The Effectiveness of Three Rating Scales in the Assessment of Upper Basic Science Students' Practical Skills in Ikole Local Government Area of Ekiti State, Nigeria

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ABSTRACT

The study analyzed and compared the effectiveness of three rating scales in the assessment of upper basic science students' practical skills in Ekiti State. The study sample consisted of 280 (male and female) students, which were selected from five junior secondary schools in Ekiti State using multi-stage sampling techniques. Two null hypotheses were formulated and tested p = 0.05 level of significance by using the analysis of covariance and student t-test for independent data, while turkeys HSD post HOC comparison was carried out on the ANCOVA results to determine the comparative nature of the rating scales. However, findings showthat there was a significant difference in the practical skills of upper basic science students assessed with numerical, Likert and graphic rating scales. The group assessed with numerical rating scales had the best performance in practical skills. Students' gender and school type did not significantly affect students' practical skills in basic science. Consequently, observational techniques should hence forth be employed in assessing basic science students' practical skills.

Keywords: *Rating scales, practical skills, science students.*

INTRODUCTION

Assessment of learning outcomes is an indispensable aspect of the teaching-learning process because of its vast implications on the students, teachers, parents, local, state and federal government and their agencies. Alonge (2004), Bandele (2006), Ilugbusi (2007), Kolawole and Ilugbusi (2007) in their studies state that hitherto, the paper and pencil test remains the major way of assessing students' learning outcomes at the various strata of Nigeria's educational system. As a result of the limitations of the pencil and paper test (because it can effectively assess the cognition domain only), there is therefore the need to consider the effectiveness of assessing those skills under the affective and psychomotor domains, whose assessment is practically impossible through the ordinary (conventional) pencil and paper test. In other to cater for skills under these two domains, the use of observational techniques (tools) is imminent. Observational tools are of different types, ranging from check lists, anecdotal records and rating scales etc. one practical advantage of rating scales over other observational tools according to Williams and Irvin (1978) is that rating

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scales take little time for the teacher to complete and can therefore be used for a large number of students. In addition, they tend to be very easily adaptable and flexible. Consequently, there is therefore the need for a comparative analysis of the effectiveness of three rating scales on the assessment of upper basic science students' practical skills in Nigeria now with the introduction of the new 9-years basic education programme. Rating scales are observational and measuring tools designed to measure certain personality traits in an objective and quantifiable manner (Agbayewa, 2000), respondents are rated others on a given scale. The rating scale is an attempt to convert subjective judgment into numerical value; there are generally different types of rating scales but because of the nature and structure of the upper basic science curriculum and its practical activities, the effectiveness of numerical rating scale, graphics rating scale, and Likert scale in assessing basic science students' practical skills will be critically examined in this study. The following null hypotheses were generated and test at 0.05 level of significance.

(1) There is no significant difference in the practical skills of upper basic science students assessed with numerical, graphics, Likert scales and conventional method in urban and rural area of Ekiti State.

(2) There is no significant difference in the practical skills of male and female upper basic science students assessed with numerical, graphic and Likert scales in Ekiti State.

(3) There is no significant difference in the practical skills of upper basic science students assessed with numerical, graphic and Likert scales in mixed (co-educational) and single sex schools in Ekiti State.

PARTICIPANTS AND PROCEDURE

The design used in this study was a non-randomized control group 3x2x1 pre-test-post-test experimental design. The study sample consisted of 280 (140 male and 140 female) students which were randomly selected from five junior secondary schools in Ikole Local Government Area of Ekiti state by using multi-stage random sampling techniques. Generally, there were three experimental groups, ($EG_{1,}$ - $EG_{2,}$ and $EG_{3),}$ whose practical skills in upper basic science were assessed by using the numerical, graphic, and Likert scales respectively and one control group. All the experimental groups as well as the control group received the normal lessons on topics in the JSS 3. Basic science syllabus for a period of three months (during the February/April 2011 teaching practice exercise of the College of Education, Ikere Ekiti students).

The major treatments given to the subjects however were that each of the experimental groups was assessed according to the "modus operandi" of the peculiar rating scale used for them apart from the control group which was assessed by the conventional method. All groups were taught and assessed by the same teacher for three months; it was only the rating scales used for each group that was different. Four major research instruments namely; a 50-item (i) numerical rating scale, (ii) graphic rating scale and (iii) Likert scale designed and validated by the researchers were used to assess the

experimental groups $EG_{1,}$ $EG_{2,}$ and $EG_{3,}$ respectively while the control group was assessed by a conventional 50-item pencil and paper test also constructed and validated by the researchers. The face, content and construct validity of the research instruments were ascertained by giving them to experts in tests and measurement as well as experts in science education and curriculum for critical appraisal, scrutiny and the corrected versions were incorporated in the research instruments. The reliability indices of the numerical, graphic and Likert scale were computed by using Kuder-Richardson formula 21 (KR21) given as:

$$KR21 = \frac{k}{(k-1)} \left[\frac{1 - \bar{x}(k - \bar{x})}{\sigma^2} \right]$$

Where

K = Number of items

$\bar{x}$ = Mean

σ^2 = Variance

The reliability indices of the numerical, graphic and Likert scale are said to be 0.77, 0.74 and 0.79 respectively, while that of the conventional pencil and paper test also by KR21 formula gave a reliability index of 0.75. According to Alonge (2004) and Macintosh (1974), these indices are good enough for this kind of study. Since intact groups in the classroom were involved in the study, analyzed of covariance was used to statistically equate the subject, groups were also compared using the student-test for independent data, while turkey's HSD post hoc comparison was carried out on the data, in other to determine the comparative nature of the effect of each of the rating scales. Lastly, the strength of effects by the sources of between – group variability was also determined. The data generated in this study were analyzed accordingly and presented on the tables.

RESULTS AND DISCUSSION

The analysis on table 1 shows that the means and standard deviations of basic science students assessed with Likert scale (EG_1) are 40.22 and 3.41, graphic rating scale (EG_2) are 38.63 and 3,26, numerical rating scale (EG_3) are 42.09 and 3.48 and the control group (i.e. those assessed with the conventional method) are 25.66 and 2.09. By implication the group of students assessed with the numerical rating scale (EG_3) performed best, among all the groups, followed by EG_1 and then EG_2 while the control group had the least performance. It appeared therefore the treatment has effect on the performance of the three groups, namely EG3, EG1, and EG2 in that order. However, the hypothesis that there is no significant difference in the practical skills of upper basic science student assessed with numerical, graphic, Likert scale and conventional method in urban and rural areas of Ekiti State is rejected. Table 2 shows one-way analysis of covariance of post-test mean scores of all groups in basic practical using the pre-test scores as covariates. From the

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table, an fc = 42.88 is significant, p>0.001 and hence the null hypothesis 1 is rejected./ consequently, there was a significant difference in the practical skills of upper basic science students assessed with numerical, graphic, Likert scales and conventional method in urban and rural area of Ekiti state. Table 2 also shows that there was a significant difference between the performance of basic science students assessed with numerical scale, graphics scale, Likert scale as well as the control group in Ekiti State. The further revealed that the mode of assessment and the type of instrument used has significant effect on all the tree groups apart from the control group. Table 3 shows that strength of the effects of the numerical, graphics and Likert rating scales as well as the conventional method on basic science practical skills, indexed by eta square. The table showed that pre-test accounted for 7% of variability, while grouping accounted for 45% of the variability among groups. Treatment effects also accounted for 36% of the variability between grouping and conventional method. By implication the group assessed with the numerical rating scale performed better than either the group assessed with Likert or graphics and even the control group in basic science practical skills.

The analysis on table 4 shows that there was a significant difference between the performance of the group assessed with numerical and alert rating scales in basic science practical skills. The table also showed that there was a significant difference between the performance of the group assessed with Likert and graphic rating scales in basic science practical skills. Furthermore, the table showed that there was a significant difference between the performances of the control group (those assessed with the conventional method) and those assessed with graphic rating scale in basic science practical skills. Turkey's HSD comparison test also indicates that the post-test mean score of the group assessed with numerical rating scale is found to be significantly greater than that of the group assessed with Likert scale and the group assessed with graphic rating scale.

Table 5 shows the results of analysis of covariance of post-test scores of upper basic science student practical skills, using pre-test scores as covariate on sex and type of school. The main effect of types of rating scale on basic science students practical skills on sex alone produced an fc = 1.05 which is not significant at p<0.01, and hence there was no significant between the practical skills of male and female upper basic science students assessed with numerical, graphics and Likert scales in Ekiti State. Also, from table (v), the main effects of types of rating scale on basic science practical skills on types of school alone produce an fc=14.02 which is also not significant at p<0.01. It can hence be deduced that the type of school is not a significant factor in assessing upper basic science students' practical skills. Lastly, the interaction effects of types of rating scale and types of school in table (v) has an fc=1.76, which is also not significant at p<0.01. Hence, the effects of the three rating scales on type of school are the same for mixed (coeducational) and single sex schools' students in upper basic science practical skills.

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Table 1: Descriptive Statistics of Pre-Test and Post-Teat Scores of All Groups in Basic Science Practical Skills

GROUP	N	PRE-TEST		POST-TEST	
		X_E	SD	X_0	SD
EG_1:	70	26.30	2.80	40.22	3.41
EG_2,	70	24.71	2.72	38.63	3.26
$EG_{3,}$	70	28.01	2.62	42.09	3.48
CONTROL	70	11.99	2.66	25.66	2.09
TOTAL	280				

EG_1: basic science students assessed with Likert scale.
EG_2, basic science students assessed with graphics scale.
$EG_{3,}$ basic science students assessed with numerical rating scale.
Control: basic science students assessed with conventional method.

Table 2: Analysis of Covariance of Post Test Mean Scores of All Groups in Basic Science Practice using Pre-Test Scores as Covariates

Source of Variation	**Sum of Squares**	**Df**	**Mean Square**	**Fc**	**Sig.**
Covariates	654.73	1	654.73	24.99	0.001
Main Effect	1457.62	2	1123.53	42.88	0.001
Explained	2112.35	3	10221.71	40.71	0.001
Residual	10588.66 276	26.20			
Total	12701.01 279	47.76			

Table 3: The Strength of the Effects of Numerical, Graphic and Likert Rating Scales as well as the Conventional Method on Basic Science Practical Skills

Sources of variation	**Sum of squares**	**Sum of squares (total)**	**$(Eta)^2$**	**% of strength**
Covariates	54.73	12701.01	0.07	7.00
Main effect	1457.62	12701.01	0.45	45.00
Explained	2112.35	12701.01	0.36	36.00

Table 4: Turkey's HSD Comparison Test between Group Means in Basic Science Practical Skills

Sources of Variation	**Absolute difference between sample means**	**Value of Cd**	**Null hypothesis rejected**
$X_1 = X_2$	7.83	2.04	Yes
$X_1 = X_c$	7.60	2.04	Yes
$X_2 = X_c$	0.36	2.04	Yes

Table 5: Analysis of Covariance of Post-Test Scores of Upper Basic Science Students Practical Skills, using Pre-Test Scores as Covariate on Sex and Type of School

Sources	**Sum of square**	**Df**	**Mean square**	**Fc**	**Sig.**
Covariates	856.50	1	856.50	25.40	0.0001
Main effects	3782.11	5	886.73	27.85	0.0001
EXPERT	2631.08	3	1737.01	63.00	0.0001
Type of schools	1899.00	2	523.23	14.02	0.0001
SEX	68.41	2	41.70	1.05	0.173
2-way interaction	550.34	8	34.67	1.67	0.114
EXPT	409.22	4	64.28	1.76	0.0001
TP of SCHLS		2			0.0001
EXPT, SEX	40.67	2	13.13	0.43	0.585
Type of school sex	89.41	2	21.77	1.10	0.280
Explained	5113.44	20	307.50	14.81	0.0001
Residual	6851.38	258	25.18		
Total	11964.82	276	40.77		

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CONCLUSION AND RECOMMENDATIONS

Finding in this study showed that out of all the groups of students assessed with different kinds of rating scales in upper basic science practical skills, the group assessed with numerical rating scale performed significantly best, followed by those assessed with Likert scale while those assessed with graphic rating scale had the least of performance with regards to the treatments given while the control group assessed by using the conventional method had the worst performance in upper basic science practical skills. Furthermore, no statistically significant difference exists between the practical skills of male and female students in basic science. Similarly, there was no significant difference in the practical skills of students chosen from mixed (coeducational) schools and those selected from single sex schools in Ekiti State. In other to achieve the much needed technological breakthrough in Nigeria in the 21st century, the single use of pencil and paper test (which assessed cognitive domain only for the assessment of students' achievement in basic science should be de-emphasized (Kolawole and Ilugbusi, 2007).

Attention should be shifted to the use of observational techniques like the rating scales so as to be able to critically assess the psychomotor and affective domains of the student's holistically. This will assure a better and a more comprehensive assessment of student achievements in both theory and practical and consequently enhance students' academic performance in basic science as shown in this study. The use of numerical rating scale is recommended. Since students' gender did not significantly affect their basic science practical skills, both male and female students should be encouraged towards the study of basic science in school. Basic science students should be allowed to attend any school of their choice (either mixed or single sex) since school type had no significant effect on basic science students' practical skills. The use of conventional method in assessing students' academic achievement in basic science which is presently in vogue should be discontinued and then replaced with other assessment techniques found to be more effective through researches.

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