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Editor

Editorial

The Journal of Science Teachers Association of Nigeria is developed to disseminate science, technology, and mathematics (STM) educational research information to classroom teachers, teacher-trainers, policy-makers, researchers, and other interest groups. This STM information is required for any scientific and technological development of a nation.

In this edition, our readers are presented with articles on a wide range of issues. These include Cognitive Correlates of Physics Achievement, Assessment Scale of Students' interest in Practical Chemistry, use of constructivism in secondary schools, and fundamental flaws in experimental research.

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Uchenna Nzewi
Editor-in-Chief

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Teacher Factors as Determinants of Achievement in Integrated Science

Dr E. Adenike Emeke & Dr Bisayo B. Odetoyinbo

Abstract

The study investigated how some teacher variables such as qualification, teaching experience in Integrated Science, area of specialization, gender, teacher's knowledge of the objectives of integrated science, teaching strategies employed and their assessment practices determine or predict achievement in Integrated Science. To do this, an eight variable model was constructed and tested in order to provide causal explanations of achievement in Integrated Science. Forty teachers and five hundred students randomly selected from twenty schools in Oyo state were involved in the study. Data collection was carried out using three instruments with reliability coefficient ranging from 0.72- 0.80. Data analysis was carried out through the multiple regression analysis procedure and path analysis technique. The results indicate that the seven predictor variables accounted for 17.6% of the variation in the criterion variable. Out of this, having the knowledge of the objectives of the programme contributed most followed by the qualification of the teacher. The implications of all these for professional development is also discussed.

Introduction

Integrated Science as a beginning course in science was introduced into the Nigerian secondary schools as a panacea for all the problems bedeviling science especially at the junior level most especially with the revised policy on education with emphasis on acquisition of skills. The emphasis of the programme is on the development of the spirit of enquiry as opposed to rote learning as well as the development of manipulative skills and scientific attitudes rather than accepting scientific fact as a dogma.

However, a lot has been documented in literature to the effect that the curriculum materials were not pilot tested before being introduced into the schools neither was the workforce trained before inception (Bajah, 1978; Mani, 1981; Ogunniyi, 1983; Egbugara, 1992). Egbugara (1992) submitted that the idea of an Integrated Science Programme for Nigerian secondary schools missed right from its inception the relevance of an adequate curriculum programme for the training of pre-service teachers. He further asserted that the curriculum developers must have assumed that familiarizing practicing teachers with the junior secondary Integrated Science curriculum was sufficient to make them teach it satisfactorily or that giving a few of them some intensive session in short term workshops and seminars would do.

There is however a symbiotic relationship between a new curriculum and professional development. The challenge of Integrated Science is complicated by the fact that few teachers were actually prepared to teach or have had an experience in integrated approach to science, for Integrated Science represents a change in approach to the teaching of science. Some are however of the opinion that any science graduate can handle Integrated Science and as a matter of fact, it was these science graduates that were co-opted to teach the subject at its onset. Research findings however revealed that teachers do not feel comfortable teaching the areas they are not familiar with (Boyejo, 1989; 1990). It is not uncommon to find a Biology teacher teaching the biology aspect of the course at the expense of those areas that have to do with concepts in Physics. Perhaps this is why some school administrators feel comfortable sharing the subject among three graduates of Biology, Physics and Chemistry; a situation that is contrary to the very essence of floating the programme as revealed in the following objectives:

Integrated Science is supposed to be presented in such a way that the child:

a) gains the concept of the fundamental unity of science
b) gains the commonality of approach to problem of a scientific nature
c) is helped to gain an understanding of the role and function of science in everyday life and the world in which he\she lives (FME, 1985, p. 3).

Also important are the strategies and assessment practices expected of an Integrated Science teacher. Hands – on activities are supposed to dominate while assessment practices are expected to call for a wide range of learning outcomes. Whereas successful implementation requires thorough and continuous professional development, as it is supposed to expose the teachers to the philosophy, objectives, strategies and assessment practices expected of an Integrated Science teacher; how well this has been put in place is an issue to be examined. It is against this background that the study sought to establish causal linkages among some teacher factors and achievement in Integrated Science.

Research Questions

1. What is the most meaningful causal model involving the seven teacher variables and achievement in Integrated Science?
2. What are the directions as well as the estimate of the strengths of the causal paths of the variables in the model?
3. What are the direct and indirect effects of the variables on achievement in Integrated Science?
4. What proportion of the total effects are (i) direct (ii) indirect?

Methodology

(a) Sampling procedure and Sample

Simple random sampling was used to select 40% of the local government areas within six educational zones in Oyo State. Consequently, ten local government areas were chosen with two schools per local government area also randomly selected. Again, the technique of random sampling was also employed to select two teachers and twenty five students per school. In all, forty teachers and five hundred students from twenty schools scattered within ten local government areas of Oyo State were involved.

(b) Instrument

Three instruments were used namely Integrated Science Objective Scale (ISOS), Teaching Strategies and Assessment Practices Questionnaire (TSAAPQ) and Integrated Science Achievement Test (ISAT). The Cronbach coefficient alpha values ranges from 0.72 to 0.80.

(c) Data collection and Analysis

Three researchers were directly involved in the gathering of data. The study involved the building of a hypothesized recursive causal model (Figure 1) based on widely accepted terms such as knowledge, theoretical consideration and temporal order or logical analysis(Kerlinger and Pedhazur, 1973; Wolfle, 1980).

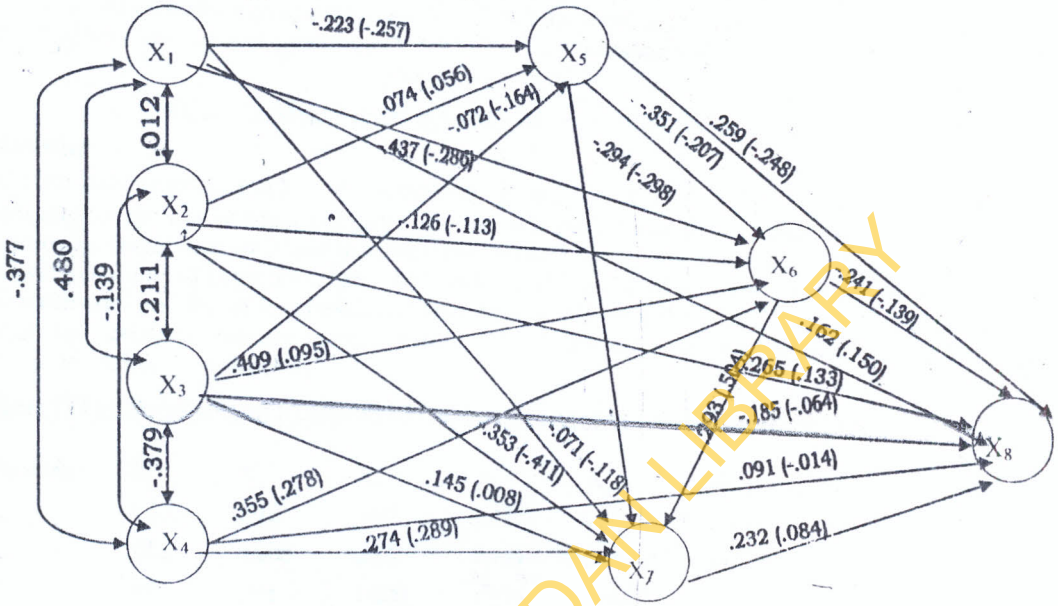
The paths of the model were identified through the following structural equations:

$$X_5 = P_{53}X_3 + P_{52}X_2 + P_{51}X_1 + e_5$$
$$X_6 = P_{65}X_5 + P_{64}X_4 + P_{63}X_3 + P_{62}X_2 + P_{61}X_1 + e_6$$
$$X_7 = P_{76}X_6 + P_{75}X_5 + P_{74}X_4 + P_{73}X_3 + P_{72}X_2 + P_{71}X_1 + e_7$$
$$X_8 = P_{87}X_7 + P_{86}X_6 + P_{85}X_5 + P_{84}X_4 + P_{83}X_3 + P_{82}X_2 + P_{81}X_1 + e_8$$

After running four regression analyses, the paths were trimmed based on statistical significance and or meaningfulness and the new model emerged (Figure 2). The new model consists of seventeen significant pathways as reflected in the following structural equations that represented the new model:

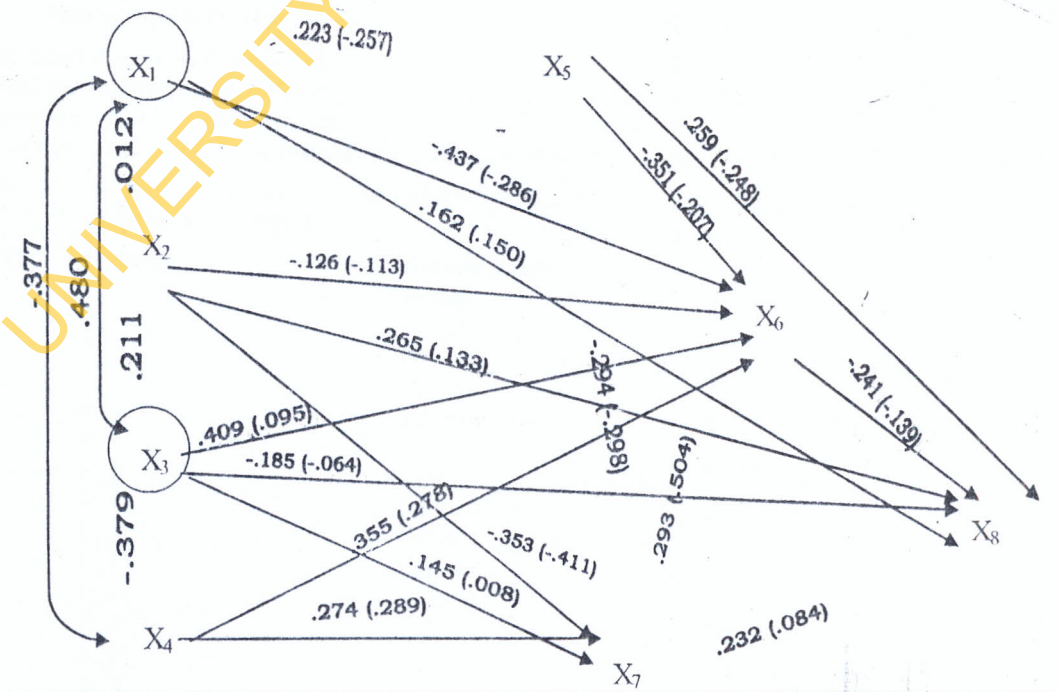
$$X_5 = P_{51}X_1 + e_5$$
$$X_6 = P_{65}X_5 + P_{64}X_4 + P_{63}X_3 + P_{62}X_2 + P_{61}X_1 + e_6$$
$$X_7 = P_{76}X_6 + P_{75}X_5 + P_{74}X_4 + P_{73}X_3 + P_{72}X_2 + e_7$$
$$X_8 = P_{87}X_7 + P_{86}X_6 + P_{85}X_5 + P_{83}X_3 + P_{82}X_2 + P_{81}X_1 + e_8$$

The efficacy or the tenability of the new model was thus verified by reproducing the original correlation data through a set of normal equations.



X_1=Teachers' qualification; X_2= Teaching experience in Integrated Science
X_3=Area of Specialization; X_4= Teachers' gender
X_5= Teachers' knowledge of objective; X_6= Teachers' teaching strategies
X_7= Teachers' assessment practices; X_8= Students achievement in Integrated Science.

Figure 1: ***Hypothesized Recursive Causal Model of the Eight Variable System.***



X_1=Teachers' qualification; X_2= Teaching experience in Integrated Science
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X_7= Teachers' assessment practices; X_8= Students achievement in Integrated Science.

Figure 2: Most Meaningful Model of the Eight Variable System

Results

A more parsimonious model with seventeen pathways that met the criteria of significance and meaningfulness was produced (Figure 2). The new model was thus verified by reproducing the zero order correlation data and the discrepancies between the original and reproduced data was considered minimal being less than 0.05 (Table 1). Consequently, Figure 2 is the most meaningful causal model and therefore considered tenable in explaining the causal interaction between the predictor variables (teacher factors; variables 1-7) and the criterion variable (achievement in integrated science; variable 8).

Table 1: The Original and Reproduced Correlation Matrix for the Eight Variables

Variable	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8
X_1	1.000	.012	.480	-.377	-.257	-.286	-.118	.150
X_2	.012	1.000	.211	-.139	.056	-113	-.411	.133
X_3	.480	.211	1.000	-.379	-.164	.095	.008	-.064
X_4	-.377	-.139	-.379	1.000	-.297	.278	.289	-.014
X_5	-.223	-.003	-.112	.084	1.000	-.207	-.298	-.248
X_6	-.295	-.095	.076	.354	-.270	1.000	-.504	-.139
X_7	-.057	-.449	.022	.348	-.365	.514	1.000	.084
X_8	-.066	.134	-.035	-.054	-.295	.139	.071	1.000

* Entries above the diagonal are the original correlation coefficient.
* Entries below the diagonal are the reproduced correlation coefficient.

The directions as well as the estimate of the strengths of the causal paths of the variables in the model are represented by pathways that are significant; meaningful as well as have links with the criterion variable and this is represented in Table 2. The beta weights associated with the pathways, that is the path coefficients provide the estimates of the causal paths of the variables.

Table 2: Significant pathways through which X_i (1,2,3,4,5,6,7) caused variations in the dependent variable X_8 (P =0.05)

S/N	Pathway	Nature of path	Path coefficient
1	P_{81}	Direct	=0.162
2	P_{82}	Direct	0.265
3	P_{83}	Direct	-0.185
4	P_{85}	Direct	0.259
5	P_{86}	Direct	-0.241
6	P_{87}	Direct	0.232
7	$P_{85}P_{51}$	Indirect	(-0.259 (-0.223) = 0.058
8	$P_{86}P_{61}$	Indirect	(-0.241 (-0.437) =.0.105
9	$P_{86}P_{65}P_{51}$	Indirect	(-0.241) (-0351) (-0.223) = -0.019
10	$P_{86}P_{62}$	Indirect	(-0.241)(-0.126) = 0.030
11	$P_{87}P_{72}$	Indirect	(0.232) (-0.353) = -0.082
12	$P_{87}P_{76}P_{62}$	Indirect	(0.232) (0.293) (-0.126) = -0.009
13	$P_{86}P_{63}$	Indirect	(-0.241) (0.409) = -0.010
14	$P_{87}P_{73}$	Indirect	(0.232) (0.145) = 0.034

15	$P_{87}P_{76}P_{63}$	Indirect	(0.232 (0.293) (0.409) = 0.028
16	$P_{86}P_{64}$	Indirect	(-0.241) (0.355) = 0.086
17	$P_{87}P_{74}$	Indirect	(0.232) (0.274) = 0.064
18	$P_{87}P_{76}P_{64}$	Indirect	(0.232) (0.293) (0.355) = 0.024
19	$P_{86}P_{65}$	Indirect	(-0.241) (-0.351) = 0.085
20	$P_{87}P_{75}$	Indirect	(0.232) (-0.294) = -0.068
21	$P_{87}P_{76}P_{65}$	Indirect	(0.232) (0.293) (-0.351) = 0.024
22	$P_{87}P_{76}$	Indirect	(0.232) (0.293) = 0.068

A total of twenty two pathways are significant enough to cause variation in achievement in Integrated Science; of these, six have direct effects while sixteen have indirect effects.

The proportion of the total effect that is direct and indirect is reflected in Table 3.

Table 3: Proportions of the Total Effects of the Predictors that are Direct and Indirect

Criterion	Predictor	Total Effect	%	Direct Effect	%	Indirect Effect	%	%
	Var 1-7	(a)	(c)	(b)	(d)	(a-b)	E	F
	1	.150	3.173	.162	3.43	-.012	-.254	18.03
	2	.133	2.813	.265	5.61	-.132	-2.79	15.98
Var 8	3	.064	1.354	.185	3.91	-.121	-2.56	7.69
	4	.014	0.296	-	-	.014	.296	1.68
	5	.248	5.246	.259	5.48	-.011	-.233	29.81
	6	.139	2.940	.241	5.10	-.102	-2.16	16.71
	7	.084	1.777	.232	4.91	-.148	-3.13	10.10
	Total	.832	17.60	1.344	28.4	-.512	-10.8	100

Note: C= (a/Ta) x 17.6%; D=(b/Ta)x 17.6%; E= (a-b/Ta)x 17.6%; F= (c/Tc x 100)
Total effect=original correlation coefficient
Direct effect=Path coefficient
Indirect effect=Total effect – Direct effect

Discussion and Conclusion

The seven teacher factors that are predictors in the model are qualification (X_1); teaching experience in integrated science (X_2); area of specialization (X_3); teachers' gender (X_4); teachers' knowledge of the objectives of the programme (X_5); teaching strategies (X_6); assessment practices (X_7) while the criterion variable is achievement in Integrated Science (X_8). The seven factors accounted for 17.6% of the variance in achievement in Integrated Science. Other factors outside the model along with measurement error could have accounted for the remaining percentage. Such other factors documented in literature are lack of pilot testing; lack of enlightenment; lack of coherence and much more (Mani,1981; Jegede, 1983; Okebukola, 1983).

Of interest however to this work is the pattern of contribution of the variables. Having the knowledge of the objectives of the programme ranked higher as it contributed 5.246% of the total variance significant at P d" 0.05. The implication of this is that having the knowledge of the objectives of the programme; that is knowing "why" and "what" of the programme is important to getting result because curriculum, instruction and learning outcomes are closely linked (Kathy, 2000).

Qualification of the teacher also contributed significantly to the variation in the criterion variable. This finding corroborates early researches with emphasis on Integrated Science graduates handling the course in order to get results (Okebukola, 1989; Akale, 1992).

The teaching strategies employed also become significant in this study and this is a clear signal that not just any teaching strategy can be employed. The order of the contribution of the

seven predictors are $X_5>X_1>X_6>X_2>X_7>X_3>X_4$. Of the seven predictors, six have direct effect with only teachers' gender having indirect effect. The following conclusions can be drawn from the study:

- There can be no substitute to a thorough professional development in the field of Integrated Science.
- Experience on the job is not enough to deliver the "goods".
- A thorough understanding of the principles, philosophy and objectives of any programme albeit Integrated Science is a prerequisite for successful implementation.

It is suggested that the whole idea of teacher education programme for Integrated Science be revisited, reviewed and if need be revised for it is said that no nation can rise above the quality of its teachers and no programme can succeed where the workforce is not well equipped.

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