

Detecting Discrete Temporal Skills Improvement Using Diagnostic Skills Instruments in the Health Professions

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ABSTRACT

This paper highlights efficient use of SAS® time variant procedures to create temporal data charts. SAS data files can be constantly updated for tracking of skills improvement in students going through special programs. SAS reports can also be used to benefit self-managed learners who want to track their progress in certain areas, e.g., problem solving and critical thinking skills in the health professions.

RESEARCH OBJECTIVES

(i) Cognitive skills-deficiency profiles were constructed for intervention programs using several MCAT® (Medical College Admission Test) testing instruments that provided a cognitive student profile in reading skills, problem solving skills, time management skills, critical thinking, and note-taking skills. Which diagnostic treatment was most effective?

(ii) Several intervention programs were examined by the author to compare duration and type of intervention, hours of skills training, teacher-guided and self-managed learning, and finally, teaching/learning methodology were critically analyzed. Collaborative learning using SAS reports to identify weaknesses was one of the interventions and its effectiveness analyzed.

INTRODUCTION

SAS provides a highly efficient data analysis system to study discrete or continuous changes in skills using Health Professions diagnostic instruments. Students with deficiencies in four health professional skills areas: problem solving, critical thinking, clinical reasoning, and information management were given six diagnostic tests over a period of six months. Each student was provided with a frequency distribution of weakest skills in each of the four areas using SAS procedures to tabulate and record results of each diagnostic instruments. Students were then given a month to enhance weaker skills using instructional resources in problem solving, analytical reasoning, and clinical scenarios to identify critical thinking and scientific reasoning. All instructional resources had different intervention models, e.g., books, videos, software, workbooks, and practice exams. Students were repeatedly analyzed each month with a new diagnostic skills instrument. SAS was used to create a tracking register of all six diagnostic instruments for six months. Students were given revised frequency distributions showing skills deficiencies in each of the four areas.

BRIEF DESCRIPTION OF METHODOLOGY

From a large bank of undergraduate populations, students with deficient skills were chosen for this academic analysis. Students were given Betz diagnostic tests before intervention and after intervention. A total of 1600 to 1700 students from several intervention programs were selected for this analysis. There are three types of interventions that were studied for over 1 year (1993-1994). Students were exposed to active learning methods either by (a) self-managed learning using independent study methods, (b) 6- to 8-week summer program with emphasis on skills development, or (c) year-long tutoring to a group of students working full time (tutoring was only 2 to 3 hours per week). Standardized test scores were used to measure improvement in skills.

RESULTS

The following deficient skills were found in all students regardless of whether they worked alone or in study groups. Tables I and II illustrate the nature of weaknesses exhibited by students before they entered an intervention program. The following improvements were detected in student performance:

(i) Enhanced vocabulary skills and better analysis of arguments and critical thinking faculties.

(ii) Enhanced math skills and verbal skills only in 6- to 8-week summer programs which emphasize on skills development. Practice exercises and strong teacher-student interaction helped students improve at a faster rate.

(iii) Students studying independently developed more confidence, had a better realistic self-appraisal and were strong in learning from multiple resources. This method works for students who are well-disciplined and have academic maturity.

(iv) Students who only received weekly tutoring primarily focused on selected topics and skills covered in class. These students demonstrated weaknesses in time management skills and lacked motivation.

DISCUSSION

Active learning methods used during class and in study groups were most successful and brought students together to solve complex problems. Students prefer having a Diagnostic Report with a list of weaknesses and they cross-examine each other's reports to understand "common" weaker topics. Students tended to remember materials with more emphasis on conceptualization than rote memorization. Note taking was more clear to independent learners than group learners. Communication and interpersonal skills showed marked improvement in students who were tutored by educators in several interventions.

CONCLUSION

It was fascinating to observe the positive changes in skills with time. Students showed remarkable progress in skills enhancement using repeated diagnostic instructional interventions. This presentation will discuss highlights of how such a study can be designed for other diagnostic instruments using SAS as an educational measurement and analysis tool. The SAS/ETS® package will be used to convert such discrete frequency distributions into a long-term, continuous, time varying multidimensional model within the next two years.

KEY WORDS

Skills Diagnostics, Tracking, Skills Enhancement, Self-Managed Learning, SAS Time Variant Tracking, Intervention Models

REFERENCES

- SAS Institute Inc. *SAS/ETS User's Guide, Version 6, Second Edition*, Cary, NC: SAS Institute Inc.
- Hassan, A. (1994). "Active Learning Treatment for Under-represented Minority Students Based on MCAT Skills Deficiency Diagnosis." *National Association of Minority Medical Educators 1994 Annual Conference*.
- Association of American Medical Colleges. *MCAT Student Manual*, Washington, DC: Association of American Medical Colleges.

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Table 1

MOST FREQUENT DEFICIENCIES IN MCAT SKILLS**Verbal Reasoning Skills (Chapter 3, ComPrep*)**

- (VR 27)** Understanding Arguments
 (VR 30) Evaluating Arguments
 (VR 28) Determining Structure of Arguments
 (VR 07) Identifying Assumptions
 (VR 01) Finding Signal Words
 (VR 02) Finding Trigger Words
 (VR 29) Detecting Fallacies
 (VR 18) Recognizing the Scope of Application of Hypotheses
 (VR 09) Identifying a General Theory or Model
 (VR 11) Identifying Comparative Relationships
 (VR 10) Recognizing a Paraphrase of Complex Information
 (VR 24) Determining How to Modify Conclusions
 (VR 25) Judging Effect of New Evidence on Conclusions

Math Concepts (Chapter 4, ComPrep*)

- (MC 04) Proportional Analysis of Algebraic Equations
 (MC 01) Basic Arithmetic Operations
 (MC 05) Percentage Increase or Decrease
 (MC 21) Approximations and Estimations
 (MC 03) Simplifying Algebraic Equations
 (MC 12) Graphic Interpretation of Functions
 (MC 22) Permutations, Combinations, and Probability

Problem Solving Skills (Chapter 4, ComPrep*)

- (PS 02)** Reasoning Skills
 (PS 03) What is Given? Step I (Problem Solving Model)
 (PS 06) How Do You Solve It? Step IV (Problem Solving Model)
 (PS 09) How to Review Sciences Using the Problem Solving Model
 (PS 01) Problem Solving Using Textbooks and Scientific Journals
 (PS 05) What is the Question? Step III (Problem Solving Model)
 (PS 04) How Can the Given Be Used? Step II (Problem Solving Model)
 (PS 07) Is Your Solution Accurate? Step V (Problem Solving Model)
 (PS 01) Problem Solving Using Journals/Text Books

Test-Taking Skills (Chapter 8, ComPrep*)

- (TT 01) Using Logic to Improve Test-Taking Skills
 (TT 03) Using Questions Analysis to Improve Performance
 (TT 02) Studying Definitions During MCAT Review
 (TT 04) Using Error Analysis to Improve Test Performance
 (TT 05) Determining Your MCAT Test-Taking Speed
 (TT 07) Using Intuition, Not Guesswork

Study Skills (Chapter 2, ComPrep*)

- (SR 09) The Analytical Process Chart
 (SR 10) D-E-F-IN-E Approach in Learning Scientific Concepts
 (SR 04) Visual Imaging or Mapping
 (SR 07) Understanding Instruments and Experiments
 (SR 02) Note-taking and Concept Extraction from Books and Journals

* A Complete Preparation for the MCAT, 6th Edition, Betz Publishing Company, Inc.

** The top-down listing of deficiencies shows the most frequent (e.g., VR 27) to the least frequent (e.g., VR 10) category.

Table 2

MCAT TOPICS MOST COMMONLY MISSED ON DIAGNOSTIC TESTS

Field testing of students indicates that the following are problematic MCAT topics:

AAMC† Topic	Physical Sciences
V*	Solution Chemistry
IV	Phases and Phase Equilibria
VII	Thermodynamics & Thermochemistry
XV	Wave Characteristics & Periodic Motion
II	Electronic Structure and the Periodic Table
VI	Acids and Bases
X	Translational Motion
XI	Force & Motion, Gravitation
XX	Atomic & Nuclear Structure
VIII	Rate Processes in Chemical Reactions
XX	Light & Geometrical Optics
II	Chemical Bonding

* Topic V was the most frequently missed and Topic III was the least frequently missed

AAMC† Topic	Biological Sciences
I	Molecular Biology
V	Nervous & Endocrine Systems
XV	Hydrocarbons
VII	Digestive and Excretory Systems
XI	Genetics and Evolution
XVIII	Spectroscopy Structural Identification
III	Generalized Eukaryotic Cell
VI	Circulatory, Lymphatic and Immune Systems
XI	Biological Molecules
IX	Respiratory & Skin Systems

* Topic I was the most frequently missed and Topic IX was the least frequently missed. AAMC Topic Numbers are based on the *MCAT Student Manual* published by the AAMC.

† AAMC represents the Association of American Medical Colleges

Table 3
DIAGNOSTIC REPORTS AT A GLANCE
(CASE I)

Report Date: 8/1/94	Name: John Doe	Summary Statistics
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(John Doe took three Betz Diagnostic Tests over a span of six months.)

	PRAC 03		PRAC 04		PRAC 05	
	Raw	Scaled	Raw	Scaled	Raw	Scaled
Verbal Reasoning	33/65	05	33/65	05	33/65	05
Comprehension Items		65%		55%		58%
Evaluation Items		45%		73%		43%
Application Items		44%		40%		0%
Incorp. of New Info. Items		43%		33%		83%
	Raw	Scaled	Raw	Scaled	Raw	Scaled
Physical Sciences	41/77	07	53/77	11	45/77	08
Gen. Chem. Passage Based Items		55%		68%		58%
Physics Passage Based Items		50%		63%		58%
Gen. Chem. Ind. Questions		71%		75%		55%
Physics Independent Questions		38%		86%		75%
	Raw	Scaled	Raw	Scaled	Raw	Scaled
Biological Sciences	37/77	06	45/77	07	49/77	07
Biology Passage-based Items		55%		57%		50%
Organic Chem. Passage-based		38%		50%		72%
Biology Independent Questions		20%		78%		73%
Org. Chem. Ind. Questions		50%		50%		75%

Note: PRAC 03, 04, and 05 are the three Betz Diagnostic Tests taken by the student on February 12th, May 19th, and July 23rd, 1994 (PRAC 03 = Most difficult; PRAC 04 = Moderate difficulty; PRAC 05 = Moderate difficulty).

Inferences: The scaled scores showed no change in verbal reasoning, showed uneven changes in physical sciences, and minor changes in biological sciences.

Table 3 Con't

Report Date: 8/1/94

Name: John Doe

Weaker Topics & Skills

VERBAL REASONING**Student needs more reading practice in the following areas of Humanities, Social Sciences, and Natural Sciences:**

<u>Verbal Reasoning Topics</u>	<u>Skills</u>
1) Dance (Humanities)	Evaluation
2) Music (Humanities)	Application
3) Business (Social Sciences)	Incorp. of New Info.
4) Literary Criticism (Humanities)	Incorp. of New Info.
5) Psychology (Social Sciences)	Application
6) Geology (Natural Sciences)	Comprehension
7) Philosophy (Humanities)	Comprehension

Verbal Reasoning Skills:**No. of times missed**

- Predict result based on content and specific steps 8
- Recognize a paraphrase of complex information 12
- Evaluating Arguments 12
- Judge soundness of an argument step 5
- Distinguish between supported and unsupported claims 5

Test-Taking Skills:

- Studying extended definitions during MCAT review 14
- Using Logic to improve test-taking skills 22

Note: Weaker topics and skills shown with numbers illustrate "frequency of missing" on each instrument. Multiple numbers indicate how many times the skill was not used in multiple tests taken over time.

Table 3 Con't

Report Date: 8/1/94

Name: John Doe

Weaker Topics & Skills

PHYSICAL SCIENCES

<u>Topics</u>	<u>No. of times missed</u>
Solution Chemistry	4,5,4
Thermodynamics and Thermochemistry	4,5
Wave Characteristics and Periodic Motion	4
Fluids and Solids	4
Electric Circuits	4
Acids and Bases	3

Verbal Reasoning Skills:**No. of times missed**

- Identify a general theory or model 18, 11
- Identify background knowledge 19

Mathematical Concepts:

- Simplifying algebraic equations 21
- Basic arithmetic operations 18, 15, 17

Problem Solving Skills:

- Reasoning skills 34, 24, 32

Test-Taking Skills:

- Using logic to improve test-taking schools 22, 27, 26

Study and Review Skills:

- Note-taking and concept extraction from books 28, 21, 22

Note: Weaker topics and skills shown with numbers illustrate "frequency of missing" on each instrument. Multiple numbers indicate how many times the skill was not used in multiple test taken over time.

Table 3 Con't

Report Date: 8/1/94

Name: John Doe

Weaker Topics & Skills

BIOLOGICAL SCIENCES

<u>Topics</u>	<u>No. of times missed</u>
Molecular Structure of Organic Compounds	9
Biological Molecules	7
Oxygen-Containing Compounds	5,7,4
Molecular Biology	5,7
Genetics and Evolution	5,5
Digestive and Excretory Systems	6
Microbiology	4,5

Verbal Reasoning Skills:**No. of times missed**

- Identify a general theory or model 18
- Identify background knowledge 20, 12
- Appraise strength of evidence 15

Mathematical Concepts:

- Proportional analysis of algebraic equations 5
- Basic arithmetic operations 11
- Graphs and data tables 4

Problem Solving Skills:

- Reasoning skills 32, 32, 28
- Problem solving using textbooks and journals 14, 14, 20

Test-Taking Skills:

- Using logic to improve test-taking schools 21, 23, 16

Study and Review Skills:

- Note-taking and concept extraction from books 30, 25, 21

Table 4
DIAGNOSTIC REPORTS AT A GLANCE
(CASE 2)

Report Date: 8/2/95

Name: Mary Sas

Summary Statistics

(Mary Sas took three tests and her performance went up in several skills)

I. Verbal Reasoning Analysis**A. Verbal Skills**

83%* Recognize a Paraphrase of Complex Information
 83% Identify Probable Cause of an Event
 67% Appraise Strength of Evidence
 56% Recognize Questions of Clarification

B. Test Taking Skills

87% Learning to Cope with Initial Stress
 54% Using Logic to Improve Test-Taking Skills
 53% Using Question Analysis to Improve Performance

II. Physical Sciences Analysis**A. Verbal Skills**

86% Judge Relevant Information Related to Argument
 85% Use Information to Solve Problems
 82% Identify A General Theory or Idea

B. Test Taking Skills

91% Studying Extended Definitions During MCAT Review
 70% Determining Your MCAT Test-Taking Speed
 69% Using Logic to Improve Test-Taking Skills

C. Math Skills

100% Estimating Square Roots of Common Numbers
 100% Exponentials
 100% Cartesian or Rectangle Coordinates
 80% Graphic Representation of Functions

D. Problem Solving Skills

80% Problem Solving Using Textbooks and Scientific Journals
 71% Step II: How Can the Given be Used?
 70% Reasoning Skills
 67% Step III: What is the Question?

E. Study and Review Skills

81% Scheduling and Time Management—Learning Definitions
 75% Note-taking and Concept Extraction from Books
 70% Correlating *ComPrep* with the *MCAT Student Manual*

F. MCAT Topics

100% Thermodynamics and Thermochemistry
 71% Phases and Phase Equilibria
 71% Solution Chemistry
 71% Electric Circuits

III. Biological Sciences**A. Verbal Skills**

88% Judge Relevant Information Related to Argument
 71% Distinguish Between Supported and Unsupported Claims
 69% Identify Comparative Relationships

B. Test Taking Skills

76% Determining Your MCAT Speed
 71% Using Question Analysis to Improve Performance
 62% Using Error Analysis to Improve Test Taking Performance

C. Math Skills

100% Percentage Increase or Decrease
 100% Simplifying Algebraic Equations
 100% Approximations and Estimations
 100% Permutations, Combinations, and Probability

D. Problem Solving Skills

100% What is the Question, Step III
 73% Step II: How can the Given Be Used
 63% Problem Solving Using Textbooks and Scientific Journals

E. Study Skills

73% Correlating *ComPrep* with the *MCAT Student Manual*
 63% Visual Imaging or Mapping of Scientific Passages
 61% Note-Taking and Concept Extraction from Books

F. MCAT Topics

86% Digestion and Excretory System
 77% Molecular Structure of Organic Compounds
 60% Amines

* The percentages represent the actual percentage of items reflecting that skill, that were incorrectly answered.