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A study was undertaken on selected sections of the Tana Haik Comprehensive Secondary School during the first semester of the 1980 (E.C.) academic year to see whether the objective type of test reflects the learning process, and to assess its impact in the teaching learning process of high school mathematics. A set of objective type mathematics teacher-made tests was restated in the essay or the "work out" form of the subjective test. The two tests (the objective and subjective types) were administered continuously in a single day. It

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was found out that although students had scored significantly higher grades in the objective test, they had failed to tackle most of the problems when framed in the "workout" format. The authors suggest that while lower order skills such as simple computation and recall of facts may be measured by the objective type of tests, problem solving and the ability to think logically should be measured by the subjective type of tests in which students will be made to show their ability to work out mathematical problems.

INTRODUCTION

When an awareness of the scale and complexity of worldwide education is coupled with the realization that education is a process for which there is no well developed technology, not even a predominant philosophy, it should be relatively easy to understand why so much attention is paid to a discipline with the two-fold objective of providing valid, reliable ways of measuring educational varia-

bles and of developing workable models for evaluating educational objectives, processes and outcomes. This has been the challenging position of the discipline of educational measurement and evaluation in recent years(1).

The lack of a scientifically founded and basically simple method of evaluating pupils' knowledge is an inhibiting factor in educational theory and practice. As noted by some authors(2), it would be helpful in the establishment of such methods to work out objective criteria which characterize both the process and the end result of learning. They say that the objective of measurement is the assimilation of knowledge, which is regarded as the end result of the pupils' cognitive activity.

It is possible to evaluate the assimilation of knowledge if suitable arrangements are made for the pupil to display what he has learned (assimilated) in class in the form of an activity. The types of activity which the individual may have to perform on the basis of his varying assimilation of a given piece of information are given in the form of a scale showing degrees of difficulty. Four levels of activity are distinguished: (i) cognition

(ii) reproduction (iii) application of knowledge, in the form of textual transposition of the appropriate response to the relevant category of tasks or problems (iv) application of knowledge, in the sense of transposition of the activities in question to situations which differ from the learning situation. The authors contend that these levels of activity can be measured, and can be used as a starting point when working out appropriate criteria or yardstick of successful classroom work.

It is clear from the foregoing statements that the evaluation of pupils' knowledge and capabilities, if it is to serve both broader and narrower educational objectives, should be process oriented. It is a fact that, at present, most high schools around the world, including in Ethiopia, often employ the objective type of examination as a means of evaluation. Within the context of this type of test, the question of merit has been a controversial issue in recent years. While the supporters of the objective type of tests (multiple choice, true/false, matching) state that such tests are mass administered, permit extensive sampling, are highly objective, less costly, time saving and scored in the same way for everyone (3,4,5), the opponents

of these tests argue that the objective type of tests reward superficiality, ignore creativity and penalize the person with a probing, subtle mind(6). Undoubtedly, the merits cited above have made objective type of tests widely acceptable by many educational institutions. However, many educational theorists are apprehensive as to whether this type of test reflects pupils' thought processes and whether it provides sufficient feedback to the teaching-learning process.

Thus this paper analyzes whether the objective type of tests reflects the learning process, and assesses its impact in the teaching-learning process of high school mathematics. In view of the foregoing, we report here a study undertaken at Tana Haik Comprehensive Secondary School, situated in Bahir Dar Town.

Materials and Methods

The study population consisted of the four levels (grades nine, ten, eleven and twelve) of the Tana Haik Comprehensive Secondary School, which had a population of 4132 students (of which 2543 were boys and 1589 were girls), 89 teachers and 27 class-

rooms that functioned in two shifts (Table 1). During the period covered by the study, there were eleven mathematics teachers, of whom only two had a first degree. (More detail about the school is given in the Appendix.) The study was conducted in the first semester of the 1980 (E.C) academic year during which there were 19 grade nine, 17 grade ten, 10 grade eleven and 7 grade twelve sections. For the purpose of this study a section was randomly selected from each level. There were 63, 66, 75 and 56 students in the study sections of grades nine, ten, eleven and twelve respectively.

Objective and subjective types of mathematics tests, which were restatements of each other, were administered to the sampled sections. For each section, a 20-item objective type of mathematics teacher-made test was prepared by the concerned researchers from the course work already completed. In another setting, each question in the objective test was restated in the essay or the "work out" form of the subjective test in which students were required to show their ability in solving problems. Since problem solving is central in mathematics education, our test outline consisted of items that demand the students' ability to solve problems.

Only those items that were unambiguous and could be solved with a few steps (3 to 4 steps) were included. Furthermore, items that could be framed in a subjective as well as an objective format were selected.

Of the 20 items in the objective test, 10 were multiple choice and 10 were true/false questions. Every multiple choice question was followed by four possible alternatives or suggested answers. The subjective test, which was the restatement of the objective test, also contained 20 questions. Each question in the subjective test was made to contain essentially the same concepts as the objective question that matched it. A scoring key was prepared for both tests at the time the test was constructed. The scoring key for the subjective test contained the crucial steps in the solving process and the number of score points allowable for each.

Every student in the sampled sections sat for the two types of examinations. Other sections that were taught by the teachers of the study sections were also included in the tests to minimize suspicion. Both tests were administered continuously in a single day in which the objective test was ad-

ministered first in order to minimize the possible positive transfer of knowledge. The school teachers (and not the researchers) were made to invigilate the tests so that the students would not be suspicious of the purpose of the tests. Students were not allowed to leave the examination hall until they had completed both tests. Furthermore, it was necessary to "buy their motivation" with the promise that their performance on both tests would be taken into account in the award of their grades. With regard to the time factor, students were made to work on both tests indefinitely (as long as they wanted) as our goal was to see the true picture of their knowledge with out the effect of time. The papers were then carefully marked by the researchers and the score points were collected and analyzed. The weekly working loads and qualifications of mathematics teachers were collected from the school administration. Responses to questionnaires regarding the two types of tests were also collected from the mathematics teachers of the school.

The Z-test was employed for statistical analysis. For all tests decisions were made at the 0.05 level of significance.

Results

Table I A presents the distribution of the results of the objective and subjective types of tests for the sampled population. The mean scores for the objective test were 35.6, 60.0, 60.6 and 60.9 for grades 9, 10, 11 and 12 respectively. While the mean scores for the subjective test were 12.3, 14.8, 30.1 and 26.3 for grades 9 to 12 respectively. In all study sections, the mean scores for the objective test were significantly higher than the means scores for the subjective test ($p < 0.001$, Table I B).

Distribution of the results of the multiple choice and true/false tests (adjusted to percentile scores) for the samples sections is presented in Table II A. Accordingly 25.0, 53.7, 42.8 and 65.0 were the mean scores of the multiple choice tests, and 50.5, 72.2,83.0 and 61.3 were those of the true/false tests. The latter were significantly higher than the mean scores of the multiple choice tests ($p < 0.001$, Table II B). However, the difference was not statistically significant for grade 12 ($Z = 1.07$, $p > 0.05$).

Male students were higher in number in the study sections (masculinity ratio was 110/100 for grade ten, 226/100 for grade eleven and 460/100 for grade twelve). In all study sections boys had better performance than girls in both the objective and the subjective tests (Table III). During the study period, the school's student-teacher ratio and average class size were 375.6:1 and 76.5 respectively.

TABLE I A

Distribution of Results of the Objective and Subjective Type of Tests for Grades 9, 10, 11 and 12 of the Tana Haik Comprehensive Secondary School

Result (100%)	Mid-Points	Grade 9, N = 63		Grade 10, N = 66		Grade 11, N = 75		Grade 12, N = 56	
		Objective (f)	Subjective (f)	Objective (f)	Subjective (f)	Objective (f)	Subjective (f)	Objective (f)	Subjective (f)
0-9	4.5	-	34	-	24	-	13	-	7
10-19	14.5	6	18	-	24	-	13	-	16
20-29	24.5	14	6	-	12	-	13	1	13
30-39	34.5	20	2	2	4	4	11	2	8
40-49	44.5	14	2	10	2	11	14	10	7
50-59	54.5	8	1	16	-	19	4	16	2
60-69	64.5	1	-	26	-	26	5	12	3
70-79	74.5	-	-	12	-	7	2	7	-
80-89	84.5	-	-	-	-	7	-	5	-
90-99	94.5	-	-	-	-	1	-	3	-
Mean (X)*		35.6	12.3	60.0	14.80	60.6	30.1	60.9	26.3
Standard Deviation		12.1	11.2	10.5	10.3	13.3	19.1	15.6	16.0
95% confidence interval for means		32.6-38.6	9.5-15.1	57.5-62.5	12.3-17.3	57.6-63.6	25.8-34.4	56.8-65.0	22.1-30.5

f = frequency

*Mean (X) = $\frac{fx}{N}$ and where X = mid-point of a class interval
f = frequency of the corresponding class interval
N = Number of students.

TABLE I B

Results on the Objective and Subjective Type Test for Grades 9, 10, 11 and 12

	Mean X	Standard Deviation (S.D)	Z-Calculated	P-Value
Grade 9, N=63				
Objective	35.6	12.1		
Subjective	12.3	11.2	11.20	<0.001
Grade 10, N=66				
Objective	60.0	10.5		
Subjective	14.8	10.3	24.97	<0.001
Grade 11, N=75				
Objective	60.6	13.3		
Subjective	30.1	19.1	11.34	<0.001
Grade 12, N=56				
Objective	60.9	15.6		
Subjective	26.3	16	11.57	<0.001

TALBE II A

Distribution of Results of the Multiple Choice and True/False Tests for Grade 9, 10, 11 and 12 of the Tana Haik Comprehensive Secondary School

Results (100%)	Mid-Point	Grade 9, N=63		Grade 10, N=66		Grade 11, N=75		Grade 12, N=56	
		Multiple Choice (f)*	True False (f)	Multiple Choice (f)	True False (f)	Multiple Choice (f)	True False (f)	Multiple Choice (f)	True False (f)
0-9	4.5	3	-	-	-	2	-	-	-
10-19	14.5	20	3	-	-	5	-	-	-
20-29	24.5	22	3	4	-	12	-	3	1
30-39	34.5	9	9	9	-	14	-	5	5
40-49	44.5	8	20	15	4	16	1	4	7
50-59	54.5	-	10	15	13	14	-	8	13
60-69	64.5	1	8	11	13	4	10	12	14
70-79	74.5	-	5	8	11	6	16	9	7
80-89	84.5	-	4	3	14	2	19	8	6
90-99	94.5	-	1	1	11	-	29	7	3
Mean (X)		25.0	50.5	53.7	72.2	42.8	83.0	65.0	61.3
Standard Deviation		11.9	17.9	16.2	15.4	18.4	11.5	19.9	16.6

*f = frequency

TABLE II B

Results on the True/False and Multiple Choice Questions for Grades 9, 10, 11 and 12

	Mean (X)	Standard Deviation (S.D)	Z-Calculated	P-Value
Grade 9, N=63				
True/False	50.5	17.9		
Multiple Choice	25.0	11.9	9.41	<0.001
Grade 10, N=66				
True/False	72.2	15.4		
Multiple Choice	53.7	16.2	6.73	<0.001
Grade 11, N=75				
True/False	83.0	11.5		
Multiple Choice	42.8	18.4	16.08	<0.001
Grade 12, N=56				
True/False	61.3	16.6		
Multiple Choice	65.0	19.9	-1.07	>0.05

TABLE III

Distribution of Results of the Objective and Subjective Type of Tests by Sex

	Grade 9		Grade 10		Grade 11		Grade 12	
	Male N=33	Female N=30	Male N=36	Female N=36	Male N=52	Female N=23	Male N=46	Female N=10
Objective								
Total Score	1225	870	2105	1755	3140	1265	2840	455
Mean (X)	37.1	29	58.5	58.5	60.4	55.0	61.7	45.5
Standard Deviation(S.D)	10.8	11.4	10.0	10.1	12.9	12.1	15.7	9.1
Subjective								
Total Score	510	189	677	273	1687	451	1248	157
Mean(X)	15.5	6.3	18.8	9.1	32.4	19.6	27.1	15.7
Standard Deviation(S.D)	13.4	5.1	10.8	6.8	17.8	17.4	17.2	7.7

Discussion

It goes without saying that measurement and evaluation of pupil's achievements play an important role in the development of a sound curriculum by providing the necessary feedback in regard to the realization of the desired educational objectives. It is therefore necessary to carry out research work in the area of measurement and evaluation in order to promote realistic assessment methods which could be vital in improving the curriculum. In the light of this, the present study has ventured to explore the impact of the objective type of tests on the learning process of high school mathematics.

Problem solving is central to good quality mathematics education. "You learn how to do it by doing it" (7). Providing students with the opportunity to work out mathematical problems is the best way to help them learn mathematics. However, the results of our study showed that although students had scored significantly higher average grades in the objective test, they had failed to work out most of the problems when these had been framed in a subjective format. The low

average scores in the subjective test in all study sections indicate that the mental faculties of students to work out or solve mathematical problems is poorly developed. Presumably, the relatively high grades in the objective test could be accounted for by chance and sheer rote learning. A possible indication that students may have used chance is made evident from the fact that the mean scores of the true/false tests were generally higher than those of the multiple choice tests (except in grade 12 where relatively higher grades were scored in the multiple choice test, probably due to the impact of the intensive preparation for the Ethiopian School Leaving Certificate Examination (ESLCE), which is totally multiple choice type. This is in agreement with the principle that while the unprepared and uninformed student has a fifty percent chance to guess correctly on a true/false question, the same student will have only a twenty five percent chance to guess correctly on a multiple choice question which has four alternatives.

In this regard, the high scores in the objective test provide a false picture of mathematical ability and mislead the concerned instructors in their evaluation of the effectiveness

of the teaching-learning process, thereby creating barriers to the educational progress of the students. Not-withstanding the claim made by several authors that the objective type of tests can be used to measure understanding and problem solving ability (8,9)*, the findings of this study indicate that these tests fail to serve the purpose they were designed for -to provide a satisfactory feedback and motivate students to work hard and grasp the desired skills (problem solving).

Furthermore, if students lack the essential skills, they become mark-oriented and under no compulsion to make vigorous intellectual effort. This means that the joy of intellectual achievement is lost and students develop a general disenchantment with mathematics as a subject. This can lead to frustration, anxiety, even hatred and fear, feelings that many people develop about mathematics (10).

*Many authors, [Ebel, 1979, DeCecco, 1968] contend that the objective type of tests can be used to measure any understanding of ability that can be tested by means of any other form of item.

While questionnaire responses show that the majority (70%) of the mathematics teachers of the school under study preferred subjective type to objective type of test, paradoxically, it is the objective type of test that they administer at all levels in the school. Since preparation for the all-objective type of the ESLCE is envisaged by many as the ultimate goal of high school education, teachers have no choice but to submit to the requirements and the test format of this examination. Today most high school teachers have resorted to "teaching to the test" by emphasizing materials tested by the ESLCE and by schooling students to be test-wise. However, lifting educational standards must be more than raising test scores. Regarding this, recent studies comment that national assessment programs, intentionally or unintentionally, promote a view about the purpose of education. According to this view, emphasis on basic or minimal accomplishments of a severely selected kind is narrowing and limiting, and definitely not conducive to the emergence of flexible and imaginative educational policies designed to cope with the future (11).

The results of our study indicate that boys had better performance than girls in both the

objective and the subjective tests. Similar observations of gender differences in mathematics education were documented by other authors(12).

To conclude, it would be necessary to conduct further research in order to determine the generalizability of these research findings. However, based on our findings, we suggest that lower order skills such as simple computation and recall of facts, the very things that calculators and computers can do more effectively than human beings, may be measured by the objective type of tests. But problem solving and the ability to think logically, which are central to good quality mathematics education, should be measured by the subjective type of tests in which students will be made to show their ability to work out mathematical problems. Furthermore, students should be protected from premature concern about performance.

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APPENDIX

Different Aspects of the Tana Haik Comprehensive Secondary School

A. General Information

Total number of students(regular).....	4132
Total male students	2543
Total female students	1589
Total number of classrooms	27
Total number of teachers	89

B. Qualification of Maths Teachers

Qualification	Number of Teachers
12 + 2	8
12 + 3	1
B.Sc. or B.A	2
Total	11