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Gene V Glass
Arizona State University

Cheryl A. Edholm
Longwood High School
Middle Island, New York

Education Policy Research Unit (EPRU)
Education Policy Studies Laboratory
College of Education
Division of Educational Leadership and Policy Studies
Box 872411
Arizona State University
Tempe, AZ 85287-2411

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Executive Summary

Arizona's Instrument to Measure Standards (AIMS) produces unusual failure rates at Grade 10 in mathematics. Forty-three (43) managers in Arizona business and industry reported whether the mathematics tested by the Grade 10 AIMS Math exam was actually used in the daily work of their employees. For one question (calculating a percentage based on an interpretation of a box-and-whiskers graph), one-quarter of the managers considered the mathematics involved to be like that used by their employees. The other questions were rated as useful by about 10 percent or fewer of the managers (12 percent, 9 percent, 7 percent, 7 percent, and 7 percent).

In other words, for the typical Grade 10 AIMS mathematics question, only three of 43 managers reported that it tested mathematics actually used by their employees. The process by which the AIMS test was constructed and the validity of the test itself are called into question.

Background

The Arizona high school graduation test known as AIMS (Arizona's Instrument to Measure Standards) has a long and troubled history. The inception and early history of the test have been the subject of at least one scholarly publication (Smith, Heinecke & Noble, 1999). The claim that AIMS was the product in large part of the volunteered judgments of citizens as to what high school graduates need to know was called into question by these scholars.

Rather, Smith and her colleagues described a hurried process of content selection in 1995 that was subject to manipulation by external consultants to the Arizona Department of Education and designed to exclude teachers in the very subjects of their expertise. The eventual content of the AIMS Mathematics test survived a period of citizen review in public meetings without any substantive changes.

Critics have also noted the near one-to-one identity of the AIMS Mathematics standards with the curriculum recommendations of the National Council of Teachers of Mathematics, a document whose authors have asserted is not a valid framework for a high-school exit examination.

Critics have alleged that the content of the AIMS math test is inappropriate as a high-school exit exam; it is seen as more appropriate for the four-year college level. Subsequent extraordinary failure rates on the AIMS test, particularly the Grade 10 Mathematics test, have reinforced the suspicion that something is wrong with the test.

The Present Study

The present study was undertaken to investigate whether employers consider the content of the AIMS test to be useful for their employees. Managers in a wide variety of businesses and industries in Maricopa County, Arizona, were given examples of AIMS Grade 10 mathematics questions and asked whether the content of these questions represented math skills used by their employees in their daily work.

The Employers

In the selection of employers, an effort was made to include a wide variety of businesses and industries. Ten categories of employment were selected to represent the vast majority of occupations performed by high school graduates in Maricopa County. These categories and the number of employers involved in this study in each category were as follows: Health Care (6), Law Firms (3), Food Industries (3), Wholesale (3), Government Agencies (6), Retail Sales (4), Construction (3), Banking (4), Service Industries (7), and Engineering (4). Of 54 managers contacted and asked to participate in the study, two declined for reasons of time. Of the 52 potential respondents, completed questionnaires were received from 43.

The Math Questions

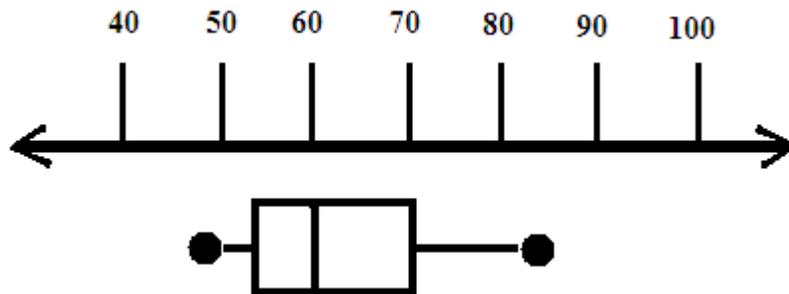
The source of the mathematics questions was the *High School Student Guide to AIMS: Arizona's Instrument to Measure Standards*, issued by the Arizona Department of Education (ADE) in 1999 as a study guide for students. Six questions were drawn from the Grade 10 AIMS Mathematics test according to a stratified random sampling frame.

One question was sampled from each of six content areas (or “standards”): Number Sense, Data Analysis and Probability, Algebra, Geometry, Measurement and Discrete Mathematics, and Mathematical Structure and Logic. The first author of this paper, who has published eight books in mathematics and statistics, and who has inspected the actual first version of the AIMS test, regards the sample of six mathematics questions as representative of the Arizona’s Instrument to Measure Standards.

The sampled questions follow:

Q1. Of the following choices, rational numbers, integers, whole numbers, irrational numbers, which of these could not be classified as the number representing the number of people in a room?

Q2. The speed for a sample of twenty-five cars is shown in miles per hour (mph) in the box-and-whiskers graph below.



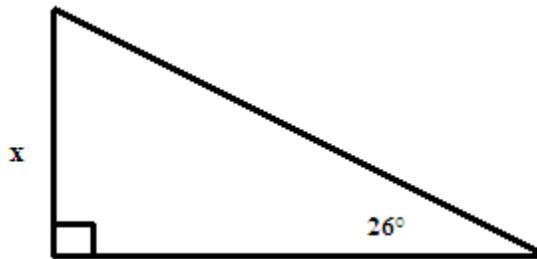
If an officer is writing speeding tickets to each driver in the sample whose speed is more than 70 mph, about what percentage of the drivers will be ticketed?

Q3. Solve for x.

$$\text{Sine } 26^\circ = .438$$

$$\text{Cosine } 26^\circ = .899$$

$$\text{Tangent } 26^\circ = .488$$



Q4. Which statement is true about the graphs of these equations?

$$3y = -12x + 6$$

$$-2y = 8x - 4$$

Q5. Which of the following algorithms are equivalent?

- I. Given a list of 25 numbers in ascending order. Entry 13 is the number you are looking for.
- II. Given a list of 25 numbers in descending order. Entry 13 is the number you are looking for.
- III. Given a list of 25 numbers in ascending order. Entry 25 is the number you are looking for.
- IV. Given a list of 25 numbers in descending order. Entry 25 is the number you are looking for.

Q6. If x is always positive and y is always negative, then xy is always negative. Based on the given information which conjecture would be valid?

The Questionnaire

The six mathematics questions were arranged in a survey questionnaire. Each question was followed by the statement, “My employees use this type of mathematics in their daily work: Strongly Agree, Agree, Disagree, Strongly Disagree.” The respondents to the questionnaire circled one option (SA, A, D, SD) for each question.

The Results

If managers circled SA (Strongly Agree) or A (Agree) to the statement, “My employees use this type of mathematics in their daily work,” the response was taken as an affirmative answer to the implied question, “Do your employees use this type of mathematics in their daily work?” Forty-three managers responded for each question. The numbers and percentages of managers answering affirmatively for each question are displayed in Table 1.

As an example of how Table 1 can be interpreted, consider Question #1, “*Of the following choices, rational numbers, integers, whole numbers, irrational numbers, which of these could not be classified as the number representing the number of people in a room?*” Only 4 of 43 (9 percent) managers agreed that the skill tested here is used by their employees in their daily work.

Table 1

Numbers and Percentages of Managers Responding *Affirmatively* to the Statement, “My employees use this type of mathematics in their daily work”

	Health Care	Law Firms	Food Indust.	Whole-sale	Govt. Agenc.	Retail Sales	Cons-truction	Bank-ing	Serv. Indust.	Engi-neer.	Totals	%
Q1	2/6	0/3	0/3	0/3	0/6	0/4	1/3	0/4	1/7	0/4	4/43	9%
Q2	2/6	0/3	0/3	0/3	3/6	1/4	1/3	1/4	2/7	1/4	11/43	26%
Q3	0/6	0/3	0/3	0/3	0/6	1/4	1/3	0/4	1/7	0/4	3/43	7%
Q4	0/6	0/3	0/3	0/3	0/6	1/4	1/3	0/4	1/7	0/4	3/43	7%
Q5	1/6	0/3	0/3	1/3	1/6	0/4	1/3	1/4	0/7	0/4	5/43	12%
Q6	0/6	0/3	0/3	0/3	0/6	0/4	1/3	0/4	1/7	1/4	3/43	7%

Only one question, Question #2, had any appreciable endorsement in the sample of managers; even there, three out of four managers did not feel that the math skill tested was used by their employees. The overall conclusion is undeniably one in which these managers regard the mathematics tested by the Grade 10 AIMS mathematics test as irrelevant to the functioning of their employees.

Discussion

Employers in Maricopa County do not see the content of the Grade 10 AIMS Mathematics test as being used by their employees in their daily work. To a knowledgeable observer, the math skills and understandings tested by AIMS Grade 10 are more appropriate for college-level mathematics assessment than for a high school exit

examination. The Texas high school exit exam, which fails approximately 10 percent of all examinees (in contrast to the vastly greater proportion of Arizona high school students who fail AIMS), has much easier questions. The TAAS (Texas Assessment of Academic Skills) Test releases large numbers of questions each year after their administration so that they can be examined by the public (unlike the ADE's practice of concealing the AIMS items).

The most difficult math question in one of the earliest administrations of the TAAS tested whether students could calculate the size of an envelope required to hold an 8.5" X 11" piece of paper folded vertically in thirds; a diagram was provided to assist the examinee. (For further analysis of the TAAS and its use as a high-school exit exam, see Haney, 2000.)

Failure rates at Grade 10 on the mathematics portion of the AIMS test have been extraordinary; as noted above, only 10 percent of Texas high-school students fail the TAAS high school exit exam. Vastly greater numbers of Arizona high school students fail AIMS. "Ninety-seven percent of African Americans, Hispanics, and Native Americans failed the math section of the AIMS, a significantly greater proportion of failures than occurred in the white community, whose students also failed the test in great numbers." (Amrein & Berliner, 2002)

Bureaucratic reactions to the AIMS situation have taken the form of pledges to adjust the AIMS test in response to the extraordinary failure rate. These rates (approaching 90 percent for all students) are in stark contrast to the perennial results for Arizona students on nationally standardized achievement tests, where the national average is consistently met and exceeded (Keegan, 2000; Kossan, 2001). However, the

problem with AIMS Math appears too serious to be cured by adjustments or delays of implementation of the use of the test as the gatekeeper of the high school diploma. Any instrument seen as so irrelevant by the employers of Arizona's high-school graduates suffers from defects more serious than what "adjustments" can correct.

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About the Authors

Gene V. Glass is Professor in the Division of Educational Leadership & Policy Studies and the Division of Psychology in Education, College of Education, Arizona State University. A Ph.D. in Educational Psychology and Statistics from the University of Wisconsin (1965), Dr. Glass has taught at the University of Illinois (1965-67) and the University of Colorado (1967-1986). He is a member of the National Academy of Education, and edits the peer-reviewed scholarly journal *Education Policy Analysis Archives* (<http://epaa.asu.edu>), a publication of the Education Policy Studies Laboratory (<http://www.edpolicylab.org>). Email: glass@asu.edu

Cheryl A. Edholm earned her Doctorate of Education from Arizona State University in December 2001. Dr. Edholm served as a school counselor at Apache Junction High School from 1991 until 1997. She was Assistant Principal of the East Valley Institute of Technology from 1997 until 2001. She is currently Assistant Principal of Longwood High School, Middle Island, N.Y. Email: cae3540@aol.com.