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THE LEVEL OF UNDERSTANDING OF RADIOACTIVITY CONCEPTS AMONG SENIOR SECONDARY SCHOOL STUDENTS IN IKOT EKPENE LOCAL GOVERNMENT AREA

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ABSTRACT

This study was prompted by the finding that teachers and students view radioactivity concepts in the physics curriculum as difficult, thereby making it a likely area in which students could perform poorly in internal and external examinations. The study sought to identify the level of understanding demonstrated by senior secondary school student on radioactivity concepts as well as determine the influence of variables such as sex and school location on the level of understanding shown by the students on the concepts. The instrument for investigation was a researcher- made 45- item multiple choice test called Test of Understanding of Radioactive Concepts (TOUR). This was administered to one hundred and twenty senior secondary three physics students from two rural and two urban schools in Ikot Ekpene Local Government Area of Akwa Ibom State. The findings showed that the students demonstrated a low level of understanding on radioactivity concepts. Also, the understanding of boys and girls did not differ significantly. Moreover, urban students did not understand the radioactivity concepts better than rural students at 0.05 Alpha Level.

INTRODUCTION:

Physics as a science subject has been acknowledged as a major prerequisite for the study of engineering, technological, medical and other applied science courses in the universities. But there exist an unimpressive state of low enrolment, declining interest and poor performance by students (Ogunneye, 1982; Ugwuanyi, 1994; Orisaseyi, 1997) resulting from many factors including the problem of understanding (Otuka, 1983). Understanding as one of the basic goals of science teaching is a condition in which students can interpret and use concepts that they have learnt. It is so important in the teaching and learning of science because it creates the ability to generalise beyond specific stimuli and to a variety of problem situations (Biehier and Snowman, 1982). In other words, a thorough understanding of scientific concepts is an essential step towards the realisation of the nations aspirations towards science and technological development and by extension the achievement of the objectives of physics education at the secondary school level.

This study therefore was undertaken to ascertain the level of understanding of radioactivity concepts by senior secondary school students so that teachers and students can take deliberate steps in ensuring effective teaching and learning to bring about understanding.

BACKGROUND OF THE PROBLEM:

Science when defined in terms of products entails knowledge in the form of facts, concepts, laws and theories (Pella, 1975). This implies that mastery and understanding of scientific concepts is necessary for technological development and sustenance.

Policy statements bordering on the ways in which government can widen science experiences through the acquisition of knowledge, concepts, skills and attitudes have been made. For instance, the National Policy on Education (Revised, 1981) states:

> *universities and other levels of the educational system will be required to pay a greater attention to the development of scientific orientation. p.25.*

This and other positive support are done with a view to improving the quality of science education in Nigerian schools. But in spite of all these, the state of physics education has been found to be the most pathetic as a steady increase in failure rate in physics over the years were recorded (Ogunleye, 1999). Further compounding the ugly situation is the difficulty experienced by students in mastering the concepts and principles outlined in the national science core curricula prescribed for senior secondary schools (Aghenta, 1982; Otuka, 1983). This indeed has been the concern of physics educators (Okeke and Akujor, 1983; Onwioduokit, 1993) as such situation can mar our dream of becoming an industrialised nation and actualising our goals of science education.

The signification of understanding in relation to scientific concepts in the senior secondary school curriculum can be considered in terms of the ability of students to visualise what is taught by making representations in the form of pictures, illustrations or model (Mansarray, 1987). It can also be by writing down a set of equations to aid description or computation of aspects of the concepts under study (Kitcher,1982) or by the ability to evaluate new facts and events within the context of an organised set of idea or information already stored in the memory (Howard,1989). Also, the importance of understanding in physics learning has been stressed in that it ensures retrieval or recall of information items or facts stored in the memory (Ekeruo et at, 1988). When a student has fully grasped a given concept or generalisations in science, it can then be expected that he will be able to define the concept in words, recognise instances of the use of the concept and solve problems which involve the concept (Adeniyi,1 986; MacGuire and Johnstone, 1987). Viewed against the backdrop of the meaning and importance of understanding in science learning, of which physics is the most fundamental, it became necessary to find out the level of understanding of radioactivity concepts among senior secondary school students in Ikot Ekpene Local Government Area on the grounds that radioactivity constitute a wide area for testing in terminal and certificate examinations and had been found to be difficult for students in secondary schools (Onwioduokit, 1996).

Broadly speaking, the National Physics Curriculum for secondary schools has two concepts-motion and energy - permeating it and directly related to major and/or sub-concepts grouped into five sections of space, time and motion; conservation principles; waves; fields and quanta. Radioactivity concepts which are generalisation of information or general notions on the disintegration effected by high-energy bombardment or the spontaneous disintegration, first observed in certain naturally occurring heaving elements (radium, actinium, uranium, thorium) with the emission of x-rays, b-rays, r-rays, is treated under the section on "fields" during the third year of the senior secondary school. It is meant to help the students appreciate the concept of the atom, identify radiation from radioactive substances using their characteristics, state some uses of radioactive substances, determine the products of a radioactive decay and solve simple problems involving half life of radioactive substances. To ascertain how effective the learning of radioactivity concept has been carried out to pave the way for better understanding, the first three levels of Bloom's cognitive domain viz: knowledge, comprehension and application was used.

According to Gronlund (1970), knowledge is the remembering of previously learned material and may involve the recall of a wide range of materials from specific facts to complete theories. The illustrative general instructional objectives at this lowest level of learning outcomes include knowing common terms, specific facts, methods and procedures, basic concepts and principles. Comprehension is the ability to grasp the meaning of material and may be shown by translating material from one form to another (words to numbers), by interpreting material and by estimating future trends, predicting consequences or effects. The illustrative general instructional objectives include understanding facts and principles, interpreting verbal material, interpreting charts and graphs, translating verbal material to mathematical formulas, estimating future consequences implied in data and justifying methods and procedures.

Application, the third level in the cognitive domain, refers to the ability to use learned material in new and concrete situations and may include the application of such things as rules, methods, concepts, principles, laws and theories. The illustrative general instructional objectives include applying concepts and principles to new situations, applying laws and theories to practical situations, solving mathematical problems, constructing charts and graphs, and demonstrating correct usage of a method or procedure. The above details buttresses the importance attached to the element of understanding in science.

Empirical studies has identified factors that creates difficulty in understanding of some science concepts to include: low intellectual growth that manifest itself through an operational process of the mind (Piaget, I 967), resistance to new methods (Hurd, 1969), inadequate resources for teaching (Davies,1971) and influence of teaching styles (Mcphail et al, 1972). Abimbola (1986) is of the view that teachers hold conflicting alternative conceptions and misconceptions of science concepts and principles while Oyeneyin and Balogun (1981) found out that achievement at lower cognitive level was higher than at higher cognitive levels in science concepts. Students were also found to have generally poor understanding of concepts in physics (Otuka, 1987). Gunstone and Watt (1985) as well as Shipstone and Gunstone (1985) using four physics concepts confirmed poor understanding of physics at the secondary school level. Johnstone and Mughol (1976) found out that a number of concepts studied in elementary physics courses gives difficulty in understanding. Therefore, it may well be said that difficulty of concepts could lead to inadequate understanding of basic concepts in physics including those of radioactivity. However, it must be pointed out that the lack of proper understanding is not peculiar or restricted to physics alone as numerous studies shows that the problem affects science students generally (Osborne and Freyberg, 1985; Olarewaju, 1993).

Furthermore, extant literature reveal that greater opportunities is given to boys to engage in science studies at the detriment of their girls counterpart (Tobin and Gamete, 1987) and teachers are bias toward elaborating more on boys' responses than girls' responses in classroom discussions (Jones and Wheatley, 1990). Such situations are likely to affect the level of understanding of science concepts in terms of sex. Iketuonye (1986) opines that since the African culture provides differential experiences to boys and girls and consequent differential opportunity and motivation for learning in specific areas, it follows that sex is a relevant factor to be associated with students' understanding. Ormerod and Duckworth (1975) concluded in their studies that boys perform better than girls in the science and attributed it the fact that boys and girls have learning styles and respond differently to various strategies and types of teacher behaviour. A number of studies (Kelly, 1987; Schibecci and Riley, 1986) also have noted differential performance between boys and girls. However, Gardner (1985) and Okeke (1981) have shown that sex is not a relevant factor to be associated with school achievements.

In considering the influence of school location on performance borne out of understanding of scientific concepts, Nwaizugbe (1981) shows that differences exist in favour of students in the co-education urban schools while Jegede and Inyang (1991) found out that the rural/urban dichotomy in spite of the apparent imbalance in facilities, etc. does not exert any significant effect on pupils understanding. However, the need for further studies to verify that position was harped.

PURPOSE OF THE STUDY:

The purpose of the study was to find out the level of understanding of radioactivity concepts among senior secondary school students in Ikot Ekpene Local Government Area. It also sought to find out the influence of sex and school location on the level of understanding of the students on radioactivity concepts. This was done with the hope that the outcome of the study will be of immense benefit to teachers, parents and government in responding to their roles as stake holders in the enhancement of science teaching and learning nay understanding in schools.

RESEARCH QUESTION/HYPOTHESES:

The study answered the one question: what is the level of understanding demonstrated by senior secondary school students on radioactivity concepts in the National science curriculum.

Also, three research hypotheses guiding the study were tested. They were:

Ho1: There is no significant difference in the understanding of radioactivity concepts among senior secondary three physics students on the first three levels of the cognitive domain of Bloom's taxonomy of educational objectives.

Ho2: There is no significant difference due to sex in the understanding demonstrated by senior secondary three physics students on radioactivity concept.

Ho3: There is no significant difference in the level of understanding of radioactivity concepts shown by senior secondary three physics students from urban and rural schools

RESEARCH METHOD

The study utilised a survey design. To select the schools for the study and therefrom a representative proportion of the population (i.e. sample) to which generalisations were to be inferred, a criterion sampling technique was used. The criteria used included: schools that are co-educational, schools that have qualified physics teacher(s), schools that have well-equipped laboratory and schools that are currently presenting candidates for the Senior Secondary Certificate Examination (SSCE). Four schools that met the criteria were randomly chosen for the study. Also, random sampling technique was used to select 30 senior secondary three physics students, comprising 15 males and 15 females from each of the four schools, to constitute a 120-member sample for the study. A researcher-made test named "Test of Understanding of Radioactivity Concepts (TOUR)" constructed based on the illustrative instructional objectives of the first three levels of the cognitive domain and using fifteen outlined radioactivity concepts (See Table 3) was face and content validated a by team of two science education experts and two experienced physics teachers before it was administered on 30 senior secondary three physics students selected as pilot sample to obtain a reliability coefficient of 0.75 using the split-half method and the kR-21 formula. After a proper and successful administration of the test to the selected sample through face to face contact and subsequent scoring (1 mark for a correct answer and 0 for a wrong answer), the test scores of the students were collated and analysed using descriptive statistic of median and inferential statistic of t-test and one-way ANOVA. Post-hoc analysis was also carried out using Scheffe test.

RESULTS:

The results of the data as analysed are displayed in Tables 1-7 below.

Table 1: Students' Grouped Scores on Test of Understanding of Radioactivity Concepts condense the table to smaller sizes.

Class x	Frequency f	f_A	f_B
10-14	4	116	0
15-19	17	99	4
20-24	47	52	21
25-29	37	15	68
30-34	13	2	105
35-39	2	0	118

NB: Calculated Median Value = 24

Table 2: Test of significance of difference in scores above and below the median.

Student' Scores	n	Mean	S.D	df	t_{cal}	Decision at p<.05
Above Median	52	28.63	2.72	109	16.68 (1.96)	*
Below Median	58	19.67	2.95			

NB * = Significant at p < 05

t-value in bracket is the critical value.

The calculated t-value of 16.68 is greater than the critical value of 1.96 at .05 Alpha level. Therefore, the students demonstrated statistically significant low level of understanding on radioactivity concepts in the National Science Curriculum.

Table 3: Students' Scores on each Radioactivity Concepts.

SIN	Radioactivity Concepts	Frequency		
		Knowledge	Comprehension	Application
1	Composition of the Nucleus	105	67	88
2	Nuclides and their Notations	68	56	44
3	Isotopes	82	50	60
4	Radioactivity and Radioactive Elements	80	60	76
5	Radioactive Emissions	78	65	64
6	Detection of Radiation	76	45	58
7	Radioactivity Decay laws and processes	70	54	65
8	Half life and Decay constant	71	43	37
9	Transformation of elements (Transmutation)	75	58	58
10	Application of Radioactivity/Radioisotopes	86	70	64
11	Nuclear Reactions and Equations	64	44	52
12	Binding Energy, Mass Defect and Energy Equation	52	43	40
13	Nuclear Reactor Principle	50	40	56
14	Radiation Hazards/Safety precaution	80	54	72
15	Peaceful uses of Nuclear Reactions/Atomic Energy	112	58	80
Totals on Levels Percentages on Levels		1149 40.0%	809 28.1%	914 31.9%

The percentages of the students scores on radioactivity concepts on the three cognitive domain levels are all less than 50%.

Table 4: One-way ANOVA Students' Understanding on Three Levels (Knowledge, Comprehension and Application) of cognitive domain.

Source of Variation	Sum of Squares SS	df	Mean Square MS	$F_{cal.}$	Decision at p<.05
Between	7651.58	2	3825.79	13.43 (3.47)	*
Within	5980.28	21	284.77		
Total	13631.83	23			

Table 4 above shows that F-calculated value *(13.43)* is greater than the critical F- value (3.47). Thus, the hypothesis that there is no significant difference in the understanding of radioactivity concepts among senior secondary three students on the first three levels of Bloom's cognitive domains was rejected.

Table 5: Scheffe Test Values

S/n	Group pairs	F_{cal}	Decision at p < .05
1	1 and 2	12.84(3.49)	*
2	1 and 3	6.06(3.49)	*
3	2 and 3	1.263,49	NS

* = significant at p<0.5 NS = not significant

The results in the table above revealed that there was a significant difference between two possible pairs thereby confirming the findings in Table 4.

Table 6: Influence of sex on understanding of SS3 students in Radioactivity Concepts

Sex	Mean	S.D	df	t_{cal}	Decision at p <.05
Boys	25	5.32	118	0.48 (1.96)	NS
Girls	23	4.55			

NS = Not significant at P< .05. The hypothesis that there is no significant difference due to sex in the understanding students on radioactivity concepts was upheld.

Table 7: Influence of School Location on Understanding of SS3 Students in Radioactivity Concepts.

Location	Mean	S.D	df	t_{cal}	Decision at p <.05
Urban	25	5.32	118	0.21 (1.96)	NS
Rural	243	7.68			

NS = Not significant at P< .05.

SUMMARY OF FINDINGS:

The major findings of the research are as follows:

1. Most senior secondary three physics students show significantly low level of understanding of radioactivity concepts by in Ikot Ekpene Local Government Area of Akwa Ibom State.
2. There is a statistically significant difference in the students' understanding of radioactivity concepts across the cognitive levels at 0.05 level of significance, thus implying variation in understanding by students in questions involving knowledge,

comprehension and application.

3. No statistically significant difference on the level of understanding of radioactivity concepts by boys and girls in secondary schools in Ikot Ekpene Local Government Area.
4. No significant influence of rural and urban environment on senior secondary three physics students' understanding of radioactivity concepts.

DISCUSSION OF FINDINGS:

RESEARCH QUESTION: *What is the level of understanding demonstrated by senior secondary school students on radioactivity concepts in the National Science Curriculum?*

The calculated median score (24) revealed the problem of low understanding of radioactivity concepts as 58 and 52 of the 120 scores of the students in the test fell under the "low' and "high" categories respectively. The median or "average" category had 10 scores. The finding when further subjected to a t-test analysis of the mean scores of subjects who were respectively above and below the median class, indicated a significant difference between the mean score of subjects above and below the median class. Also, the percentage score on each level of the three cognitive domain considered was less than 50%. Thus, it could be said conclusively that most students demonstrated a low level of understanding on radioactivity concepts in the National Science Curriculum. This agrees with the work of Johnstone and Mughol, 1976; Osborne and Freyberg, 1985 and Olarewaju, 1993) and points to the fact that students do not understand the basic principles and concepts in radioactivity (Gunstone and Watt, 1985; Shipstone and Gunstone, 1985). The explanation could be then that teachers have contributed to the low level of understanding depicted by the students through conflicting alternative conceptions and misconceptions of science concepts and principles held by them, to which evidence from researches suggest (Abimbola, 1986). Moreso, influence of teaching styles and inadequate resources for teaching could also contribute to the problem of low understanding on radioactivity concepts by the students (Mcphail et al 1972; Davies, 1971).

HYPOTHESIS ONE: *The is no significant difference in the understanding of radioactivity concepts among senior secondary three students on the first three levels of the cognitive domains of Bloom's taxonomy of educational objectives.*

The one-way ANOVA analysis of students' understanding on the knowledge, comprehension and application levels of the cognitive domains gave a higher calculated F-value (13.43) than the critical value

(3.47). Thus, the value is statistically significant at 0.05 probability level and suggest a difference among the three levels considered. A post-hoc analysis using Scheffe test also result in noticeable difference that cannot be attributed to the concepts alone but to some other variables. This is in line with the thinking of Oyeneyin and Balogun (1981) that understanding differs on the taxonomic levels of the cognitive domain. Specifically, the students' level of understanding on radioactivity concepts in questions involving comprehension and application varies while those between knowledge and comprehension as well as those between knowledge and application does not vary. This clearly shows that comprehension and application requires urgent attention if improvement in students' learning is desired. This is with a view to checking the glaring cases of inability by students not only to translate and interpret materials on the concept tried but also that of using the materials learned in new and concrete situations.

HYPOTHESIS TWO: *There is no significant difference due to sex in the understanding demonstrated by senior secondary three physics students on radioactivity concepts.*

With a calculated t-value of 0.48 compared to a critical value of 1.96, it is evident that sex in not an important factor in students' understanding of radioactivity concepts. This is in total agreement with the researches by Gardner (1985) and Okeke (1981). However, the work contradicted the studies conducted by Ormerod and Duckworth *(1975),* Iketuonye (1986), Schibecci and Riley (1986) and Kelly (1987) which establishes that boys and girls exhibit differential performances on scientific concepts.

Thus, the learning styles and response to various strategies and types of teacher behaviour are not tenable reasons that could be adduced for the difference in performances by the students, since they had equal opportunity, motivation and exposure to learn radioactivity concepts as taught in schools. Rather, teachers bias towards elaborating on boys responses in class and the male domination syndrome in most African Societies could be pinpointed. (Jones and Wheatley, 1990; Iketuonye 1986).

HYPOTHESIS THREE: *There is no significant difference in the level of understanding of radioactivity concepts shown by senior secondary three students from rural and urban schools.*

The t-test yielded a value of 0.21 which in lower than the critical value of 1.96 at 0.05 level of significance. This portrays that the understanding of radioactivity concepts by students from rural and urban schools was not significantly different in any way. This implies seriousness to teaching and learning by the teachers and students in spite of their operating environment. This result is in consonance with the finding of Jegede and Inyang (1991).

RECOMMENDATIONS:

Based on the summary of the findings and likely implications to educational practice, the following recommendations are made.

1. The scope of the test should be broadened to include higher cognitive levels and/or test on process skill development and affective outcomes to fall is line with the assessment requirement of the present 6-3-3-4 system education in the country. The test should also be adopted by teachers for the purpose of criterion and norm-referenced testing in physics to evaluate students' understanding of this all important concept.
2. Authors and textbooks writers should assist in simplifying radioactivity concepts for easy understanding by the students. Resourcefulness, practical value and problem solving approach should characterise books published in ordinary level physics.
3. Teachers should be emphatic on teaching for application rather than teaching for memorisation and regurgitation of facts that does not give room for comprehension, application and other higher levels of the cognitive domain. Also, the use of innovative teaching strategies, teaching materials and the stimulation of students' interest by teachers is strongly recommended.
4. Equity in exposing students to educational experiences regardless of gender is highly recommended for thorough conceptual and process understanding. Thus, role differentiation in boys and girls should be avoided when teaching radioactivity and other science concepts.
5. Urban and rural schools should be equitably staffed without discrimination to reduce high student-teacher ratio that can impede effective teaching and understanding. In addition, the balance in rural-urban dichotomy between secondary schools in terms of supply of teachers and materials should be maintained.
6. Periodic seminars and workshops aimed at improving teachers'/ students' level of understanding on radioactivity concepts should be organised by government and other stakeholders in the education sub-sector.
7. Curriculum planners should thinker with the content and teaching approaches of radioactivity concepts to enhance understanding by the students across geographical bounds.
8. Further researches into the level of understanding of other physics concepts should be carried out by physics teachers and science educators with a view to optimising learning.

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