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ABSTRACT

Out of the tradition of behavior analysis has come a system of behavioral measurement which is both sufficiently exact and sufficiently general to be used effectively in meeting the problems of educational accountability. The Standard Behavior Chart is a measurement tool that meets the specifications of frequency, celeration, sensitivity (in order to measure changes in the behavior of an individual child and all the behaviors of which individuals or groups are capable), and standardization (to permit direct comparison among the variables differentiating a number of situations. Four measures--frequency, accuracy, celeration and improvement index (a combination of accuracy and celeration)--are easily obtained from this chart and provide direct measures of both the quantity and quality of behavior and behavior change. The Standard Behavior Chart is most effective when it is made an integral part of the teaching process; teachers and students should be trained in its use so that it can aid in individualized evaluation, decision-making and planning. A high speed computer can be used in collating and analyzing the masses of data resulting from the use of the chart by teachers and students. Measures of benefit and efficiency can be obtained through analysis of the data. The Learning Abilities Development Program in North Carolina, which sought to screen first graders for potential learning deficiencies and give individualized service to each one targeted, utilized the Standard Behavior Chart successfully. (KM)

COST EFFICIENCY AND EFFECTIVENESS IN THE EARLY DETECTION AND IMPROVEMENT OF LEARNING ABILITIES

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It is now becoming clear that, stripped to its essentials, the task of education is to bring about changes in human behavior in the direction of improvement. It follows that evaluation of any educational program or enterprise must necessarily involve some form of measurement of behavior and behavior change. In a very real sense, the difficulties which the educational community has experienced in coming to grips with the questions of cost efficiency, cost effectiveness, and problems of accountability in general are traceable to its difficulty in defining and agreeing upon suitable units and procedures of behavioral measurement.

Out of the tradition of behavior analysis, however, comes a system of behavioral measurement which is both sufficiently exact and sufficiently general to permit its effective utilization in meeting the problems of educational accountability. Our purpose in the present chapter will be two-fold: first, we will briefly examine the history and describe the major components of this measurement system as it presently exists. Second, we will illustrate the applicability of this system by considering its use in the evaluation of a program aimed at the early identification and remediation of the academic problems of children possessing insufficiently developed learning abilities.

* * * * *

Among the many contributions made by B. F. Skinner to the experimental analysis of behavior, perhaps none is more significant than his early (1938) and repeated (e.g., 1950, 1953, 1957) identification of frequency (number of responses/unit of time) as the basic datum of the science and any subsequent technologies. Thus, in 1953, Skinner writes "When we extend an experimental analysis to human affairs in general, it is a great advantage to have a conceptual system which refers to the single individual, preferably without comparison with a group. The study of frequency of response appears to lead directly to such a system." Skinner also emphasized the importance of frequency as a continuous measure of behavior when he wrote, "... frequency of response provides a continuous account of many basic processes. This is in marked contrast to methods and techniques which merely sample a learning process from time to time where the whole process must be inferred. The sample is often so widely spaced that the kinds of details we have seen here are completely overlooked." It is perhaps unnecessary to add that frequency is also a universal unit of behavioral measurement; all behavior, regardless of its topography, may be defined in terms of instances of its occurrence and these instances are countable. Since countable instances of a repeatable behavior must take place in time, this second parameter, time, is also common to all behavior. Consequently, the combination of count and time into one unit--frequency--renders that unit universal, with respect to its appropriateness as a unit of behavioral measurement. Skinner's choice of frequency as the basic datum for the science of behavior was obviously a wise one.

We have already indicated that behavioral technologies, particularly education, are concerned primarily with <u>behavior change</u>. In 1969, O. R. Lindsley called attention to the fact that the first derivative of frequency with respect to time yields a measure of change in frequency over time. Applying this notion to the measurement of changing behavior frequencies, Lindsley produced a measure known as <u>celeration</u>. the units of which are of the general form: Number of Movements/unit of time/unit of time. Thus, by describing changes in the universal behavior unit (frequency) over time, Lindsley has given us an equally universal measure of behavior change. It is perhaps not suprising that from the two most productive pioneers in the experimental analysis of behavior (Skinner and Lindsley) have come the two measures necessary to meet the needs of evaluation and accountability in education.

One need must be met, however, before we can apply these universal measures to the problems of describing behavior and behavior change within broad programmatic and educational contexts. We must incorporate these conceptual units--frequency and celeration--into a measuring tool or instrument which, like the metric ruler or cumulative recorder, may be applied to the broadest possible class of events for which its units of measurement are appropriate. If it is to be useful within the context of educational measurement and evaluation, this instrument must at once possess sufficient sensitivity to immediately reveal changes in the behavior of an individual child while at the same time being of sufficient generality to measure--with equal sensitivity--all the behaviors of which individuals or groups of individuals are capable. Finally, if such a tool is to be used across any number of situations, it should be <u>standard</u> in nature so as to permit direct comparison among the variables which differentiate these several situations. A measurement tool meeting these specifications exists and is known as the Standard Behavior Chart.

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Insert Figure 1 about here

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Figure 1 is a reproduction of the Standard Behavior Chart showing diagrammatically the major types of measurement afforded by its use. One notes immediately that the ordinate of the chart is frequency, the fundamental unit of behavioral measurement. One also notes that frequencies are scaled in ratio or logarithmic fashion on the Standard Behavior Chart. Such a scale, familiar to natural scientists and engineers, is strange to many psychologists and educators and therefore requires some justification.

It should immediately be apparent that the <u>range</u> of frequency values afforded by this scale (1,000 per minute to 1 per 1,000 minutes) is many times greater than would be afforded by an interval scale of equal length and sensitivity. Thus, the ratio scale chosen more easily meets the needs for universality we require of any standard measuring device used in education.

There are a number of other advantages to the ratio, or semi-logarithmic, scale which are succinctly described by Schmid:

"The semilogarithmic chart is unequaled for many

> purposes, especially in portraying proportional and percentage relationships. In comparison with the arithmetic line chart, it possesses most of the advantages without the disadvantages. This type of chart not only correctly represents relative changes but also indicates absolute amounts at the same time. ...For the uninitiated, the term "semilogarithmic," as well as the characteristic ruling of the vertical axis, may seem formidable; but actually the theoretical principles on which this chart is based, and also its construction and use are comparatively simple. Prejudice and general lack of understanding unfortunately have resulted in considerable resistance to the use of semilogarithmic charts. Generally, rates of change (celeration) are more significant than absolute amounts of change in statistical analysis and presentation. In using the ratio chart, one can have confidence that relative changes are portrayed without distortion and uncertainty.
> (p. 109).

As indicated in Panel A of Figure 1, daily frequencies are recorded on the Standard Behavior Chart by placing a dot at the intersection of the vertical line corresponding to the appropriate calendar day and the horizontal line representing the frequency of the behavior observed on that day. Conventions for displaying the length of the daily recording period, as well as for designating days where the recording opportunity was missed or where the behavior in question had no chance to occur have been developed and are described in detail elsewhere (Pennypacker, Koenig & Lindsley, 1972).

A property of the ratio scale which is of fundamental importance in the measurement of behavior and behavior change may be stated as follows: equal distances represent equal ratios. A valuable application of this principle in educational measurement may be seen in Panel B. Panel B shows that if, on a particular day, we chart the frequency of movements performed correctly in addition to the frequency of movements performed incorrectly on a given academic task, the distance by which these two points are separated provides a measure of the accuracy of the day's performance. This accuracy measure may be expressed either as a ratio, a multiple, or a percentage. In any case, because of the equal ratio nature of the frequency scale, it is clear that the distance on the chart corresponding to a given measure of accuracy will be the same regardless of the overall frequency of the performance being measured. Thus, it is possible to compare performances of vastly different frequencies with respect to this measure of their accuracy; since many educational objectives are stated in terms of either frequency, or accuracy, or both, the value of an instrument which simultaneously yields both measures would appear to be obvious.

In Panel C in Figure 1, graphic representation of Lindsley's celeration measure of behavior change is illustrated. By fitting a straight line to a series of daily behavior frequencies, celeration may be seen to be represented by the slope of such a line.[1] The equal ratio property of the frequency scale dictates that the slope of the celeration line will be a measure of the ratio or percentage of change taking place over a given period of time. A convenient time unit for assessing behavior change is one week; hence, celerations are usually expressed as ratios or multiples of frequency (x2 movements/minute/week, ÷5 movements/minute/week, etc.). These values may also be converted to percentages. A celeration of x2, for example, means that the behavior frequency

[1]Empirical validation of the practice of fitting straight lines to the logs of behavior frequencies has been established by Koenig, 1972.

is doubling each week, corresponding to a 100% weekly increase.

It is particularly important to note that the celeration measure, like the accuracy measure, is independent of frequency. Thus, equal proportions of change in the frequencies of two behaviors will be represented by parallel celeration lines possessing identical celeration values. regardless of the initial frequencies of either behavior. It is therefore possible to directly assess and compare rates of changes in behaviors that occur with vastly differing frequencies. As we shall see, this characteristic of the celeration measure obtained from the Standard Behavior Chart is extremely useful in the evaluation of the effectiveness of educational programs which are concerned with generating improvement in a wide variety of different behaviors.

Finally, the last panel of Figure 1 shows how accuracy and celeration may be combined to yield a composite measure known as the improvement index. The improvement index, defined as the ratio of the celeration of correct frequencies to the celeration of incorrect frequencies, may be regarded as a measure of the change in accuracy over time. One may calculate as improvement index either by forming a ratio of the two celerations as just described or by plotting the accuracy ratios on a daily basis and fitting a celeration line to the resulting display. The numerical result will be identical. The improvement index is, of course, independent of either celeration just as celeration and accuracy are are independent of basic frequency.

These four measures--frequency, accuracy, celeration and improvement index--are easily obtained from the Standard Behavior Chart and provide us with direct measures of both the quantity and quality of behavior and behavior change. Thus, by using this one instrument, we have at our disposal a set of behavioral measures which are universal (may be applied to any behavior) and standard (the units remain the same regardless of the behavior being measured). Before illustrating the use of these measures in the evaluation of a particular educational program, let us briefly consider some of the general strategies for educational evaluation afforded by the availability of a measuring instrument with the characteristics of the Standard Behavior Chart.

Strategies for Educational Evaluation

It is widely held that effective teaching presupposes continuous evaluation. Since the Standard Behavior Chart utilizes both continuous and direct measures of behavior it is not suprising that its most effective application occurs when it is made an integral part of the teaching process. Both teachers and children must therefore become proficient in its use so that it may serve as an aid to individualized evaluation, decision making, and planning. Experience has shown that training in classroom use of the Standard Behavior Chart can be both efficiently and economically accomplished on an inservice basis (e.g., Haughton, 1972, Pennypacker, 1973). Thus, our major strategy has been to introduce the evaluation process where and when it is needed most: at the level of individual teacher's daily interaction with individual children.

This strategy is at obvious variance with many traditional evaluation practices which require independent "pre-post measurement" with instruments presumed sensitive to the behavior changes assumed to be taking place. Evaluation practices of this sort are demonstrably not a part of the teaching process and are viewed by most, if not all, teachers as possessing scant validity, owing, as a rule, to the highly non-representative nature of the infrequent measurement occasions. Giving the evaluation tool directly to the teachers for daily use with children is, then, an effort to maximize the effectiveness of the evaluation process as an integral part of the teaching process, albeit at the expense of that form of "objectivity" which is thought to be characteristic of infrequent, indirect measurement.

Instructing teachers and children in the use of the Standard Behavior Chart also insures that the data base for any evaluation will be orders of magnitude greater in quantity then that provided by virtually any other means. It is at this point that the universality and standard nature of the Standard Behavior Chart once more prove their incalculable worth. Because, as we have seen, the measures derived from the Standard Behavior Chart may be used to evaluate the quantity and quality of all human behavior and human behavior change. It is both possible and convenient to enlist the aid of the high speed computer in collating and analyzing the masses of data which inevitably result when teachers and children are encouraged to use the Chart.

The computer can easily digest and store these data to any desired level of sensitivity up to and including a single child's performance on a single page of a single arithmetic book on a specified day. In order, however, for the computer to analyze such data and render composite summaries with respect to meaningful parameters of an educational program, it is essential that an orderly and logically hierarchial relationship exist between the goals or objectives of a program and the behaviors emitted by the children in that program. It is therefore essential to involve program administrators at an early stage in the development of any evaluation format based on charts of daily behavior frequencies. The oft mentioned requirement of stating program goals in behavioral terms now becomes an obsolute necessity since the computer has no way of defining on its own which changing behavior frequencies are representative of which programmatic goals. Once a logical hierarchy relating charted behavior changes to program goals has been established, it is easy to have the computer provide composite statements, based on the daily records made in the classroom, of the degree to which the objectives have been attained.

Summarizing the data with respect to one or more of the measures of behavior change discussed above may be said to yield an overall measure of benefit derived from the program. This summarization can, of course, occur with respect to any independent parameter of the program or any sub-population of the participants in the program. Since all of the behavioral measures taken from the chart incorporate a time dimension, one can readily view any resultant behavior change in terms of the time taken to produce it and thus arrive at a measure of efficiency. Finally, one may add to such statements whatever cost figures are deemed appropriate and thereby provide a quantitative basis for statements of accountability in terms of cost benefit. We feel that a major virtue of this system lies in the fact that all such analyses are based entirely on the directly observed and recorded behavior of the individuals served by whatever program is being evaluated. The same information which guides the teacher in her daily planning and decision making constitutes, when assembled across the appropriate units of a program, the data base for administrative planning and decision making at any level of responsibility. Such a system virtually insures that educational decisions and policies are formulated in consultation with the ultimate experts--the children themselves (Lindsley, 1972).

Let us turn now to an illustration of this evaluative system as it was recently applied to an ESEA Title III Program designed to improve the learning abilities of first grade children of a county in North Carolina.

THE PROGRAM

The Learning Abilities Development Program (LAD) of Albemarle and Stanly County, North Carolina, had two main objectives in its initial year of operation. First, it sought to screen all rising first graders in the district and identify those for whom subsequent success would depend upon marked enhancement of one or more of a variety of learning abilities.[1] Second, the program attempted to provide individualized service aimed at developing in each child sufficient proficiency in each of the isolated abilities to insure normal academic progress. This was attempted for each child selected by the screening process.

The program was situated in Stanly County, North Carolina, the county seat of which is the city of Ablemarle. Nearly all of the 42,000 residents of Ablemarle and Stanly County are native North Carolinians who enjoy a

[1]We eschew the term learning disabilities for its obvious negative connotations as well as the logical impossibility of its empirical definition. Observation of a child's behavior reveals only his abilities--inferring the presence of a disability provides nothing of additional value to those whose responsibility is to improve the child's behavior.

lower middle class way of life, supported predominantly by small farm agriculture and the textile industry. Although the median family income in the area is slightly above the median for the state, the average annual expenditure per child in the public school system ranks near the bottom of all districts in the state of North Carolina. The [illegible] Program was launched in a community whose cultural homogeneity might invite the label "provincial" and which is not given to displays of largesse on behalf of its educational institutions.

The staff of the LAD Program consisted of a director, 3 certified resource teachers, 6 teacher aides, and a secretary. The resource teachers, and frequently the teacher aides as well, spent a portion of each work day in the administrative center assembling materials, comparing procedures and progress, or participating in informal training sessions conducted by the Director. The majority of their time, however, was spent in the 15 elementary school scattered throughout the city and county. Although arrangements varied from school to school the teacher and her two aides typically removed target children from ongoing classroom activity and worked with them on an individual basis in storage closets, empty classrooms, empty offices or lounges.

The initial activity of the LAD staff involved assisting first grade teachers in the administration of a gross screening device to the approximately 720 first graders in the district. The instrument used in the initial screening required the teacher to evaluate each child on a five point scale in each of 9 areas: reasoning ability, speed of learning, ability to deal with abstract ideas, perceptual discrimination, psychomotor abilities, verbal comprehension, verbal expression, number and space relations, and creativity.

One hundred and eighty children were initially selected in the program on . . t . is of low evaluation in one or more of these 9 areas. Each child selected was then further evaluated by a member of the LAD staff using the Remedial Diagnostic Form developed by Robert A. Farrald (1971). A total of 90 children were again selected as positive and were targeted for individualized assistance by the LAD staff. Of these, a total of 18 had only brief contact of a referral nature with the program, leaving 62 whose charted behavior formed the basis of our evaluation.

Early in the year, the Director conducted extensive staff training in the area of remediation of learning abiliities; the orientation of this training and the basic materials and techniques used may be found in the works of Ferrald (1971) and Valett (1967). In addition, the first author and his staff conducted inservice training, marked by periodic follow-ups, in both the use of the Standard Behavior Chart and the tactics of precisely defining and recording appropriate target behaviors.

The professional staff then began, on an itinerant basis, the task of individually assisting each selected child in the enhancement of one or more of the learning abilities judged insufficient by the two screening devices. Specialized curricular materials were either developed or purchased for use with each child. The list of such materials is too extensive to be catalogued here; it ranged, however, from the Peabody Language Kit and Frostig materials to teacher-made card games, sandpaper letters, and macaroni stringing devices.

As soon as the child and the member of the LAD staff became acquainted, an effort was made to determine which behavior(s) was responsible for the judged insufficiency. For example, if the screening instruments indicated the presence of arrested gross motor development, the teacher might begin recording steps taken on a 10-foot balance beam. In the event this behavior showed a need for improvement, a variety of behavioral techniques such as shaping and fading were introduced, with the results recorded daily on the behavior chart. Similar tactics were used to enhance behaviors underlying academic abilities; for example, in order to enhance visual form discrimination, various symbol naming, letter naming, and matching-to-sample tasks would be tried and the results charted. Together, the teacher and child would view the progress displayed on the chart; in the event that improvement was not evident, new procedures would be tried until one was eventually found which produced success.

THE EVALUATION

A total of 337 charts resulted from the contact made by the LAD staff with the 62 children served directly during the first year. Each chart was a record of one child's performance of one particular behavior; e.g., "says alphabet letter correctly," "identifies missing object incorrectly", etc. In the appropriate blanks at the bottom of the chart (see Figure 1) were recorded the name and identifying numbers of the child, the resource teacher and/or teacher aide working with the child and the school attended. In the blank marked Label was put a number signifying which of the 53 possible learning abilities (Valett, 1967) the particular recorded behavior was judged to represent.

Vertical lines were drawn on each chart to identify points in time at which major curriculum or procedural changes were introduced, as well as at the beginning and end of each project. Thus, any adjacent pair of these so-called phase lines marks the temporal boundaries of the phases of a project, each phase corresponding to the period of application of a distinct set of materials or procedures. For each phase, the LAD teachers reported the number of contact minutes that had occurred during that phase. Celeration lines were fit, either freehand or by the method of least squares, to the frequencies plotted within each phase and the resulting numerical celeration value was entered on the chart. When all the charts had been prepared in this fashion, they were transferred to the Behavior Research Company for coding, computer storage, and analysis.

A macroscopic view of the temporal dimension of the service provided by the LAD Program is furnished by considering calendar weeks of involvement in the program on the part of the children served. A total of 2,058 child-project-weeks of service was provided during this first year; on the average, each child participated in 5.4 projects each of which lasted an average of 6.1 calendar weeks.

A total of 172 different behaviors were recorded in accumulating the total of 337 charts. This data testifies to the wide variety of observable behaviors which may be indicative of insufficient learning abilities and to the scope of the efforts on the part of the LAD staff to customize their tactics to meet the needs of the individual children. Another indicator of the extent of individualization of instruction is furnished by the fact that a total of 996 different phases were reported; a new phase was initiated whenever the charted data indicated that some procedural change would be required to generate further improvement.

For the entire program, a total of 85,230 teaching minutes were reported. The average number of teaching minutes per project, then, is 253; the average number of teaching minutes per child in the program is 1,373 while the average number of teaching minutes per phase was 86 (s.d.=95.0).

A major conceptual parameter of the program was Valett's extensive list of learning abilities. Although Valett's list includes 53 such abilities, behaviors related to only 19 of these abilities were observed and recorded by the LAD staff. Table 1 summarizes the amount of activity that occurred on behalf of remediation within each of these 19 ability areas. The total number of projects

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Insert Table 1 about here

- -

represented, 333, does not include 4 behavior modification projects, the targets of which are not readily classified under any of the listed learning abilities.

Summing the number of children served within each ability area across the ability areas yields a total of 116, implying that most children received assistance with respect to more than one ability area. Table 2 shows that, in

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Insert Table 2 about here

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fact, 60% of the target population were judged to require assistance in two or more ability areas. These data suggest that the listed learning abilities are not mutually exclusive at the functional level; if a child displays an insufficiency in one of the abilities, he is likely to display insufficiencies in others as well. It may be of interest to future researchers to attempt a functional redefinition of these ability areas in terms of non-overlapping behavior clusters.

The effectiveness of the services provided by the LAD Program within each of the ability areas is summarized in Table 3. The charts within each ability area were subdivided according to whether the aim of the project was to increse (accelerate) or decrease (decelerate) the behavior being recorded. The geometric means[1] of the within-phase celeration values within each ability area by target grouping were computed. These values, together with the total number of weeks for which each value is representative, are presented in Table 3.

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Insert Table 3 about here

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Since the geometric mean represents the average weekly ratio of behavior change, raising the average value to the power given by the number of weeks yields a ratio value equivalent to the average total behavior change achieved in each ability area-target grouping. Consider, for example, the ability "auditory sequencing." The geometric mean weekly acceleration in those projects where the aim was to accelerate the behavior was x1.6. Since this rate of increase

[1] Appropriate measure of central tendency for logarithmic values.

(which may also be read as 60%/week) occurrrd for a total of 7.1 weeks, the average total frequency change is x28.13,($1.6^{7.1}$). Thus, we could say that if the aggregate of all the behaviors began at a frequency of 1 movement/minute, by the end of the intervention, that aggregate behavior was occurring at a frequency of 28.13 movements/minute. The reader may make similar interpretations concerning the other ability area-target combinations.

Perhaps the most interesting information to emerge from Table 3 is found on the bottom line. Across all children and all projects where the objective was to increase the frequency of the recorded behavior, the average weekly celeration was x1.2, meaning that, on the average, the program produced 20% per week improvement in all such charted behaviors. Similarly, where the objective was to decrease the frequency of the recorded behavior, the overall mean weekly celeration was ÷1.3--the overall weekly reduction of these behaviors was, therefore, 23%. Assuming, for the sake of illustration, that in the absence of systematic intervention no change in these behavior frequencies would have been observed, we now have a useful approximation of the composite benefit which resulted from the implementation of this program.

What of changes in accuracy of the academic performances charted? We recall recall that the measurement of accuracy requires the simultaneous charting of the frequencies with which a movement is performed both correctly and incorrectly on a given day. By forming the ratio of the celerations of these two sets of frequencies as they change over days, we produce, as the reader will recall, a measure known as the improvement index which, in essence, is the ratio describing the weekly rate of change in accuracy.

Of the 337 projects analyzed from the first year of the program, 334 were members of accuracy pairs--pairs of projects where correct and incorrect frequencies are charted simultaneously. In other words, a total of 162 different correct-incorrect pairs were recorded. The improvement index was computed for every phase within each of these pairs of projects. Collecting all of the improvement indices for each learning ability and computing their geometric mean yielded the results displayed in Table 4. Examination of Table 4 reveals

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Insert Table 4 about here

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that the greatest weekly improvement in accuracy was achieved in those projects falling in the ability category--"auditory sequencing." Reference to Table 3 shows that the major source of this improvement in accuracy is to be found in the extremely rapid deceleration of errors (÷4.3); the acceleration of correct frequencies being only x1.6. Further examination of Table 4 suggests that the abilities of "body localization" and "word attack skills" yielded the least improvement in accuracy. For "word attack skills," for example, no general decrease in incorrect frequencies was observed so all the improvement is contained in the x1.2 geometric mean weekly acceleration of correct frequencies. The reader may make similar interpretations concerning the other ability areas for himself.

Overall, the geometric mean of all improvement indices (taken across children and abilities) is x1.6. In other words, in those cases where accuracy was recorded, the average weekly increase in accuracy was over 60%!

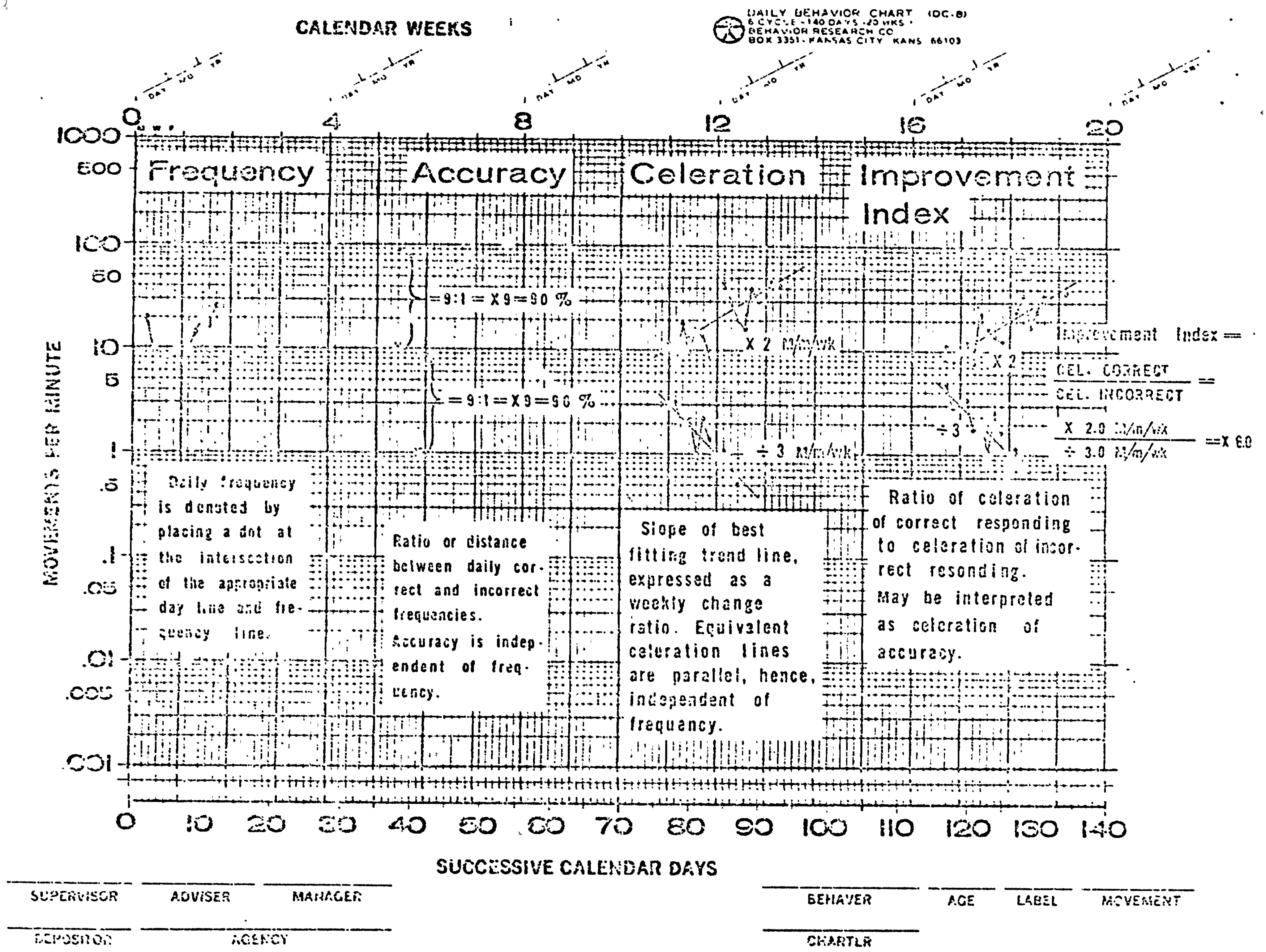
The foregoing analyses should be viewed not as exhaustive, but as illustrative of the class of evaluative analyses which result from the marriage of the Standard Behavior Chart and the high speed computer. For example, a complete analysis was performed using teachers as the major parameter so that the efficiency and productivity of each teacher working within each ability area was determined. These data are now guiding the Director in deployment of his staff.

Given summary data of this sort, it is a simple matter to take the final step of adding cost figures to arrive at cost benefit statements based on recorded changes in the behavior of the population served. For example, the reader will recall that a total of 2,058 child-project-weeks of data were accumulated during the first year. Dividing this number into the total cost of the program and multiplying the result by the average number of projects conducted on each child yields an estimate of the cost of bringing the service of this program to one child for one week. During that week, the average benefit obtained was a 20% increase in the frequency of each acceleration target, and a 23% decrease in the frequency of each deceleration target, or, overall, a 60% increase in accuracy. One may regard the cost of these benefits then, as being approximately equal to the cost of each child-project-week.

We must quickly add that these calculations do not take into account the cost to the children, and ultimately to society, of withholding such benefits. Only when accurate data become available relating drop out rates, drug offenses, and delinquent acts in general to the presence of undetected and/or unremediated early deficiencies in key learning abilities will the complete picture of the benefits provided by a program such as this become known. In the meantime, the potential contribution of continuous and direct measurement of behavior frequencies to an effective, humane and accountable educational technology has, we believe, finally been realized.

Figure Caption

Figure 1. Basic Measures of Behavior and Behavior Change Furnished by the Standard Behavior Chart



CALENDAR WEEKS
DAILY BEHAVIOR CHART (DC-8)
6 CYCLE - 140 DAYS - 20 WKS
BEHAVIOR RESEARCH CO
BOX 3351 - KANSAS CITY KANS 66103
0
4
8
12
16
20
1000
500
100
50
10
5
1
.5
.1
.05
.01
.005
.001
MOVEMENTS PER MINUTE
Frequency
Accuracy
Celeration
Improvement Index
= 9:1 = X 9 = 90 %
= 9:1 = X 9 = 90 %
X 2 M/m/wk
÷ 3 M/m/wk
X 2
÷ 3
Improvement Index =
CEL. CORRECT / CEL. INCORRECT =
X 2.0 M/m/wk / ÷ 3.0 M/m/wk = X 6.0
Daily frequency is denoted by placing a dot at the intersection of the appropriate day line and frequency line.
Ratio or distance between daily correct and incorrect frequencies. Accuracy is independent of frequency.
Slope of best fitting trend line, expressed as a weekly change ratio. Equivalent celeration lines are parallel, hence, independent of frequency.
Ratio of celeration of correct responding to celeration of incorrect resonding. May be interpreted as celeration of accuracy.
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
SUCCESSIVE CALENDAR DAYS
SUPERVISOR
ADVISER
MANAGER
DEPOSITOR
AGENCY
BEHAVER
AGE
LABEL
MOVEMENT
CHARTER

Table 1

SUMMARY OF ACTIVITY WITHIN EACH

LEARNING ABILITY SAMPLED

Learning Ability	Num. of Projects	Total. Num. of Teaching Min.	Number of Different Children
Throwing	4	400	2
Body Localization	2	180	1
Balance and Rhythm	18	3554	9
Directionality	6	1780	3
Laterality	6	1080	3
Auditory Acuity	26	7650	8
Auditory Decoding	14	3720	6
Auditory-Vocal Association	2	540	1
Auditory Memory	10	1140	4
Auditory Sequencing	8	2160	1
Visual Acuity	2	240	1
Visual-Form Discrimination	14	3988	6
Visual Memory	82	31165	30
Visual-Motor Fine Muscle Coordination	65	13360	21
Fluency and Encoding	18	3303	2
Word Attack Skills	2	600	1
Reading Comprehension	1	300	1
Number Concepts	49	9580	14
Social Maturity	4	190	2
	333	85230	116

Table 2

FREQUENCIES OF CHILDREN SERVED WITH RESPECT

TO DIFFERENT NUMBERS OF ABILITIES

Number of Abilities	Number of Children	% of Total
1	25	40
2	26	42
3	7	11
4	4	7
		100

Table 3

GEOMETRIC MEAN WEEKLY CELERATIONS FOR ACCELERATE (A) PROJECTS AND DECELERATE (D) PROJECTS GROUPED ACCORDING TO THE LEARNING ABILITY SAMPLED

Learning Ability	Weekly Celeration[A]	Total Projects Weeks	Weekly Celeration[D]	Total Project We
Throwing	x1.9	4.3	÷1.7	4.30
Body Localization	÷10.0	.4	÷11.0	.40
Balance and Rhythm	x1.3	62.0	÷1.2	58.70
Directionality	x1.2	8.6	÷1.8	8.60
Laterality	x1.2	28.0	÷1.5	28.00
Auditory Acuity	x1.3	55.2	÷1.7	55.50
Auditory Decoding	x1.4	27.2	÷1.3	27.20
Auditory-Vocal Association	x1.2	4.1	÷2.0	4.10
Auditory Memory	x1.5	12.8	÷1.8	12.80
Auditory Sequencing	x1.6	7.1	÷4.3	7.10
Visual Acuity	x1.2	4.4	÷1.4	4.40
Visual-Form Discrimination	x1.6	25.9	÷1.8	25.90
Visual Memory	x1.2	322.4	÷1.2	317.20
Visual-Motor Fine Muscle Coordination	x1.1	207.8	÷1.8	167.10
Fluency and Encoding	x1.4	19.4	÷1.3	19.40
Word Attack Skills	x1.2	1.6	x1.0	1.60
Reading Comprehension	x1.2	9.3	--	--
Number Concepts	x1.1	132.1	÷1.2	131.00
Social Maturity	x1.2	19.4	÷1.2	19.40

Grand Geometric Mean = x1.2

Grand Geometric Mean = ÷1.3

Table 4

GEOMETRIC MEANS OF IMPROVEMENT INDICES FOR

EACH LEARNING ABILITY

Learning Ability	Geometric Mean
Throwing	x3.2
Body Localization	x1.1
Balance and Rhythm	x1.6
Directionality	x2.2
Laterality	x1.8
Auditory Acuity	x2.2
Auditory Decoding	x1.8
Auditory-Vocal Association	x2.4
Auditory Memory	x2.7
Auditory Sequencing	x6.9
Visual Acuity	x1.7
Visual-Form Discrimination	x2.9
Visual Memory	x1.4
Visual-Motor Fine Muscle Coordination	x2.0
Fluency and Encoding	x1.8
Word Attack Skills	x1.2
Reading Comprehension	--
Number Concepts	x1.3
Social Maturity	x1.4
Grand Geometric Mean	x1.6

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