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ABSTRACT

A study was undertaken to assess the relationship between the DMI Mathematics Systems Objective Inventory (DMIMS) and the National Assessment of Educational Progress (NAEP) content by process matrix prepared for the Fourth Assessment of Mathematics. The DMIMS is a criterion-referenced standardized test comprised of seven levels, and it can be used to assess student performance from the middle of kindergarten to the end of ninth grade. Two mathematics educators participated in the study and completed the same task. Findings indicate that the DMIMS reached from 17% to 48% of the NAEP's matrix cells, figures that did not differ dramatically from earlier results on norm-referenced tests and an earlier NAEP system. The NAEP does not address each content-process combination at each level, and comparing these figures to a 100% base would not be appropriate. These findings show that individuals concerned with student assessment in mathematics along the NAEP system will find that the DMIMS attends to the same interests as do the norm-referenced standardized tests on mathematics. Findings also have implications for inclusion in tests of items other than those that deal with operations with numbers. Thirteen tables are included, and notes and references are appended. (TJH)

A CONTENT ANALYSIS OF THE DMI MATHEMATICS SYSTEMS INSTRUCTIONAL OBJECTIVES INVENTORY ACCORDING TO THE 1985-86 NATIONAL ASSESSMENT OF EDUCATIONAL PROGRESS CONTENT BY PROCESS MATRIX FOR MATHEMATICS

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A CONTENT ANALYSIS OF THE DMI MATHEMATICS SYSTEMS INSTRUCTIONAL OBJECTIVES INVENTORY ACCORDING TO THE 1985-86 NATIONAL ASSESSMENT OF EDUCATIONAL PROGRESS CONTENT BY PROCESS MATRIX FOR MATHEMATICS

The National Assessment of Educational Progress (NAEP) has conducted four mathematics assessments, 1972-73, 1978-79, 1981-82 and 1985-86.[1] In the 1985-86 Assessment, the NAEP prepared a content by process matrix which covered the mathematics domain.[2] Seven content and five process categories made up the matrix which was used to help prepare and classify the exercises constructed by the Assessment. In the same sense, the matrix can be used to study and classify the items included in the norm-referenced and criterion-referenced standardized mathematics tests marketed today. Earlier studies used the 1972-73 NAEP system,[3] which was based on content alone, to classify the items used in norm-referenced standardized mathematics achievement tests designed to measure elementary[4] and secondary school student achievement.[5] This study will examine the content of a current criterion-referenced test series, the DMI Mathematics Systems Instructional Objectives Inventory (DMIMS),[6] according to the NAEP content by process matrix in order to determine the extent to which this test series follows the NAEP system.

Criterion-Referenced Testing

Criterion-referenced tests measure specific objectives which are stated as behavioral changes anticipated in the test-taker as a result of instruction[7] while norm-referenced testing deals with relative status in the subject assessed. Most educators acknowledge the need for both forms of assessment but differ with regard to the emphasis assigned to each.

Advocates of criterion-referenced testing claim that normative achievement comparisons can be misinterpreted as aptitude comparisons.[8] Additionally, the results of norm-referenced tests can be misconstrued; indicating fixed rather than malleable abilities. On the other hand, criterion-referenced tests focus on clearly defined behavioral samples and the results are not as susceptible to misinterpretation. The same items may be used to build norm-referenced and criterion-referenced tests, but criterion-referenced test items tend to be more detailed as the test constructor can work with a limited number of objectives. In the norm-referenced system, test constructors may try to examine several skills with a single item.

Criterion-referenced testing has attracted researchers' attention over time. Five references appeared under Criterion Referenced Tests in the 1986-87 edition of Education Index[9] and eleven references appeared under the same title in Resources in Education.[10] Despite the attention given to this topic, Mitchell cited only one commercially-prepared, criterion-referenced mathematics achievement test series in the Ninth Mental Measurements Yearbook,[11] the DMIMS.

Criterion-referenced tests have become integral parts of school district assessment programs across the country. Rose and Custin described the development of a criterion-referenced testing program for the Charleston, South Carolina schools.[12] The school district prepared reading comprehension and general mathematics tests for students enrolled in grades one through eight. Jost et al. discussed the development and presented the results of criterion-referenced and norm-referenced tests in Los Angeles.[13] The Denver schools used criterion-referenced tests to supplement a norm-referenced testing program which did not address all of the school district's instructional objectives.[14] Glickman and Pajak studied a group of Georgia schools which showed improvement in criterion-referenced test scores over time.[15] These studies underscore the role of criterion-referenced testing in America's schools and show that this assessment strategy has earned a place in the nation's educational system.

The DMI Mathematics System

According to CTB/McGraw-Hill, their experience with the Prescriptive Mathematics Inventory[16] and the Diagnostic Mathematics Inventory (DMI)[17] led to the development of the DMIMS.[18] This test series provides information which helps educators place students for measurement, diagnose their instructional needs, prescribe instructional activities, teach skills, monitor progress and suggest reinforcement and enrichment exercises.

The DMIMS is made up of seven levels and can be used to assess student performance from the middle of kindergarten to the end of ninth grade.[19] Table 1 shows grade coverage and the number of items contained in each level.

The information shown in Table 1 is not unusual. Seven of the eight levels cover a year's time, from the middle of one grade to the middle of the next, and the highest level, Level G, covers two and one-half years or more, depending on its application. The item count increases from one level to the next, another feature followed by many test publishers.

Table 1

The DMI Mathematics Systems Instructional Objectives Inventory: Grade Coverage and Number of Items by Test Level

Level	Grade Coverage	Number of Items
A	K.6 - 1.5	48
B	1.6 - 2.5	64
C	2.6 - 3.5	72
D	3.6 - 4.5	88
E	4.6 - 5.5	116
F	5.6 - 6.5	132
G	6.6 - 8.9+	168

Durost critiqued the DMIMS's predecessor, the DMI, and noted that the publisher did not provide norms, a policy which could encourage school districts to construct their own.[20] He saw implications for individualized instruction through the DMI but added that this ideal is rarely achieved.The critic believed that the instrument was at least as sound as any other on the market at the time, but the lack of an item difficulty index was a serious problem. Durost said the items included in the DMI were excellent but the instrument was more an inventory than a test.

O'Brien said that the DMI dealt with topics addressed in the textbooks which were available at the time.[21] These topics, however, focused on computational skills and neglected the topics which contemporary mathematicians would look on as important:

> A major problem is that the 325 objectives upon which the DMI is based seem to be based on a view that 'mathematics knowing' is a static business based on memory of procedures, nomenclature, and association rather than a dynamic affair involving the construction testing and generalizing of relationships.[22]

Hambleton and Eignor called the DMI a popular test when they discussed guidelines for evaluating criterion referenced tests and their manuals.[23] Interestingly, the writers said that many criterion-referenced tests fell short of the technical quality necessary for them to accomplish their goal. Or, the supporting measurement theory had not reached the level of sophistication demonstrated by criterion-referenced tests. Finally, Hambleton and Eignor mentioned the lack of guidelines for criterion-referenced test evaluation and prepared a list of desirable characteristics.

According to Hanna, the DMI offers its users a systematic means for placing students in mathematics programs and levels, diagnosing their instructional needs, and prescribing proper instructional materials.[24] The information produced by the test results may be used to teach specific skills, monitor progress and reinforce and enrich those skills which have been mastered. Hanna liked the locator tests which are part of the DMI because their use can maximize utility in terms of testing time. "Locator tests match students with levels capable of providing the most reliable scores."[25]

Alvarez used the DMI in a study designed to help identify second grade students at risk.[26] She also administered the Prescriptive Reading Inventory. Eight hundred twenty-two third grade students participated in the study and Alvarez used multiple regression and stepwise discriminant anlysis to analyze her data. The researcher found that f rst grade test scores and report card grades were significant contributors to second grade test performance and achievement. Gender was not a factor. Thus, the DMI provided data which could be used for prediction. The instrument was effective and efficient.

Constantine studied the influence of the number of test items on mastery decisions.[27] He used the DMI to collect data. Generally, between ten and twenty items ought to be used to measure objective mastery.[28] Constantine prepared simulated test forms for the study. The number of items used to mesure each objective ranged from zero or chance to twenty. One item represented DMI specific objectives, two to eight, DMI category objectives, four, revised DMI objectives, ten, Popham's minimum, and twenty, his maximum. The researcher found that single item objectives generated significantly more consistent decisions than those attributed to chance. This finding occurred at all grade levels. Moreover, there were no significant differences between decisions made on the basis of ten or twenty items. Decisions based on more than one item were more consistent than those based on a single item.

Tests, Texts and National Assessment

Alford commented on the relationship between textbooks and standardized test content and showed a need for the NAEP. Working through a pair of studies, Freeman et al. and Mehrens and Phillips,[29] Alford found that the tests' contents varied. Since all of the tests reviewed emphasized computational skills and some of the textbook material was not attended to by the tests, the textbook-test match was weak. Therefore, Alford continued, teachers must be aware of the discrepancy between texts and tests when they develop their instructional programs. If they neglect this relationship, teachers who use their state guidelines as a frame of reference for their curriculum will deliver a different instructional program than those who use standardized tests or textbooks to fill this role. Those who use their state guidelines as an explicit curriculum will teach a different course than those who use standardized test or textbook content as an implicit one.

Alford suppported the use of standardized tests while noting that their items only sample the appropriate domain. This domain is large and the tests seem to be representative. The textbooks used in mathematics teaching cover more material than that which is taught. "Thus, the picture emerging from studies of textbook and test content almost certainly is an overestimation of the match between the curriculum students are taught and the tests they take."[30]

Alford's comments are pertinent to the issue at hand because they reflect the confusion surrounding mathematics education. Perhaps the NAEP can help focus mathematics curricula in the schools and promote more uniform mathematics instruction across the country. Improving the correlation between the subject matter taught and that tested will benefit teachers and their students.

The NAEP attempted to improve this relationship by constructing the content by process matrix which was designed to cover the mathematics domain. Each Assessment's objectives have reflected the positions of educators, mathematicians, researchers and the public. Moreover, each

Assessment has developed a character of its own as the information produced has been used to focus on policy decisions, student competencies and the interrelationships among subjects.

For the 1985-86 Assessment, a group of tewnty-five mathematics educators and classroom teachers examined the objectives set for the 1981-82 Assessment. NAEP staff personnel summarized the results and submitted them to the Mathematics Learning Area Committee (MLAC) which updated the 1985-86 Assessment objectives.[31] The MLAC used the NAEP Assessment Policy Committee's guidelines in order to prepare the objectives. Here, the Policy Committee asked those responsible for setting up all the 1985-86 Assessments to emphasize the "higher-level, critical-thinking skills."[32] The MLAC draft was reviewed by another twenty-five member panel made up of mathematics educators and classroom teachers. The MLAC reviewed this panel's comments and produced the Assessment's objectives.

The Objectives: Five objectives were defined for the Asessment: (1) Problem Solving/Reasoning, (2) Routine Application, (3) Understanding/ Comprehension, (4) Skill and (5) Knowledge. Some degree of problem solving was incorporated into each objective in response to the Policy Committee's interest in examining critical thinking skills. Elementary and secondary school mathematics up to but not including the calculus served as the Assessments content domain. The MLAC defined seven process categories: (1) Fundamental Methods of Mathematics, (2) Discrete Mathematics, (3) Data Organization and Interpretation, (4) Measurement, (5) Geometry,

(6) Relations, Functions, and Algebraic Expressions, and (7) Numbers and Operations.

Problem Solving/Reasoning was designed to measure a student's higher order thinking skills. Consequently, the exercises prepared to measure this skill were somewhat more intellectually complex than the ones used to measure skill application or basic understanding. Routine Application measured a student's ability to solve familiar problems, those studied in class or textbooks and Understanding/Comprehension, asked students to demonstrate their facility in interpreting and elaborating on basic concepts, assumptions and relationships. Skill encompassed routine manipulations and Knowledge, recall and recognition.

Mathematical Methods examined the processes crucial to mathematics. Deductive and inductive proof, logic and standard problem-solving strategies were included in this objective. Discrete Mathematics focused on probability and matrix operations while Data Organization and Interpretation included central tendency measures and variance. Measurement took in mass, weight, area, volume, money and scale drawings and Geometry, the characteristics of geometric figures and formal proofs. Relations, Functions and Algebraic Expressions, a broad area, covered the use of variables in expressions, words and symbols and exponential and trigonometric functions. Numeration and number concepts were addressed by Numbers and Operations which offered problems in whole numbers, common and decimal fractions, integers and percent.

Procedures:

The researcher asked a CTB/McGraw-Hill representative for a set of the DMIMS levels and its supporting materials. This request was answered and each item in Level D, a random choice, was examined and assigned to a cell in the NAEP content by process matrix. Two mathematics educators completed the same task. Agreement reached 95 percent as the classifiers made the same assignment for eighty-four of eighty-eight items.
This figure established the classification procedure's reliability and the researcher completed this activity for the remaining DMIMS levels. The NAEP, CTB/McGraw Hill and the researcher's experience established validity. Tables 2 through 8 present the results.

Results:

Table 2 shows that Level A addressed seven of the thirty-five cells in the matrix: (1) Measurement-Skill, (2) Measurement-Knowledge, (3) Geometry-Routine Application, (4) Geometry-Knowledge, (5) Number-Routine Application, (6) Number-Skill and (7) Number-Knowledge. For Process, Skill was addressed by twenty-four of the forty-eight items (50 %) and for Content, Number by twenty-four items (50 %).

Table 2

A Classification of the Level A DMIMS Items according to the NAEP Content by Process Matrix

	Content			
	Measurement	Geometry	Numbers & Operations	
Process				
Routine Application		4 (8 %)	4 (8 %)	8 (17 %)
Skill	8 (17 %)		16 (33 %)	24 (50 %)
Knowledge	8 (17 %)	4 (8 %)	4 (8 %)	16 (33 %)
	16 (33 %)	8 (17 %)	24 (50 %)	48 (100 %)

Table 3 shows that Level B addressed six of the thirty-five cells in the matrix: (1) Number-Problem Solving, (2) Measurement-Routine Application, (3) Number-Routine Application, (4) Number-Understanding, (5) Measurement-Skills and (6) Number-Skills. For Process, Skill accounted for thirty-six items (57 %) and for Content, Number by forty-four items (69 %).

Table 3

A Classification of the Level B DMIMS Items according to the NAEP Content by Process Matrix

	Content		
	Measurement	Numbers & operations	
Process			
Problem Solving		4 (6 %)	4 (6 %)
Routine Application	8 (12 %)	12 (19 %)	20 (31 %)
Understanding		4 (6 %)	4 (6 %)
Knowledge	12 (19 %)	24 (38 %)	36 (56 %)
	20 (31 %)	44 (69 %)	64 (100 %)

Table 4 shows that Level C attended to nine of the thirty-five matrix cells: (1) Number-Problem Solving, (2) Data-Routine Application, (3) Measurement-Routine Application, (4) Number-Routine Application, (5) Measurement-Understanding, (6) Number-Understanding, (7) Geometry-Skill, (8) Number-Skill and (9) Geometry-Knowledge. For Process, Skill accounted for thirty-nine items (54 %) and for Content, Number, by fifty-four items (75 %).

Table 4

A Classification of the Level C DMIMS Items according to the NA_ Content by Process Matrix

	Content				
	Data Org. & Interp.	Measurement	Geometry	Numbers & Operations	
Process					
Problem Solving				5 (7 %)	5 (7 %)
Routine Application	4 (6 %)	3 (4 %)		8 (11 %)	15 (21 %)
Understanding/ Comprehension		3 (4 %)		6 (8 %)	9 (12 %)
Skill			4 (6 %)	35 (49 %)	39 (54 %)
Knowledge			4 (6 %)		4 (6 %)
	4 (6 %)	6 (8 %)	8 (11 %)	54 (75 %)	72 (100 %)

Table 5 shows that Level D addressed twelve of the thirty five cells in the matrix: (1) Mathematical Methods-Problem Solving, (2) Measurement-Problem Solving, (3) Number-Problem Solving, (4) Data-Routine Application, (5) Number-Routine Application, (6) Mathematical Methods-Understanding, (7) Data-Understanding, (8) Data-Skill, (9) Measurement-Skill, (10) Geometry-Skill, (11) Number-Skill and (12) Mathematical-Method. For Process, Skill accounted for forty-eight items (54 %) and for Content, Number, fifty-three items (60 %).

Table 5

A Classification of the Level D DMIMS Items according to the NAEP Content by Process Matrix

	Content			
	Mathematical Methods	Data Org. & Interp.	Measurement	Geometry
Process				
Problem Solving	5 (6 %)		3 (3 %)	
Routine Application		2 (2 %)		
Understanding/ Comprehension	9 (10 %)	2 (2 %)		
Skill		4 (4 %)	5 (6 %)	4 (4 %)
Knowledge	1 (1 %)			
	15 (17 %)	8 (9 %)	8 (9 %)	4 (4 %)

Table 5 (cont.)

	Content	
	Numbers & Operations	
Process		
Problem Solving	7 (8 %)	15 (17 %)
Routine Application	11 (12 %)	13 (15 %)
Ur erstanding/ Comprehension		11 (12 %)
Skill	35 (40 %)	48 (54 %)
Knowledge		1 (1 %)
	[illegible]3 (60 %)	88 (100 %)

Table 6 shows that Level E addressed fifteen of the thirty-five Process-Content combinations: (1) Mathematical Method-Problem Solving, (2) Measurement-Problem Solving, (3) Number-Problem Solving, (4) Data-Routine Application, (5) Neasurement-Routine Application, (6) Geometry-Routine Application, (7) Relat'ons-Routine Application, (8) Number-Routine Application, (9) Mathematical Method-Understanding, (10) Measurement-Understanding, (11) Measurement-Skill, (12) Geometry-Skill,

(13) Number-Skill, (14) Measurement-Knowledge and (15) Geometry-Knowledge. For Process, Skill accounted for forty items (34 %) and for Content, Number, fifty-six items (48 %).

Table 6

A Classification of the Level E DMIMS Items according to the NAEP Content by Process Matrix

	Content			
	Mathematical Methods	Data Org. & Interp.	Measurement	Geometry
Process				
Problem Solving	3 (3 %)		7 (6 %)	
Routine Application		8 (7 %)	2 (2 %)	2 (2 %)
Understanding/ Comprehension	16 (14 %)		2 (2 %)	
Skill			4 (3 %)	4 (3 %)
Knowledge			6 (5 %)	2 (2 %)
	19 (16 %)	8 (7 %)	21 (18 %)	8 (7 %)

Table 6 (cont.)

	Content		
	Relations Functions +	Numbers & Operations	
Process			
Problem Solving		12 (10 %)	22 (19 %)
Routine Application	4 (3 %)	12 (10 %)	28 (24 %)
Understanding/ Comprehension			18 (16 %)
Skill		32 (28 %)	40 (34 %)
Knowledge			8 (7 %)
	4 (3 %)	56 (48 %)	116 (100 %)

Table 7 shows that Level F attended to thirteen of the thirty-five Process-Content combinations: (1) Mathematical Method-Problem Solving, (2) Data-Problem Solving, (3) Number-Problem Solving, (4) Mathematical Method-Routine Application, (5) Data-Routine Application, (6) Measurement-Routine Application, (7) Geometry-Routine Application, (8) Relations-Routine Application, (9) Mathematical Method-Understanding, (10) Measurement-Skill, (11) Geometry-Skill, (12) Number-Skill and (13) Geometry-Knowledge. For Process, Skill accounted for forty-seven items (36 %) and for Content, Number, sixty-five items (50 %).

Table 7

A Classification of the Level F DMIMS Items according to the NAEP Content by Process Matrix

	Content			
	Mathematical Methods	Data Org. & Interp.	Measurement	Geometry
Process				
Problem Solving	8 (6 %)	2 (2 %)		
Routine Application	4 (3 %)	3 (2 %)	4 (3 %)	12 (9 %)
Understanding/ Comprehension	14 (11 %)			
Skill			4 (3 %)	6 (5 %)
Knowledge				5 (4 %)
	26 (20 %)	5 (4 %)	8 (6 %)	23 (18 %)

Table 7 (cont.)

	Content		
	Relations Functions +	Numbers & Operations	
Process			
Problem Solving		28 (73 %)	38 (29 %)
Routine Application	4 (3 %)		27 (21 %)
Understanding/ Comprehension			14 (11 %)
Skill		38 (28 %)	47 (36 %)
Knowledge			5 (4 %)
	4 (3 %)	66 (50 %)	132 (100 %)

Table 8 shows that Level G responded to seventeen of the thirty-five Content by Process matrix cells: (1) Mathematical Method-Problem Solving, (2) Data-Problem Solving, (3) Geometry-Problem Solving, (4) Relations-Problem Solving, (5) Number-Problem-Solving, (6) Discrete Mathematics-Routine Application, (7) Data-Routine Application, (8) Measurement-Routine Application, (9) Geometry-Routine Application, (10) Relations-Routine Application, (11) Number-Routine Application, (12) Mathematical Method-Understanding, (13) Geometry-Skill, (14) Relations-Skill, (15) Number-Skill, (16) Measurement-Knowledge and (17) Geometry-Knowledge.

For Process, Problem Solving accounted for fifty-one items (30 %) and for Content, Numbers, eighty-four items (50 %).

Table 8

A Classification of the Level G DMIMS Items according to the NAEP Content by Process Matrix

	Content			
	Mathematical Methods	Discrete Mathematics	Data Org. & Interp.	Measurement
Process				
Problem Solving	8 (5 %)		4 (2 %)	
Routine Application		4 (2 %)	2 (1 %)	5 (3 %)
Understanding/ Comprehension	20 (12 %)			
Skill				
Knowledge				3 (2 %)
	28 (17 %)	4 (2 %)	6 (4 %)	8 (5 %)

Table 8 (cont.)

	Content			
	Geometry	Relations Functions +	Numbers & Operations	
Process				
Problem Solving	1 (1 %)	1 (1 %)	37 (22 %)	51 (30 %)
Routine Application	10 (6 %)	12 (7 %)	12 (7 %)	45 (27 %)
Understanding/ Comprehension				20 (12 %)
Skill	8 (5 %)	4 (2 %)	35 (21 %)	47 (28 %)
Knowledge	2 (1 %)			5 (3 %)
	21 (12 %)	17 (10 %)	84 (50 %)	168 (100 %)

The number of matrix cells addressed by the DMIMS seven levels ranged from six in Level B (17 %) to seventeen (48 %) in Level G. The mean for the levels was eleven (31 %). These percents approximate those found by the researcher in his study on norm-referenced tests at the elementary school level. Here, the objectives prepared by the NAEP for its first mathematics assessment served as the criterion. There were seventeen content objectives and the number addressed by each test ranged from three (17 %) to nine (52 %).[33]

Since the NAEP assessed the mathematics performance of nine-year old and thirteen-year old students, the researcher analyzed the DMIMS levels which would be used with students at these ages. For nine-year olds who would probably be enrolled in fourth grade, Levels D and E would be appropriate. For thirteen-year olds, Level G would be the DMIMS level used. Tables 9 and 10 show these findings expressed as percents of Content and Process Items for Levels D and E and the NAEP.[34] Tables 11 and 12 take the same approach for Level G and the NAEP.

Table 9

Distribution of Level G DMIMS Items and NAEP Content Objective Items for Nine-Year Old Students

	Test		
	Level D	Level E	NAEP
Objective			
Mathematical Methods	17 %	16 %	12 %
Discrete Mathematics			2 %
Data Organization & Interpretation	9 %	7 %	11 %
Measurement	9 %	18 %	19 %
Geometry	4 %	7 %	5 %
Relations, Functions +		3 %	5 %
Numbers & Operations	60 %	48 %	47 %

Table 10

Distribution of Level G DMIMS Items and NAEP Process Objective Items for Nine-Year Old Students

	Test		
	Level D	Level E	NAEP
Objective			
Problem Solving	17 %	19 %	17 %
Routine Application	15 %	24 %	12 %
Understanding/ Comprehension	12 %	16 %	19 %
Skill	54 %	34 %	40 %
Knowledge	1 %	7 %	12 %

Table 11

Distribution of Level G DMIMS Items and NAEP Content Objective Items for Thirteen-Year Old Students

	Test	
	Level G	NAEP
Objective		
Mathematical Methods	17 %	9 %
Discrete Mathematics	2 %	4 %
Data Organization & Interpretation	4 %	8 %
Measurement	5 %	17 %
Geometry	12 %	8 %
Relations, Functions +	10 %	5 %
Numbers & Operations	50 %	49 %

Table 12

Distribution of Level G DMIMS Items and NAEP Process Objective Items for Thirteen-Year Old Students

	Test	
	Level G	NAEP
Objective		
Problem Solving	30 %	18 %
Routine Application	27 %	15 %
Understanding/ Comprehension	12 %	25 %
Skill	47 %	32 %
Knowledge	3 %	11 %

The data presented in Tables 9 through 12 were analyzed by Spearman's rank-order correlation procedure and the results appear in Table 13. These data show that the correlations for Level D, Level E and the Assessment exceeded .90 in Content. For Level G and the Assessment, the figure was .67. For Process, the correlations ranged from .46 to .70. The correlations for Content were higher than those for Process. Level D had a stronger relationship with the Assessment than Level E for nine-year old students.

Table 13

Spearman Rank-Order Correlation Coefficients: DMIMS Levels D, E and NAEP Nine-Year Cld Item Correlations and DMIMS Level G and NAEP Thirteen Year-Old Item Correlations

Instruments	Content	Process
Level D - Assessment Nine-Year Olds	.91	.61
Level E - Assessment Nine Year-Olds	.97	.46
Level G - Assessment Thirteen Year-Olds	.67	.70

Conclusions:

This study examined the relationship between the DMI Mathematics Systems Objective Inventory (DMIMS), a criterion-referenced standardized test, and the National Assessment of Educational Progress Content by Process (NAEP) matrix prepared for the Fourth Assessment of Mathematics. The findings showed that the DMIMS reached from seventeen percent to forty-eight percent of the NAEP's matrix cells, figures which did not differ dramatically from the researcher's efforts with norm-referenced tests and an earlier NAEP system. The NAEP does not address each Content-Process combination at each level and comparing these figures to a 100 p cent base would not be appropriate. These findings show that individuals concerned with student assessment in mathematics along the NAEP system will find that the DMIMS attends to the same interests as the norm-referenced standardized tests on mathematics.

The investigator's efforts with norm-referenced standardized tests are dated and may not serve as an appropriate comparison. Perhaps the current norm-referenced tests are more in line with the NAEP system in mathematics. This matter can be resolved by further study within the framework used in this investigation.

Mathematics educators have called for courses of study which emphasize interests in mathematics other than operations with numbers. Unfortunately, the mathematics textbooks and standardized tests continue to emphasize operations with numbers. While other areas are addressed, operations with numbers account for roughly half the items in standardized tests.

Numbers and Operations is one of the NAEP's content categories. The percentage of DMIMS items assigned to this category ranged from 48 percent in Level E to 75 percent in Level C. The Assessment's Numbers and Operations category for nine-year olds included 47 percent of its exercises and for thirteen-year olds, 49 percent. While it is difficult to dispute the need for facility with numbers in today's society, the apparent discrepancy between the constructors of the NAEP's exercises who emphasize operations with numbers and those who call for adjustments in this emphasis ought to be resolved.

Notes

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