Health Numeracy in General Educational Development Testing

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Background

Over 16.3 million individuals worldwide have used General Educational Development (GED) testing over the past 65 years as a way of earning a high school credential. GED practice tests are a primary tool to prepare individuals for the actual GED tests, because they use the same pool of questions (GED Testing Service 2001-2007). The GED Testing Service reports that jurisdictions requiring individuals to pass the practice tests normally have higher pass rates on the GED tests (GED Testing Service 2009). It is therefore important to have appropriate levels of health numeracy in health-literacy-related questions on the GED practice tests.

In a previous study, we developed a definition and four-level operational framework for health numeracy (Golbeck et al 2005). We pioneered the concept of ***health numeracy*** as the 'degree to which individuals have the capacity to access, process, interpret, communicate, and act on numerical, quantitative, graphical, biostatistical, and probabilistic health information needed to make effective health decisions'. At the same time, we established four functional categories for degrees of health numeracy as 'overlapping clusters of concepts defined by skill level, degree of manipulation, and the extent of literacy involved'. The lowest level is basic health numeracy, followed by computational, then analytical, and finally statistical health numeracy. We presented the definition and four levels as a way to focus needed attention on health numeracy.

In a subsequent study, we identified the health-related questions among the 931 questions on the English language pencil-and paper version of the General Educational Development (GED) official practice tests (Golbeck et al 2010). For that study, a team of allied health professionals (medical sociology, epidemiology, biostatistics, curriculum and instruction, and adult education) identified the health-related questions and noted lack of alignment between the practice tests and national health education standards for U.S. high school graduates.

In the present paper, we extended the work of these two earlier studies. We further developed the operational framework for health numeracy, and we developed categorizations of numbers per se, numeracy terms, and data displays. Here we applied the improved framework and the developed categorizations within content analysis methodologies to determine the numeracy information in a subset of the identified health-related GED practice test questions.

Adult numeracy has been described as 'mathematical activity situated in its cultural and historical context' (Coben 2003, p. 7). In the present study, we explored this view of adult numeracy. We considered adult numeracy as a *quantitative activity*, rather than a *mathematical activity*. Then, we situated the quantitative activity in the cultural and historical context of health.

This more expansive view of adult numeracy, situated in health, drove our numeracy content analyses and health numeracy level categorizations.

Methods

In the present study, we expanded the definitions of the four health numeracy levels. The original and revised definitions are as follows:

Level 1: Basic health numeracy involves:

(original) 'sufficient basic skills to identify numbers, and make sense of quantitative data requiring no manipulation of numbers'.

(revised) individuals having sufficient basic skills within everyday health situations in order to competently use descriptive, temporal and comparative numeracy terms; understand staged, temporal, and ranked information; identify numbers; and make sense of introductory quantitative data; all without manipulation of numbers.

Level 2: Computational health numeracy involves:

(original) 'the ability to count, quantify, compute, and otherwise use simple manipulation of numbers, quantities, items, or visual elements in a health context so as to function in everyday health situations'.

(revised) individuals having sufficient computational skills within everyday health situations in order to competently use arithmetic operator terms; and perform simple manipulations of numbers, quantities, items, or visual elements.

Level 3: Analytical health numeracy involves:

(original) 'higher-level concepts such as inference, estimation, proportions, percentages, frequencies, and equivalent situations'.

(revised) individuals having sufficient analytical skills within everyday health situations in order to competently use descriptive statistics terms having to do with units of measurement, grouped data, location, spread, and graphics; and understand simple data displays such as bar charts, pie diagrams, maps, flow diagrams, basic line graphs, and basic tables; often requiring information to be pulled from multiple sources and in multiple formats for comparative purposes.

Level 4: Statistical health numeracy involves:

(original) 'an understanding of basic biostatistics involving probability statements, skills to compare information presented on different scales…the ability to critically analyze quantitative health information such as life expectancy and risk, and an understanding of statistical concepts such as randomization…'.

(revised) individuals having sufficient statistical skills within everyday health situations in order to competently use intermediate probability and statistical terms; compare information presented on different scales; critically analyze probabilistic and statistical information such as life expectancy and risk; and draw intermediate level conclusions from data displays.

We also developed 8 categories for types of ***numbers per se*** that were informed by the 'Format Cells' window in Microsoft EXCEL. The categories are: Whole numbers, decimal numbers, currency, dates, times, fractions/proportions, percentages, and other.

Then, we developed 15 categories of ***numeracy terms*** that were informed by a review of concepts in the literature and common approaches to statistical education (e.g. Selvin 2004). The categories for numeracy terms are: Number, descriptive, temporal, comparative-occurrence, comparative-spatial, comparative-other, arithmetic operator, unit of measurement, location, spread, grouped data, data display, probability, statistical, and other. Examples of each type of numeracy term are given in Table 1.

Next, we developed 8 categories of ***data displays*** that were informed by the 'Charts' window in Microsoft EXCEL, and the 'Analyze, Descriptive Statistics, Frequencies, Charts'

window in PASWStatistics 18.0 software. The categories are: pie charts, maps, flow diagrams, bar charts, histograms, data tables, line drawings, and other.

In summary, the above methodological developments provided expanded definitions of four levels of health numeracy; and they provided lists of types of numeracy terms, types of numbers per se, and types of data displays. The tripartite categorization may be used with the definitions to help determine level of health numeracy.

Application

There are seven sets of English language pencil-and paper GED practice test forms. Test forms PA, PB, and PC were published in 2001; PD and PE in 2003; and PF and PG in 2007. There are a total of 931 questions on these forms. We identified 93 of these to be health-related (Golbeck et. al., 2010).

For the present study, we selected one set from each year. This resulted in our working with test forms PA, PE, and PG. On these forms, there were 49 identified health-related questions.

We analyzed the questions and their parts: Set-up, stem, options, and data display. The set-up is any text that precedes the stem. The stem is the paragraph that states the question. The options are the possible answers to the question. The data display is any table or graph.

For each of these questions, the authors independently identified all of the numbers per se and numeracy terms, and whether there was a data display. A list of 293 unique numeracy terms, by category, was built as part of this process (Table 1).

The authors then compared their findings and came to agreement on the numeracy content of the question. Next the authors collaboratively determined the appropriate category for each number per se, numeracy term, and data display. Finally, the authors jointly determined the level of health numeracy of the question.

There were a total of 6,635 terms in the 49 analyzed questions, including numbers per se, numeracy terms, and non-numeracy terms. Among these, we identified 229 numbers per se (3.5 per 100). Most were whole numbers. Table 2 shows the prevalence of type of number per se, per 100 terms in the GED questions, by category and part of question.

Also among the 6,635 terms, we also identified 821 numeracy terms (12.4 per 100). Almost half of these were temporal, descriptive, and arithmetic operator terms. Table 2 also shows the prevalence of type of numeracy term, per 100 terms in the GED questions, by category and part of question.

Among the 49 questions, we identified only 11 questions (22%) that had data displays. There were no pie charts, four maps, one flow diagram, one bar chart, one histogram, two basic data tables, and two line drawings.

Almost half (45%) of the questions were at the basic level of health numeracy. There were no questions at the computation level of health numeracy. About a third (31%) of the questions were at the analytical level, and a quarter (25%) of the questions were at the statistical level, of health numeracy.

Discussion

Even though we took an expansive view of adult numeracy, we found a low prevalence of numbers per se, numeracy terms, and graphs in the GED questions. The list of unique numeracy terms contained relatively few unique location and grouped data terms, and relatively many unique temporal terms. We also noted that there were no health-contextual questions at the computational level of health numeracy.

The focus of the GED official practice tests on temporal terms (n=137) was striking. Whether planned or not, the tests were less tuned to arithmetic operations than we initially assumed. Also, there were nearly as many descriptive terms (n=114) as there were arithmetic operators (n=119). Further editions of the GED practice test may need refinement in these areas.

We noted that almost half of the questions were at the basic level of health numeracy. However, individuals need to be proficient in the computational level of health numeracy, for example, in order to manage their nutritional intake and energy expenditure toward achieving and maintaining healthy weight. Individuals also need to be proficient in the analytical level of health numeracy, for example, in order to understand their medical laboratory test results as compared to standard scores when making follow-up decisions regarding their health. They also need to be proficient in the statistical level of health numeracy, for example, in order to weigh the risks and benefits of consenting to randomized-group medical treatments. In order to ensure individuals are equipped with sufficient computational, analytical and statistical skills for in everyday health situations, future editions of the GED practice test should include greater proportions of questions at these higher levels of health numeracy.

A limitation of this study is that there is a lack of consensus on what is a numeracy term. The definition used here was relatively expansive, and often determined by context. Yet, as we know from the work of Zadeh (1965) and others, the natural boundaries of conceptual categories are graded and not discrete. This is also certainly true for numeracy terms. What was noteworthy in this study was the relative ease with which the graders reached agreement on categorizing the numeracy terms. Future work of this team will involve applying the analytic model presented in the present study to the remaining 44 health-related questions on the remaining 4 GED official practice test forms.

Table 1: Number of Unique Numeracy Terms, by Category, in 49 Health-Related GED Official Practice Test Questions

Category	*Examples*	*Number*
Number	hundred, millions	12
Descriptive	about, amount	30
Temporal	before, during	45
Comparative-Occurrence	few, part	20
Comparative-Spatial	above, steep	22
Comparative-Other	faster, smaller	31
Arithmetic Operator	add, equal	28
Unit of Measurement	AM, mg/dL	11
Location	average, middle	7
Spread	minimum, most	19
Grouped Data	frequency, proportion	7
Data Display	diagram, regions	17
Probability	likely, normally	24
Statistical	data, method	20
Other	-	0
TOTAL		293

Table 2: Prevalence (per 100) of Numbers per se and Numeracy Terms, by Category and Part of Question, among the total terms[a] in 49 Health-Related GED Official Practice Test Questions

	Part of GED Question (total number of terms in the 49 questions)									
	Set-up[b] (3,627)		**Stem[c] (810)**		**Options[d] (1,775)**		**Data Display[e] (423)**		**Total (6,635)**	
Category	n	per 100	n	per 100	n	per 100	n	per 100	n	per 100
Numbers per se										
Whole	88	2.43	22	2.72	18	1.01	43	10.17	171	2.58
Decimal	1	0.03	0	0.00	0	0.00	5	1.18	6	0.09
Currency	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Date	4	0.11	1	0.12	1	0.06	15	3.55	21	0.32
Time	0	0.00	0	0.00	10	0.56	18	4.26	28	0.42
Fraction/Proportion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Percentage	1	0.03	0	0.00	0	0.00	0	0.00	1	0.02
Other[f]	2	0.06	0	0.00	0	0.00	0	0.00	2	0.03
TOTAL	96	2.65	23	2.72	29	1.63	81	19.15	229	3.45
Numeracy Terms										
Number	34	0.94	0	0.00	4	0.23	1	0.24	39	0.59
Descriptive	80	2.21	2	0.25	31	1.75	1	0.24	114	1.72
Temporal	81	2.23	8	0.99	37	2.08	11	2.60	137	2.06
Comparative-Occurrence	55	1.52	7	0.86	16	0.90	2	0.47	80	1.21
Comparative-Spatial	37	1.02	5	0.62	10	0.56	5	1.18	57	0.86
Comparative-Other	24	0.66	4	0.49	23	1.30	1	0.24	52	0.78
Arithmetic Operator	36	0.99	2	0.25	77	4.34	4	0.95	119	1.79
Unit of Measurement	12	0.33	0	0.00	13	0.73	12	2.84	37	0.56
Location	5	0.14	1	0.12	2	0.11	0	0.00	8	0.12
Spread	22	0.61	13	1.60	9	0.51	0	0.00	44	0.66
Grouped Data	8	0.22	1	0.12	2	0.11	0	0.00	11	0.17
Data Display	15	0.41	7	0.86	12	0.68	4	0.95	38	0.57
Probability	29	0.80	7	0.86	3	0.17	1	0.24	40	0.60
Statistical	31	0.85	5	0.62	6	0.34	3	0.71	45	0.68
Other	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
TOTAL	469	12.93	62	7.65	245	13.80	45	10.64	821	12.37
Numbers per se and Numeracy terms	565	15.58	85	10.49	274	15.44	126	29.79	1,050	15.83

[a]Total terms include numbers, numeracy terms, and non-numeracy terms.
[b]The set-up is any text that precedes the stem.
[c]The stem is the paragraph that states the question.
[d]The options are the possible answers to the question.

[e]The data display is any table or graph.
[f]The Other category in 'numbers per se' included address numbers.

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