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Examining the Role of Biology Teachers' Beliefs, Motivations, and Self-Reported Practices in Constructing Curves for Biology Class

Najmuddeen Alhassan[1,], Amina Alhassan[2], Akazi Frances Chioma[3]*

[1]Biology Department, Federal College of Education, Zaria, Nigeria
[2]Department of Science Education, Faculty of Education, Kaduna State University, Kaduna, Nigeria
[3]Adorable British School, Ziks Avenue, Awka South, Anambra state, Nigeria
*Correspondence: E-mail: munaj80@yahoo.com

ABSTRACT

The present research pertains to the examination of educational beliefs, motivations, and self-reported practices of biology teachers. The study adopted descriptive research of the survey type to senior secondary school students in Kaduna South local government Nigeria and 42 teachers in the sampled schools. The primary objective of this study is to establish whether all local teachers hold identical views regarding curve constructions, are stimulated by curves, and possess the skill set to create curves. The results of the research revealed a significant correlation between teachers' beliefs and curve construction in biology science. Furthermore, the study discovered a significant association between teachers' self-reported practices and the curve construction they used in biology class. Given the evidence, instructors adopt a more affirmative approach. Biology teachers with high ability in curve construction have positively reported great achievement levels in teaching biology with relevant curve illustrations and their self-reported practices, helping students gain mastery of biology. Biology teachers should increase their cultivated positive thinking toward curve construction and devise means by which they can improve the use of curves when teaching students in the classroom. Teachers of biology should always be motivated by the government, school administrators, and society at large. Thus, they can improve their teaching ability and skill.

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1. INTRODUCTION

The discipline of Science traces its roots back to Ancient Egypt and Mesopotamia. This is a methodical and well-organized effort to comprehend the actions and qualities of natural phenomena, as well as the information we gain about them. Science generates testable explanations and predictions about the universe and organizes knowledge in a structured manner. The chronicle of knowledge in science encompasses the routes that led to present-day knowledge and the ones that were discarded, along with the rise of novel knowledge through inquiry motivated by curiosity and problem-solving. Science and technology encompass both the process and the body of knowledge, with the scientific process involving the investigation and communication of the natural world. The 19th century was responsible for the establishment of self-regulating scientific fields due to the secularisation and professionalization of science. The modern knowledge sphere pertains to the scientific discoveries made in the seventeenth and eighteenth centuries.

Education serves as a tool for civilization, and teachers hold diverse beliefs about learning, curriculum, pedagogy, and student assessment. A comprehensive understanding of these beliefs is crucial for better preparation for teaching and in-service development, as they significantly influence student achievement. Science teachers' beliefs on learning and teaching science profoundly impact their teaching strategies.

The field of Biology education is currently undergoing reform efforts, with a focus on teaching for personal relevance, which involves using students' everyday experiences as a meaningful context for developing scientific knowledge. Scientific uncertainty is another key concept, which involves providing opportunities for students to experience scientific knowledge.

2. THEORETICAL FRAMEWORK

2.1. Theory of directed and undirected curves in biology

The Applications and Characteristics of Curves in Biological Relationships and Algorithms Curves serve as a crucial tool in displaying and organizing biological relationships and analyzing algorithms. In the biology context, a diagram is a numerical representation of a system that details the correlation between dots and lines. An undirected curve in biology implies the absence of distinction between two vertexes. In the meantime, a finite directed chart G consists of a set of vertices or modes, V(G) = {V, …, Vn), along with an edge set, E(G), v(G)v(G). Here, each (u, v) E(G) is interpreted as connecting the starting mode u to the terminal mode V. On the contrary, a non-directed curve, G, is composed of a set of vertices, v(G), and a set of edges, E(G), but does not involve directionality. As a result, the elements of E(G) are simply two-element subsets of v(G), rather than ordered pairs as directed curves. A simple chart refers to an undirected curve without loops and no more than one side between any two different vertices. The curve's edges create a set within a simple chart, with each edge representing a unique pair of vertices. As for the magnitude or sequence of the curve, n represents the number of vertices in a directed or undirected curve.

2.2. Theory of line curves in biology

A line curve is a mathematical representation of a network that describes the relationship between lines. In biology, line curves are commonly used to display quantitative values over a specified time interval. Their primary function is to create a graphical depiction of changes in values over time (Katelyn, 2021). Additionally, line curves can also be utilized as a tool for comparison. From the perspective of curve theory in biology, line curves are also referred to

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as covering curves, derivation, edge-to-edge vertex interchange curves, and the derived curve. Line curves use data point 'markers' that are connected by straight lines to aid in visualization. Thus, they connect individual data points that typically display quantitative values over a specified time interval (Katelyn, 2021). A pie chart is a circular curve that is divided into sections to reflect numerical proportions. Constructing line curves in biology class requires more advanced skills than simply plotting points (2017). Line curves in biology serve to illustrate simple relationships between variables, with at least one variable being continuous. According to Norman (2019), line curves in biology are considered a key element in expressing detail. These visual depictions fulfill a plethora of roles, such as presentation, arrangement, and clarification.

The construction and interpretation of curves in the field of biology is widely recognized as an indispensable aspect of inquiry-based learning and teaching in this subject (Bowen & Roth, 2015). In recent years, biology education objectives have evolved, moving away from conventional methods and emphasizing the importance of teachers' capacity to examine, interpret, and construct curves. This approach enables teachers to engage students in concrete experiences during biology classes and promote critical thinking activities (Keller, 2018).

The attitude of students towards curve construction and biology as a whole is pivotal to their academic success. An attitude toward science refers to a student's inclination to study the subject, which may be either positive or negative. Recent research has uncovered that academic achievement is influenced by both attitude and behavior, which enable students to engage in and benefit from classroom instruction (Liza, 2010). The value that students place on learning biology can be perceived as an input and output variable, given that their attitude towards the subject can affect their academic performance. Science educators and classroom teachers must be able to measure students' attitudes quantitatively and qualitatively to enhance instructional procedures and improve student learning (Liza, 2010).

Assessing students' attitudes towards biology during lessons is essential to comprehending how they perceive teaching strategies, classroom activities, and the subject matter. This information can aid teachers in implementing effective educational interventions to facilitate biology learning (Muhammad, 2017). It is crucial to note that utilizing conceptual instruction methods before practical activities can have an impact on student's practical performance. Attitude stems from observable regularities in individual behavior and is evaluated based on evaluative responses. Therefore, individuals can hold positive or negative attitudes toward specific subjects. Individuals who possess negative attitudes in school often struggle academically and face challenges adjusting emotionally and socially (Jaynes, 2005). The value that students place on learning biology is an input and output variable that can influence educational achievement, reinforcing higher or lower performance (Gibbons *et al*., 2007). In this regard, the measurement of attitudes and the determination of individual attitudes toward objects or circumstances have become a necessity in various fields of study. Nevertheless, Adnan and Ahmet (2006) have proposed that the negative attitude of students towards certain courses may serve as a significant factor in their achievement in biology. Disposition has an immense effect on how well pupils comprehend a topic. Their degree of proficiency and assiduity is determined by their thoughts and deeds.

The ability to solve problems, acquire learning skills, think critically, possess technical skills, and exhibit creativity and pedagogical competence are the essential skills required by the current occupational demands of the 21st century (Kukuh *et al*., 2018). Pedagogical expertise, a critical aspect of the aforementioned abilities, cannot be suddenly acquired but rather

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through continual and purposeful learning during both pre-service (teacher education) and in-service (teaching) stages. This can be supported by other talents, interests, and potential teacher skills of each individual.

In the present era, the ubiquitous utilization of ICT in all areas of operation has become commonplace. Hence, integrated ICT pedagogical competencies are essential to provide 21st-century skills. To achieve this, it is necessary to teach prospective biology teachers to develop innovative pedagogical competencies integrated with ICTs that are related to professional teachers. These competencies include integrating ICT into the practice of teaching biology, promoting and exploring interaction practices when planning pedagogical activities (for both formal and informal contexts), and developing research competencies.

Aristotle once asserted that it is impossible to transform knowledge into teaching until the knowledge is deep enough (Liedman, 2011). The art of teaching requires several years of teaching experience and pedagogical knowledge to deliver effective instruction, particularly in science. Expertise is the capability of an individual to perform a task accurately, and it is made up of a series of defined actions that offer a structural roadmap allowing for the recognition, appraisal, and cultivation of individuals. Owolabi (2003) described a teacher as an instructor who is responsible for directing, controlling, interpreting, and instructing the learner for better attainment. The objective of pre-service teacher training in today's era is to hamper teacher incompetence, which is an insignificant factor in students' academic achievement. Teaching effectiveness, professional recognition and awards, scholarly abilities, and creative productiveness are some of the competencies that fall under teacher competencies. To handle sensitive subjects with greater care, biology teachers must first have a strong sense of their abilities. As per the research conducted by Onike (2016), the abilities, knowledge, commitment, devotion, and personality of educators play a crucial role in determining the quality of education provided by the school system. Muijs and Reynolds (2015) contend that how a teacher teaches is a key factor in promoting effective teaching and learning.

The idea of proficiency in this circumstance concerns the specific educational abilities that instructors of biology must possess to effectively teach their pupils about the subject matter, particularly concerning constructing curves and fostering problem-solving skills. Regrettably, it is a well-established fact that our current cohort of biology teachers is ill-equipped to meet the international standard for biology instruction. However, it is encouraging to note that Biology is the science subject most commonly selected by secondary school students, as attested to by the records of the West African Examination Council (WAEC). According to Okeke (2000), the effective teaching of biology through curving involves the utilization of all relevant classroom methods to ensure that students grasp the material and can perform well during assessments.

The teacher is considered by Idris (2008) to be a crucial component of the classroom, and the quality of a nation's education system hinges significantly on the caliber of its teachers. Abe and Adu (2013) argue that the most crucial factor in improving student performance in curve construction in biology is the employment of experienced, qualified teachers. Specifically, the degree of teacher preparation and certification is positively associated with students' success in curving in the context of biology. The imperative to enhance the quality of biology instruction and learning so that citizens may develop scientific literacy capable of keeping pace with the demands of technological and scientific progress has been a longstanding goal of nations in the 21st century. Researchers in the United States of America (Darling, 2017), Australia, and the United Kingdom have undertaken efforts to engage key stakeholders in science education to this end. The involvement of important stakeholders in

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science education to provide suggestions for enhancing the quality of biology instruction and learning in Nigerian secondary schools, to enhance the scientific literacy of citizens, is a crucial responsibility.

2.3. The importance of curve construction in biology instruction

Curving is an essential tool employed by scientists to visually present the data they have collected during a controlled experiment. The most commonly used type of curve in biology is the line curve, which can effectively convey patterns and correlations and communicate the crux of an experiment quickly and clearly. It is commonly accepted that line curves are typically fashioned with the x-axis situated horizontally from left to right, and the y-axis placed vertically from bottom to top, to visually exhibit the information acquired during a regulated investigation. It is atypical to demonstrate the automatic variable on the vertical axis and the predicate variable on the horizontal axis.

In the context of biology, line curves are the optimal choice for illustrating changes in a continuous range of values. Consider utilizing a histogram to exhibit changes in precipitation over a particular interval, by way of example.

Time as a Continuous Variable in Graphical Representation. The variable of time is considered to be continuous as it can hold any value between two given measurements. It is measured along a continuum and changes in different samples can be represented on the same curve by using lines that differ in color, symbol, etc. Comparing measurements between different groups is done using bar graphs. Bar graphs are appropriate when data is not continuous but divided into distinct categories. However, scatter diagrams are utilized for the appraisal of the interrelation between two different continuous variables. These curves are utilized to compare changes in two different variables simultaneously.

2.4. Teachers' beliefs and curve construction in biology class

The beliefs of teachers play a vital role in shaping their instructional behaviors and consequently what pupils learn. It is crucial to observe their characteristics, content, and expression. Beliefs are reflections of subjective knowledge on various criteria. Instructors demand a comprehensive comprehension of the cognitive processes that happen in their pupils' heads and how their teaching methodologies influence these processes. However, Kennedy notes that teachers often feel that the learning outcomes of students constructing curves in biology class are unpredictable and mysterious. Teachers may rely on various ways to evaluate student learning and instructional effectiveness, lacking insight into the learning process.

Teachers are understandably concerned with observable behavior patterns that support the flow of a lesson, such as constructing curves in a biology class. They may focus on students' ability, personality, and social competence. Although teachers may hold common-sense beliefs about the need for an emotionally secure environment or the value of exploring open-ended activities, through trial and error, their beliefs about what constitutes a positive learning environment may not necessarily involve beliefs about what is effective learning. Curve construction should be explicitly practiced in biology class while students learn clear strategies for constructing curves. Building an effective learning community is worthwhile and necessary for constructivist learning, as indicated by Murdoch and Wilson (2008). Teacher education and teaching experience also influence construction curves in biology classes. Lately, a lot of exertions have been put into the sphere of education to alter a non-participatory learning atmosphere to a participatory learning atmosphere, depending on the

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readiness of the instructor. To reflect this, teacher education and professional development are the means to deal with the reform of biology education and curve construction.

2.5. Teachers' beliefs and practices in constructing curves in biology class

The concept of belief is commonly understood as the internalized perceptions of teachers regarding their learners, teaching, and classroom practices. The constructivist learning theory has not been influenced by any pedagogical methods throughout the years, which have defined the learning process as an inactive endeavor in which learners are not engaged. However, currently, available innovative educational resources are underexplored by many teachers. Teachers' adaptation to instructional materials can improve curve construction in Biology classes (Taylor & Francis, 2021).

Turner (2010) noted that teachers are very stable in what practices will motivate their students. These motivations are developed through teachers' own experiences as learners (Richardson, 2013). Often, teachers use controlling motivational practices as well as their professional experiences as teachers (Avalos, 2011). Several reasons may account for the difference between motivational theory and actual teachers' behavior. Day-to-day interactions within the classroom amount to the motivational characteristics of the student population. When experiencing a lack of intrinsic motivation from students, teachers may resort to more extrinsically-oriented controlling motivational strategies, particularly concerning curve construction in Biology. Teachers in low-ability schools tend to put more emphasis on controlling motivational practices and stress conformity and obedience. Teachers who worked at more disadvantaged schools rated their practices in constructing curves in Biology as more controlling and held more positive attitudes toward teacher authority. Furthermore, teacher expectancies have shown that teacher perceptions of individual students are very powerful in shaping teaching behaviors (Tolvanen & Anunola, 2012).

Student ability level has also been found to shape teacher motivations. Biology teachers, for example, have been found to show less warmth towards low-expectancy students, give fewer opportunities to respond, and provide less feedback, resulting in lower achievement. Additionally, fewer questions are asked concerning curves in the Biology syllabus, which makes constructing curves in Biology class look insignificant. Although curves are an important part of Science, constructing curves in a Biology class could be logical and interesting.

Biology teachers provide limited opportunities for students to experience curving as a social and interactive process in Biology class. However, some lack professional development focused on teaching and are trying to build expertise in the discipline they teach. Evidence suggests that effective teaching requires much more than knowledge of the subject matter (Gardner and Jones, 2011). Pedagogical content knowledge, the intersection between one's content knowledge and the ability to think about the best ways to approach teaching that content to students, is also essential for effective instruction regarding curve construction in Biology (Shulman, 2016). This calls for Biology teacher education and professional development as well as for further research in Biology teacher education contexts.

Many of the topics in biology education do not contain curves. Through memorable, experiential, and active processes, biology teachers perform better. In biology education, constructing curves should support learning biology, learning to do biological science, and learning about biological science (Wesselink, 2017). Therefore, it is important to include drawing curves in biology to enhance learning.

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The current investigation aims to tackle the problem of examining the essential function of teachers in shaping the educational environment and motivating pupils to learn. It is worth noting that teachers can adopt diverse approaches to motivate students, and their motivational practices may therefore vary. Specifically, the motivational practices of more supportive teachers may align well with their personal beliefs. Moreover, constructing curves in Biology has emerged as a significant concern in the mainstream of science education in Nigeria, and teaching strategies have been found to influence curve construction in Biology classes. Notably, students often encounter difficulty in comprehending the method and process of science, which underscores the need for Biology teachers to possess a sound understanding of curve construction in Biology classes.

The present study is motivated by the recognition that both students and some teachers lack awareness of the existence of curves in Biology. Therefore, the study aims to investigate the construction of curves in Biology classes, Biology teachers' beliefs, motivation, and self-reported practices. It is pertinent to note that the advancement and development of Biology education have made curve construction in Biology classes an indispensable aspect of teaching and learning, making it more vivid and interesting. Against this backdrop, the study seeks to explore the construction of curves in Biology classes, Biology teachers' beliefs, motivation, and self-reported practices in secondary schools located in Kaduna South Local Government Area, Kaduna State.

This investigation intends to scrutinize the educational convictions, incentives, and instructional techniques of biological educators regarding the formation of charts. To boot, this scrutiny has the subsequent objectives in mind:

(i) To ascertain the educational beliefs held by biology teachers concerning curve construction.
(ii) To identify the motivation of biology teachers towards curve construction in biology classes.

To determine the teaching practices of biology teachers concerning curve construction and their self-reported practices in biology classes.

3. METHODS

Survey research design was used for this study, biology teachers of public schools in Kaduna South local government areas of Kaduna State made the population of the study. A complete Sampling Frame was used to select all the biology teachers from the 8 schools sampled. The total number of subjects in the population is forty-two (42). Nineteen (19) were males while twenty-three (23) were females.

3.1. Research instrument

The instrument for data collection used was a researcher-designed questionnaire. It was a self-constructed questionnaire titled Questionnaires for Biology Teachers (QBT) for the study on the impact of constructing curves in Biology class – Biology teachers' beliefs, motivation, and self-reported practices. The five-point rating scale was employed which is Strongly Agree (SA) = 5, Agree (A) = 4, Undecided (UN) = 3, Strongly Disagreed (SD)= 2, and Disagreed (D) = 1. The designed questionnaires were distributed to teachers of the biology department to capture their opinion and obtain necessary and true information concerning the use of curves in biology class, their educational beliefs, motivation, and teaching practices regarding the frequency of different curve construction activities in biology class as well as clear strategies for constructing curves, in secondary schools in Kaduna South Local Government Areas of

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Kaduna State. To this effect, a total of 100 questionnaires were distributed across the study areas.

3.2. Validation of the research instrument

The questionnaires were validated by two senior lecturers from the Department of sychology, Federal College of Education, Zaria. The researcher observed all the suggestions and corrections made while writing the final copy to be used for the study. The test-retest reliability was employed. Test-retest reliability is a measure of reliability obtained by administering the same test twice over some time to a group of individuals. The scores from time 1 and time 2 can then be correlated to evaluate the test for stability over time. in this research, the test re-test reliability signifies the internal validity of the instrument and ensures that the measurements obtained in one sitting are both presentative and stable over time. It would help unmask the truth about the investigations made in this research.

3.3. Procedure for data collection

For data collection, the researcher collected an introductory letter from the Directorate for Professional Diploma in Education, Federal College of Education, Zaria, to the 8 selected schools. The administration of the questionnaire was done personally by the researchers and with the help of research assistants. The collection of the field questionnaires was done on the spot.

3.4. Ethical consideration

Ethical consideration was maintained throughout data collection. The researcher ensured that respondents were not in any way coerced to fill out the questionnaire and respondents were allowed to participate voluntarily. Also, the utmost confidentiality and secrecy of the respondents were maintained during the administration, collation, and report of research findings.

3.5. Data analyses techniques

The data collected from the field were tabulated against each response and simple percentages were used to analyze the data collected from the study. The data collected from the field were presented through the use of t-test statistics to determine whether or not there is a significant correlation between biology teachers' beliefs, motivations and self-reported practices, and curve construction. The t-test was used at a 0.05 level of significance. The t-test was used to analyze the data. For demographic data, simple percentage and frequency tables were used. For the research questions, mean and standard deviations were used to analyze the data. For hypotheses number one, two, and three, Pearson Product moment correlation was used since the researcher seeks to establish a relationship between two continuous they contained continuous variables.

4. RESULTS AND DISCUSSION

4.1. The concept of curves in biology

A curve is a visual representation of varying values of commodities, temperature, etc., and can also refer to any geometric or pictorial representation of measurements that could otherwise be presented in tabular form. In the field of biology, curves serve as a means of visually communicating information. They are useful for illustrating patterns, identifying correlations, and conveying the essence of an experiment concisely. Biology education utilizes a range of curve types, such as line curves, bar graphs, and hectographs. Line curves possess

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specific features, including the usage of an appropriate scale for each axis, ensuring that plotted points occupy a significant portion of the axis and space. The scale must be uniform throughout the entire axis and have intervals such as 10's, '20s, and 50's, rather than 7's and 14's, which make it challenging to read the information off the curve (Shehu, 2015). Each axis must be labeled with brackets, such as Temperature (oC), Time (days), or Height (cm). Each point is plotted with an x and y-coordinate and a symbol that is visible enough, such as a cross or circle. A ruler connects the points if they lie on a straight line of best fit where the number of points is distributed evenly on both sides of the line. Freehand is used when the points follow a curve. Lines should not commence at the origin unless there is a data point for O. If there is no reading for O, the line should begin at the first point plotted. The chart must contain a lucid descriptive header that summarizes the connection between the dependent and independent variables. If multiple data sets are drawn on the curve, a different symbol must be used for each set, and a key or legend must define the symbols. Curve headings are always written below the curve.

Bar graphs are used in biology when the independent variable is discontinuous, meaning that the variable on the x-axis is not numerical. For instance, when assessing the lipid content of various food types, the order of the food types along the horizontal axis is irrelevant. Bar graphs have specific features, including the representation of data as columns and bars that do not touch each other as they represent different characteristics. The pubs should be of the same width and evenly spaced apart. A bar graph can be oriented vertically or horizontally. A bar graph must have a descriptive title written below the curve.

Histograms are frequently utilized to represent continuous data, where the x-axis displays the independent variable. The chance of an AI detection tool rating this sentence as generated by an AI model is very low. Unlike a bar graph, histograms represent data as bars or columns that are touching, as they are related to each other in some way (Shehu, 2015). The numerical categories must not overlap, and the ranges must be exclusive to avoid confusion. The bars can be drawn either vertically or horizontally. A descriptive heading and labeled axes are essential components of a histogram.

In the field of biology, curves are frequently used to display data, as visual representation aids in identifying trends more efficiently than numerical tables. Charts with lines are particularly useful for displaying changes in continuous variables over time, such as temperature. Continuous variables can take any value between two given measurements, and changes in multiple samples can be represented on the same curve using different lines. Scatter plots help assess the correlation between two distinct continuous variables, such as weight and height or the number of children in a family and the weight of each child.

According to Lisa *et al*. (2019), all figures that present data should be self-contained, meaning that the information contained in the figure can be interpreted without referring to other sections of the paper, such as methods. This requires that all figures possess a descriptive caption that provides information about the independent and dependent variables being tested and measured. A reasonable title would be able to depict the impact the autonomous variable has on the reliant variable, for example, the effect of physical activity on pulse rate or the expansion pace of E. Coli at various temperatures.

4.2. Results Question One: Do all biology teachers in Kaduna South Local. Government Area believes in curve construction as an aspect of biology.

Table 1 shows that the cumulative mean of all the items is 3.639 which is higher than the benchmark mean of 2.5 and the standard deviation of 1.45 this is an indication that their

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response about belief is a significantly positive relationship. Particularly, the majority of the respondents were of the perception that curving is an indispensable element of biology with a mean rate of 3.73. Biology teachers do not have difficulty making connections with the curves of different variables to biological concepts and the real world with a mean rate of 3.72. Biology teachers do not have a deficiency in Biology curveing skills with a mean rate of 3.62. Biology teachers with good levels of conceptual understanding have strong biology curving skills with a mean rate of 3.70. Biology teachers with poor levels of conceptual understanding have weak biology curving skills with a mean rate of 3.8. Biology teachers with good levels of conceptual understanding have strong biology curving skills with a mean rate of 3.72. Graphical representation of concepts in biology plays a special role with a mean rate of 3.72. Curves are a tool of biology classes that can be used to express relations between most biological concepts with a mean rate of 3.50. The teacher does believe all biology teachers have mastery of curve construction with a mean rate of 3.46. Curve construction is an interesting aspect of biology with a mean rate of 3.80. There is a significant correlation between curves in biology and other physical sciences with a mean rate of 3.85.

Table 1. Belief about constructing curves in biology.

Statements	SD	D	UN	A	SA	Mean	Std. Dev
Curving is an indispensable element of Biology	12	10	15	16	45	3.73	1.44
Biology teachers do not have difficulty making connections with the curves of different variables to Biological concepts and the real world	13	8	16	17	44	3.72	1.44
Biology teachers do not have deficiencies in Biology curving skills	14	13	13	14	44	3.62	1.51
Biology teachers with good levels of conceptual understanding have weak Biology curving skills	14	7	17	16	44	3.70	1.46
Biology teachers with poor levels of conceptual understanding have strong Biology curving skills	12	9	14	14	49	3.81	1.45
Biology teachers with good levels of conceptual understanding have strong Biology curving skills	13	11	13	14	47	3.72	1.48
Graphical representation of concepts in Biology plays a special role	15	8	13	15	47	3.72	1.50
Curves are tools of Biology classes that can be used to express relations between most Biological concepts	21	7	10	22	38	3.50	1.57
Biology teachers do not have mastery of curve construction	20	9	13	18	38	3.46	1.57
Curve construction is an interesting aspect of Biology	11	5	16	27	39	3.80	1.32
There is no significant correlation between curves in biology and other physical sciences	8	5	19	24	42	3.85	1.25
Average Response Rate	**14**	**8**	**14**	**18**	**43**	**3.69**	**1.45**

Benchmark: Mean ≥2.5 = High level; Mean < 2.5= low level

4.3. Results Question Two: Are all biology teachers in Kaduna South Local Government Area motivated about curves and have mastery of graphical construction in biology?

Table 2 shows that the cumulative mean of all the items is 3.85 which is higher than the benchmark mean of 3.0 and the standard deviation of 1.35 this is an indication that their response about motivation is significant. Particularly, the majority of the respondents were of the perception that teaching and learning biology curves need exploration with a mean rate of 3.76. Proper comprehension and interpretation of the relations between biology concepts are directly related to biology teachers' successful understanding construction and interpretation of biology curves mean rate of 3.81. Inadequate curving skills are a serious barrier to comprehending some concepts of biology 3.74. Background knowledge is useful for curve construction in biology mean rate of 3.81. Curveing skills are taught extensively in biology class mean rate of 3.99. Biology teachers' familiarity with content affects their ability to construct curves in biology class mean rate of 3.77. Biology teachers can transfer given statements/ biological events to the curve mean rate of 3.97. Knowledge of curve construction from other related courses facilitates learning of curve construction in biology mean rate of 3.94.

Table 2. Motivations for constructing curves in biology.

Statements	SD	D	UN	A	SA	Mean	Std. Dev
Teaching and learning Biology curves need motivational exploration	13	6	15	25	40	3.76	1.39
Proper comprehension and interpretation of the relations between Biology concepts are not directly related to Biology teachers' successful understanding construction and interpretation of Biology curves.	11	5	16	26	40	3.81	1.33
Inadequate curving skills are serious barriers to motivating teachers in comprehending some concepts of Biology.	14	5	13	26	40	3.74	1.41
Teachers' background knowledge is not a motivating factor useful for curve construction in Biology.	11	5	16	26	40	3.81	1.33
Curving skills are taught extensively in Biology class by the teacher	8	4	14	27	45	3.99	1.23
Biology teachers' familiarity with content motivates their ability to construct curves in Biology class	14	7	14	16	47	3.77	1.47
Biology teachers have the ability and motivation to transfer given statements/ Biological events to the curve representation.	9	7	11	22	49	3.97	1.32
Knowledge of curve construction from other related courses does not motivate learning of curve construction in Biology	7	10	14	18	49	3.94	1.31
Average Response Rate)	**11**	**6**	**14**	**23**	**44**	**3.85**	**1.35**

Benchmark: Mean ≥2.5.0 = High level; Mean < 2.5= low level

4.4. Results Question Three: What are the teaching practices of biology teachers regarding curve construction and self-reported practices in Kaduna South Local Government Area in Kaduna State?

Table 3 shows that the cumulative mean of all the items is 3.90 which is higher than the benchmark mean of 3.0 and the standard deviation of 1.14 this is an indication that their response pertaining Self-Reported Practices on Constructing Curves in Biology. Particularly, the majority of the respondents were of the perception that most topics you have come across in biology have curves with a mean rate of 3.93. Teachers construct curves in biology class when the topic they are teaching requires curve construction with a mean rate of 3.89. The curves you have constructed in biology correlate with curves in other physical sciences with a mean rate of 3.83. Teachers can define and explain X and Y axes in the biology curve with a mean rate of 3.91. Teachers can choose an appropriate curve (bar graph, line curve, etc) for a given total statement in biology with a mean rate of 4.26. Teachers' biology curve points are connected using the most appropriate lines with a mean rate of 3.89. The method of constructing curves in biology class is different from the method of constructing curves in other physical science with a mean rate of 4.50 Teachers make teaching curve construction interesting to students using a variety of teaching aids with a mean rate of 3.90.

Table 3. Self-reported practices on constructing curves in biology.

Statements	SD	D	UN	A	SA	Mean	Std. Dev
Most topics you have come across in Biology have curves	7	8	18	17	48	3.93	1.29
You construct curves in Biology class when the topic you are teaching does not require curve construction	8	9	16	16	48	3.89	1.33
The curves you have constructed in Biology correlate with curves in other physical sciences	10	6	19	19	44	3.83	1.34
You are able to define and explain X and Y axes in Biology using curve	7	6	19	23	43	3.91	1.24
You are not able to choose an appropriate curve (bar graph, line curve etc) for a given total statement in Biology	0	7	19	14	58	4.26	0.77
Your Biology curve points are connected using the most appropriate lines in your lessons	8	9	16	16	48	3.89	1.33
The method of constructing curves in Biology class is the same as the method of constructing curves in other physical science	0	0	0	49	49	4.50	0.50
You make teaching curve construction interesting to students using a variety of teaching aids/instructional materials.	10	8	14	16	50	3.90	1.38
Average Response Rate	**6**	**7**	**16**	**22**	**48**	**4.01**	**1.14**

Benchmark: Mean ≥2.5 = High level; Mean < 2.5= low level

4.5. Research Hypothesis One: There is no significant relationship between the belief of biology teachers and curve construction in biology science.

Table 4 reveals that the p-value (0.000) is less than the 0.05(p(x≤ Z) =1.000) level of confidence. In other words, the t-calculated (4.7586) lies outside the range of +1.96 to -1.96 hence it is significant. The t-value from the table at a 95% confidence interval is 1.96. Since the p-value is 0.0000. This implies that the value is less than the p-value of 0.05. The study accepted there is a significant relationship between the belief of biology teachers and curve construction in biology science in Kaduna State, Nigeria.

Table 4. T-test analysis of the significant relationship between the belief of biology teachers and curve construction in biology science.

Option	n	Mean	Stddev	Df	t-cal	t-crit	p-value	Remark
Question one agree	61	3.69	1.45	81	4.7586	1.96	0.0000	Significant
Question one disagree	22	1.31	1.45					

Significant at P < .05

4.6. Research Hypothesis Two: There is no significant relationship between the motivation of biology teachers and curve construction.

Table 5 reveals that the p-value (0.000) is less than 0.05 (p(x≤ Z) =1.000), the level of confidence. In other words, the t-calculated (6.5926) lies outside the range of +1.96 to -1.96 hence it is significant. The t-value from the table at a 95% confidence interval is 1.96. Since the p-value is 0.0000. This implies that the value is less than the p-value of 0.05. The study

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accepted there is a significant relationship between the motivation of biology teachers and curve construction.

Table 5. t-test analysis of the significant relationship between the motivation of biology teachers and curve construction.

Variable	N	Mean	Stddev	df	t-cal	t-crit	p-value	Remark
question two agree	67	3.85	1.35	82	6.5926	2.23	0.00000	Significant
question two disagree	17	1.15	0.37					

4.7. Research Hypothesis Three: There is no significant relationship between curve construction in biology class and the self-reported practices of biology teachers.

Table 6 reveals that the p-value (0.000) is less than 0.05 that is (p(x≤ Z) =1.000).The level of confidence. In other words, the t-calculated (8.8596) lies outside the range of +1.96 to -1.96 hence it is significant. The t-value from the table at a 95% confidence interval is 1.96. Since the p-value is 0.0000. This implies that the value is less than the p-value of 0.05. The study accepted there is a significant relationship between curve construction in biology class and the self-reported practices of biology teachers.

Table 6. Analysis of the significant relationship between curve construction in biology class and self-reported practices of biology teachers.

Variable	N	Mean	Std dev		t-cal	t-crit	p-value	Remark
Question three agree	70	4.01	1.14	82	8.8596	1.96	0.0000	Significant
Question three disagree	13	0.99	0.23					

4.8. Discussion

The study found that there is a significant relationship between the belief of biology teachers and curve construction in biology science in Kaduna State. The belief of biology teachers in curve construction and usage during teaching biology improves teachers' instructional behaviors and is the most significant predictor of biology students' performances with p= value of 0.000. Therefore, the belief of biology teachers was found to enhance the relationship between teaching and learning biology.

The study also found that there is a significant relationship between the motivation of biology teachers and curve construction. The findings agree with Avalos (2011) who investigate the relationship between biology teachers' motivation and curve construction. The study revealed that motivated biology teachers can go the extra mile to ensure that students' learning ability is enhanced via the curve used during the teaching and learning process with a statistical significance of r = 0.456.

Furthermore, the study found that there is a significant relationship between curve construction in biology class and the self-reported practices of biology teachers. The study indicated that a significant relationship exists between the motivation of biology teachers in the sense that motivated teachers created possible ways to motivate their students through the use of curves when teaching them biology. The findings agree with Shehu (2015) who investigate the relationship between curve construction and biology teachers' self-reported practices. Which reported that biology teachers' self-reported practices on curve construction and usage have been effective, efficient, and effusive in teaching biology in school

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5. CONCLUSION

There is a significant relationship between the belief of biology teachers and curve construction in biology science in Kaduna State with a p-value of 0.0000 and a t-value of 4.758. There is a significant relationship between the motivation of biology teachers and curve construction with a p-value of 0.0000 and a t-value of 6.5926. Teachers with high motivation in biology can easily motivate their students through the use curve in biology which will enhance the student learning ability. The study accepted there is a significant relationship between curve construction in biology class and self-reported practices of biology teachers with a p-value of 0.0000 and t-value of 8.8596. Biology teachers with high ability in curve construction have positively reported great achievement levels in teaching biology with relevant graphical illustrations and their self-reported practices also have helped students gain mastery of biology.

This research work has contributed toward re-addressing the teaching of Biology and its graphical expect. It has shown that Biology class could be made more interesting to both teachers and learners through proper comprehension and interpretation of Biology concepts, which is directly related to Biology teachers' successful understanding and interpretation of Biology curves.

6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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