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Meta-Analysis of Teacher Demographic Variables and Their Association with Pupil Attitude towards Science

By Ephias Gudyanga
Midlands State University, Zimbabwe

Abstract- This paper purposed to find out whether teacher demographic variables had an association with pupil total attitude towards the teaching and learning of science amongst secondary school students. A random sample of 243 pupils (115 girls, 128 boys: age range 12-17 years) comprised the respondents. The study was premised on survey paradigm with a self designed and administered questionnaire as the main tool for data collection. Meta analysis based on (Ho) testing was implemented, leading to F- ratios at $p < 0.05$ being tabulated and discussed. It was found out that teacher experience, teacher qualification and teacher gender were significantly related to pupil attitude towards the learning of classroom science. It was concluded that science must be taught by well qualified and experienced teachers. Institutions of higher learning educating science teachers must envisage gender equity and equality, among others.

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I. Introduction

The Cockcroft committee reporting the findings of a study in which about 5 000 people aged 15 or over were interviewed about physics, (a science subject) noted that, "the extent to which the need to undertake even an apparently simple physics calculation could induce feelings of anxiety, helplessness, fear and even, guilt in some of those interviewed was, perhaps, the most striking feature of the study", (Cockroft Committee, 1984 p. 16). Is it not strange that Science, often described as the "Queen of the school subjects", should be regarded with distaste, and even fear? I therefore sought to find out whether teacher demographic variables had an association with pupil attitude toward teaching and learning of Science in Zimbabwe.

II. Context

On the basis of studies of attitudes toward Science (Gudyanga & Gudyanga, 2013; Myers & Fouts, 1992; Yore, 1991; Zoller, Ebenezer, Morley, & Paras, 1990), the following Null hypothesis (Ho) was examined: Teachers have no significant influence on the pupils' attitude towards the learning and teaching of science.

Author: Midlands State University, Faculty of Education, Department of Educational Foundations, Management and Curriculum Studies, Bag 9055, Gweru, Zimbabwe. e-mail: gudyangae@gmail.com

In this study, the term, teaching was used to refer to all classroom activities. Various types of classroom activities can be cited as examples of Science teaching and learning. Science students are taught to observe, to classify, to control variables, to design, to report experiments, to tabulate results amongst others. Science teaching also involves group or individual practical work. This is an important part of normal teaching techniques or teaching methods. If a teacher carries out such classroom activities, he / she is deemed to have correct Science teaching techniques and students are considered to be learning science.

Bonnstetter et al (1983) surveyed the views of science teachers and found that there was some denial about a swing from science and suggestion "of a shift of emphasis from physical to biological science|". Reasons for the swing came in two categories:

- Science teachers were either too young and inexperienced or too old and out of date.
- Specialist teaching in the sixth form left no time for junior school teaching, hence teacher demographic variables were associated with pupil attitude toward science, (Committee, 1984; Talton & Simpson, 1987).

Affective behaviours in the science classroom, particularly achievement motivation and science self-concept, were strongly related to achievement (Bonnstetter, Penick & Yager, 1983; Oliver & Simpson 1988). About the influences of home, school and peer groups on student attitudes and achievement in Science revealed a strong interrelationship among the affective and cognitive variables (Schibeci, 1989).

Previous studies have shown that students maintain a poor attitude toward Science, with that attitude declining from the junior to the Senior High School (Ebenezer & Zoller, 1993; Fleming & Malone, 1983; Gudyanga & Gudyanga, 2013; Hofstein & Welch, 1984; Jegede, 1989; Zoller et al., 1990).

Attitudes hold varied meanings for different people. However, one meaning of attitude generally accepted is that attitudes have three components, the cognitive, the affective and the psychomotor. (Deaux & Wrightsman, 1984; Freedman & Carlsmith, 1981). The cognitive component is that part of our attitude which has something to do with our beliefs, ideas and

knowledge about an object. The affective component is our emotional feelings of like and dislike. The psychomotor component is the action or the practicals of Science. Within social psychology, there is an emerging consensus that, attitudes are best understood as structures that reside in long term memory (Fazio, Sabonmasu, Powell, & Kardes, 1986; Fazio & Williams, 1986; Tourangeau, 1987) and are activated when the issue or object of the attitude is encountered (Fazio et al., 1986; Fazio & Williams, 1986).

The conventions that have been found useful for representing other information in long term memory ought to be useful for representing attitudes as well. In most psychological work, attitudes have been represented networks of interrelated beliefs. Although social psychologists tend to refer to the constituents of attitudes as beliefs, the term has been loosely used to encompass memories of e.g. specific experiences, general propositions, images, feelings, value systems held by different cultures, convictions, desires, feelings, opinions (Edwards, 1957). All these must be interwoven as a set of interconnected ideas lying in the long term memory.

Other researchers argue that attitudes are organized into schemata (Fiske & Dyer, 1985; Fiske & Kinder, 1981; Hastie, 1981) or stereotypes (Hamilton, 1981; Linville & Jones, 1980). But whenever attitudes form network structures, schemata, stereotypes, or some combination of these, it is clear that the dimensional representation of attitude structure implicit in classical scaling techniques, such as Likert, Guttman and Thurstone scaling, does not fully capture the important structural properties of attitudes. However, since interested mainly in the affective domain, the Likert scale was the best possible to measure such (Anderson, 1983; Bower, 1981; Sears, Huddy, & Schaffer, 1986) and it is the one which was used in this study.

The study is informed by the gestalt school of thought. Gestaltism (the lens through which I viewed my study) is based on the fact that perception, just like attitudes, should be considered as a whole or a gestalt (a German word), if it is to be meaningful. The whole of a phenomenon is greater than the sum of its parts (Reyna, 2012). The sum total of individual components of attitudes, (i.e. cognitive, affective and psychomotor) is more important than individual parts. In this study, total attitude towards science teaching and learning is more important than perceiving demographic variables as being associated to cognitive domain, affective and psychomotor domain. For this investigation, Meta – analysis procedure is respected, in order to raise the reliability and validity of the study.

III. Method

A pilot study was carried out to establish the construct validity and reliability of the Likert instrument, which I designed to measure attitude traits. A sample of 50 respondents was randomly selected in the same district where the main study was carried out. After content analysis of the instrument, some items were modified and reworded. Factor analysis, using Principal components with Varimax Rotation, Kaiser Normalisation and Scree testing, were used to determine validity and reliability coefficients of instrument and categorization of factors.

Variables with factor loading of 0.3 and above, Eigen values of 1 and above were considered for the main research study (Rust & Golombok, 1989 p. 1220). A 65 item attitude scale was considered long enough to keep the probability of random error low, yet not so long as to introduce data unreliability resulting from fatigue and boredom. The split half-alpha reliability and Cronbach reliability was .68 and .61 respectively. This suggested adequate reliability of the Attitude Toward Science (ATS) scale since the alpha and Cronbach values were relatively high enough (Helmstadter, 1988; Mason & Bramble, 1991).

Two hundred and forty-three randomly selected Gweru urban district secondary school pupils took part in the main study. One hundred and fifteen were females and one hundred and twenty-eight were males. Forty-nine of the respondents were in form one, thirty-four in form two, ninety three in form three and sixty seven were in form four. All respondents completed the ATS scale, which was self administered.

Data were analysed using the SPSS – PC program (Hull & Nie, 1984; Rust & Golombok, 1989). The hypothesis was tested using Analysis of Variance statistics (ANOVA) and one way Anova statistics. The independent variables were teacher qualification, teacher's experience, and teacher gender. The dependent variables were total attitude, cognitive domain, affective and psychomotor domains which were carried out in order to test the hypothesis. The power of a statistical test depended on: The level of significance adopted, via, the probability of rejecting a true null hypothesis and accepting a false alternative hypothesis or Type 1 error, and the sample size. In this study, the hypothesis was tested using 3 levels of significance. These were 0, 05; 0, 01 and 0,001 which are all relatively high levels of significance, (Rust & Golombok, 1989).

IV. Results

a) Antecedent variables by pupil total attitude about Science.

Table 1 : Teacher antecedent variables by pupil total attitude about Science (N=243).

Source of Variance	Mean Square	DF	Means	F-Ratio	Sign. of F	Eta
Main effects	7151.549	6	84.567	5.738	.000**	.36
Teaching qualification	1708.421	1	41.333	7.559	.006*	.17
Teaching experience in years	2044.431	1	45.215	9.046	.003*	.19
Teacher gender	2028.989	1	45.044	9.768	.002*	.19

***Significant at p<.001 level * Significant at p<.01 level*

Table 1 shows the Analysis of variance statistics for total attitude of pupils towards teaching and learning of Science by teacher's demographic characteristics, (antecedent variables).

The main effects for each of teacher qualification (F=7.559; p=.006<.01), teacher experience (F = 9.046; p= .003<.01), teacher gender (F=9.768; p=.002<.01), thus, for total attitude variable, the sources of variance were teacher qualification, teacher experience, and teacher gender.

Similarly, interaction effects for all the variance were significant, (F=5.738; p=.000<.0010. The demographic variables of teacher qualification, teacher experience, teacher gender, reflected significant variance at .01 level, ETA values for above variables are as follows: teacher qualification (.17), teachers experience in years (.19), teacher gender (.19), these values for the above demographic variables accounted for the observed alphas at .05 or less of 2,89%; 3,61%, and 4% respectively.

It is interesting to also note that all the demographic variables are important in explaining the total pupil attitude towards the teaching and learning of Science. The hypothesis that teachers have no significant influence on the pupil's attitude towards the learning and teaching of Science is rejected.

b) One way analysis for Total attitude by demographic variables

Table 2 : One way analysis for pupil total attitude by teachers demographic variables (N=243).

Variable	DF	Means	F-Ratio	F-Prob.
Teacher experience in years	1	23.93	2.4653	.1177
Teacher gender	1	16.09	1.1155	.2920

**Significant at the p <.01 level*

Table 2 shows a one way analysis computed for pupil total attitude by teacher's independent (demographic) variables. It was observed that although teachers' gender and teachers experience were significant in Table 1 of ANOVA, the one way analysis only showed teachers experience, and gender being not significant.

c) Antecedent variables by pupil knowledge and beliefs about Science

Table 3 : ANOVA for teacher antecedent variables by pupil beliefs (cognitive dimension) about science (N=243).

Source of Variance	Mean Square	DF	Means	F-ratio	Sign of F	Eta
Main Effects	1158.722	1	34.040	3.520	.002*	.17
Teacher qualification	603.970	1	24.576	3.897	.005*	.13
Teacher experience in years	1156.827	1	34.012	7.464	.007*	.17
Teacher gender	902.584	3	30.043	7.807	.006*	.15

**Significant at the p <.01 level.*

Table 3 shows the results of Anova for knowledge and or beliefs of pupils towards teaching and learning of Science by teachers demographic variables. The main effects for each of teacher qualification (F=3.897; p= .005 < .01), teacher experience in years (F = 7.464; p =.007 <.010, gender of teacher (F = 7.807; p= .006 < .01), were significant. Thus, like in Table 1, for cognitive dimension variable, the significant sources of variance were teacher qualification, teacher experience, and teacher gender. In the similar manner, the interaction effects for all the variance were significant, (F=3.520; p =.002<.01). The demographic variables of teacher qualification, teacher experience, and teacher gender reflected significant variance at .01 level, Eta values for above variables are as follows: teacher qualification (.13), teacher

experience (.17), gender of teacher (.15). These values for the above demographic variables accounted for the observed alphas at .01 of 1, 69%; 2, 25%; and 0, 36%. respectively.

It is interesting to note that teacher variable accounts for a large (comparatively) 6, 83% of the variance of total attitude. The hypothesis that teachers have no significant influence on the pupil's attitude towards the learning and teaching of Science is rejected.

d) One way analysis for cognitive dimension variable by teacher's demographic variables

Table 4 : One way analysis for cognitive dimension by teachers demographic variables (N=243).

Variable	DF	Means	F=Ratio	F-Prob.
Teachers experience	1	23.69	3.5785	0597
Teacher Gender	1	3.92	0.0971	.7557

**Significant at the p<.05 level*

The hypothesis that says that teachers have no significant influence on the pupil's attitude towards learning and teaching of science is rejected.

e) Teachers antecedent variables by pupil affective domain about Science

Table 5 : ANOVA for teacher antecedent variables by pupil feelings about science (N= 243).

Source of Variance	Mean Square	DF	Means	F- Ratio	Sign. of F	Eta
Main effects	125.390	6	11.198	9.840	.000***	.18
Teacher qualification	201.958	1	14.211	13.629	.000***	.23
Teacher experience in years	165.273	1	12.856	11.153	.00188	.21
Teacher gender	72.375	1	8.507	5.959	.018*	.14

**** Significant at p<.001 level*
*** Significant at p<.01 level*
** Significant at p<.05 level*

Table 5 shows the analysis of variance statistics for total feelings (affective dimension) of pupils towards teaching and learning of Science by teacher's demographic characteristics, (antecedent variables). The main effects for each of teacher qualification (F=13.629; p =. 000<.001), teacher experience (F=11.153; p =.002<.01), teacher gender (F=5.959; p=.018<.05). Thus, for affective domain variable, the sources of variance were teacher qualification, teacher experience and teacher gender. Similarly, interaction effects for all the variance were significant, (F =9.804; p= .000<.001). Eta values for above significant variables are as follows: teacher qualification (.23), teachers experience in years (.21) and teacher gender (.14), These values for the above demographic variables accounted for the observed alphas at .05 or less of 5,29%; 4,41%; and 1,96% respectively.

It is interesting to note that all teacher demographic variables are important in explaining the total pupil feelings towards the teaching and learning of Science. The hypothesis that teachers have no significant influence on the pupil's attitude towards the learning and teaching of Science is rejected.

f) One way analysis for pupils affective dimension variable by teacher's demographic variables.

Table 6 : One way analysis for affective dimension by teachers demographic variables (N=243).

Variable	DF	Means	F-Ratio	F-Prob
Teachers' experience	1	4.65	1.3880	.2399
Teacher gender	1	7.26	3.4186	.0657

** Significant at the p<.001 level*

Both F- ratios for teachers experience, teachers gender are not significant at (p<0.05) therefore the hypothesis that teachers have no significant influence on the pupils attitude towards the learning and teaching of science is not rejected.

g) Antecedent variables by pupil action about Science.

Table 7 : ANOVA for teacher variable antecedent variable by pupil practical orientation (psychomotor dimension) about science (N=243).

Source of Variance	Mean Square	DF	Means	F.Ratio	Sign. of F	Eta
Main Effects	26.403	6	5.138	1.538	.166	.08
Teacher qualification	5.955	1	2.440	0.340	.560	.04
Teacher experience in years	5.110	1	2.261	0.292	.590	.03
Teacher gender	8.334	3	2.887	0.070	.71	.04

**Significant at the p<.05 level*

Table 7 shows the results of analysis of variance statistics for action / practical orientation of pupils towards the teaching and learning of Science by teacher demographic variables. It can be observed that the overall main effects, teacher qualification, teacher experience, teacher gender for psychomotor dimension for teacher demographic variables were all insignificant ($p<0.05$).

V. Discussion and Conclusion

The results of this study suggest that teacher gender, teacher qualification, teacher experience influenced secondary school pupil total attitude towards teaching and learning of Science (Tables 1, 3 and 5). However, when attitudes were analysed in their different components i.e. cognitive, affective and psychomotor, the teacher demographic variables were found not to have a significant effect, Tables 2, 4, 6 and 7). The Gestalt psychology, whose theoretical framework informed this study, emphasizes a holistic overview of events if any phenomena are to be explained meaningfully. Total attitude is therefore a meaningful picture, in this case, rather than to explain attitude in their individual components, cognitive, affective and psychomotor. The findings that teacher variables are associated with pupil attitude towards teaching and learning of science are considered meaningful. In the schools where the study was carried out, there were no female Science teachers. The girl child lacked feminine role models. This impacted negatively on the attitude towards Science teaching and learning.

Teachers' colleges must encourage positive attitude and inculcate into future science teachers, a strong interest and knowledge of the subject, in order to promote proper scientific methodology. Through modeling (Bandura, 1997), the secondary school pupils develop strong interest and positive attitude towards science. All males and females; experienced and non – experienced teachers, must aim at making science enjoyable to others through their good and correct Scientific teaching approaches. Science teachers should pay greater attention to selecting those teaching methods that would point out to the students the relevance of science to life. Students are to be motivated to like Science subjects. Institutions of higher learning which educate science teachers must envisage gender equity and equality as a mechanism for promoting pupil's attitudes towards classroom science. I am forced to conclude that to improve attitude towards Science teaching and learning, recruitment and retention of able, bright, experienced and enthusiastic teachers of Science is critical.

I have to mention as well the limitations of my study which are with regards to the representative character of my respondents, which was wholly selected from urban schools. In pursing this study, it was not in the hope of finding out the practical solutions to problems, but rather in the hope that findings would be relevant to understanding of attitudes towards teaching and learning of Science. It was not possible, in this study, to link pupil's attitude with their Science performance in class and with career aspirations. Future study in this area is therefore called for, not only to seek answers to these questions but also to further investigate the relationships between pupils' attitudes towards science subjects and their perceptions of the world of science at work.

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