

Analysis of Longitudinal Achievement Data

George H Olson, Ph.D.
Appalachian State University

February 2013

Achievement data typically available to, or at least typically examined by, local school and school district educators are those that are collected at a single point in time, e.g., mid-semester benchmark data, end of year EOG/EOC data, the results a nationally-normed aptitude assessment, such as the SAT. Such data can be referred to as “snapshot” data, or more accurately as cross-sectional data. Snapshot data provide a picture of the current status quo. They provide a picture of how a school or district is performing at a given point in time. While of momentary interest, snapshot data provide little useful information. They cannot be used, for instance, to determine whether achievement levels have been declining or advancing over the years, nor can they be used to predict future levels of achievement. In short, snapshot data cannot be used to investigate trends.

To investigate trends (in achievement, say) we need longitudinal data, preferably longitudinal data collected over three or four, or more, years. It is only then that we can begin to appreciate the direction of trends in achievement levels

Three ways of examining achievement data over years

There are, basically, three approaches for examining achievement trends over years: (1) an examination of repeated snapshots over years, in which, for example, the achievement performances of students in individual grade levels are examined over several years; (2) tracking of the achievement of a specific group individuals, or cohort, over several years, and (3) following the achievement levels of all students in a particular group over years and grade levels (for reasons made clear later, this third option is referred to as a “quasi-cohort.” We will examine each of these three approaches in turn.

Repeated snapshots over years. Figure 1a-f provides a display of yearly achievement levels over six years for each of six grade levels. The graphs display grade-level median national percentiles obtained from an administration of a nationally, norm-referenced achievement test.¹ The actual data points are given in Table 1 on the page following the graphs.

Figures 1a and 1b show that achievement levels of students in Grades 1 and 2 were maintained at a fairly high level over the years, with median percentiles well above the national 50th percentile. Furthermore, following a mild depression in the second year, both

¹ A median national percentile for, say, Grade 2 is the national percentile equivalent of student in the norm group whose score was equal to that of the middle-scoring student in the second grade.

grade levels showed steady growth over the next four or five years, ending up, in Year 6, well above the performance of first- and second- graders four or five years earlier.

Graphs of Grade Level Median Percentiles Over Six Years

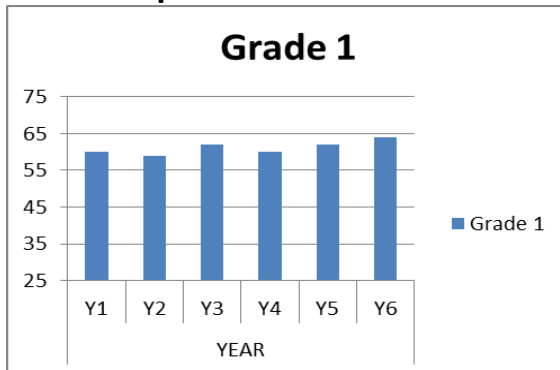


Figure 1a

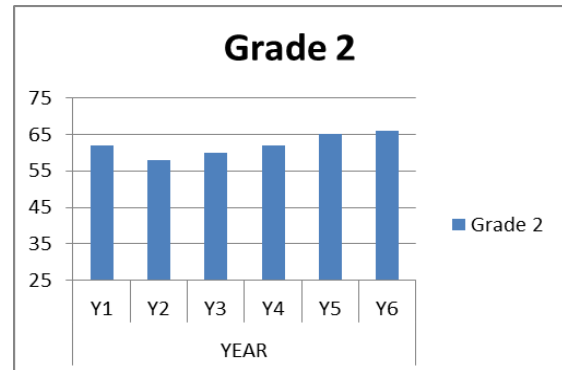


Figure 1b

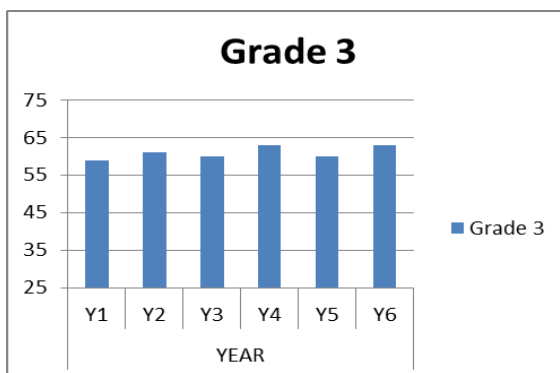


Figure 1c

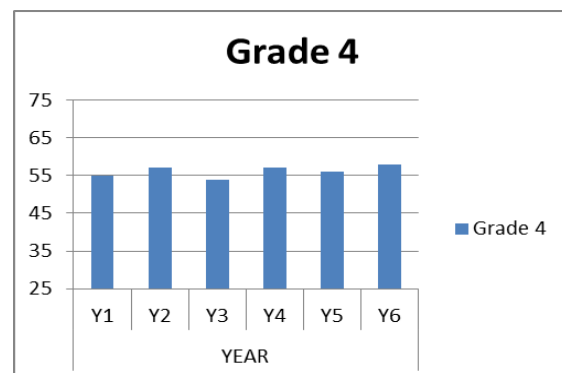


Figure 1d

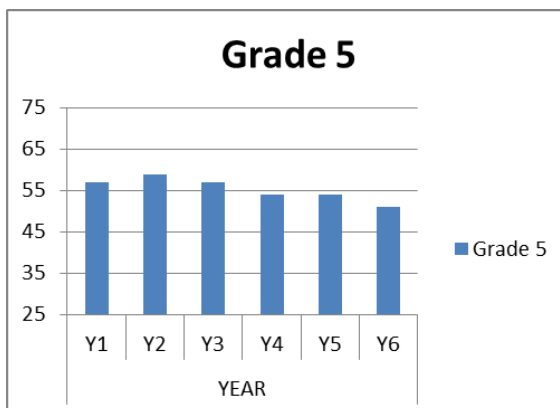


Figure 1e

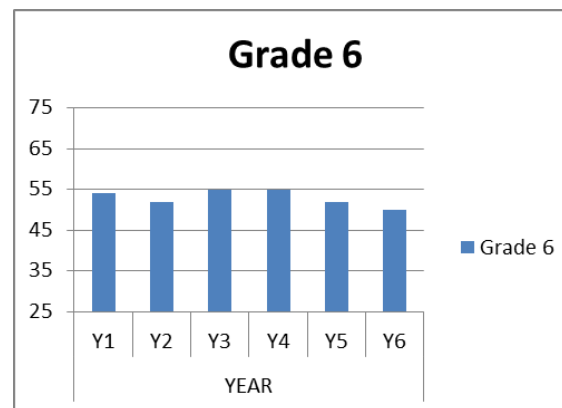


Figure 1f

The performance levels of students in Grades 3 and 4 remained fairly steady, with minor modulations, over the years. At both grade levels, median performance in the sixth year was higher than

it was in the first or second year. In fact, for Grades 1-4, the last year's performance was greater than or equal to any previous achievement level. The modulation in median performance over the years for Grade 4 may make prediction somewhat problematical.

Table 1: Median Percentiles by Grade Level over Years

Grade Level	YEAR					
	Y1	Y2	Y3	Y4	Y5	Y6
Grade 1	60	59	62	60	62	64
Grade 2	62	58	60	62	65	66
Grade 3	59	61	60	63	60	63
Grade 4	55	57	54	57	56	58
Grade 5	57	59	57	54	54	51
Grade 6	54	52	55	55	52	50

The performance levels of students in Grades 3 and 4 have remained fairly steady, with minor modulations, over the years. At both grade levels, median performance in the sixth year was higher than it was in the first or second year. However, the modulation in median performance over the years makes it somewhat difficult to predict achievement levels in Year 7.

While median achievement at Grade 5 showed mild improvement in Year 2 it declined steadily thereafter, ending up eight scale scores below where it was in Year 2.

Following a slight depression in median performance in Year 2, followed by a recovery in Year 3, Grade 5 has exhibited a precipitous decline in achievement over the last three years.

Comparing True Cohorts and Quasi-Cohorts. Recall that true cohorts follow the *same* students over years. Since it is reasonable to expect yearly attrition from a cohort over years, the numbers of students remaining in the cohort should be much smaller than those in the quasi-cohort. A quasi-cohort, on the other hand, tracks students over years, over grade levels. In a quasi-cohort, all students in Grade 1, in Year 1 are included; all students in Grade 2 in Year 2 are included; and so on. Hence, while the students in a true cohort remain the same from year to year, in any given year, the quasi-cohort is likely to include new students who were not present in a previous year, and have lost students who were present in a previous year. By comparing the two types of cohorts, it may be possible to draw inferences about the types of students who were retained, were new, or were lost.

In Figure 2, for instance, where the data points plotted for the quasi-cohort are taken from Table 1, it is shown that whereas the students in the true cohort (i.e., those students who were still present at the end of Grade 6 in Year 6) exhibited higher achievement in Grade 1 than did the combined group of Grade 1 students, by Grade 6 the achievement of students in the true cohort declined to nearly the same level as the Grade 6 students as a whole.

What is the implication? First, the achievement of all students has declined, at essentially the same rate, over the first four years, for both the true cohort and the quasi-cohort. Second, by Grade 5 the

Longitudinal Achievement Trends (Median National Percentiles)
Comparing a True Cohort and a Quasi-Cohort

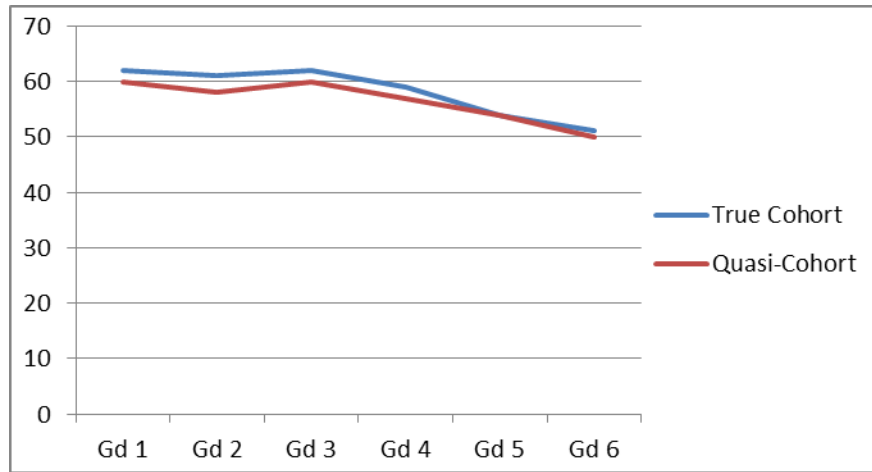


Figure 2: A more typical example of longitudinal achievement trends.

Table 2: True Cohort and Quasi-Cohort Median National Percentiles

Median Percentiles Over Six Years (Grades 1-6)						
	Gd 1	Gd 2	Gd 3	Gd 4	Gd 5	Gd 6
True Cohort	62	61	62	59	54	51
Quasi-Cohort	60	58	60	57	54	50

achievement levels of both groups were nearly identical, which could happen in one of three ways: all or nearly all the non-true cohort students left the school or district, leaving only true-cohort students; Grades 5 and 6 gained new students who were higher achievers than the true cohort students; or a combination of the two. To untangle this we would need a corresponding display of enrollment trends over the same years.

Figure 3 (and Table 3) provides another example of true cohort vs. quasi-cohort achievement trends. For these data, I also have provided longitudinal enrollment data, in Figure 4 (and Table 4). In [Forum 6](#) the prompt is to interpret Figures 3 & 4 (and Tables 3 & 4.) You can respond to this prompt individually or in small groups. What I am hoping for is that through your interaction you can reach a reasonable explanation of the longitudinal achievement trends.

Another Example of True Cohort and Quasi-Cohort
Median National Percentiles

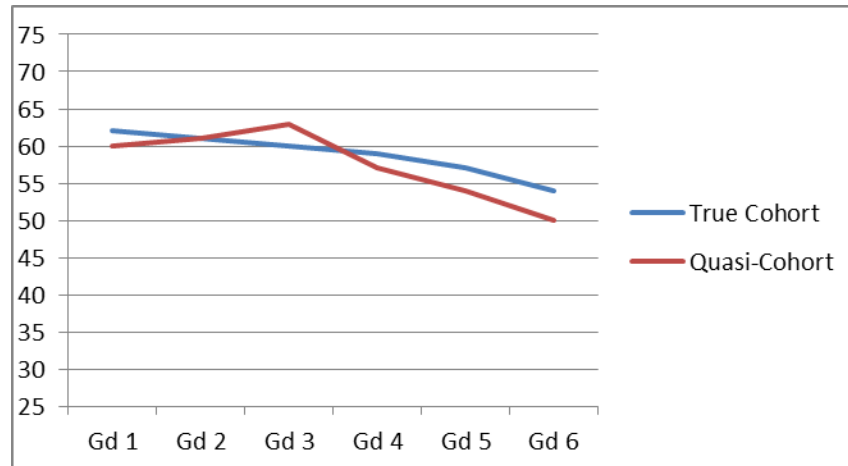


Figure 3

Table 3: Another Example of True Cohort and Quasi-Cohort
Median National Percentiles

Median Percentiles Over Six Years (Grades 1-6)						
	Gd 1	Gd 2	Gd 3	Gd 4	Gd 5	Gd 6
True Cohort	62	61	60	59	57	54
Quasi-Cohort	60	61	63	57	54	50

Longitudinal Enrollment Comparing a True Cohort,
Cohort Survivors, and a Quasi-Cohort

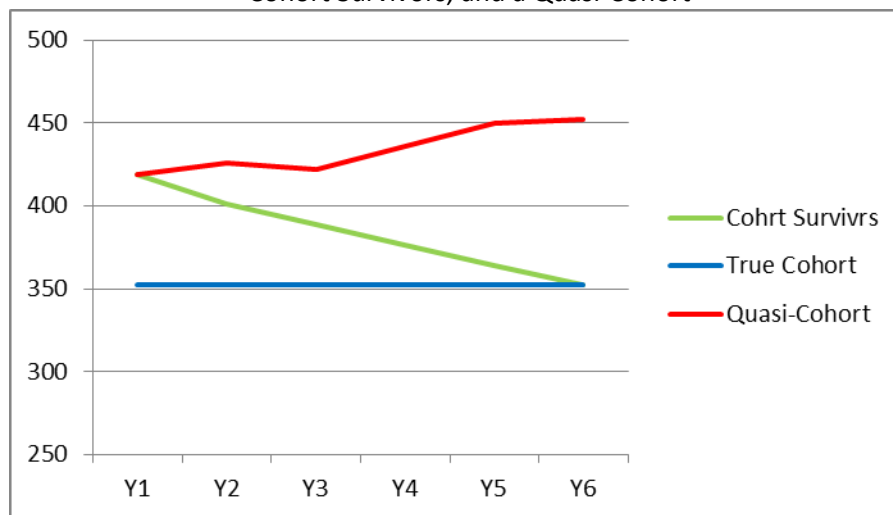


Figure 4

Table 4: True Cohort and, Cohort Survivors, and Quasi-Cohort Enrollments over Six Years

Grade Level	YEAR					
	Y1	Y2	Y3	Y4	Y5	Y6
Cohort Survivors	419	401	389	376	364	352
True Cohort	352	352	352	352	352	352
Quasi-Cohort	419	426	422	436	450	452

Remember, the size of a true cohort is determined by the students who remain members of the cohort over all the years in the period. Assuming we begin with all the group of students who are members of Grade 1 in Year 1, then this will shrink over successive years. In Figure 4 (and Table 4)

Simpson's Paradox

No discussion of longitudinal achievement trends would be complete without a discussion of a phenomenon that sometimes occurs when the composition of the groups being compared changes over time. Simpson's Paradox occurs when longitudinal trends for disaggregated groups exhibit a trend that is different, indeed sometimes in a different direction, than the trend for the combined group.

In Figure 5 (the data are given in Table 5), for instance, the achievement levels of all three groups (Groups 1, 2, & 3) have a positive trend over the four years exhibited. The trend for the TOTAL group, on the other hand, exhibits a different trend. Basically, except for a slight depression in Year 3, and a slight increase in Year 4, the trend line for achievement for the combined group remained flat.

Longitudinal Trends in Disaggregated Data: An illustration of Simpson's Paradox.

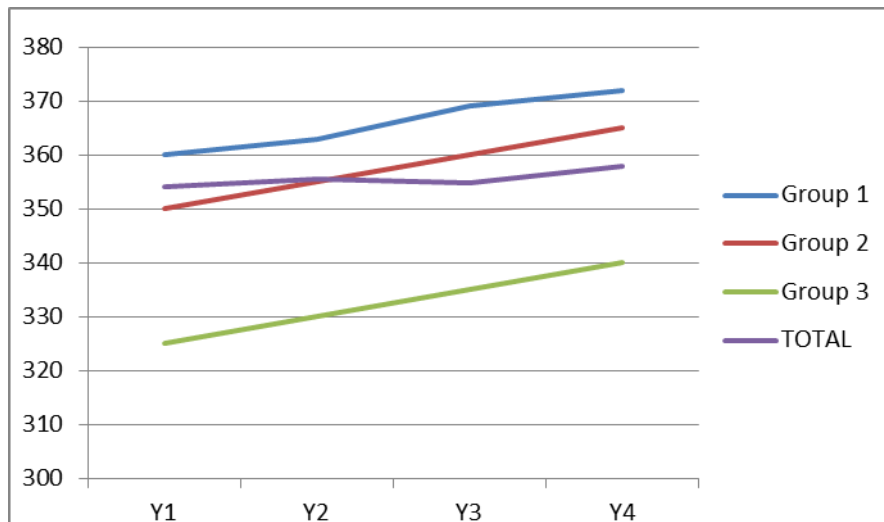


Figure 5

What is the explanation? I'll leave this as a challenge to you in Forum 7. The explanation is really not all that difficult.

Table 5: Ns and Median EOG Scale Scores over Years Disaggregated by Race

Group	EOG SCALE SCORES							
	Year 1		Year 2		Year 3		Year 4	
	N	Mean	N	Mean	N	Mean	N	Mean
Group 1	350	350	315	352	305	354	260	356
Group 2	250	340	255	343	270	346	265	349
Group 3	70	320	105	324	125	328	200	332
TOTAL	670	343	675	344	700	346	725	347