ISSN-L: 2223-9553, ISSN: 2223-9944
Vol. 5 No. 1 January 2014

AN ASSESSMENT OF SECONDARY SCHOOL PHYSICS TEACHERS CONCEPTUAL UNDERSTANDING OF FORCE AND MOTION IN EDO SOUTH SENATORIAL DISTRICT

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ABSTRACT

This study was aimed at assessing the conceptual understanding of secondary school physics teachers in the concept of force and motion. Two (2) research questions and one (1) hypothesis were raised to guide this study. The research design used for this study was the survey design. A sample of 80 physics teachers selected from both public and private schools across the seven (7) Local Government Areas in Edo South senatorial district participated in the study. The data collected were analyzed using the frequencies, percentages and chi-square statistics. Results of the data analysis showed that majority of the physics teachers do not have conceptual understanding of the concept of force and motion. Also the qualification, teaching experience and specialization of physics teachers did not significantly influence their conceptual understanding of the concepts of force and motion. Based on the findings of this study, it was recommended among others that there should be the organization of workshops, seminars and any other form of in- service training for physics teachers.

Keywords: Teachers, Conceptual Understanding, Misconception, Physics, Force, Motion

INTRODUCTION

Physics is an important subject in the school curriculum because of its contribution to the scientific and technological development of any society. Thus for the proper understanding of scientific and technical subjects, physics indeed plays a major role (Ivowi, 1994). As a result of its application and importance, physics is one of the subjects required for the study of Engineering, Medicine, Physical Sciences and other related courses in tertiary institutions. Without adequate foundation and knowledge of physics in our society, the scientific and technological advancement in Nigeria will be a mirage (Ogumogu, 2011). In order to have the adequate foundation and knowledge in physics that will be needed for the advancement and development of science and technology in our society, there is the need for physics students to have the right conceptions of the various physics concepts (ideas) they are been exposed to in schools in order to apply these knowledge to their day to day activities (Omosewo, 2007).

Students' performances in physics over the past decade have been very poor and not encouraging; as a breakdown of students' performance shows that there is a downward trend (Omoifo, 2012). The West African Senior School Certificate Examination (WASSCE) Chief Examiners' Reports (WAEC, 2007; 2008) revealed that candidates weakness in physics were traceable to lack of knowledge of the basic principles, concepts, laws and their appropriate

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applications to explaining and solving physics problems. These are as a result of physics students having poor understanding of physics concepts, a situation which may arise from a number of causes; one of which is students having misconceptions (a situation that occurs when an individual idea is at variance with the current scientific agreed ideas, views or explanations) of physics concepts. Studies on students' understanding of physics concepts show that many students posses misconception of some concepts that are basic to the thorough knowledge of physics; as it is now widely acknowledged that students' misconceptions in physics do impede their meaningful understanding of and good performance in the subject (Chee, 2010; Helm, 1980; Ivowi, 1984; 1986; Simanek, 2008). Studies on students conception of physics concepts reveals that many students do have misconceptions of physics concepts after receiving formal instruction. Among the concepts investigated are force and motion (Dariese, 2012; Helm, 1980; Ivowi, 1984; Lark, 2007), light (Blizak, Chafiqi & Kendil, n.d), signals and systems (Nasr, Hall & Garik, n.d), conservation of principles and fields (Ivowi, 1986), electricity and magnetism (Raduta, n.d) and so on.

Students misconceptions in physics may originate from many sources, these include: interactions with the socio-physical world prior to formal science instruction, textbooks, reference books, teachers, language, cultural beliefs and practices (Balci, 2006; Ivowi, 1987 Soyibo, 1993). Of particular interest in this study are teachers as a source of students' misconceptions in physics, since teachers serve as a source of authority for knowledge to students. It is however expected that formal instructions in physics should lead to either the modification, reduction or even a change of misconceptions in students because effective teaching should not only teach students what is correct, it also ensures that students do not believe what is incorrect (Dergisi, 2010). Bruner (1960) in Akpan (1999) argued that the child is ready to learn when the teacher is ready to teach and that any subject can be taught effectively in some intellectually honest form to any child at any stage of development. Hence teachers have a major role in challenging and changing the conceptions of students.

Since students have misconceptions after instruction, it therefore indicates that physics teachers need a knowledge base that will enable them to have conceptual understanding (right conception of an idea or concepts which is in agreement with current scientific explanations or conception) of the concepts they do teach in the classroom in order to help students undergo a process of conceptual change from the unscientific conceptions they might hold to acceptable scientific conceptions. Such a knowledge base is the knowledge of content which is one of the forms of professional knowledge that is needed by teachers for effective teaching (Carlsen, 1999; Grossman's, 1990; Magnusson, Krajcik & Borko, 1999; Shulman, 1986; 1987). Teachers' adequate conceptual understanding of the concepts they teach is an evidence of his content (subject matter) knowledge.

Teachers' adequate conceptual understanding of the content they do teach may enable them to be aware of students' likely misconceptions and the learning difficulties students may encounter in trying to learn these physics concept and hence there is the likelihood of the teacher helping the students to correct these misconceptions and also assist the students in overcoming these learning difficulties. In order words, if physics teachers do not have conceptual understanding of the concepts they are teaching then meaningful conceptual change cannot take place in students because teachers do teach what they know. The lack of conceptual understanding among some physics teachers may be one of the reasons why physics teachers do not seem to know or predict the level of misconceptions in their students (Berg & Brouwer, 1991; Ivowi, 1986; Simanek, 2008; Smith & Neale, 1991) and this thus affect learning.

Teachers' level of understanding the concepts they teach is one of the obvious factor affecting his effectiveness in the class and this effectiveness in the classroom is very crucial in the formation of concepts by the students. Since teachers serve as a source of authority for knowledge to students and formed misconceptions in students may be removed or minimized through teaching then it becomes necessary to investigate teachers conceptual understanding of the concepts they teach. A conscious effort to correct misconceptions in students should be preceded by teachers themselves having an adequate conceptual understanding of the concepts they teach. Hence if physics teachers do not have the conceptual understanding of the physics concepts they do teach then our starting point for any remediation should be the teacher, because the conceptual understanding of the teachers must first be improved upon before any meaningful improvement can be expected in students learning and understanding of physics concepts. This study will therefore attempt to investigate secondary school physics teachers' conceptual understanding of force and motion. The choice of these concepts is because it is one of the concepts that are widely taught in schools as compared to other physics concepts and studies have shown that students have misconceptions in the concepts of force and motion (Dariese, 2012; Ivowi, 1984).

In Nigeria, several studies have been carried out about the conceptions of different concepts in science, majority of these studies mainly focus on student conceptions either at the secondary or tertiary institutions, only little work (empirical study) exist in the area of teachers' conception, one of such few studies is the study carried out by Ivowi (1986) on teachers misconceptions of some physics concepts. The study used teachers from only public secondary schools and considered only the influence of qualification on teachers' conception. This present study will involve teachers in both private and public secondary schools, because the performance of students in physics is reported for students in both public and private schools, so using teachers from public schools alone for this study will not be convincing enough as it may affect the external validity (generability) of the results obtained. Also since physics teaching is characterized with teachers of varied qualification, teaching experience and specialization, this study will also look at the influence of all these factors towards the conceptual understanding of physics teachers in the concepts that are under study. Finally this study will serve to provide current information (data) or an idea on teachers' conception of the concepts of force and motion.

STATEMENT OF PROBLEM

Students' performances in physics over the years in external examinations have been very poor and not encouraging. This may be due to their misconceptions of some physics concepts that are basic to the thorough knowledge of physics; as it is now widely acknowledge that students' misconceptions in physics do impede their meaningful understanding of and good performance in the subject (Dariese, 2012; Ivowi, 1987). If teachers have conceptual understanding of the concepts they do teach, then it will be expected that formal instructions in physics should lead to either the modification, reduction or even a change of misconceptions in students. But however several studies that have been carried out on students' conceptions in physics revealed that students still possess misconception after they have been taught. Since students do have misconceptions after they have been taught in secondary schools, hence there will be the need to find out the conceptual understanding of physics teachers in the concepts they do teach in classrooms.

In Nigeria, several studies have been carried out on conceptions of different concepts in science, majority of these studies mainly focus on student conceptions either at the secondary or tertiary institutions, only little work (empirical study) exist in the area of teachers' conception, thus there will be the need to address this area. Students conceptions in physics

have to some extent received considerable attention to show that students do have misconceptions in physics concepts after they have been taught in schools; hence there is the need to take this study further towards investigating teachers conceptual understanding of the concepts they do teach in the classroom as empirical studies in this area is scarce; considering the fact that literatures have shown that teachers are one of the major source of misconception in students. This study is deliberately aimed at paving the way for further research on teachers conceptions as it have serious implications for students' achievement and curriculum development. For this study the underlying issues will be:

1. Do physics teachers have conceptual understanding in the concepts of force and motion?
2. To what extent do factors such as qualification, teaching experience and physics specialization influences teachers' conceptual understanding of force and motion?

RESEARCH QUESTIONS

Arising from the issues raised in the problem of the study, the following research questions are raised to guide this study:

1. Do secondary school physics teachers have conceptual understanding of force and motion?
2. Do qualification, teaching experience and specialization of physics teachers influences their conceptual understanding of force and motion?

Research question 1 will be answered directly while research questions 2 was hypothesized and tested as hypothesis 1.

HYPOTHESIS

1. Qualification, teaching experience and specialization of physics teachers do not significantly influence their conceptual understanding of force and motion.

RESEARCH METHODOLOGY

The research design employed for this study was the Survey research design. This survey design involves giving a two tier diagnostic test instruments to the sample of the study (teachers) in other to provide the relevant information that will be used in making decisions concerning secondary school physics teachers' conceptual understanding of the concepts under study.

The target population of this study was all the physics teachers in both public and private senior secondary schools in Edo South Senatorial district, Edo State. The researchers used the stratified random sampling technique in selecting 80 physics teachers across the 7 Local Government Areas in Edo South Senatorial District. The stratification was done by school location (urban and rural), school type (public and private), sex of teachers (male and female) qualification (qualified and unqualified), area of specialization (physics specialist and non-physics specialist) and teaching experience (experienced and novice teachers). The researchers ensured that subjects (teachers) in each of the subgroups was adequately sampled and represented in the study so as to allow adequate representation of the specified groups in the target population.

In other to achieve the objective of this study; a two-tier diagnostic instrument for assessing Physics Teachers Conceptions of Physics Ideas (PTCPI) in force and motion was used for the study. The PTCPI consist of Section A & B. Section A will seek the personal data (demographic data) of the teachers; Section B contains 20 items (10 items for the concept of

force and 10 items for the concepts of motion) to elicit teachers' conceptions in force and motion. In Section B of the PTCPI, the first part of each item consist of a multiple choice content question having four options, the second part of each items contains a set of four possible reasons for the answers to the first part. However, the teacher will be allow to give his own explanation if he feels his reason to the choice made in the first part is not provided in the instrument. The distracters in the multiple choice response and reasons were derived from actual misconceptions in the physics concepts under study gathered from literature review and also from interviews of students' teachers. This PTCPI was a slight modification of the two-tier diagnostic instrument used by Dariese (2012). The slight modification was as a result of the fact that the instrument developed by Dariese (2012) was used to elicit students' conception. Since the PTCPI was for physics teachers, there was the need to modify the instrument so as to obtain relevant information from the teachers so as to suit this study. Basically what was modified was the time limit to respond to the items, biodatas, and opportunity for teachers to provide their own explanation to their choice of options. The two-tier multiple choice instrument is different from the common objective test. This instrument allows the examinees (teachers) to select an answer and provide the reason for the answer which will help the researcher to elicit the right conception or misconceptions held by the examinees (teachers). Whereas the objective test instrument allows the examinees to select either the right or wrong answers only and one can't really use that to ascertain the certainty of the teachers' conceptual understanding. The PTCPI was validated by two Physics teachers in senior secondary schools, a lecturer in physics department in University of Benin, an expert in measurement and evaluation and finally by an expert in science education in the Department of Educational Psychology And Curriculum Studies, University of Benin. This was done in other to ensure that the instrument measure what it is designed to measure so as to provide information that will be relevant to the decision that is to be made. Their opinions and suggestions were incorporated into the instrument so as to improve the research instrument which was used for the study.

Table 1. Test Item Table of Specification for PTCPI

Content	*Objectives*				*Total (100%)*
	Knowledge (20%)	*Comprehension (35%)*	*Application (30%)*	*Higher Abilities (15%)*	
Force (50%)	2 (10%)	3 (15%)	3 (15%)	2 (10%)	10
Motion (50%)	2 (10%)	4 (20%)	3 (15%)	1 (5%)	10
Total (100%)	4	7	6	3	20

To determine the reliability of the instrument a pilot testing was carried out. The PTCPI was administered to twenty (20) physics teachers; these physics teachers were not involved in the main study. Data collected were analyzed using the Kuder-Richardson 20 (KR-20) technique. The reliability coefficient was found to be 0.77; this high alpha value indicated that the instrument was reliable for the study. The instrument (PTCPI) was administered by the researchers and 5 research assistants. The instrument was administered to physics teachers in the sampled schools that were used for the study. The physics teachers were given up to one week to provide solutions to the items in the PTCPI, after which the completed instruments were collected. This one week was given to physics teachers to complete the instrument in order to ensure high rate of returns and also to allow the physics teachers to provide solutions to the questions in the PTCPI at their own pace, so that the actual conceptual understanding

of the physics concepts under study can be obtained. The statistics that were used for the analysis of the data collected include the frequencies, percentages and the chi-square statistics. The hypothesis was tested at significant level of 0.05.

RESULTS

The research question and the hypothesis raised for the study were carefully answered and tested respectively.

Research Question 1: Do secondary school physics teachers have conceptual understanding of force and motion?

In order to answer the research question, the researcher decided that if a teacher is able to score 50% and above of the maximum score for right conception; then it means that the teacher have conceptual understanding of the concept of force and motion. Since the maximum score for the right conception is 20, thus the test score used for making decision is 10 and above. A summary of the table showing the percentage of teachers that have conceptual understanding of force and motion is presented in Table 2.

Table 2. Percentage of Physics teachers with conceptual understanding of force and motion

Score Categories	*Frequency*	*Percentage*	*Proportion*
10 and Above	22	27.5	0.275
Below 10	58	72.5	0.725
Total	80	100	1.000

(Test Score = 10)

Table 2 reveals that out of the 80 physics teachers sampled for the study, 22 of them scored 10 and above, while 58 of the teachers scored below 10. This thus gave a percentage of 27.5 (0.275) who scored 10 and above; while the percentage that scored below 10 was 72.5(0.725). This result clearly indicates that majority of the physics teachers in the sampled schools do not have conceptual understanding of the concept of force and motion.

Research questions 2 was hypothesized and tested as hypothesis 1.

Hypothesis 1

Qualification, teaching experience and specialization of physics teachers do not significantly influence their conceptual understanding of force and motion.

A summary of the descriptive table is presented in Table 3.

Table 3. Descriptive table of physics teachers conceptual understanding of force and motion based on qualification, teaching experience and specialization

Scores on Conceptual understanding	*Qualification*		*Teaching Experience*		*Specialization*	
	Qualified Teachers	*Unqualified Teachers*	*Less Experienced Teachers*	*Experienced Teachers*	*Physics specialist teachers*	*Non-physics specialist teachers*
10 and above	10	12	15	7	15	7
Below 10	25	33	40	18	44	14
Total	35	45	55	25	59	21

ISSN-L: 2223-9553, ISSN: 2223-9944
Vol. 5 No. 1 January 2014

Table 3 above shows the number of physics teachers in the two score categories of conceptual understanding based on qualification, teaching experience and specialization of physics teachers. To test if there is a significant difference among the variables identified above in order to see if these variables significantly influence physics teachers' conceptual understanding of force and motion; the chi-square statistics was used. A summary of the table on chi-square statistics is presented below:

Table 4. Chi-square test on the influence of qualification, teaching experience and specialization of physics teachers on the conceptual understanding of force and motion

Variables	*Df*	X^2 *value*	*Sig.(p)*	*Decision*
Qualification	1	0.036	0.850	Not significant
Teaching Experience	1	0.005	0.946	Not significant
Specialization	1	0.486	0.345	Not significant

α= 0.05

Using the chi-square statistics at significant level of 0.05 to test the hypothesis, table 4 shows that the difference observed in qualification, teaching experience and specialization of physics teachers on their conceptual understanding of force and motion was not significant (since the p value for each variable is greater than the α value of 0.05). Therefore one can say that qualification, teaching experience and specialization of physics teachers do not significantly influence their conceptual understanding of force and motion.

DISCUSSION OF FINDINGS

This study revealed that majority of secondary school physics teachers (about 73%) scored less than 50% of the maximum score on conceptual understanding of force and motion. The average overall score for conceptual understanding was 35.6% of the total conceptual score. However, the scores on the numerical achievements were higher than that of the conceptual achievements. This therefore implies that majority of physics teachers do not have conceptual understanding of the concepts of force and motion. This finding is similar to the finding of Dergisi (1999) whose study reveals that pre-service physics teachers have conceptual difficulties of physics concepts in Turkey. Other studies which look into the understanding of Chemistry concept resulted in similar findings, the studies of Sheehan, Childs and Hayes (n.d) and that of Mulson and Robin (2002) revealed that the average conceptual scores of preservice Chemistry teachers in Ireland were below average. The finding of this work is somehow related to the finding of Ivowi (1986) where it was revealed that physics teachers have misconceptions in force and motion. These findings may be the reason why students do have misconceptions in physics concepts which have been confirmed in earlier results (Dariese, 2011; Ivowi 1984). The inability of majority of physics teachers in predicting possible students misconceptions as confirmed in some studies (Berg & Brower, 1991; Eryilmoz, 1999; Ivowi, 1986; Smith & Naele, 1991) can be as a result of physics teachers having poor conceptual understanding of physics concept as confirmed in this study. The reason for this poor conceptual understanding of physics concepts among physics teachers may be due to the carryover of wrong idea of some physics concepts during their students' days, since the physics teacher was once students. Ivowi (1987) and Soyibo (1993) opined that many of the misconceptions that physics teachers harbour in physics are likely to have originated partly from physics texts and reference books they consult for their teaching and partly from the misconceptions they too had acquired as students of physics; this partly

explains why students continue to have misconception in physics after formal instruction in physics. Also in tertiary institutions where the physics course is taught to students who may later become physics teachers; the teaching method often use for physics instruction (which is mainly the lecture method) do not promote conceptual understanding of the physics concepts that are been taught. Another reason for this finding may be that physics instructors in the tertiary institutions may be in a hurry to finish their course content without the concern of the students (who may later become physics teachers) having the conceptual understanding of the physics concepts been taught; in other words they do not give detailed explanation of concepts to the pre-service teachers. Another reason for this finding may be that since there are non specialist physics teachers teaching physics subject in secondary schools, it may be that the knowledge these non specialist teachers use in teaching physics is the classroom is the knowledge from their first year introductory physics course in tertiary institution. It is the believe of these researchers that first year introductory physics course is insufficient for teaching physics in secondary school.

Literature has shown that teachers are one of the sources of misconceptions among their students (Anamali, 2012; Dariese, 2012; Ivowi, 1986; Simanek, 2008) and since this study have shown that majority of physics teachers have poor conceptual understanding of physics concepts, thus the physics teacher is likely to transmit what they know to their students, which may translate to what the students now understand about the concept been taught. In order words since majority of physics teachers lacked theoretical arguments to promote students understanding, hence the arguments they present to their students for a particular idea are weak and not very convincing to their students. The best the teachers could now do is to give the students numerical explanations and undermine the conceptual explanation of a concept or an idea. In order to reduce the misconceptions or poor understanding of physics concepts among students, it is necessary that teachers themselves should first and foremost have a conceptual understanding of the concepts they are to teach, if this is not done, then we will continue to have a cycle of reproduction in physics teaching. Further analysis on the conceptual understanding among physics teachers revealed that the conceptual understanding of the concepts understudy were not significantly dependent on their qualification, teaching experience and specialization. This finding is surprising and revealing, as the researcher expected that these variables should have strong influence on the conceptual understanding of physics concepts among physics teachers, but however this was not the case. This finding in terms of qualification is somehow in agreement with Ivowi (1986) whose finding revealed that misconceptions of physics concepts were held by both trained and untrained teachers in Nigerian secondary schools. The finding in terms of specialization contradicts the finding of Sheehan, Childs and Hayes (n.d) which reported that the course of study of pre-service Irish science teachers had impact on their level of misconceptions.

CONCLUSION AND RECOMMENDATIONS

The overall findings of this study revealed that majority of physics teachers in secondary schools do not have conceptual understanding of the concepts of force and motion and the conceptual understanding of physics teachers are not significantly influenced by their qualification, teaching experience and specialization.

Based on the findings of this study, the following recommendations are made:

1. The need for follow up courses or training for physics teachers cannot be overemphasized thus there should be the organization of workshops, seminars and any other form of inservice training programmes (conferences, further training etc.) for physics teachers. Doing this will help physics teacher to be informed of the

various misconceptions in physics concepts and thus efforts will then be made in correcting these misconceptions. In the process of correcting these misconceptions, it will automatically lead to the improvement of physics teachers' conceptual understanding.

2. Authors of physics textbook should give detailed explanations of physics concepts in their book; as oftentimes teachers do rely so much on textbooks as the source of their knowledge. The authors should also try as much as possible to review their books in line with the new challenges and needs as they arise, so as to enable the physics teachers be informed of these and hence be updated.
3. Teachers themselves should try as much as possible to be aware of the various misconceptions and the learning difficulties students are likely to encounter in various physics concepts. Doing this will enable the teachers to find ways in overcoming these challenges which in turn can improve their conceptual understanding of these concepts.
4. In tertiary institutions where physics courses are been taught, there is the need for the lecturers teaching this physics concepts to use instructional strategies or activities that will help to provide detail information or explanations that will enhance students understanding of the physics concepts that the students are exposed to; so as to enable the students develop a strong content knowledge base which is necessary for physics teaching. Because some of these students (especially the student -teachers) may end up teaching physics in secondary schools.

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