DEFINING AND MEASURING STUDENT LEARNING

Clay M. Starlin*, **& Sue Fan Foo***
Department of Education, Worcester State University, Worcester, Massachusetts (USA)
* Ed.D.

Abstract

A foundational purpose of education is to enhance student learning. However, to accomplish this goal effectively requires agreeing on how to define and measure student learning. In the United States, and many other countries, the education systems' formal assessments are infrequent large scale achievement tests. These tests function as program evaluation measures. Classroom teachers characteristically use idiosyncratic informal assessments to gauge the effectiveness of their instruction and evaluate student progress. This article shares a more precise and standard classroom-based learning measurement process that better informs decision making and thus supports equitable individualized education.

Keywords: Educational measurement, student learning, equity, individualizing.

1. Introduction

A foundational purpose of education is to enhance student learning. However, to accomplish this goal effectively requires agreeing on how to define and measure student learning. In the United States, and many other countries, the education systems' formal assessments are infrequent large scale achievement tests. These tests function as program evaluation measures. Classroom teachers characteristically use idiosyncratic informal assessments to gauge the effectiveness of their instruction and evaluate student progress. However, there is a need for more precise and standard classroom-based learning measurement to better inform decision making and thus support equitable individualized education.

As a discipline improves in scientific rigor, it more successfully accumulates knowledge. A hallmark of this progress is the standardization and precision in the discipline's measurement units, procedures, display and analysis systems. To enable education to become more effective it is important that we adopt a standard and more precise learning measurement system.

2. Frequency – Our most sensitive performance measure

Performance **always** involves a number of responses and **always** occurs over time. Consequently, both number and time are essential parts of a performance measure. The scientific term for events per unit of time is frequency. Frequency is the most sensitive measure of student performance because it provides information that is the most *complete* (i.e., includes both number of responses and duration of time) and *direct* (i.e., quantifies what we see and hear students do). This is in contrast to other commonly used education measures: *derived scores* (e.g., % correct, achievement test scores) or *inferred scores* (e.g., rating and rubric scales).

As education strives to become more scientific and thus accountable it is useful to note that frequency (events/time) is a universal measure across all sciences (e.g., cycles/second, planetary revolutions/year). Thus, using frequency as our base student performance measure aligns us with the broader scientific community.

3. Mastery

"I can tell when I hit mastery, and it feels good." Colin, 2nd Grade

Learning involves progressing from non-mastery to mastery. This requires that we agree on what constitutes masterful performance. *If we don't know where we are aiming, we are aimless.* Mastery delineates the skills/knowledge we wish to be part of a student's memory - as 3rd grader Melody says, "Memory means it is stuck in our head." Of course, in our internet and artificial intelligence (AI) era, there is less information we need to store in our heads. Parenthetically, being sophisticated and discerning

information consumers is an important area of mastery. Yet, we do need to maintain a certain breadth of knowledge in our memory in order to communicate, solve problems and create. It is important to continuously reevaluate the skills/knowledge students should "*master" versus "be aware of" versus "disregard*." (In accommodating individual needs this will vary within and across students.)

Accepting that frequency is our most sensitive performance measure it follows that mastery is defined in terms of responses per unit of time. For example, if persons are not limited by developmental, environmental or physiological constraints they achieve masterful performance such as the following:

Walking – 120[+] - 100 correct steps per minute

Oral Reading – 250[+] - 150 correct words per minute (European-based languages)

Keyboarding (composition) – 60[+] – 40 correct words per minute (European-based languages)

(See Starlin, 2022, pp. 231-241 for detailed summary of mastery standards.)

4. Measuring and displaying learning

The visual display of quantitative information is generally preferred by the consumer (Tufte, 1997). The visual display and analysis of learning data is more efficient and accurate if the graphic system meets the following criteria: (Kubina, et al, 2023).

1. Remains standard. Measurement standardization is a hallmark of science which facilitates accurate and efficient communication. However, the popular spreadsheet program Excel violates this principle by adjusting graphic scales to fit the data. As a result, we get pictures as shown in Figure 1.

Figure 1. Altering graphic axes based on differences in data elements.
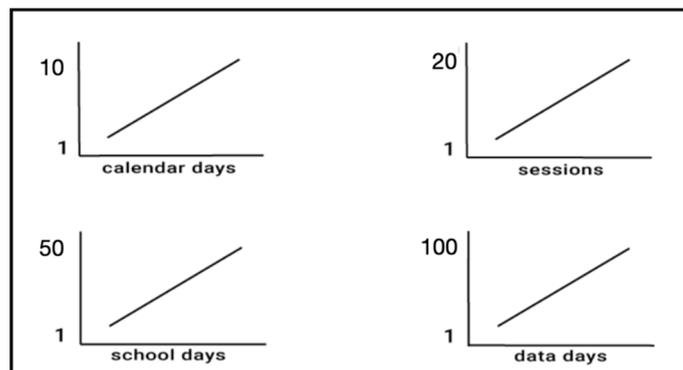
2. Real time scale. In order to view learning, we must have a successive real time scale. The common practice of using sessions to represent the time dimension violates this requirement since we cannot *visually* determine the amount of time within or between sessions.

3. Frequency multiply scale. Using frequency as our base performance measure requires that learning is represented by a change in frequency over time. By using a multiply scale, rather than the commonly used add scale, we can view and quantify the rapidity of learning. In Figure 2 (from Starlin, 2022, p. 31), we see the change from 1/minute to 21/minute compared to a change from 60/minute to 80/minute on an "add scale" versus a "multiply scale." Note on the add scale the visual representation is the same because both change by +20. However, on the multiply scale from 1/minute to 21/minute represents a change of x20[+] while from 60/minute to 80/minute equals a change of x1.3.

Figure 2. Comparing performance frequencies plotted on an add scale versus a multiply scale.

Add Scale   Multiply Scale
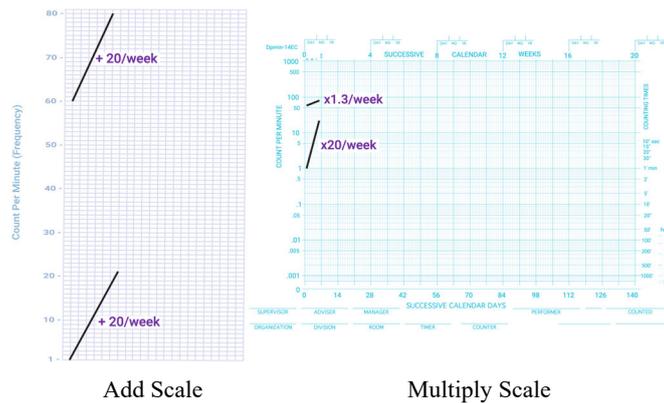
The multiply chart represented in Figure 2 is a Standard Learning Chart (technical name Standard Celeration Chart) and has been in use since 1967 (Kunzelmann, et al, 1970, Kubina & Yurich, 2012, Starlin, 2022). Due to the standardization of the horizontal axis as successive calendar days and the vertical axis as a frequency (i.e., count/minute) multiply scale, we can actually quantify learning as a multiplying function (e.g., x2/week improvement in correct performance) or a dividing function (e.g., ÷ 1.5/week improvement in incorrect performance).

5. Student involvement in the learning process

Because learning is dynamic, frequent measurements are necessary versus the more common static performance test measures. It requires from 5 – 11 data points to establish an accurate trend (learning) line. (Koenig, 1972). This is accomplished by collecting short performance samples, ideally on a daily basis. It is not possible for a classroom teacher to manage this volume of data across multiple students and/or curriculum areas. The solution is to teach students how to chart and participate in monitoring their own learning. (Bates & Bates, 1971, Maloney, 1982).

We can reinforce democratic values, by supporting students' involvement in their education. A significant portion of this participation should include monitoring and recording their learning progress. Such involvement stimulates comments such as the following:

"I am doing better than I was. I thought you'd like to know." – Chris

"My chart is going down! (Help!) I don't know why!" – Shelli

"Please look at my chart. I don't think I'm ready for this skill." – Debbie

"I think I need to do something a little harder." – Mary   (Sokolove, 1978)

Students may use paper charts available from the Behavior Research Company or make use of digital charting software. (See resources at the end of the reference section). Note: Although students may practice individually, in pairs or groups and measure and chart their learning it is important that teachers create a validation process that confirms achievement of desired benchmarks.

6. Educational equity (individualizing)

"If we wish to give persons equal opportunity, we must treat them all differently." Author Unknown

Educational equity means **learning equity** not **achievement equity**. This re-emphasizes the need for a sensitive learning measurement system to facilitate individualized/differentiated instruction. Most educators would embrace individualized programming with a focus on learning versus achievement. Yet the demands of high stakes achievement testing and the requirement to cover grade level curriculum (regardless of the mastery of previous skills) thwart our efforts. The state of Massachusetts is highly ranked in US measures of educational excellence. Yet the following comments from Massachusetts teachers, highlights the systemic roadblocks that prevent accommodating individual needs.

". . . students are being taught grade level standards even though they do not have the requisite knowledge or skills. It is so frustrating for both students and teachers! This exposure approach is just not working for anyone!" *3ʳᵈ Grade Teacher*

I have begged that we throw out the "scope and sequence" that we must follow and take time to build a solid base for the struggling math students. The response is that we must stay on task with scope and sequence and teach only grade level content." *5ᵗʰ Grade Teacher*

". . . in my school where classrooms are highly diverse, and I would say most students are not performing at grade level. We are told to only teach grade level content and keep going, despite the fact that students are not demonstrating understanding. It is purely exposure. As a teacher, it feels, so, so wrong." *Elem ESL Teacher*

"As teachers, many of us I think want to push into curriculum that helps prepare students for the adult world; however, due to standardize testing and state mandates teachers are stuck teaching their grade level material." *Middle School Teacher*

"The students get frustrated because being able to move on to the next level either doesn't happen or they move ahead and are totally lost. Then the behavioral aspect sets in. Every day the same students give up very easily, disrupt the class, act up, and by the time we get them settled, class is over." *High School Teacher* (Starlin, 2024)

Requiring <u>same</u> age peers "learn" (be exposed to) the <u>same</u> content at the <u>same</u> time is at the heart of educational inequity. Note: The term "achievement gap" used in the United States buys into the notion that all same age peers should be "performing at grade level."

Practices such as: Universal Design for Learning (UDL), looping, cross age groupings, grouping by level of skill competence, co-teaching and reasonable class sizes can all facilitate individualized practice. However, to achieve equity and accommodate the diversity of learners we must place each student at developmentally appropriate skill levels and adjust programs based on their **learning** progress.

7. Conclusion

Agreeing on how to define and measure learning is fundamental to educational equity. In order to ensure students are learning we need to monitor learning and make adjustments in their educational programs when learning is inadequate. Such an individualized focus champions *learning equity*. Not all students will learn the same amount of content at the same time at the same age, but we can strive for comparable learning at each student's developmental level.

In the US context, and in many other parts of the world, what will allow equitable individualized education based on learning progress is a deemphasis on high stakes achievement tests. These tests maintain the system that requires **same** age peers be exposed to the **same** content at the **same** age (i.e., grade level scope and sequence). This will require policy changes at state, and at many countries' national levels, such as the following:

1. Define learning as the process of moving from non-mastery to mastery.
2. Define standard mastery ranges for desired skills in terms of frequency (responses/time) analogous to medical *standard health indicator ranges*. (See Starlin, 2022, pp. 231-241).
3. Use the standard mastery ranges to decide when a student is competent to move on to higher level content versus when a unit is completed or the student changes grade level.
4. Replace high stakes achievement testing with precise, standard classroom-based learning measures which can be aggregated across various educational levels as program evaluation measures.

Public schools are the only option available for the less privileged in society. We continue to face challenges in creating public school systems that address the needs of all students. Yet to bolster equitable and democratic societies we need to continue to strive for robust public-school systems that adjust student programs based on a precise, standard measure of learning.

Resources

AimStar Pro Charting Software - Xcelerate Innovations
https://apps.apple.com/us/app/aimstar-pro/id1580401923

Behavior Research Company
Provides paper copies of the Standard Celeration Chart and other related products and publications.
https://www.behaviorresearchcompany.com

Fluency Project
Provides information and publications relating to Precision Teaching, masterful performance/behavioral fluency.
https://www.fluency.org

Heart the Chart Video Segments featuring Clay Starlin
1. Educational Units of Measurement, 2. The Standard Learning Chart, 3. Selecting Describing & Organizing Skills, 4. Mastery, 5. Tools for Measurement
https://www.youtube.com/c/HearttheChart/videos

Precision X Charting Software - Central Reach
https://centralreach.com/products/precisionx/

Standard Celeration Society
Organization that supports use of the Standard Celeration Chart and technology.
https://www.celeration.org

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