A COMPUTER ASSESSMENT TOOL FOR STRUCTURAL COMMUNICATION GRID

Soner DURMUŞ, Erol KARAKIRIK
Abant Izzet Baysal University, Faculty of Education

ABSTRACT
Assessment is one of the most important part of educational process that directs teaching, learning as well as curriculum development. However, widely used classical assessment techniques such as multiple choice tests are not adequate to provide neither a correct picture of students' performances nor the effectiveness of the teaching process. Structural Communication Grid is an alternative assessment approach to classical multiple choice tests because it reveals students' ideas and reasoning by forcing them to organize interrelated set of givens rather than focusing on the correct answer. The set of givens such as statements, graphics, pictures, etc can be presented as a grid of numbered boxes each containing a piece of information. The grid is usually designed to contain more than one correct choice in order to externalize the student's conceptual structure and to assess their degrees of meaningful learning. Several questions could be designed with the same set of givens in order to avoid finding the correct choices by elimination method. However, it is difficult to implement and evaluate it by paper and pencil tests since both the boxes chosen and the choosing order are required to be graded. In this study, the basic features and elements of the first computerized version of structural communication grid tester, called SCGT, will be presented and its possible contributions to mathematics education will be discussed.

INTRODUCTION

Classical assessment techniques such as multiple choice, true-false, fill in the blanks type tests etc. do not give a clear picture of learners. Hence, alternative assessment techniques are proposed to get a better picture of not only procedural understanding but also conceptual understanding of learner. Some researchers call alternative assessment as authentic assessment and think it as a general term including different types of assessment tools (Bintz & Harste, 1994; Worthen, 1993). Alternative assessment techniques are very important because they aim Ii) to evaluate conceptual and meaningful understanding, ii) to focus on the process of learning not the product, and iii) to motivate the learning may also be he teaching process. Contemporary educators defend performance based assessment, portfolio assessment and authentic assessment as alternative assessment (Belanoff & Dickson, 1991; Darling – Hammond, 1994; Kane & Mitchell, 1996; Tellez, 1996; Witte & Flach, 1994). They propose that alternative assessment techniques are effective and efficient for evaluating performance of students. Using different assessment techniques may provoke thinking strategies of students and may lead to better academic performances (Darling, 1994; Resnick & Resnick, 1992; Wiggins, 1989).

Alternative assessments have common characteristics as listed by Herman, Ascbacher and Winters (1992): Students

i) ask, analyze, create and produce.
ii) use higher order thinking and problem solving skills
iii) encounter meaningful learning activities
iv) see real-life applications of the subject at hand
v) ask teachers new assessment activities.

Constructivist approaches emphasize active involvement of students during teaching-learning process and alternative assessment tasks provide an environment in which students fulfill their potentials. Students are active participant on determining evaluation criteria (Anderson, 1998). . Therefore, the roles of teachers and students will change if alternative tasks are implemented.

STRUCTURAL COMMUNICATION GRID TECHNIQUE

Multiple choice tests have only one answer and this is one of the weaknesses of them because students may reach to the answer by chance although they don't know the answer. Structural communication grid may be sees as an alternative to multiple choice tests because it is formed of boxes which may contain more than one correct answer that students are asked to select. Since students should consider possibility of more than one answers it may encourage students to make mindful decisions. The idea of structural grids backs to studies of Egan (1972) and development of it are rooted other researchers (Duncan, 1974; Johnstone & Mughol, 1978, 1979; Johnstone, 1981; Johnstone et al., 1981; MacGuire & Johnstone, 1987; Scottish Exam Board, 1997).

Structure of Structural Communication Grid Technique

The structural communication grid is formed of rows and columns. The number of boxes in the structure of the grid may vary depending of the age of learners. Johnstone et al. (1983) determined in their study that 12 boxes (4

by 3 grid or 3 by 4 grids) are appropriate for elementary school students, 16 boxes are secondary school and 20 for high school students.

The Usage Structural Communication Grid

Teacher prepares first question and put possible answers in boxes. Boxes containing correct answers are distributed randomly. Second question and possible answers are put in the same boxes in similar way. Second question and possible answers may or may not be related the first question and answers to it. This continues until all boxes are filled (Johnstone, Bahar & Hansell, 2000). Each box may contain different types of answers and alternatives. Box may contain a text, a graph, table etc. This helps teacher make rich and objective assessment decisions.

Students are asked to mark the boxes which they think the most appropriate one. Students sometimes may be asked to put selected boxes in a prescribed order. This is one of the most important aspects of the structural communication grid technique because students should select the correct ones first and then put them in correct order. This feature of the technique differs from multiple choice tests. Students can not reach to answer by chance because there are more than one possible answers to be selected and students are required to put possible answers in an order. The technique provides a medium in which students communicate with teachers and reveal their cognitive structure. This is why the technique is called as "Structural Communication Grid" (Johnstone, Bahar & Hansell, 2000).

SCG could be used as a diagnostic assessment tool for determining students' misconceptions and their lack of conceptual understanding. However, it is not easy to employ this technique by paper and pencil. Hence, a computerized system called structural communication grid tester (SCGT) was developed. SCGT provides an environment in which a structural communication grid test could be designed and fully assessed. SCGT supports many different elements to be included in the grid such as detailed analysis of students' responses. The main advantage of SCGT lies on its capability of assessing students' partial responses. Hence, SCGT enables users to get a clear picture of different student profiles.

There are two different grading mechanisms for two different question types employed in the method. For regular questions, in which the order of the selected boxes is not important, SCG assess students' performances from two different perspectives; students get the 50 points out of 100 for the correct boxes they have chosen and the 50 points for the incorrect boxes they have not chosen for the raw score.

$$\text{Raw Score} = \frac{\text{The number of correct boxes chosen}}{\text{Total number of correct boxes}} - \frac{\text{The number of incorrect boxes chosen}}{\text{Total number of incorrect boxes}}$$

The raw score of a student could range from -1 to +1. The total score of the student is then calculated as follows: $\text{Total Score} = (\text{Raw Score} + 1) \times 50$ .The total score then ranges from 0 to 100.

For ordered questions, in which the order of the selected boxes is important, SCG assess students' performances by checking the order of each correct boxes into consideration. In order to be able to evaluate an order question, one has to check the correct order of each boxes in the answer by asking two simple questions namely;

1- Does the nth correct box come before the n+1st correct box?
2- Is the nth correct box immediately before the n+1st correct box?

For a question having *n* boxes in the answer, one has to ask these two questions *n-1* times. For each correct response, students get a point and wrong answers yields. Then the raw score of the student is calculated as:

$$\text{Raw Score} = \frac{\text{The number of points taken}}{\text{Maximum points one could get}}$$

The raw score of a student could range from 0 to +1. The total score of the student is then calculated as follows: $\text{Total Score} = (\text{Raw Score}) \times 100$. The students' total score for a question having both regular and ordered parts is calculated by averaging the total scores taken from each part. The test score is also calculated by averaging the scores of each question in the test.

The details of the evaluation will be exemplified in the following example. Assume that we have a 3x3 grid which contains 9 different graphs (Figure 1) and directed the following question having two parts to the students.

Question1: A) Which one(s) of the following graphs have a positive slope? (Answer: 3,5,9)
B) Sort the slope of the selected graphs in an ascending order. (Answer: 3,5,9)

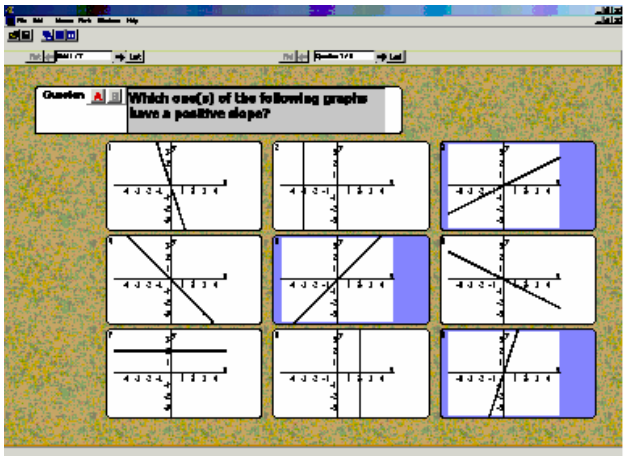

Figure 1. A screenshot from SCGT of 3 by 3 grid highlighting the correct answers.

The students may select the boxes numbered 3,4,5,6 for the first question and put them in the order of 3,6,5,4 for the second question. The first question is a regular question and could be evaluated as follows:
Correct Boxes: 3,5,9
Student Response: 3,4,5,6
The number of correct boxes chosen :2
Total number of correct boxes :3
The number of incorrect boxes chosen :2
Total number of incorrect boxes : 6

$$\text{Raw Score} = \frac{\text{The number of correct boxes chosen}}{\text{Total number of correct boxes}} - \frac{\text{The number of incorrect boxes chosen}}{\text{Total number of incorrect boxes}}$$

$$\text{Raw Score} = \frac{2}{3} - \frac{2}{6} = \frac{4-2}{6} = \frac{1}{3}$$

Then the total score of the student could be calculated as follows:

$$\text{Total Score} = (\frac{1}{3}+1)\times 50 = \frac{4}{3}\times 50 = \frac{200}{3} \approx 66,6$$

The second question is an order question and could be evaluated as follows:
Correct Boxes: 3,5,9
Student Response: 3,6,5,4
Does the 3rd box come before the 5th box? (Yes) (1 point)
Is the 3rd box immediately before the 5th box? (No) (0 point)
Does the 5th box come before the 9th box? (No) (0 point)
Is the 5th box immediately before the 9th box? (No) (0 point)

The number of points taken :1
Maximum points one could get :4

$$\text{Raw Score} = \frac{1}{4} = 0.25$$

$$\text{Total Score} = 0.25 \times 100 = 25$$

The student's total score for this question is: $\frac{(25+66.6)}{2} = 45.8$ out of 100.

These calculations are done by SCGT and a detailed output of each student's responses is provided as a text file by SCGT.

CONCLUSION:

SCGT gives the teachers the ability to assess students' conceptual frameworks by requiring them to select the boxes containing plausible answers since one is never sure of how many boxes are included in the answer. SCGT assesses students' partial performances and focus on the process of evaluation rather than just the product.

Furthermore, SCGT provides detailed feedback of student responses. SCGT also simplifies the test preparation and assessment phases of the structural communication grid method.

REFERENCES

Anderson, R. (1998). Why talk about different ways to grade? The shift from traditional assessment to alternative assessment. *New Directions for Teaching and Learning*, 74, 5-16.

Bahar, M. (1999). *Investigation of biology students' cognitive structure through word association tests, mind maps and structural communication grids.* Ph.D. Thesis, University of Glasgow.

Belanoff, P., & Dickson, M. (1991). *Portfolios: Process and product*. Portsmouth, N. H.: Heinemann.

Bintz, W. & Harste, J. (1994). Where are we going with alternative assessment and is it really worth our time? *Contemporary Education*, 66, 7-12.

Darling, H. L. (1994). Setting standards for students. The case for authentic assessment. *The Educational Forum*, 59, 14-21.

Egan, K. (1972). Structural communication – A new contribution to pedagogy. *Programmed Learning and Educational Technology*, 1, 63-78.

Herman, J. L., Aschbacher, P. R., & Winters, L. (1992). *A practical guide to alternative assessment*. Alexandria, VA: Association for Supervision and Curriculum Development.

Johnstone, A. H. & Mughol, A. R. N. (1979). Testing for understanding. *School Science Review*, 61, 147-150.

Johnstone, A. H. (1981). *Diagnostic testing in science. In evaluation roles in education*, London: Gordon and Breach.

Johnstone, A. H., Morrison, T. I., & Reid, N. (1981). *Chemistry about us*. London: Heinemann Educational Books.

Johnstone, A. H., MacGuire, P. R. P., Friel, S., & Morrison, E. W. (1983). Criterion referenced testing in science – thoughts, worries and suggestions. *School Science Review*, 64, 626-634.

Johnstone, A. H. (1988). *Meaning beyond readability*. Surrey: Southern Examining Group.

Johnstone, A. H., Hogg, W. R., & Ziane, M. (1993). A working memory model applied to physics problem solving. *International Journal of Science Education*, 15(6), 663-672.

Johnstone, A. H., Bahar, M., & Hansell, M. H. (2000). Structural communication grids: A valuable assessment and diagnostic tool for science teachers. *Journal of Biological Education*, 34(2).

Kane, M. B., & Mitchell, R. (1996). *Implementing performance assessment: promises, problems and challenges*, N.J.: Lawrance Erlbaum.

MacGuire, P. R. P. & Johnstone, A. H. (1987). Technique for investigating the understanding of concept in science. *International Journal of Science Education*, 9, 565-577.

Resnick, L. B., & Resnick, D. P. (1992). Assessing the thinking curriculum. New Tools for Educational Form. In B. R. Gifford & M. C. O'Connor (Eds), *Changing assessment: Alternative views of aptitude, Achievement and Instruction* (pp. 37-75). Boston: Academic Publisher.

Scottish Exam Board (1997). *Higher grade biology examination papers*. Glasgow: Gibson

Tellez, K. (1996). Authentic assessment. In J. Sikula (ed.), *Handbook of Research on Teacher Education*. (2nd ed.) New York: Simon & Schuster Macmillan.

Wiggins, G. (1989). Teaching to the (Authentic) Test. *Educational Leadership*, 46, 41-47.

Witte, S. P., & Flach, J. (1994). Notes toward an assessment of advanced ability to communicate. *Assessing Writing*, 1 (2), 207-246.

Worthen, B. R. (1993). Critical issues that will determine the future at alternative assessment. *Phi Delta Kappa*, 74, 444-456.