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Epistemological Beliefs, Scientific Literacy, and Gender of Pre-Service Biology Teachers in Colleges of Education, Nigeria

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ABSTRACT

This study examined the levels of epistemological beliefs and their relationship with scientific literacy and gender among pre-service Biology teachers in Osun State, Nigeria. A descriptive survey design was employed, involving 221 purposively selected participants from two Colleges of Education. Two instruments the Epistemological Beliefs Scale (reliability = 0.77) and Scientific Literacy Scale (reliability = 0.72) were used to gather data. Descriptive statistics (mean and standard deviation) were applied to assess the levels of epistemological beliefs, while Pearson Product-Moment Correlation was used to examine relationships between variables. Findings revealed that the pre-service Biology teachers demonstrated a high level of epistemological beliefs. However, no significant relationship was found between epistemological beliefs and scientific literacy ($r = -0.16$, $p > 0.05$), epistemological beliefs and gender ($r = 0.03$, $p > 0.05$), or scientific literacy and gender ($r = 0.62$, $p > 0.05$). The study concluded that although the pre-service teachers possessed strong epistemological beliefs, these beliefs were not significantly linked to their scientific literacy or gender. Thus, factors beyond epistemological beliefs may influence scientific literacy among pre-service Biology teachers, suggesting the need for further research into other contributing variables.

Keywords: epistemological beliefs, gender, pre-service biology teachers, scientific literacy

INTRODUCTION

Teacher education is basically classified as pre-service preparation or in-service preparation which can be received from Colleges of Education, Institutes of Education, National Teachers' Institute (NTI) and universities which are post-tertiary institutions in Nigeria. Teacher education involves acquiring the skills, methodologies and techniques of teaching (Adebisi & Dania, 2018). Teacher education is also defined as the series of programmes and initiatives designed to assist aspiring educators in obtaining the essential knowledge, art, attitudes, habits, and proficiencies essential for entering as well as maintaining the teaching profession (Maduewesi & Ezeoba, 2010). As stated by the Federal Republic of Nigeria (NPE, 2013), a key objective of teacher education is to generate motivated, conscientious, and effective classroom

instructors to serve at every tier of the nation's educational framework. This will entail developing educators who are not only skilled in their teaching but also possess a strong sense of motivation, conscientiousness, and proficiency in their teaching practice (Ahmed, Pasha & Malik, 2021). These educators should possess the ability to proficiently teach students across all tiers of the educational system in areas or discipline they are trained for, besides, possess the ability to enhance better emotions, values, attitude in their students. In addition, they should be adequately equipped to adjust their teaching approaches and tactics to accommodate the varied needs and learning capacities of students across various age groups. Pre-service teachers are students in the Faculty of Education in the University or Colleges of Education of higher learning who are on stage to develop their competencies through training to become teachers at their various disciplines. Pre-service teachers undertake courses such as teaching methods, psychology of learning, subject contents, classroom management and other pedagogical skills. They also embark on teaching practice during the course of their studies, all of which are to prepare them to be effective teachers after their graduation from school of education in higher institutions.

The major purpose of education is to produce effective individuals who have been adequately developed in their totality to be responsible individuals in the society (Adeyemi & Akinrimisi 2022), and to cultivate well-rounded individuals who have developed high intellect, empathy and practical skills; ultimately shaped individuals into responsible contributors to the main stream of the society. This makes education an indispensable key that is able to ensure the development of individuals within an immediate society and the country at large; it also been known to serve as the bedrock for scientific and technological breakthroughs and advancements.

The scientific and technological breakthroughs are major reasons nations of the world including Nigeria prioritise education and emphasis science. Education and the study of science go along the same pace because science education lies within the scope of education, that is, education is a universal scope in which science finds itself. Science is defined as systematic knowledge based on facts, observations, and experiments. It also refers to the way of knowing, describing, classifying, and understanding our universe (Eastwell, 2002; Hepburn & Andersen, 2021). The Merriam-Webster dictionary defined science as a body of knowledge encompassing universal truths focused on the physical world and its occurrences or functioning of overarching principles, particularly derived and verified through the scientific approach. With these assertions, science can be vividly explained as the comprehension of universal truths and validation of the physical world through the scientific method with practical relevance to daily life affairs.

The importance of science cuts across diverse course of study, in Agriculture, science has contributed to the development of several machineries; improved and more disease-resistant seeds, and production of more efficient fertilizers. In medicine, the impact of science has led to the development of machines such as Magnetic Resonance Imaging (MRI), dialysis and Electro Cardiogram (ECG) machines to name a few. It has also led to the development of new and novel drugs, injections and vaccines such as the COVID vaccine which was developed to immunise

and safeguard individuals during the COVID-19 pandemic amongst others. In recent times, science has contributed to the world's digital legacy, robotic engineering and automated intelligence (AI). These have thrown weight behind the scope of science education which is the aspect of science that involves the teaching and instruction of scientific contents, laws, principles and theories; and it also involves the usage of science pedagogical skills and methods to effectively impart knowledge in individuals. Science education focuses on the instruction and comprehension of science concepts, teaching methodologies and safe-guarding various fallacies held by learners pertaining to science concepts (Aina, 2013). The teaching of science also helps individuals to develop the ability to understand the best way to apply science knowledge practically to everyday life affairs. It helps to develop critical thinking in students such that they can possess the routine of problem-solving skills and abilities which are essential competencies needed to survive the challenges of this century. An essential objective of science and science education is the acquisition of scientific literacy which empowers learners to comprehend and engage with the complexities of the modern World (Nja, 2019). The scope of science in secondary school is taught within the confines of the following subjects: Biology, Chemistry, Physics, Agricultural Science, and Computer Studies amongst others.

Biology constitutes a division of biological sciences related to the study of life and living beings. The study of Biology encompasses the physical and chemical structure, functions, developmental processes and evolution process of living organisms. It involves the research of life and living entities in all their manifestations and occurrences, particularly focusing on aspects such as origin, development, propagation, arrangement, and conduct. For the much-needed technological breakthrough desired in any country; the acquisition of sound, robust knowledge and a comprehensive attitude toward Biology along with other scientific disciplines is of necessity (Nwagbo & Okoro, 2012). This is because of the indispensable role the knowledge of Biology assumes across various fields such as in food production, manufacturing and processing industries, medicine, biotechnology as well as agriculture. Biology is a prerequisite for study Zoology, Ecology, Bioinformatics, Biotechnology, Biomedical Research, Molecular Biology, Genetics, Haematology, Oncology, and medical disciplines.

Biology is not only indispensable in shaping the educational journey of learners but also a broader prospect for the economics of the society. The process of learning science subjects, especially Biology is associated with appropriate and proficient application of scientific skills such as observation, specification, identification, classification and measurement. Meaningful learning of Biology involves laboratory experiences based on inquiry that extends beyond rote learning. These experiences necessitate that students go beyond mere execution of techniques or learning laboratory skills. It will involve posing questions, devising hypotheses, planning experiments, collaboration, analysing data, drawing meaningful conclusions and proficiently communicating findings to peers. These ensure that students attain an in-depth of scientific understanding and knowledge which cannot be attained without the input of qualified teachers. The efficiency of qualified teachers are pre-dominantly rest within the training received and the depth of their psychological factors of epistemological beliefs.

Epistemological beliefs relate to views or perspectives of the content of knowledge, the phenomena and the inherent essence of knowing. It refers to the individual perspectives about how knowledge is perceived, acquired and comprehended (Hofer & Pintrich, 2002; Lee & Chan, 2018). Epistemological beliefs differ in complexity from one individual to another because of individual differences and this is reflected in a diverse array of cognitive frameworks. The belief of an individual about the essence of knowledge or what knowledge should entail might have an influence on their ability to grasp essential information and acquire the all- important knowledge and mastery of competences in a given educational programme. Several researches carried out have highlighted a connection between epistemological beliefs with different dimensions of academic engagement; and concluded that epistemological perspectives are connected to achievement, motivation, and overall performance of students (Phan, 2008; Aypay, 2010; Panergayo, 2023). To fulfil the established objectives of Biology teaching, Biology pre-service teachers have to acquire and develop high levels of epistemological beliefs so as to be scientifically literate in teacher education programme. The trends at which epistemological beliefs are influencing education processes and goals demand that pre-service science teachers are inducted through their training to possess high echelon of how knowledge is pursued irrespective of gender. This will help pre-service science teachers to pass to their students of how and the use of science knowledge to strengthen the foundation of scientific literacy. Basically, epistemological beliefs are not stable in individuals but do change with time but it can rather be coordinated through training towards knowledge based. Research finds out that the gender imbalances in terms of orientation in sciences have been of serious attention to science educators and the society. However, considering the varying potentials in gender differences, it is very important that teachers in training at the higher institutions should be motivated and helped to possess high tendency of epistemological beliefs and practicable scientific literacy. It is posited that the personal epistemology construct has several important implications for education (Sayey & Goudarz, 2020). Personal epistemologies of pre-service teachers would most likely influence the way they conceptualize scientific facts and hence the learning of science for individual students, besides, also likely that teachers' epistemologies may also be reflected in their classroom behaviour (David and Babalola (2015). It is very vital that the pre-service science teachers' level of scientific literacy be stirred up considering the impact of scientific literacy around the world today, for this will enable them to positively influence science students that will be entrusted to them in the nearest future (Obodo, Izekor & Ozoeze 2024).

Scientific literacy of pre-service teachers particularly among the biology teachers in Nigeria has been observed to be below average, as evidenced by previous studies (Kareem & Yoade, 2021; Nja, 2019). Since the scientific literacy entails the essence of knowing, Epistemological belief is an important factor which determines the individual perspectives about how knowledge is perceived, acquired and comprehended which by extension can explain the comprehension of scientific literacy. Studies of relationship between the two variables, epistemological belief and scientific literacy have not received much attention particularly to colleges of education. Therefore, the study aimed to ascertain the relationship among

epistemological belief, scientific literacy and gender of pre-service Biology teachers in Colleges of Education in Osun State, Nigeria.

METHODS

Descriptive survey research design was considered appropriate for the study. This design was deemed suitable for gathering necessary information on the epistemological beliefs, scientific literacy and gender of Biology pre-service teachers in Colleges of Education in Osun State, enabling the assessment of the relationship among the three variables for the representative of the entire population. The study population comprised 240 pre-service teachers offering Biology Education in Government owned tertiary Colleges of Education in Osun State, Nigeria. The research involved a sample size of 221 pre-service Biology teachers drawn from government-owned College of Education Osun State College of Education, Ilesa and Ila-Orangun College of Education in Osun State through purposive sampling technique. The basis of their selection was because they are readily available for the study and they are Biology pre-service teachers.Two research instruments were used for the study:

Epistemological Beliefs Scale (EBS): The instrument was adapted from the previous study conducted by Conley, Pintrich, Vekiri & Harrison (2004) on changes in epistemological beliefs in elementary science students. The instrument was used in collecting data on the levels of epistemological beliefs of pre-service Biology teachers. The EBS comprised of two sections, A and B. Section A solicited information regarding the personal data of respondents such as gender and school type while section B comprised 15 items structured on a 4-point Likert Scale on the response of Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD). Each response category was assigned a corresponding score of 4 marks for Strongly Agree, 3 marks for Agree, 2 marks for Disagree, and 1 mark for Strongly Disagree. These scores were added together to determine the total score of each respondent.

Scientific Literacy Scale (SLS): The instrument was adapted from the previous study conducted by Gormally, Brickman & Lutz (2017) on developing a Test of Scientific Literacy Skills (TOSLS). The SLS instrument was used in determining the scientific literacy of pre-service Biology teachers, comprised of two sections, A and B. Section A requested personal data from respondents on gender and school types while Section B included 10 items questions where respondents selected the correct answer from the set of options. The answers provided to each question was assigned 1 mark for correct option and 0 for incorrect option, the total of correct answers were collated to determine the scientific literacy level of the pre-service Biology teachers.

The two research instruments were validated by three experts in teacher education from the university. The trial testing of the research instruments was conducted by administering the instruments on 30 pre-service Biology teachers in Adeyemi College of Education, Ondo, Ondo State, Nigeria. The questionnaires' reliability was determined using Cronbach's alpha for Epistemological Beliefs Scale (EBS) and a reliability coefficient of 0.77 was obtained while Scientific Literacy Scale (SLS) reliability was determined through Kuder-Richardson (KR-20)

and a value of 0.72 was obtained. The two values obtained were adjudged good for the study. The difficulty indices for Scientific Literacy Scale (SLS) obtained ranged from 0.25 – 0.75.

The researchers obtained official permission from the Head of the Department of Science in the two Colleges of Education used for the study. The Head of the Departments gathered and hand over pre-service Biology teachers to the researchers. The selected students co-operated with researchers in making themselves available and they responded promptly. Data collected were analysed based on the stated research questions and hypotheses with the use of Statistical Package for Social Sciences (SPSS) version 25.0. Total mean score and standard deviation were used in answering the research questions raised while Pearson's product moment correlation was used for the hypotheses raised.

RESULTS AND DISCUSSION

The results obtained from the data analysis of epistemological beliefs, scientific literacy and gender of pre-service Biology teachers in Colleges of Education in Osun State, Nigeria are presented in tables corresponding to the research questions and the tested hypotheses.

Research Question One

What is the level of epistemology beliefs of pre-service Biology teachers in colleges of Education in Osun State, Nigeria?. In answering this research question, the mean score and standard deviation for each question were calculated. The result is presented in Table 1 below.

Table 1. Epistemological beliefs of pre-service biology teachers

No	Items	Mean	Standard deviation	Remarks
1	It is necessary for everyone to trust the information provided by scientists	2.99	0.747	High
2	In the realm of science, it's essential to accept the information presented in scientific literature.	3.08	0.640	High
3	Only scientists have the certainty about what is true in the field of science.	3.12	0.744	High
4	Once scientists obtain a result from an experiment, that represents the sole solution.	2.94	0.888	High
5	Certain concepts in contemporary science differ from previous scientific understandings	3.22	0.677	High
6	There are certain inquiries that even scientists cannot resolve.	3.13	0.741	High
7	Concepts in science can undergo alterations.	3.33	0.638	High
8	Ideas regarding science experiments stem from curiosity and contemplation about the functioning of phenomena.	3.31	0.717	High

No	Items	Mean	Standard deviation	Remarks
9	An essential aspect of science involves conducting experiments to generate novel insights into the functioning of phenomena.	3.33	0.700	High
10	It is beneficial to repeat experiments multiple times to confirm the accuracy of your findings.	3.73	0.483	High
11	Valuable insights in science can originate from anyone, not solely from scientists.	3.37	0.660	High
12	A reliable method to determine the veracity of something is conducting experiments	3.33	0.810	High
13	Sound conclusions are founded on evidence obtained from numerous experiments.	3.40	0.737	High
14	Concepts in science can emerge from inquiries and experimentation	3.26	0668	High
15	It is advantageous to have a hypothesis before initiating an experiment.	3.37	0. 697	High
	Mean = 3.26			

Table 1, Adapted from Conley, A., Pintrich, P., Vekiri, L., & Harrison, D. (2004).

The results in Table 1 showed that the epistemological beliefs of pre-service Biology teachers was high with a mean score value of 3.26 greater than mid mean score value of 2.5

Hypothesis One

There is no significant relationship between epistemological beliefs and scientific literacy of pre-service Biology teachers in colleges of Education in Osun State, Nigeria. In testing this hypothesis, the relationship between epistemological belief and scientific literacy of pre-service Biology teachers was determined using the Pearson's product moment correlation. The result in the Table 2 shows there is no significant relationship between epistemological beliefs and scientific literacy of pre-service Biology teachers in colleges of Education in Osun State, Nigeria.

Table 2. Relationship between epistemological beliefs and scientific literacy of pre-service biology teachers

Variables	N	Mean	SD	Pearson Correlation	Sig
Epistemology beliefs	121	45.54	4.301		
				-0.16	0.09
Scientific Literacy		3.50	1.001		

Hypothesis Two

There is no significant relationship between epistemological beliefs and gender of pre-service Biology teachers in the study area**.** The result in Table 3 shows there is no significant

relationship between epistemological beliefs and gender of pre-service Biology teachers in colleges of Education in Osun State, Nigeria.

Table 3. Relationship between epistemological beliefs and the gender of pre-service biology teachers

Variables	N	Mean	SD	Pearson Correlation	Sig
Epistemology beliefs		48.53	4.301		
	121			0.03	0.71
Gender		1.74	0.438		

Hypothesis Three

There is no significant relationship between scientific literacy and gender of pre-service Biology teachers in study area. The result in Table 4 shows there is no significant relationship between scientific literacy and gender of pre-service Biology teachers in Colleges of Education in Osun State, Nigeria.

Table 4. Relationship between scientific literacy and gender of pre-service biology teachers

Variables	N	Mean	SD	Pearson Correlation	Sig
Scientific literacy		3.50	1.001		
	121			0.05	0.62
Gender		1.74	0.438		

The results of research question one revealed that the pre-service teachers have high level of epistemological beliefs. The findings is in support of Yalcin and Yalcin (2017) who found out that the average means ranging from 3.80 to 3.97 for the pooled data without considering sub dimensions of scale suggest that pre-service science teachers' epistemological beliefs are considerable high. This implies they have developed well informed epistemological beliefs. The result also aligns with the prior research undertaken by Dorsah, Shahadu and Kpemuonye (2020) whose findings showed that the epistemological beliefs of pre-service science teachers were well- informed. The significant level of epistemological beliefs as found by this study implies that pre-service Biology teachers have to capability to make use of constructivist approach in teaching in the classroom upon graduation, thereby making them more efficient and competent teacher. The pre-service Biology teachers with high epistemological beliefs might have robust scientific mind-set, possess the capacity to think like scientists, proficiently articulate scientific concepts, and adeptly apply scientific knowledge in various real-world situations.

Findings from the study also showed that there is no significant relationship between epistemological beliefs and scientific literacy of pre-service Biology teachers in Colleges of Education in the study area. This finding was not in the agreement with previous studies conducted by Kutluca and Mercan (2022), Sargioti and Emvalotis (2020), and Tanik Onal and

Saylan Kirmizigul (2021) who found that epistemological beliefs has a significant relationship with scientific literacy. This finding suggests that interventions aimed at improving scientific literacy among pre-service Biology teachers should consider addressing and potentially modifying their epistemological beliefs.

The result of hypothesis testing which stated that there is no significant relationship between epistemological beliefs and gender of pre-service Biology teachers in Colleges of Education in the study area is not rejected. The finding of the study is in support of the findings from the reports raised that epistemological beliefs is not significantly related to gender (Yenice 2015; Tumkaya 2012; Eren 2007; Kaygın, Bas, Kanbolat and İnenc (2010). In conclusion, these results suggest that further and more comprehensive studies must be conducted with pre-service teachers. The results of present study are limited with only two hundred ten pre-service Biology teachers.

The result of hypothesis testing which stated that there is no significant relationship between scientific literacy and gender of pre-service Biology teachers in Colleges of Education in the study area is not rejected. The study is in support of the findings of Ibe and Nwosu (2016) conducted on gender and levels of attainment of scientific literacy among science students under constructvist instructional model. The studies found out that gender do not influence scientific literacy attainment. There are other findings from Kristyasari, Yamtinah, SUtomo and Ashadi (2018) that male students showed a clearer difference in each science literacy indicator in three different schools. According to them, female students have better mastery in some indicators of scientific literacy while, male students are better at drawing conclusions. Reis and Park (2001) concluded that the superiority of female students in the mastery of science literacy also applies across different countries, age groups, survey periods, and study program on a consistent basis. In conclusion, these results suggest that further and more comprehensive studies must be conducted with pre-service teachers at different levels of higher education with different programme of studies.

CONCLUSION

The study concluded that the pre-service Biology teachers in Colleges of Education had high level of epistemological belief which is very good to prepare them for their future professional teaching career. From the findings, it was observed that there is no significant relationship between epistemological beliefs and scientific literacy of pre-service Biology teachers in colleges of Education. Besides, the study's results bear no significant relationship between epistemological beliefs and gender and also between scientific literacy and gender of pre-service Biology teachers in Colleges of Education in the study area.

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