"How SEC Measures Alignment" from an article by Andrew Porter

Tools for Measuring Content and Alignment

Creating a Uniform Language for Describing Content

The past 25 years of research on teachers' content decision making have seen the development of the following three types of tools for measuring content and alignment:

- Surveys of teachers on the content of their instruction,
- Content analyses of instructional materials, and
- Alignment indices describing the degree of overlap in content between, for example, standards and assessment.

The central idea behind these tools is the development of a uniform language for describing content. It is this uniform language that makes it possible to build useful indices of alignment.

The language I have developed in my research consists of uniform descriptors of topics and categories of cognitive demand[1] that together can describe the content of instruction. For example, Table 1 illustrates a two-dimensional matrix that uses this language to describe mathematics content. The topic dimension lists some of the descriptors of mathematics topics: multiple-step equations; inequalities; linear equations; lines/slope and intercept; operations on polynomials; and quadratic equations. The cognitive demand dimension lists five descriptors of categories of cognitive demand:[2] (a) memorize; (b) perform procedures; (c) communicate understanding; (d) solve nonroutine problems; and (e) conjecture/generalize/prove (see Appendix for definitions of each category).[3]

Content of instruction is then described at the intersection between topics and cognitive demand, based on data gathered from teacher surveys. I ask teachers to indicate, for the past school year (a) the amount of time devoted to each topic (level of coverage) and then, for each topic, (b) the relative emphasis given to each student expectation (category of cognitive demand) (see Figure 1).[4] I use a 4-point scale as follows:

- Level of coverage, (a) none/not covered; (b) slight coverage (less than one class or lesson); (c) moderate coverage (one to five classes or lessons); and (d) sustained coverage (more than five classes or lessons).
- Relative emphasis given to each category of cognitive demand, (a) no emphasis; (b) slight emphasis (less than 25% of time spent on this topic); (c) moderate emphasis (accounts for 25–33% of time spent on this topic); and (d) sustained emphasis (accounts for more than 33% of time spent on this topic).

These basic data are then transformed into proportions of total instructional time spent on each cell in the two-dimensional matrix defined by the language (e.g., Table 1). Across the cells in the content matrix, the proportions sum to 1 (Porter & Smithson, 2001a).

The two-dimensional language also can be used for content analyses of instructional materials. A key decision is the unit to be analyzed. For assessments, the unit is an item. Sometimes, a rule is made that no more than three cells in the content matrix can represent an item; sometimes no restrictions are placed on the number of cells representing a single item. When an item has more than one score point, the item is weighted according to its number of score points. For content standards, selecting the unit to analyze is more difficult. The most successful approach has been to pick the most specific version of the content standards and, within that, analyze the content of each objective, paragraph, or phrase.

Creating Indices of Alignment

Figure 2 illustrates the types of content alignment that might be described; each arrow in the figure depicts a particular alignment. Achievement can be more or less aligned to instruction, instruction to district standards and assessments, and district standards and assessments to state standards and assessments. These are all examples of vertical alignment. Horizontal alignment is a

Table 1
Content Matrix

	Category of cognitive demand				
Topic	Memorize	Perform procedures	Communicate understanding	Solve nonroutine problems	Conjecture/ generalize/prove
Multiple-step equations					
Inequalities					
Linear equations					
Lines/slope and intercept					
Operations on polynomials					
Quadratic equations					

Time on Topic		*Elementary School Mathematics Topics*	*Expectations for Students in Mathematics*				
<none>	1	**Number sense / Properties / Relationships**	**Memorize Facts/ Definitions/ Formulas**	**Perform Procedures**	**Demonstrate Understanding of Mathematical Ideas**	**Conjecture, Generalize, Prove**	**Solve Non-Routine Problems/Make Connections**
⓪ ① ② ③	101	Place value	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③
⓪ ① ② ③	102	Patterns	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③
⓪ ① ② ③	103	Decimals	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③
⓪ ① ② ③	104	Percent	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③
⓪ ① ② ③	105	Real numbers	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③
⓪ ① ② ③	106	Exponents, scientific notation	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③
⓪ ① ② ③	107	Factors, multiples, divisibility	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③
⓪ ① ② ③	108	Odds, evens, primes, composites	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③
⓪ ① ② ③	109	Estimation	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③
⓪ ① ② ③	110	Order of operations	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③
⓪ ① ② ③	111	Relationships between operations	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③

FIGURE 1. *Teacher survey.*

measure of the consistency of standards and assessments within a district or state—that is, the degree to which these policy instruments deliver a coherent set of expectations to teachers.

Alignment is the core idea in systemic, standards-based reform (Smith & O'Day, 1991). An instructional system is to be driven by content standards, which are translated into assessments, curriculum materials, and professional development, which are all, in turn, tightly aligned to the content standards. The hypothesis is that a coherent message of desired content will influence teachers' decisions about what to teach, and teachers' decisions, in turn, will translate into their instructional practice and ultimately into student learning of the desired content.

But how best to measure the degree of alignment? As explained earlier, use of a uniform language for describing instruction, assessment, instructional materials, and content standards makes it possible to build meaningful indices of alignment. Because content analyses and teacher surveys produce data of proportions in a content matrix, measuring alignment becomes a question of the extent to which the proportions in one content matrix (e.g., describing an assessment) match the proportions in another content matrix (e.g., describing standards) (see Figure 3).

I have experimented with different indices of alignment. A particularly promising index is

$$\text{Alignment Index} = 1 - \frac{\Sigma|X - Y|}{2},$$

where X denotes cell proportions in one matrix and Y denotes cell proportions in another matrix. The possible values of this index range from 0 to 1.0, with 1.0 indicating perfect alignment. Conceptually, the index is the sum of cell-by-cell intersects. For ex-

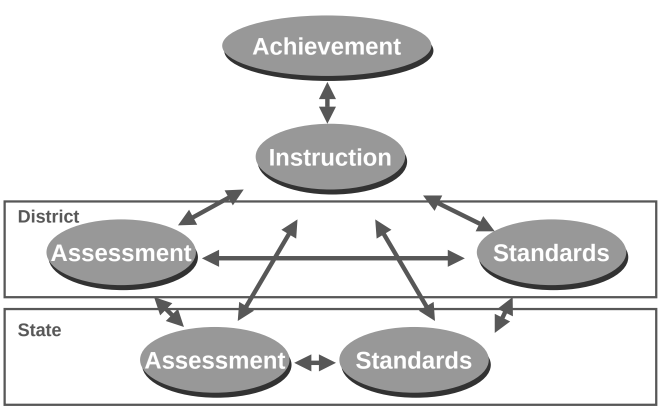

FIGURE 2. *Vertical and horizontal alignment.*

Cognitive Demand

Topics

Assessment

.3	0	.1
0	.1	0
0	.2	.1
0	.1	.1

Standards

.2	0	.1
0	.2	0
.1	.2	.1
0	0	.1

$$\text{Alignment Index} = 1 - \frac{\Sigma\,|\,X\text{-}Y\,|}{2}$$

X=Assessment Cell Proportions
Y=Standards Cell Proportions

FIGURE 3. *Example matrices to measure alignment.*

ample, in Figure 3, the intersect in the (1,1) cell for assessment and standards is .2. Although one can say that the larger the value of the index, the better the alignment, there is still no easy way to think about how big the alignment index value must be to be considered "good." The index does not have a straightforward interpretation like the proportion of common content between, say, standards and assessment. Nevertheless, the index does make it easy to see if content standards and student achievement tests are more aligned in one state than another.

Alternatively, one could calculate the correlation across cells between content proportions for two matrices. In theory, this cell correlation ranges from −1.0 to 1.0, but for alignment, the range is from 0 to 1.0. In a study (Gamoran et al., 1997) using a data set derived from an end-of-year self-report survey of teachers' instructional practices and the results of student achievement tests administered in the fall and spring, the alignment between test content and instructional content measured by the two indices correlated .86. At least for that data set, the two indices yielded quite similar values.

In my earliest work measuring alignment (Gamoran et al., 1997), I created what I called a "level index" and a "configuration index." I defined *level* as the proportion of instructional content that was also tested and *configuration* as the degree to which the relative emphasis of tested content that was also taught matched the relative emphasis of tested content as a whole. I calculated configuration using the alignment index given earlier. An overall index of alignment was then formed by multiplying level by configuration. The level index correlated .62 with the cell correlation and .77 with the first alignment index. The configuration index correlated .72 with the cell correlation and .59 with the first alignment index. The first alignment index discussed above is the easiest to conceptualize and is the approach referred to in this article when the term *alignment index* is used.