DOCUMENT RESUME

ED 318 789 TM 014 904

AUTHOR Anderson, Paul S.; Schoner, James S.
TITLE Testing--1,2,...523,...641,...999--Testing: The MDT Multi-Digit Technique Applied to Science Education.
PUB DATE 87
NOTE 6p.
PUB TYPE Guides - Non-Classroom Use (055) -- Reports - Evaluative/Feasibility (142)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Answer Sheets; Biology; *Computer Assisted Testing; Educational Technology; Higher Education; *Science Education; *Scoring; Test Construction; *Test Format; Test Items; Test Scoring Machines
IDENTIFIERS *Multi Digit Technique; *Multi Digit Tests

ABSTRACT

The MDT multi-digit technique, a development in testing technology, is described; and its application to science classrooms is discussed. Some actual materials for use in a cell biology class are included. The primary characteristic of an MDT multi-digit test is a long list of possible responses, with each term marked with a three-digit number that can be marked on the response grid or on a computer-scored sheet. Up to 1,000 alternative answers may appear on a single sheet. A single list can often be sufficient for an entire course because it is the "answer blank" for thousands of questions. The MDT method has been used in university courses with over 6,000 students in a number of disciplines. More than half the students found the method as desirable as or more desirable than other testing methods. A sample test for cell biology is provided, and instructions are given for making an answer key for hand scoring. A software system for machine-scoring has recently become available, and software under development will address issues of higher order thinking more fully. The MDT method has considerable potential for analysis, feedback, academic rigor in testing, and time savings for teachers. Two figures illustrate test application. (SLD)

Paul S. Anderson
Illinois State University
James S. Schoner
MDT Corporation
107 N. Broadway
Normal, Illinois 61761

TESTING--1,2,...523,...641,...999--TESTING: THE MDT MULTI-DIGIT TECHNIQUE APPLIED TO SCIENCE EDUCATION

Chemists, ecologists, physicians, and all science-related professionals must possess factual knowledge for daily activities and intelligent decision making. Yet, the educational preparation of these individuals is often relegated to mere recognition from five alternatives. The ease of grading multiple-choice questions has made that style of testing an educational norm. Unfortunately, the decisions of life are rarely packaged among five choices.

In response to this educational dilemma, a fill-in-the-blank style testing method has been developed which has the capability of being scored as easily as the multiple-choice method. This development in testing methodology is known as the MDT multi-digit technique. Whether the tests or exercises are scored manually or with computer assistance, the MDT method is now available to schools nationwide. This article describes the application of the method and provides actual materials that can be used immediately in a variety of science classrooms. Pedagogical attributes of the MDT method are also discussed.

The MDT Multi-Digit Testing Method

Multi-digit testing was first conceptualized in the Fall of 1982 by Paul S. Anderson for use in his courses at Illinois State University (ISU). The primary characteristic of an MDT multi-digit test is a long list of possible responses. As an example, a list for cell biology is shown in the sample test provided.

Multi-Digit Test Answer Sheet

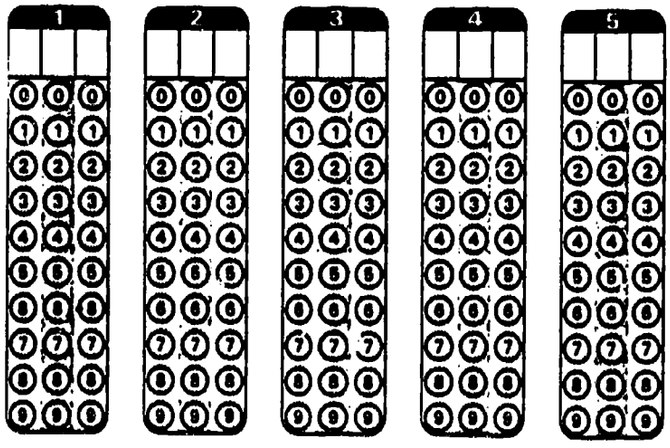


Figure 1: Response Grids on an MDT answer sheet

Each term in the list is labeled with a three-digit number which can be marked in a response grid on the test itself or on a computer-scored sheet. Response grids on the sample test are designed for manual scoring, while those shown in Figure 1 are designed for computer scoring. The three-digit response capability means that up to one-thousand alternative answers (labeled 000-999) may appear on a single list. When a list is very short, the method is similar to matching. On the other hand, when a list contains several hundred terms, the method approximates a fill-in-the-blank test because there are far too many alternatives to permit searching for and recognizing correct answers. The terms in an MDT list are sorted alphabetically, which allows students to quickly find the three-digit labels for their responses.

A single list is often sufficient for the testing needs of an entire course since it is literally the "answer bank" for many thousands of questions. The list for the sample test contains only 100 terms, though most lists contain many more. MDT-style tests can also accommodate numeric answers from calculations (up to three digits) and answers from labeled diagrams (see questions 8 and 9 of the sample test). Peggy Fortune, an ISU instructor in Criminal Justice Sciences, states, "Using the MDT method, I can put a test together in half the amount of time. I just ask the question. There's no need to come up with four distractors for each question."

The MDT method has been used in university courses totaling more than 6,000 student enrollments. The disciplines include home economics, political science, English, history, military science, art, computer science, mathematics, biology, chemistry, and earth science. More than half of the students questioned find the method to be as desirable as or more desirable than other forms of testing. Written comments contain statements like, "good test method"..."provides a much more accurate score"..."will raise retention and lower unearned grades"..."contains the best aspects of both the multiple-choice and fill-in-the-blank testing methods...."

A Sample Test For Manual Scoring

A complete, ready-to-use MDT multi-digit test for cell biology is provided as a sample test. Depending on the grade level of the student, some questions may be too difficult or too easy. The first page contains test

NAME:_____ ID#_____ DATE:_____

last first

INSTRUCTIONS: BLOCKOUT THE NUMBERS FOR YOUR ANSWER.
EXAMPLE: 186

COURSE and SECTION:_____

Format HS-2 = 20:3D

MULTI-DIGIT™ Technologies Corporation
ANSWER SHEET

SCORES:

Subtotals:

a._____

b._____

c._____

d._____

TOTAL:_____

Test Questions for Cell Biology

1. In what part of the nucleus are genes found?

2. Name the special type of cell found in the human body which is distinguished by its transmission of electrical impulses.

3. Most plants manufacture their own carbohydrates by the process of (blank).

4. In 1665, cells were first identified and given their name by whom?

5. Name the discipline of cell biology which is the study of structure and function of the parts of the cell.

Note: Normally you would block out any unused response grids.

For questions 6-9, refer to Figure "A", "Schematic Diagram of a Cell."

6. Name the part of the cell pointed to by label 201.

7. Name the part of the cell pointed to by label 205.

8. What label on Figure "A" points to the Nuclear Membrane?

9. What label on Figure "A" points to a Lysosome?

10. Fermentation is a type of respiration known as (blank) ?

11. A cell's living matter is made up largely of carbon, hydrogen, oxygen, and nitrogen. What is the common term for this living matter?

12. In cells with nuclei, an important step in cell division is the division of the nucleus. Name the process by which the nucleus (except in sex cells) divides.

13. Give the biological term for sex cells.

14. Sex cells are produced by a special type of cell division. This is this called (blank).

15. Give the name for the network of fine membranes which extends throughout the cytoplasm. These membranes form canals or channels which are believed to be avenues of communication between the cytoplasm and the exterior of the cell.

Answer Key:

131, 166, 179, 154, 135, 199, 171, 209, 211, 106, 187, 165, 146, 161, 141

Ref: Article on "Cell" in New Standard Encyclopedia (1972), Volume Three, page C-190, by Standard Education Corporation, Chicago, Illinois.

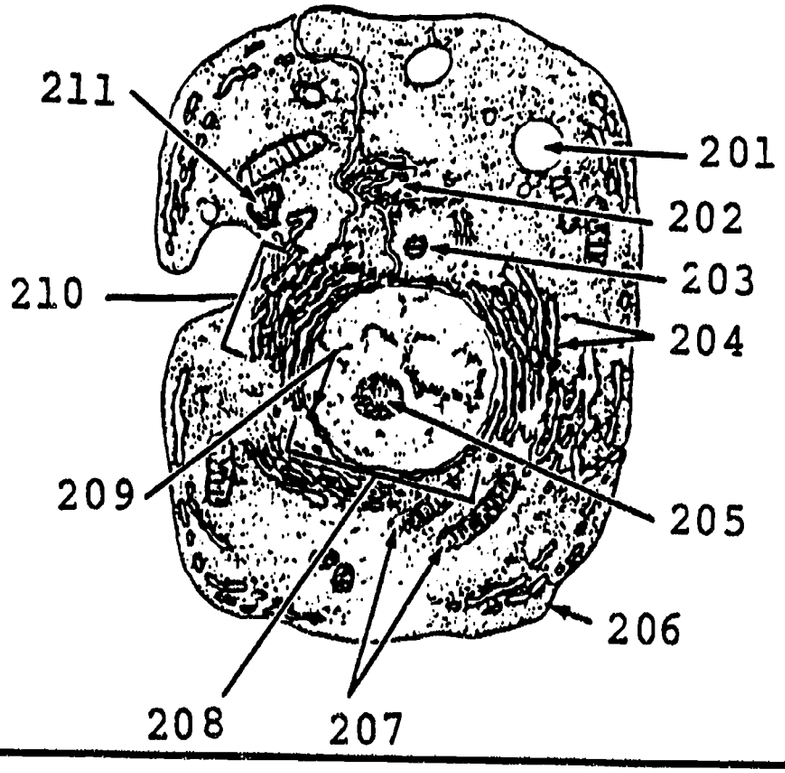
MDT List for Cell Biology

101 Adenosine Triphosphate
102 Aerobic Respiration
103 Alpha
104 Amino Acid
105 Amoeba
106 Anaerobic Respiration
107 Anaphase
108 Antibodies
109 Arachnoid
110 ATP
111 Bacteria
112 Beta
113 Biochemistry
114 Biology
115 Blood
116 Carbohydrate
117 Carbon
118 Cell
119 Cell Division
120 Cell Membrane
121 Cell Wall
122 Cellular Respiration
123 Cellulose
124 Centriole
125 Centromere
126 Cerebellum
127 Cerebral Cortex
128 Chadwick, J.
129 Chloroplasts
130 Chromatids
131 Chromosomes
132 Corpus Callosum
133 Currie, M.
134 Cytokinesis
135 Cytology
136 Cytoplasm
137 Deoxyribonucleic Acid
138 DNA
139 Dura Mater
140 Embryos
141 Endoplasmic Reticulum
142 Enzyme
143 Excretion
144 Fat
145 Fermentation
146 Gametes
147 Gamma
148 Gas
149 Genes
150 Genetics
151 Golgi Body
152 Heisenberg, W.
153 Heredity
154 Hooke, R.
155 Hydrogen
156 Hypothalamus
157 Interphase
158 Ion
159 Lysosome
160 Medulla
161 Meiosis
162 Metaphase
163 Miscible
164 Mitochondria
165 Mitosis
166 Nerve
167 Newton, I.
168 Nitrogen
169 Nuclear Membrane
170 Nucleic Acid
171 Nucleolus
172 Nucleus
173 Olfactory
174 Organelle
175 Organism
176 Osmosis
177 Oxidation
178 Oxygen
179 Photosynthesis
180 Pia Mater
181 Plasma
182 Plastids
183 Polymer
184 Pons
185 Prophase
186 Protein
187 Protoplasm
188 Protozoa
189 Ribonucleic Acid
190 Ribosomes
191 RNA
192 Schleiden, M.
193 Schwann, T.
194 Spindle Fiber
195 Synthesis
196 Telophase
197 Thalamus
198 Tracheid
199 Vacuole
200 Virus

Schematic Diagram of a CELL

(greatly enlarged)

Figure A.



questions adjacent to response grids (or "bubbles") where the three-digit response labels are to be recorded. The second page contains a labeled cell diagram and a list of 100 biological terms. The sample test may be reproduced and/or modified for use in your classroom. To write your own MDT test, create a clean master answer sheet by covering the cell biology questions with a blank sheet of paper. (Other formats for manual scoring have varying grid arrangements and sizes. They are available from the MDT Corporation, as are sheets and software for machine scoring.)

To make an answer key for hand scoring, use a single-hole paper punch. Simply place the punched answer key over each test to be scored; then mark incorrect responses through the holes onto the student sheets. Special punches for smaller holes and longer reach are available.

Machine Scoring Of MDT Multi-Digit Tests

The features of the MDT technique are most striking when the method is accompanied by machine scanning of the answer sheets. An elaborate software system for that purpose has recently become available for mainframe and IBM PC compatible computers. The complete MDT Educational System software (available separately) includes a test scoring package, a computerized grade book, the MDT list maker (special purpose word processor), and report generator. Reports which can be printed include statistical analyses, histograms, item analysis, listing of scores by name or identification number, and individual sheets for feedback to students. On the item analysis and individual sheets, a unique and highly beneficial capability is the printing of the actual word responses used by the students. An example of item analysis is shown in Figure 2.

Pedagogical Issues

Science education uses the full range of the hierarchy of learning. At the higher end, the MDT technique is applicable if the result of evaluation and synthesis is either a discrete term/concept or a calculated numerical value. As Peggy Fortune states, "with analysis questions, the students have to understand, think, and then draw logical conclusions without gigantic hints." Software development already underway will address more fully the issue of higher order learning.

At the lower end, the power and superiority of the multi-digit technique is clearly evident. Essays and short answer sentences are not the best way to determine if the students have mastered the basic factual information essential to firmly grasp a given subject. To determine that knowledge, teachers commonly utilize multiple-choice or fill-in-the-blank tests. The multiple-choice method has the obvious disadvantage of encouraging recognition, the elimination of alternatives, and outright guessing. It is difficult to imagine that a student would not pick out the term Right Triangle from a selection of five names for "a triangle containing a 90 degree angle." Furthermore, the onus is on the teacher to think

Page: 2
Date: 02-10-1987
Time: 02:18:16

-- M -- Assignment File...bitimdt3.ASN
-- D -- Class File.....bi*
-- T -- List File.....biwgmaster.LST

ITEM ANALYSIS BY QUESTION NUMBERS (Report 8)
Item Analysis of Multi-Digit Answers (Report 8a)
(Number of Students = 38) (* = Not on list)

Q013	Responses	Freq	Percent
247	Diffusion	1	2.6310
555	Mississippi	6	15.789
556	Missouri	1	2.6310
647R	Ohio	30	78.947

Q014	Responses	Freq	Percent
	No Response	1	2.6310
017	Adriatic	1	2.6310
025	Alaska	1	2.6310
028	Alberta	2	5.2630
131R	British Columbi	24	63.157
152	Canada	2	5.2630
636	Northern Territ	1	2.6310
653	Ontario	2	5.2630
956	Vatican	1	2.6310
965	Virginia	1	2.6310
971	Washington	1	2.6310
980	Winnipeg	1	2.6310

Q015	Responses	Freq	Percent
	No Response	2	5.2630
059	Arizona	1	2.6310
192R	Colorado	25	65.789
333	Gobi	1	2.6310
556	Missouri	1	2.6310
758	Rio Grande	4	10.526
836	Snake	4	10.526

Q016	Responses	Freq	Percent
	No Response	10	26.315
322	Ganges	2	5.2630
505R	Mackinzie	15	39.473
677	Parana	1	2.6310
738	Red	1	2.6310
836	Snake	1	2.6310
992	Yukon	8	21.052

Q017	Responses	Freq	Percent
	No Response	2	5.2630
070	Atlantic	1	2.6310
376R	Hudson	33	86.842
378	Humid Subtropic	1	2.6310
381	Huron	1	2.6310

Q018	Responses	Freq	Percent
	No Response	1	2.6310
167	Cascade	35	92.105
168R	Caspian	0	.00000

Figure 2: Example of MDT Item Analysis with Printed Word Responses for Geography

of the four wrong answers (foils) that are intended to have a reasonable likelihood of being selected if the student does not recognize the correct answer. It is doubtful that all teachers have the time to refine their foils to the desirable accuracy. The result is that students frequently avoid full learning of essential factual information because they are skilled in the recognition and elimination of foils.

One alternative to this situation is to utilize fill-in-the-blank questions. Without any suggestive foils, students must rely on recall rather than recognition and elimination. Recall requires better learning of the tested material. Although the questions are actually easier to write than those of multiple-choice testing (because no alternative answers need be generated), the major difficulty with fill-in-the-blank testing is the amount of time it takes to score such tests. It would be useful to have a computer-scored fill-in-the-blank test for terms and concepts that could be quickly generated and graded so that essential learning is evaluated without the often excessive time commitment required of the teacher. The Multi-Digit testing procedure is designed exactly for that purpose.

The power for analysis, feedback, academic rigor in testing, and savings of time for teachers is tremendous. An entirely new dimension in educational testing is now available to every aspect of science education in virtually every school nationwide.

Bibliography

Anderson, Paul S. (1987), The MDT Innovation: Machine Scoring of Fill-in-the-Blank Tests. Normal, Illinois: Multi-Digit Technologies Corporation.

Duchastel, Philippe C. (1981). "Retention of Prose Following Testing with Different Types of Tests," Contemporary Educational Psychology, Vol. 6, pp. 217-226.

Duchastel, Philippe C., and R. Nungester. (1981a). "Long-term Retention of Prose Following Testing," Psychological Reports, Vol. 49, p. 470.

Gay, Lorraine R. (1980). "The Comparative Effects of Multiple Choice Versus Short-Answer Tests on Retention," Journal of Educational Measurement. Vol. 17, pp. 45-50.

Nungester, Ronald J., and Philippe C. Duchastel. (1982a). "Testing Versus Review: Effects on Retention," Journal of Educational Psychology, Vol. 74, No. 1, pp. 18-22.

Sax, G., and L. S. Collett. (1968). "An Empirical Comparison of the Effects of Recall and Multiple-Choice Tests on Student Achievement," Journal of Educational Measurement, Vol. 5, pp. 169-173.

About the Authors

Paul S. Anderson, Ph.D., is an Associate Professor of Geography at Illinois State University. His education includes study as a Fulbright-Hayes scholar, with degrees from Augustana College, the University of California at Berkeley, and the Australian National University.

James S. Schoner is the lead software designer for Multi-Digit Technologies Corporation. He is a Phi Beta Kappa graduate of Purdue University with degrees in Mathematics and Computer Science.