than three months during which no instruction or practice took place. We discuss implications of fluency building for retention of skill acquisition.

The development of basic math skills is a major concern to parents and teachers. Horton, according to White (1986), estimated that 98% of all adult Americans "do not compute." Most Americans know basic arithmetic facts, but they are unable to perform computations fluently (White, 1986). Binder (1988) defined fluency, the true measure of mastery of arithmetic or any other skill, as accuracy plus speed.

There are at least three reasons why arithmetic instruction should include instructional aims for fluency, as opposed to simply accuracy (i.e., most typically, percentage correct). First, accuracy is just one dimension of competent performance. Accuracy measures do not provide complete information about how well a learner can perform a given skill. Skill assessments that measure performance with frequency (i.e., count per unit of time) of response are the only means of gaining an account of how well a skill is performed.

Second, learning should endure over time, but students who acquire new knowledge and skills but do not learn them well are unlikely to retain them over time. Retention of knowledge and skills correlates positively with behavior fluency.

Third, an emphasis on fluency may reduce distractibility during academic instruction. Binder, Haughton, and Van Eyk (1990) suggest that there is a vicious circle between distractibility and ever-diminishing academic performance,

but that teacher intervention addressing academic endurance will break that circle. A skill practiced to fluency systematically improves academic endurance and often reduces distractibility.

Only practice produces fluent performances. Precision Teaching is an assessment system that properly used can lead to effective practice because it requires continuous and systematic assessment of progress toward instructional (fluency) aims (Lindsley, 1990). Precision teachers and their students count behaviors during assessments of student performance and learning; thus, they gain direct information regarding the effectiveness of an instructional program. They use these data to make instructional decisions (White, 1986). An additional benefit of this information is that it can also increase student motivation (Van Houten, 1980).

It is well to assert that fluency is important, but the question then becomes, how quickly must students perform a skill? The answer depends upon the skill and the use of that skill. Haughton (1972) found that students who wrote answers to math problems at 70 to 90 correct digits per minute advanced more easily to more complex mathematical skills than students who wrote fewer digits per minute (e.g., from single digit multiplication to multi-digit multiplication).

The primary purpose of our initial instruction was to help one student become fluent in math facts, sums to 10. Following Haughton's recommendation, we set instructional aims at 70 to 90 correctly written digits per minute. We then wondered whether the student would maintain fluency with sums to 10: (a) after a prolonged time without instruction or practice, and (b) while receiving instruction on different math skills. Our purpose in presenting this case study is to share the convincing answers to our questions.

Method

Student and Setting

Shamus, an African-American male, was 11-years-old and in the fourth grade at a parochial school when instruction began. He was in a fifth grade public classroom when we assessed retention. In both settings, Shamus spent a portion of his school day in a resource room for specific learning disabilities. Shamus was enthusiastic and cooperative, though his intake evaluation for The Ohio State University Psychoeducational Clinic stated that he had difficulty staying on task in the regular classroom.

Shamus was referred to The Ohio State Clinic in the Spring of 1992 for instruction in reading and math. We gave instructional priority to the development of math skills after doing informal assessments in math and reading. Shamus, who had no prior experience with Precision Teaching, attended one-hour sessions at the Clinic, twice a week for 10 weeks. In Autumn 1992 (after summer vacation), Shamus returned to the Clinic for 10 weeks of instruction and long-term retention assessment. Tutoring took place in a 12 by 20 ft room furnished with instructional carrels for up to 12 teacher-learner pairs.

Materials

We used addition practice sheets with sums to 10, flash cards with corresponding sums to 10 problems, an addition facts wheel with sums to 10, and a timer that counted both up and down. For see-write exercises during instruction and counting periods, we placed the practice sheet in an open manila folder under a sheet of clear acetate (an 8 1/2" by 11" overhead transparency);

we used dry erase markers to write the answers on the acetate.

Movement Cycle

Our movement cycle was sums to 10 addition problems. The learning channel set was see-write. The correct-incorrect pair was number of correct addition facts per one-minute counting period, and number of learning opportunities per one-minute counting period. Learning opportunities were the incorrect answers; we did not count skipped problems incorrect. During instruction (i. e., the 10 weeks in the Spring of 1992), Shamus' instructional aim for sums to 10 was 70 to 90 correct written responses in one minute, with no learning opportunities.

Procedures

Entry assessment. We used a one-minute counting period, computing sums 1 to 10 (see-write), to assess Shamus' entry performance. He wrote 23 correct digits with 6 learning opportunities in a minute. We instructed sums to 10 because Shamus' fluency was well below the instructional aim.

Instruction. We used four main instructional strategies to increase Shamus' addition fluency: practice with assessment for accuracy, review of math rules, sprints, and repeated timings.

We assessed for accuracy at the start of every lesson. Shamus would see-write answers to 40 to 60 problems at his own pace. When he completed all the problems, we corrected learning opportunities together and praised correct answers and diligence in completing and correcting the problems. Shamus also practiced problem solving several times throughout the lesson using various learning channels. For see-say problem solving, Shamus practiced a set of flash cards by saying the solutions to the problems written on them, and trying to beat his best time for completing the whole deck correctly. For hear-say, we stated a math fact, and Shamus said the answer; this procedure continued for only a minute or two. For hear-point, we stated a math fact, and Shamus pointed to the answer among a matrix of randomly arranged numerals.

Math rules primarily involved use of a number line (visual) and finger-counting (tactile), as well

as such phrases as "zero plus any number equals that number." Our rationale for permitting finger counting during acquisition was that Shamus' school teacher used finger counting to teach addition. As instruction continued, we discouraged Shamus from depending on his fingers to compute math facts, and as fluency improved, Shamus abandoned the use of his fingers to compute sums to 10. Again, we celebrated correct answers with Shamus, and we corrected learning opportunities.

Initially, Shamus wrote 20 digits correctly in 30 seconds, but he had difficulty keeping up this pace during 60-second counting periods. To build endurance, each session we used several see-write 15, 30, or 45 seconds sprints, and a minimum of two 30-second counting periods each lesson. The sprints were identical in form and materials to the regular counting periods except for the duration of time that became progressively longer throughout a session.

Long-term Retention

Shamus returned to the Clinic following a summer break with no instruction or practice. Before further instruction, we assessed retention of see-write sums to 10 facts, using a one-minute counting period. Shamus retained acceptable fluency with these math facts. We therefore chose to instruct subtraction facts (numerals 1 to 10 subtracted from 10) because the operation of subtraction is logically consistent with the skills Shamus had practiced in the clinic the previous spring. It included the same numbers that were involved in the reciprocal operation (i.e., sums to 10). We reasoned that it would provide Shamus with additional opportunities to recognize relationships between the numbers that we worked on during formal instruction (e.g., $2+8=10$, but also, $10-8=2$, and $10-2=8$). Further, during instruction that took place in the spring, we observed that Shamus seemed to confuse the operation he was to perform (i.e., subtraction rather than addition). We thought that because the same numbers were involved in both movement cycles, it might serve to incidentally strengthen Shamus' discrimination between operations: (whether this is indeed the case remains an empirical question).

Results

See-write addition (Spring, 1992). During instruction with sums to 10, Shamus' median number of correctly written digits per one-minute counting period was 67, with a spread from 23 to 74. His median number of learning opportunities per minute was 0, with a spread from 6 to 0. As Chart 1 shows, Shamus' performance change (i.e., the distance between the lowest and highest data points for a given movement cycle) multiplied by 3.2 for corrects and divided by 6 for learning opportunities. Shamus' weekly celeration for correctly written digits per minute multiplied by 1.4 and the weekly celeration for learning opportunities divided by 1.4.

After instruction with sums to 10 had ended, Shamus maintained fluency with that skill. His weekly celeration for correctly written digits per minute multiplied by 1, and his celeration for learning opportunities divided by 1.

Long-term retention. As Chart 2 shows, Shamus' median number of correctly written digits for sums to 10, in a one-minute counting period, was 53, with a spread from 50 to 59. His median number of learning opportunities per minute was 0, with a spread from 2 to 0. During assessment for retention, following three months without instruction or practice, Shamus' performance showed a slight jump down (from 74 to 56) with no turns (celeration $\times 1.0$) while learning opportunities remained near zero.

Discussion

When Shamus first came to The Ohio State University Psychoeducational Clinic, he wrote 23 correct digits to sums to 10, and had 6 learning opportunities in a one-minute counting period. Within six weeks (12 one-hour lessons), Shamus achieved his instructional aim (i.e., 70 to 90 correct digits in one minute, with no learning opportunities) for sums to 10.

We assessed the retention of sums to 10 at the end of the first 10 weeks of instruction, and again following 9 weeks of summer break with no instruction or practice. In the Autumn, Shamus consistently performed near aim, even

though he no longer practiced sums to 10 and while he practiced subtraction skills.

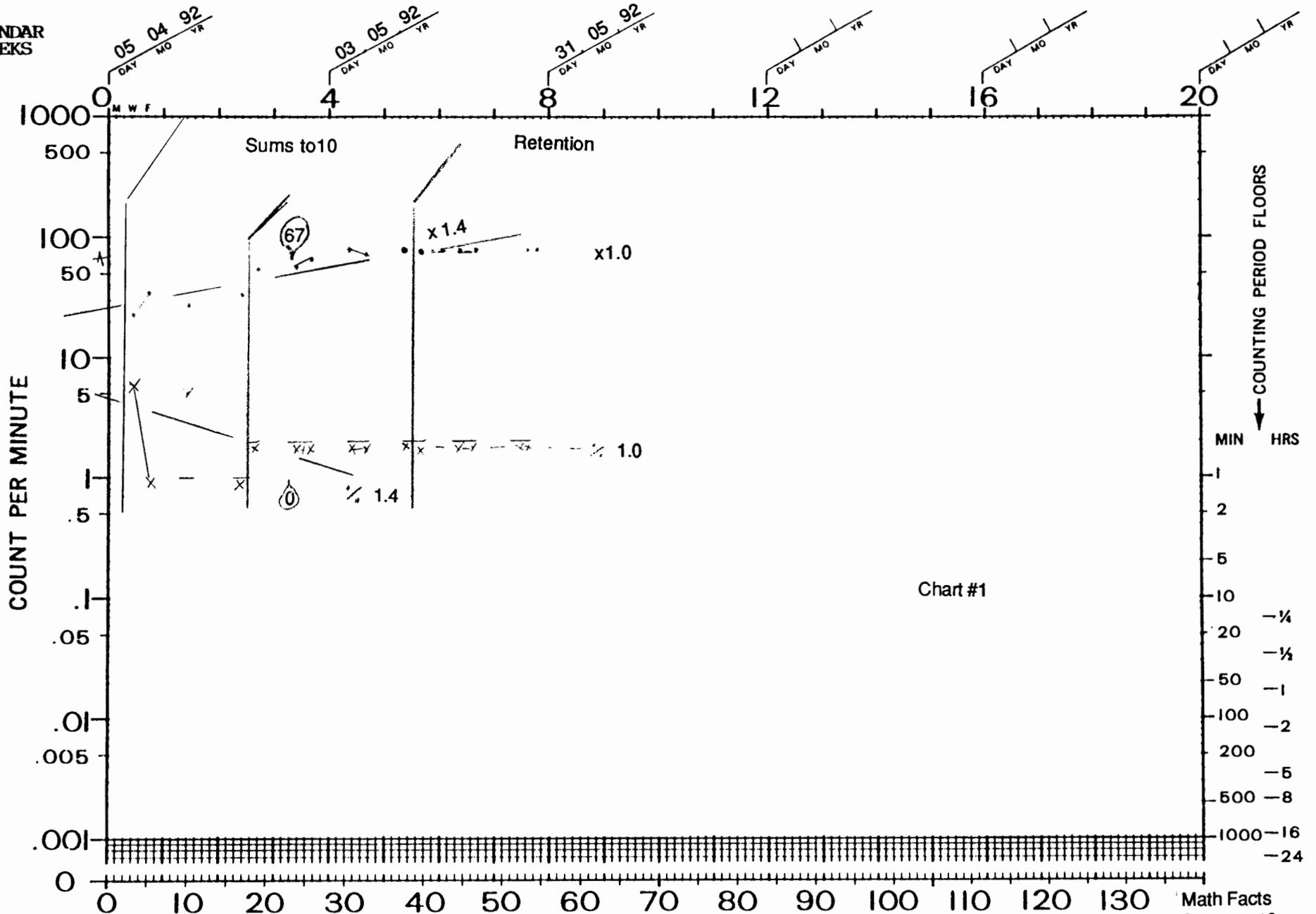
The Precision Teaching experience that we shared with Shamus seems to support the three purposes for incorporating fluency aims into arithmetic instruction. First, Shamus' performance improved not only with accuracy, but with competence as well. Second, he was able to fluently perform skills he had learned in the Spring, three months after we stopped teaching them. Finally, given these first two points, Shamus' "distractibility" became a nonissue for him. It may be unfortunate that we were unable to determine how the components of our intervention contributed to Shamus' success. We think it is reasonable, however, given the degree of fluency that Shamus achieved in a short time and the extent to which he maintained his skills, to make one conclusion. For Shamus, Precision Teaching was both effective and efficient.

References

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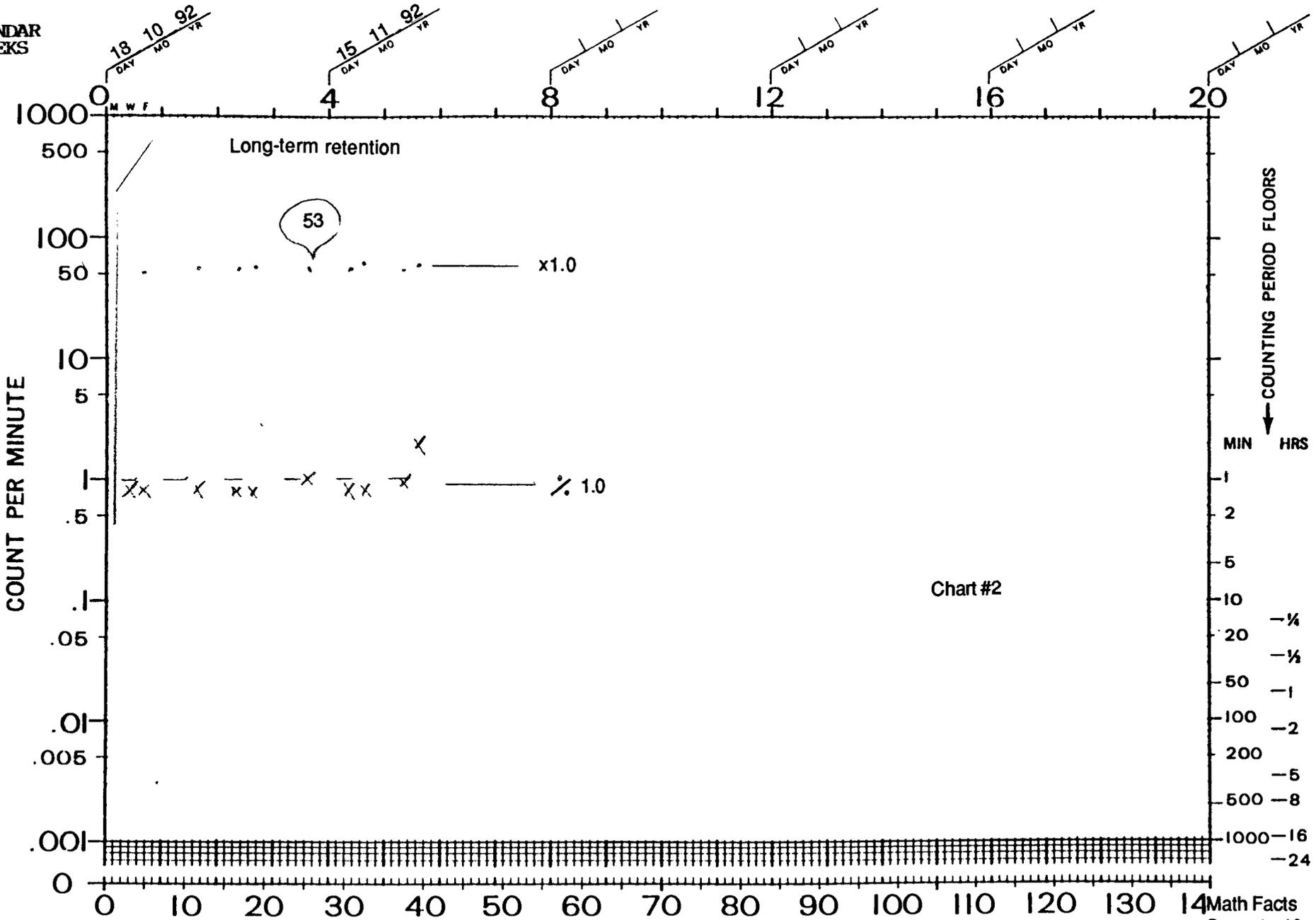
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CALENDAR WEEKS



SUPERVISOR	J. Cooper	D. Bullara	Shamus	10	4th gr.	Math Facts
DEPOSITOR	OSU Clinic	Bullara	Bullara/Shamus	AGE	LABEL	Sums to 10
	AGENCY	TIMER	CHARTER			See/Write
						COUNTED

CALENDAR WEEKS



SUPERVISOR	J. Cooper	J. Kimball	SUCCESSIVE CALENDAR DAYS			Shamus	11	5th gr.	Math Facts Sums to 10 See/Write
DEPOSITOR	OSU Clinic	AGENCY	Kimball	Shamus	Kimball/Shamus	BEHAVER	AGE	LABEL	COUNTED
			TIMER	COUNTER	CHARTER				