Conceptions Of The Nature Of Science Held By Undergraduate Pre-Service Biology Teachers In South-West Nigeria

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ABSTRACT

This study investigated the conceptions of the nature of science held by pre-service undergraduate biology teachers in South-West, Nigeria. Specifically, the study examined the influence of their gender on their conceptions of the nature of science. The study was a descriptive research of the survey method. The population for the study comprised all undergraduate pre-service biology teachers in Nigerian universities. Stratified random sampling technique was used to select ninety nine (99) undergraduate pre-service biology teachers from three universities in South–West, Nigeria. The nature of science questionnaire (NoSQ) was used to collect data. Results revealed that pre-service undergraduate teachers' gender did not influence their conceptions. It was recommended that biology teacher educators should equip the pre-service undergraduate biology teachers with meta-cognitive tools such as Study Technology to enable them to learn for meaningful understanding.

Keywords: *Nature of Science, Conceptions, Misconceptions, Correct Conceptions*

INTRODUCTION

Science has since the dawn of civilization been a potent tool for finding solutions to the never ending human problems, or at least, help man to manage his challenges well. Science as a field of study and endeavour will always be an important aspect of human lives. Science involves all conscious activities that man engages in to understand nature and its components. Science, according to Abimbola (2013), can be seen as a body of knowledge; it could also mean a way or method of investigation and a way of thinking in an attempt to understand nature. Amongst others, the scientific process involves particular skills of inquiry that include: observing, classifying, experimenting, measuring, inferring and organizing data.

The nature of science according to Gess-Newsome (2002) is defined as the epistemological foundations of science, which include its empirical basis, tentativeness, subjectivity, creativity, unification, and its cultural and social embedded characteristics. The nature of science encapsulates the characteristics of science that make people understand scientific endeavours with less acquisition of cumbersome scientific knowledge. The preceding descriptions of the nature of science cannot be wholesome because science is viewed from different points of view and perspectives by researchers and scientists the world over. If there is a list that attempts to reveal all the values, processes, usefulness, prospects and products of science, the list will be endless.

Scientists and science educators have emphasized the absence of a consensus among researchers and scientists on the meaning of the nature of science. They opined that the situation is so because the

nature of science is multifaceted, ever-changing and convoluted. Like scientific knowledge, conceptions of the nature of science are ever dynamic and have witnessed different transformations throughout the development of science and scientific processes. Moreover, despite continuing disagreements about a particular definition of the nature of science, at a certain level of generality and within a set period, there is a shared perspective about the nature of science. There is a general agreement on several elements of the nature of science that is used for research purposes (Abd-El-Khalick, 2005; Abd-EL-Khalick and Lederman, 2008; Akerson, Morrison & McDuffie, 2006; Lederman, 2007). The main purpose of this study was to gain useful insight into what the conceptions of the nature of science held by Nigerian undergraduate pre-service biology teachers are and take appropriate actions where necessary. Specifically, the study also aimed to; find out undergraduate pre-service biology teachers' conceptions of the nature of science; determine the influence of gender on conceptions of the nature of science held by undergraduate pre-service biology teachers in South-West, Nigeria.

For any science student to excel in the field of science, adequate knowledge of the nature of science is essential. The structure, epistemology and philosophy of science as described by Abimbola (2013) include its products, processes, and ethics. It is only when a student gets a good grasp of these concepts that such student could stand a good chance of a constructive academic success.

Literature shows that relatively little attention has been paid to students' views about the nature of science. This is more so in the case of undergraduate pre-service biology teachers (Kang, Scharmann & Noh, 2005; Çelikdemir, 2006). There have been many studies about students' views of the nature of scientific knowledge, but those conducted among the undergraduate pre-service biology teachers in Nigeria are relatively few. Meanwhile, there exist numerous studies carried out among undergraduate pre-service science teachers and practicing science teachers in other parts of the world (Aslan, 2009; Ayvacı, 2007; Kenar, 2008; Yücel-Oyman, 2002).

The results of these studies made it clear that the majority of Turkish elementary school students and pre-service science teachers held misconceptions and alternative conceptions of some aspects of the nature of science. Many of the undergraduate science education students had the conception that there is certain and defined scientific method to develop scientific knowledge (Bülbül & Küçük, 2007; Şahin, Deniz & Görgen, 2006; Ünal-Çoban & Ergin, 2008). However, Most of these studies have neglected the possible influence of pre-service biology teachers' gender on their conceptions of the nature of science. Also, many of these researches were conducted involving only pre-service biology teachers from one particular university or college, whereas, this study focused on pre-service biology teachers from three different Nigerian universities. This is the knowledge gap this study intended to fill.

Bearing in mind the cultural diversity in the Nigerian context and the peculiarities of the Nigerian educational system, considerable attention should be focused at understanding what the views of pre-service biology teachers about the nature of science are. This knowledge will help stakeholders arrive at a comprehension of the Nigerian biology teachers' conception of the nature of science and take appropriate palliative or remedial measures where necessary.

The theoretical foundation upon which this study was based is constructivism. This area of educational interest is a learning theory propounded by cognitive psychologists with constructivist epistemological perspectives such as Jean Piaget (1896-1980). Other writers and philosophers who have enormously influenced constructivism are: John Dewey, Maria Montessori, Lev Vygotsky among others (Wikipedia, 2014).

Brooks (2004) defined the term constructivism as an instructional approach that emphasises the active participation of learners in the instructional process. Effective learning takes place, as learners are active components of a process of meaning and knowledge construction instead of passively receiving information. Brooks (2004) perceived constructivism as a learning theory based on observation and scientific study. The researcher also went further to explain it as a philosophy of learning founded on the belief that by reflecting on human experiences, man can build up an understanding of the world. Learning could also be perceived as the process of adjusting our mental states to accommodate new experience (Brooks, 2004).

Read (2004) opined that, there is widespread agreement among researchers in education that learners should not be seen as passive recipients of information during the teaching and learning process. Instead, they are active constructors of their knowledge. He explained that before a child begins school, he has a wealth of experiences, and these prior experiences have led him to develop a common sense

understanding of his social and natural environment. These experiences give the learning process a boost because the formation of new knowledge will likely be influenced by pre-existing knowledge. However, there may be a challenge that could arise from learners' personal construction of new knowledge.

The study was guided by the following research questions;

1. What are undergraduate pre-service biology teachers' conceptions of the Nature of Science?
2. Is there difference in the number of correct conceptions about the nature of science held by male and female undergraduate pre-service biology teachers?
3. Is there difference in the number of misconceptions about the nature of science held by male and female undergraduate pre-service biology teachers?

Based on the preceding research questions, it was hypothesised that;

HO_1: There is no significant difference in the number of correct conceptions about the nature of science held by male and female undergraduate pre-service biology teachers.

HO_2: There is no significant difference in the number of misconceptions about the nature of science held by male and female undergraduate pre-service biology teachers.

The outcome of this study is envisaged to be of importance to the teaching and learning of science. Specifically; students, secondary school biology teachers and lecturers in tertiary institutions, teacher educators, curriculum planners and textbook writers.

Secondary school biology teachers and lecturers in higher institutions of learning stand to gain immensely from the findings of this research work. The outcome of this research might help them realize the conceptions held by their students, and take appropriate steps towards improving the meaningful understanding of scientific concepts and the nature of science by the students.

On the part of biology teacher educators, the findings of this research work could help them to tailor biology teacher education practices towards producing biology teachers that can successfully handle students' misconceptions and improve the image of biology among the students. Curriculum experts need to be sensitive to students' preconceptions at various stages of curriculum development. Hence, results of this study could provide them with useful information on students' conception of the nature of science.

Textbook writers might also find the outcome of this study useful because it might illuminate the hidden educational needs of secondary school science students. The upshot of this study would keep them abreast of the conceptions of the nature of science held by students, thereby giving them directions in which they should make improvements in addressing students' misconceptions and alternative conceptions of the nature of science.

A review of literature related to this study was carried out. Bello and Abimbola (1997) conducted a study to determine the impacts of gender on student's concept-mapping ability and achievement in evolution. The upshot of the study showed that there was no gender influence on students' concept-mapping ability and their achievement in evolution. In Ghana, Taale (2014) also conducted a study to inquire about the influence of biology teacher's gender on their conceptions of the nature of science. The outcome of the study is also similar to that of Bello and Abimbola (1997). The study also showed that teachers' gender is not a major factor in their conceptions of the nature of science.

From the information provided by the reviewed literature, it is evident that the researchers share the opinion that there exist various misconceptions and alternative conceptions about the nature of science among undergraduate pre-service science teachers, especially practicing biology teachers and secondary school students alike. Unlike what was observed in some of the reviewed literature, where the researchers utilized simple random sampling and in some cases, purposive sampling, the researcher in the case of this study employed the stratified random sampling technique in selecting the sample for the study, this is at variance with some of the reviewed studies where the purposive sampling method was adopted for drawing samples.

The need for this sort of research was borne out of the fact that most researches into the conceptions of the nature of science held by pre-service biology teachers were conducted outside Nigeria while those conducted in Nigeria are relatively few. The execution of a research work of this nature is envisaged to help bridge the gap created by the relatively small number researches into the conceptions of the nature of science held by Nigerian undergraduate pre-service biology teachers. The sample that was used for the

present study was gotten from three different universities, unlike other past researches that made use of just one institution. This would also enhance the external validity of the study.

METHODOLOGY

The study was a descriptive research of the survey method. The population for this study was all undergraduate pre-service biology teachers in South-West Nigeria. Stratified random sampling technique was adopted to select the representation of the population. The universities from which samples was drawn are government universities that have a long history of graduating biology education students. Specifically, ninety nine (99) pre-service biology teachers were selected from three universities in South-West Nigeria.

The research instrument that was employed to gather data in this study is the 'Nature of Science Questionnaire' (NoSQ). The researcher adapted the NoSQ from the previous instrument developed and used by Indiana State University (2015). The NoSQ was divided into two sections; sections A and B. Section A of the questionnaire sought for demographic information while items in Section B sought for the pre-service biology teachers' conceptions about the nature of science. There were 25 items in Section B, some of which have been re-structured to suit this study. These items were based on the various tenets of the nature of science. Respondents were required to indicate their conceptions about the nature of science by ticking (√) or crossing (X) the various statements about the tenets of the nature of science. A reliability coefficient of 0.74 was obtained using Pearson product moment correlation statistics.

Both descriptive and inferential statistics were employed in the analysis of the collected data. All the research questions raised and hypotheses earlier stated were tested using the chi-square (x^2) statistical tool. The hypotheses were tested at 0.05 level of significance.

RESULTS

Research Question 1: *What are undergraduate pre-service biology teachers' conceptions of the Nature of Science?*

To answer research question 1, undergraduate pre-service biology teachers were requested to indicate their conceptions of the nature of science. Table 1 and table 2 show the number, as well as percentages of undergraduate pre-service biology teachers that held correct conceptions and misconceptions about various aspects of the nature of science respectively. As shown in table 1 and table 2, undergraduate pre-service biology teachers held a mixture of correct and misconceptions about the nature of science. However, they appeared to hold more misconceptions than correct conceptions about the nature of science. This finding provides the answer to research question 1.

Table 1. Correct Conceptions about the Nature of Science held by Undergraduate Pre-Service Biology Teachers.

S/N	Pre-service undergraduate biology teachers' misconceptions about the nature of science	Correct Conceptions	
		Frequency	Percentage
1	Science is primarily concerned with understanding how the natural world works.	78	79.4%
2	Science requires a lot of creative activity.	77	78.6%
3	Science typically provides only temporary answers to questions.	50	51.0%
4	Scientists can believe in God or a supernatural being and still do good science.	64	64.6%
5	Science can be done poorly.	40	40.4%
6	Science can study and explain events that happened millions of years ago.	72	73.5%
7	Knowledge of what science is, what it can and cannot do, and how it works, is important for all educated people.	85	85.9%
8	Scientists have observed that nature apparently follows the same rules throughout the universe.	65	65.7%

9	Scientists often try to test or disprove possible explanations.	78	78.8%
10	Science can be influenced by the race, gender, nationality, or religion of the scientists.	55	55.6%

Table 2. Misconceptions about the Nature of Science held by Undergraduate Pre-Service Biology Teachers.

S/N	Pre-service undergraduate biology teachers' misconceptions about the nature of science	Misconceptions	
		Frequency	Percentage
1	Science is primarily a search for truth.	85	86.7%
2	Science can solve any problem or answer any question.	66	66.7%
3	Science can use supernatural explanations if necessary.	36	36.4%
4	Astrology (predicting your future from the arrangement of stars and planets) is a science.	66	66.7%
5	A hypothesis is an educated guess about anything.	73	74.5%
6	Science is most concerned with collecting facts.	79	82.3%
7	Most engineers and medical doctors are actually scientists.	83	83.8%
8	A scientific fact is absolute, fixed, and permanent.	59	59.6%
9	A scientific theory is a guess.	47	48.5%
10	Scientists have solved most of the major mysteries of nature.	67	67.7%
11	Modern scientific experiments usually involve trying something to see what will happen, without predicting a likely result.	71	74.7%
12	Anything done scientifically is always accurate and reliable.	69	69.7%
13	All scientific problems must be studied with The Scientific Method.	73	73.7%
14	Disagreement between scientists is one of the weaknesses of science.	45	45.9%
15	Any study done carefully and based on observation is scientific.	73	73.7%

Research Question 2: *Is there difference in the number of correct conceptions about the nature of science held by male and female undergraduate pre-service biology teachers?*

HO_1; *There is no significant difference in the number of correct conceptions about the nature of science held by male and female undergraduate pre-service biology teachers.*

Table 3: Chi-square Analysis of Significant Difference in the Number of Correct Conceptions held by Male and Female Pre-service Undergraduate Biology teachers

Gender	χ^2	Df	Sig
Pearson Chi-Square	25.296	1	.235
Likelihood Ratio	32.165	1	.056
Linear-by-Linear Association	.326	1	.568
N of Valid Cases	99		

Not Significant at .05 alpha level of significance.

As shown in Table 3, a chi-square analysis was conducted to compare the correct conceptions about the nature of science held by male and female undergraduate pre-service biology teachers. It was found that there was no significant difference in the number of correct conceptions about the nature of science held by male and female undergraduate pre-service biology teachers. [$\chi^2(1, 99) = 25.296$, $p = .235$]. Since the p-value (.235) is greater than 0.05 (level of significance), the null hypothesis (HO_1) was not rejected. This finding provides an answer to research question 1. That is to say, there is no gender difference in the number of correct conceptions about the nature of science held by undergraduate pre-service biology teachers. This

result suggests that gender really does not have influence on the number of correct conceptions of the nature of science held by undergraduate pre-service biology teachers.

Research Question 3: *Is there difference in the number of misconceptions about the nature of science held by male and female undergraduate pre-service biology teachers?*

HO_2; *There is no significant difference in the number of misconceptions about the nature of science held by male and female undergraduate pre-service biology teachers.*

Table 4:Chi-square Analysis of Significant Difference in the Number of Misconceptions held by Male and Female Pre-service Undergraduate Biology teachers

Gender	χ^2	Df	Sig
Pearson Chi-Square	.009	1	.923
Likelihood Ratio	.009	1	.923
Linear-by-Linear Association	.009	1	.924
N of Valid Cases	99		

Not Significant at .05 alpha level of significance.

A chi-square analysis was conducted to compare the number of misconceptions about the nature of science held by male and female undergraduate pre-service biology teachers. As shown In Table 4, There was no significant difference in the number of misconceptions about the nature of science held by undergraduate pre-service biology teachers based on their gender at the p>. 05 level [$\chi^2(1, 99) = .009$, p =.923]. Since the p-value (.923) is greater than 0.05 (level of significance), the null hypothesis (HO_2) was not rejected. This finding answers research question 2, meaning there is no difference in the number of misconceptions about the nature of science held by undergraduate pre-service biology teachers based on their gender. This result indicates that undergraduate pre-service biology teachers' gender does not have much influence on their conceptions of the nature of science.

DISCUSSION

Findings from the study showed that undergraduate pre-service biology teachers held both correct conceptions and misconceptions about the nature of science. The finding suggests that undergraduate pre-service biology teachers held more misconceptions about the nature of science than correct conceptions. This is in line with the works of Butler et al. (2014), Hanson (2015), Onijamowo (2010), Sangsa-ard et al. (2014), Stojanovska, Soptrajanov, and Petrusevski (2012), Tan and Taber (2009), Pinarbasi, Sozbilir, and Canpolat (2009) all these researchers claimed that there exist numerous misconceptions among practicing and pre-service biology teachers about the nature of science.

The gender difference in the conception of undergraduate pre-service biology teachers was found to be statistically insignificant. This outcome agrees with those of Oluwatayo (2011), Taale (2014) who concluded that there is no significant difference in the number of biology teachers who held correct conceptions and misconceptions about the nature of science regarding gender. Parts of the reasons adduced for this is that both male and female undergraduate pre-service biology teachers are trained by the same teachers; under the same conditions; and are taught using the same curriculum. Hence, there is little or no room for a variance in their conceptions.

Consequent upon the fact that there exist various misconceptions about the nature of science among pre-service biology teachers which spreads across both genders as reported in this study, the teaching of science and biology in particular in secondary schools and institutions of higher learning is at a disadvantage. Olorundare (2014b) reported that students usually experience difficulty in learning science topics because of the misconceptions held by their science teachers which are easily transferred to the students. Misconceptions are understood to be stubborn and resistant, hence the higher risk of learners, carrying along the same misconceptions about the nature of science through their elementary education till graduation.

The implication of this is that such graduates eventually become teachers and transfer same misconceptions about the nature of science on to another generation of learners which will make the task of overcoming students' failure in science subjects and biology in particular difficult if not impossible. The findings of this study should stimulate the education authorities to proactively device methods to arrest the unwanted level of misconceptions among pre-service biology teachers and enable them to effectively educate their students for meaningful understanding of biology and science generally.

CONCLUSION

The study concluded that undergraduate pre-service biology teachers held both correct conceptions and misconceptions about the nature of science; however, they held more misconceptions than correct conceptions about the nature of science. The study further concluded that the gender of pre-service biology teachers did not influence their conceptions about the nature of science.

This study has shed more light on the conceptions of the nature of science held by undergraduate biology teachers in Nigeria. Irrespective of pre-service biology teachers' gender, they exhibited similar conceptions of the nature of science. The high number of misconceptions held by these teachers implies that remedial measures that will help these biology teachers reconcile their misconceptions about the nature of science with the appropriate scientific conceptions of the nature of science should be prioritized. Also, the study has pointed out the urgent need for capacity building programs on the nature of science for biology teachers in both government and private schools. These programs may include; symposia, seminar and workshops. The findings of this study conform to the international realities of the existence of various misconceptions and alternative conceptions of the nature of science among biology teachers in many countries. This being the case, international agencies with focus on the advancement of science and biology in particular should focus more attention on the minimization and possible eradication of misconceptions among biology teachers in Nigeria. This could be through the introduction of international scientific literacy exchange programs for both pre-service and in-service biology teachers.

RECOMMENDATIONS

The following recommendations are considered relevant based on the findings of this study:

1. Biology teacher education curriculum planners should take cognisance of the fact that there exist numerous misconceptions about the nature of science among pre-service biology teachers; hence, there is a need to introduce the nature of science as a separate course in the Nigerian biology teacher education curricula.
2. There is also a need to retrain practicing biology teachers to help them reconcile their misconceptions about the nature of science with the appropriate scientific conceptions of the nature of science. This will prevent such teachers from passing misconceptions to their students in the science classroom.
3. Biology teacher educators should regularly identify the pre-service undergraduate science teachers' misconceptions about the nature of science and take appropriate pedagogical measures to help them to reconcile the misconceptions with the appropriate scientific conceptions
4. Biology teacher educators should equip the pre-service undergraduate science teachers with meta-cognitive tools such as Study Technology to enable them to learn how to learn for meaningful learning.
5. Biology education programmes should include Misconceptions in science a core course. This will help the biology teachers and students to be more sensitive to misconceptions about scientific concepts and how to avoid and reconcile misconceptions with the appropriate scientific conceptions.
6. Biology textbooks writers should also take note of misconceptions about the nature of science, hence, guide against statements and assertions that encourage misconceptions.
7. Biology teacher training programmes should make room for the use of instruments such as the nature of science questionnaire as formative tools. This would improve undergraduate biology

teachers' awareness of the nature of science and aid their understanding of the processes of scientific inquiry and the scientific enterprise.

This study was specifically carried out on the conceptions of the nature of science held by pre-service biology teachers in South-West Nigeria, this kind of study can be carried out in other parts of the country to give a holistic view of what the conceptions of the nature of science held by Nigerian undergraduate pre-service biology teachers are. Variables not covered in this study can also be investigated by other researchers. Further studies can also be conducted to look into the sources of the misconceptions or correct conceptions of the nature of science held by biology teachers in Nigeria. Researches can also be conducted to compare the conceptions of the nature of science held by pre-service and in-service biology teachers to see if their conceptions of the nature of science changes with their teaching experience.

More researches can also be carried out to determine if there is any relationship between pre-service biology teachers' conceptions of the nature of science and their academic achievement in biology courses. Also, this can be replicated among in-service biology teachers to find out if their conceptions of the nature of science have anything to do with their classroom instruction or the academic achievement of their students in biology.

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