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INFLUENCE OF MISCONCEPTIONS ABOUT THE HUMAN SKELETAL SYSTEM ON SENIOR SECONDARY SCHOOL STUDENTS' INTEREST AND PERFORMANCE IN BIOLOGY.

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Abstract: This study investigated the influence of misconceptions about the human skeletal system on senior secondary school students' interest and performance in biology. Four research questions guided the study. The literature review was organized under conceptual framework, theoretical framework and review of empirical studies. Descriptive survey design was adopted for the study. The study was carried out in Enugu East Local Government Area of Enugu State. The sample comprised of one hundred (100) students drawn from the population of six hundred and seventy (670) SSII biology students using random sampling technique. A well-structured questionnaire tiled questionnaire on misconception about the human skeletal system was used for data collection. Data analyzed was done using mean and standard deviation. The result revealed that senior secondary school students harbor misconceptions about the human skeletal system, show low interest in skeletal system and perform poorly in biology. The study also showed that instructional materials and good teaching strategies are helpful in increasing students' interest which in turn will bring about good performance in biology. Recommendations were made that teachers should make use of practical manual, 3D models and innovative instructional strategies to demystify misconception about the human skeletal system. Finally, limitations were stated and suggestions were made for further study.

Keywords: Misconceptions, human skeletal system, senior secondary school students, interest and performance, biology.

Introduction

Misconception regarding the human skeletal system is a significant challenge that must be addressed in order to promote a more favourable attitude and accurate understanding of concept related to the skeletal system, biology and other scientific fields among individuals. A misconception is a belief that's wrong because it's based on faulty thinking (Wikipedia, 2015). In simple terms, it is an inaccurate idea or notion that may result from misunderstanding or wrong information. According to Oluwatosin (2017), misconceptions in science education are commonly held beliefs about science that have no basis in actual scientific fact. The human skeletal system is described as the framework that supports and protects the organs in the body, enables movement, and stores minerals. Andrew and Matthew (2023) described the skeletal system as the frame work of the body, consisting of bones and other connective tissues, which protects and supports the body.

Understanding the importance of the skeletal is fundamental for individuals especially those in the field of science, particularly biology. Researchers

have repeatedly reported that there are misconceptions about the human skeletal system among students (Khosla, 2015). In biology, there are many misconceptions which include (1) bacteria are bad (2) seeds and eggs are not living things (3) human growth is caused by cells getting larger (4) if your dad is tall, you will be tall and many more misconception too. However, our focus is on misconceptions about the human skeletal system. Many people think of bones as dead, dry, and brittle. While these adjectives may accurately describe the bones of a preserved skeleton, the bones of a living human being are very much alive. (Wakim and Grewel, 2021). These misconceptions have adversely affect students' interest and academic performance in sciences, particularly in biology. Performance is regarded as the efficiency or quality of an action, process or system in achieving a set goal (Chang & Mao 2017).

Interest is important in learning and development. Cambride Dictionary, (2023) defines interest as the wanting to give your attention to something or wanting to be involved with in other to discover more about something Students' interest in the skeletal system and biology in general depends heavily on the instructional approach used by teachers: inquiry-based learning, multimodal resources, interactive learning, real-world applications, online learning etc. (Chamisjatin, et al. 2020). Derek (2023) reported that the holistic combination of increases students' engagement and comprehension. He added that the 3D models and interactive technologies used in skeletal system lessons aid in students' retention and understanding. Many students show apathy towards learning about the human skeletal system in the class. Over the years, research has shown that most students lack interest in learning of biology practical involving skeletal system (Kathy, 2023). He added that most students are not working well to understand the concept of the human skeletal system because most teachers fail to use instructional materials in teaching the skeletal system. According to Kathy (2023), the ineffective use of instructional material in teaching and learning the skeletal system is among the top factors militating against students' performance in science subjects particularly in learning the concept of skeletal system in biology. Oluwatosin (2017) recommended several strategies for effective teaching of the human skeletal system which include: the use instructional materials especially concrete materials like animal bones, articulated human or model skeleton and videos.

Statement of the Problem

Although the human skeletal system is being taught in secondary schools, students have misconceptions about the skeletal system, indicating that instructional strategies used by the teachers are probably not effective enough to dispel misconceptions about the skeletal system. Research has shown that many secondary school students harbor misconceptions about skeletal system despite its importance in human anatomy. These misconceptions create problems such as lower academic performance and subsequently lead to a lack of interest in science subjects. Moreover, misconceptions about the skeletal system can have multiple negative effects on medical industry, as medical practitioners or doctors need an accurate knowledge and understanding of the human body to properly diagnose and treat patients. Researches have shown that most of the students' performance towards the practical involving skeletal system is not encouraging. Considering their poor performance in biology, there is a need to investigate and address the problem.

Purpose of the Study

The main purpose of the study is to investigate the influence of misconceptions about the human skeletal system on senior secondary school students' academic performance and interest in biology in Enugu East Local Government Area of Enugu State.

The specific purposes of this study are to:

1. determine the misconceptions about the human skeletal system among senior secondary school students.
2. determine the influence of misconceptions about the human skeletal system on senior secondary school students' interest in the teaching and learning biology.
3. determine the influence of misconception about the human skeletal system on senior secondary school students' performance in biology.
4. identify teaching strategies for rectifying or demystifying these misconceptions among senior secondary school students

Research Questions

This study seeks to answer the following questions:

1. What are the common misconceptions about the human skeletal system among senior secondary school students in Enugu East Local Government Area?
2. How do misconceptions about the human skeletal system influence senior secondary school students' interest in biology?
3. How do misconceptions about the human skeletal system influence students' performance in biology?
4. What are the helpful teaching strategies for demystifying misconceptions among senior secondary school students?

Design of the Study

The study used a descriptive survey design. Survey is a generalized method of getting data through the use of interview or questionnaire. This survey design is appropriate for this study because it tends to find out the opinions and views of the respondents on misconceptions about the human skeletal system.

Methods

Descriptive survey design was adopted for the study. The population of the study was 670 SS II students from 10 secondary schools in Enugu East Local Government Area based on the statistical data collected (PPSMB, Statistical Unit, Enugu 2024). These groups were selected because they have been introduced to the human anatomy and the topic 'human skeletal system' is not completely strange to them. The sample for the study is made up of 100 senior secondary biology students. Simple random sampling technique was used to select 100 students from the population of the study. In statistics, a sample of 15% – 18% gives more accurate representation of the population and increases reliability. 100 is the 15% of the population. Therefore ten (10) students from each of the ten schools in Enugu East; the researcher wrote out ballot papers having 'Yes' or 'No' written on them and folded. These ballot papers were presented to all the students to pick. Those who pick 'Yes' were the respondents. This was to provide equal opportunity for selection. Structured questionnaire prepared by the researcher was used for data collection. Cronbach Alpha was used to determine the reliability of the instrument. Cronbach Alpha was used because it tests the internal consistency of the instrument to establish the coefficient of the reliability. The reliability coefficient is 0.86, this showed that the test is highly reliable. The data from the respondents were analyzed using means and standard deviation. The frequency was used to determine the extent of the agreement or disagreement in each of the items in the questionnaire. Nominal values were assigned to the rating scale item. From the mean calculation of four-point scale, if the mean score of any item is

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greater or equal to 2.50, the item is interpreted as "accept" but if the mean score is less than 2.50, the item is interpreted as "rejected".

The criterion mean score was computed with the formula; $\bar{x} = \frac{\sum fx}{N}$

Where $\bar{X} =$ mean, $\sum fx$= summation of the frequency, N= Number of items

Hence $\bar{X} = \frac{4+3+2+1}{4} = \frac{10}{4} = 2.50$

RESULTS

Research Question 1: What are the common misconceptions about the human skeletal system among secondary school students in Enugu East Local Government Area?

Table 1: Mean rating of respondent on common misconceptions about the human skeletal system among secondary school students in Enugu East Local Government Area.

S/N	Item Description	SA	A	D	SD	FX	$(\bar{x})$	(SD)	Decision
1	Cartilage is a not part of the skeletal system	32 128	25 75	23 46	20 20	269	2.6	1.6	Accepted
2	Tendon is not a part of the skeletal system	32 128	25 75	23 46	20 20	269	2.6	1.6	Accepted
3	Ligament is not a part of the skeletal system.	32 128	25 75	23 46	20 20	269	2.6	1.6	Accepted
4	Adult male humans have fewer number of bones compared to the females.	37 148	25 75	23 46	15 15	284	2.8	1.6	Accepted
5	The skeletal system is made up of only bones.	40 160	29 87	21 42	10 10	299	2.9	1.7	Accepted
6	Bones are dry and do not grow.	2 8	5 15	38 76	55 55	154	1.5	1.2	Rejected
7	Bones do not contain any nutrient.	2 8	5 15	38 76	55 55	154	1.5	1.2	Rejected
8	Blood is not manufactured in the bone.	10 40	7 18	35 76	56 55	154	1.5	1.2	Rejected
9	Teeth are bones	46 184	29 87	22 44	3 3	318	3.1	1.7	Accepted

Key: Strongly Agree (SA), Agree (A), Disagree (D), Strongly Disagree (SD)

Table 1 represents the opinion of respondents about the human skeletal system. From the table 1, responses from items 1,2,3,4, 5, and 9 with the mean scores of 2.6, 2.6 2.6, 2.8, 2.9 and 3.2 with standard deviation of 1.6, 1.6, 1.6, 1.6, 1.7 and 1.7 are above cut off point of 2.5. Therefore agreed despite skeletal system being taught in schools, students still harbor misconceptions that the human skeletal does not consist of cartilages, tendons ligament but made up of only bones. Many of them think that teeth are bone while items 6, 7, and 8 with the mean scores of 1.5, 1.5 and 1.9 with standard deviation of, 1.2, 1.2 and 1.2 are below cut off point of 2.5 therefore, rejected.

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Research Question Two: What are the impacts of misconception about the human skeletal system on senior secondary school students' interest in biology?

Table 2: Mean rating of respondents on the impact of misconception about the human skeletal system on students' interest in biology.

S/N	Item Description	SA	A	D	SD	FX	$(\bar{x})$	(SD)	Decision
10	Many students see the skeletal system as a boring topic in biology.	30 120	27 81	24 48	19 19	268	2.6	1.6	Accepted
11	Most students show apathy to the study of the skeletal system.	32 128	27 81	24 48	17 17	274	2.7	1.6	Accepted
12	Many avoid classes during classes on skeletal system.	0 0	0 0	54 108	56 56	164	1.6	1.2	Rejected
13	Many do not have practical manuals on human skeletal system	46 184	29 87	22 44	3 3	318	3.1	1.7	Accepted
14	Teachers teach human skeletal system without a model of it.	46 184	29 87	22 44	3 3	318	3.1	1.7	Accepted
15	Prior knowledge held by the student about the human skeletal system sometimes contradicts the information presented in the class.	40 160	29 87	21 42	10 10	299	2.9	1.7	Accepted

Table 2 represents opinion of respondents on the impact of misconception about the human skeletal system on students' interest in biology. From the table 2, responses from items 10, 11, 13, 14 and 15 with the mean scores of 2.6, 2.7, 3.1, 3.1 and 2.9 with standard deviation of 1.6, 1.6, 1.7, 1.7 and 1.7 are above cut off point of 2.5, therefore agreed many students perceive the skeletal system as a boring topic in biology, most students show apathy towards the study of the human skeletal system, many students do not have practical manures on human skeletal system, some teachers teach the human skeletal system without the model of it and some prior knowledge held by the students contradicts the one presented in the class while item 12, with the mean score 1.6 with standard deviation of 1.2 is below the cutoff point therefore, rejected.

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Research Question Three: What are the impacts of misconception about the human skeletal system on senior secondary school students' performance in biology?

Table 3: Mean rating of respondents on impact of misconception about the human skeletal system and students' performance in biology.

S/N	ITEM DESCRIPTION	SA	A	D	SD	FX	($\bar{x}$)	(SD)	DECISION
16	Students find it difficult to draw samples of axial skeleton.	32 128	27 81	24 48	17 17	274	2.7	1.6	Accepted
17	Most students hardly comprehend the composition of the human skeletal system.	30 120	27 81	24 48	19 19	268	2.6	1.6	Accepted
18	Some schools do not teach about the human skeletal system.	0 0	5 15	38 76	57 57	147	1.4	1.1	Rejected
19	Students do not pay attention when skeletal system is being taught.	0 0	5 15	38 76	57 57	147	1.4	1.1	Rejected
20	Some students confuse the function of the skeletal system with the muscular system	34 136	27 81	24 48	15 15	280	2.8	1.6	Accepted
21	Students hardly comprehend the protective role of the skeletal system	0 0	0 0	53 106	57 57	163	1.6	1.2	Rejected
22	Students find it difficult to comprehend the metabolic function of the bone in the skeletal system.	31 124	26 78	26 52	17 17	271	2.7	1.6	Accepted

Table 3 represents opinion of respondents on the impact of misconception about the human skeletal system on students' performance in biology. From the table 3, responses from items 16, 17, 20 and 22 with the mean scores of 2.7, 2.6, 2.8, and 2.7 with standard deviation of 1.6, 1.6, 1.6 and 1.6 are above cut off point of 2.5, therefore agreed that students find it difficult to draw samples of axial skeleton, most students hardly comprehend the composition of the human skeletal system and find it difficult to comprehend the metabolic function of the bones in the skeletal system which items 18, 19 and 21 with the mean scores of 1.4, 1.4 and 1.6 with standard deviation 1.1, 1.1, and 1.2 are below the cutoff point therefore, rejected.

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Research Question Four: What are the teaching strategies for demystifying misconceptions among senior secondary school students?

Table 4: Mean rating of respondents on teaching strategies for demystifying misconceptions among senior secondary school students.

S/N	Item Description	SA	A	D	SD	FX	(x̄)	(SD)	Decision
23	Project method is helpful in demystifying misconception about the human skeletal system.	80 320	15 45	2 4	3 3	372	3.7	1.9	Accepted
24	Hand – on activities in teaching and learning are helpful in demystifying misconception about the human skeletal system.	90 360	10 30	0 0	0 0	390	3.9	1.9	Accepted
25	Gamification in teaching is helpful in demystifying misconception.	50 200	44 88	4 8	2 2	298	2.9	1.7	Accepted
26	Demonstration method in teaching and learning is helpful in demystifying misconception about the human skeletal system.	85 340	15 45	0 0	0 0	385	3.8	1.9	Accepted
27	The use of visual aids in teaching is helpful in demystifying misconception about the human skeletal system.	98 392	2 6	0 0	0 0	398	3.9	1.9	Accepted
28	Group discussion is helpful in demystifying misconception about the human skeletal system.	60 240	38 114	2 4	0 0	358	3.5	1.8	Accepted
29	Inquiry teaching method is useful in demystifying misconception about the human skeletal system.	80 320	15 45	2 4	3 3	372	3.7	1.9	Accepted

Table 4 represents opinion of respondents on the teaching strategies for demystifying misconception about the human skeletal system. From the table 4, responses from item 23, 24, 25, 26, 27, 28 and 29 with the mean scores of 3.7, 3.9, 2.9, 3.8, 3.9, 3.5, and 3.7 with the standard deviation of 1.9, 1.9, 1.7, 1.9, 1.9 and 1.8 are about the cut-off point therefore agreed that project method is helpful in demystifying misconception about the human skeletal system, hand-on activities in teaching and learning are helpful in demystifying misconception about the human skeletal system, gamification in teaching is helpful in demystifying misconception, demonstration method in teaching and learning is helpful in demystifying misconception about the human skeletal system, the use of visual aids in teaching is helpful in demystifying misconception about the human skeletal system, group discussion is helpful in demystifying misconception about the human skeletal system and that inquiry teaching method is useful in demystifying misconception about the human skeletal system.

Summary of the Findings

The findings revealed that:

- Senior secondary school students harbor misconceptions about the human skeletal system.

- Misconceptions about the human skeletal system have negative influence on students' interest and performance in biology.
- Innovative teaching strategies and instrument materials especially 3D models and practical manual on human skeletal system are helpful in demystifying misconceptions about the human skeletal system have negative influence on students' performance in biology.

Discussion of the Principal Findings of the Study

The discussions were based on the research question.

Research Question One: What are the common misconceptions about the human skeletal system among secondary school students in Enugu East Local Government Area?

The findings of research question 1 showed that there are misconceptions about the human skeletal system among secondary school students. From the table 1, responses from items 1,2,3,4, 5, and 9 with the mean scores of 2.6, 2.6 2.6, 2.8, 2.9 and 3.2 with standard deviation of 1.6, 1.6, 1.6, 1.6, 1.7 and 1.7 are above cut off point of 2.5. Therefore agreed despite skeletal system being taught in schools, students still harbor misconceptions that the human skeletal does not consist of cartilages, tendons ligament but made up of only bones. Many of them think that teeth are bone while items 6, 7, and 8 with the mean scores of 1.5, 1.5 and 1.9 with standard deviation of , 1.2, 1.2 and 1.2 are below cut off point of 2.5 therefore, rejected. This observation could be because secondary school students have prior knowledge about the human skeletal system that is conflicting with the one presented in the class, are being taught without instructional material especially a model of the human skeletal system or due to inadequate teaching strategies employed by the teacher. Quite often, students tend to forget or mix-up the component of the human skeletal system. Some students do not know that adult human whether male or female have the same number of bones (206); those who habour this misconception believe that male have fewer number of bones. Some students think that teeth are bones; this notion is probably from creation story that narrates how a rib was taken out of a man to create a woman. The findings of this study goes with Khosla, (2015) which states that researchers have repeatedly reported that there are misconceptions about the human skeletal system among students

Research Question Two: What are the impacts of misconception about the human skeletal system on senior secondary school students' interest in biology?

The findings revealed that students show apathy toward skeletal system classes, tent to mix-up the functions of the human skeletal system with that of muscular system, find it difficult to comprehend the metabolic role of the bones and have difficulty drawing samples of axial skeleton. From the table 2, responses from items 10, 11, 13, 14 and 15 with the mean scores of 2.6, 2.7, 3.1, 3.1 and 2.9 with standard deviation of 1.6, 1.6, 1.7, 1.7 and 1.7 are above cut off point of 2.5, therefore agreed many students perceive the skeletal system as a boring topic in biology, most students show apathy towards the study of the human skeletal system, many students do not have practical manures on human skeletal system, some teachers teach the human skeletal system without the model of it and some prior knowledge held by the students contradicts the one presented in the class while item 12, with the mean score 1.6 with standard deviation of 1.2 is below the cutoff point therefore, rejected. It is observed that students who harbor misconceptions about the human skeletal system lack interest in biology. This study is in line with Khosla, (2015) that students who have misconceptions about the human skeletal system usually have lower interest

and poor performance in biology, he emphasized that misconceptions adversely affect students' interest and academic performance in sciences, particularly in biology.

Research Question Three: What are the impacts of misconception about the human skeletal system on senior secondary school students' performance in biology?

The findings of this study revealed that students who habour misconception about the human skeletal system have difficulty in grasping the concept of the human skeletal system and perform poorly in biology. From the table 3, responses from items 16, 17, 20 and 22 with the mean scores of 2.7, 2.6, 2.8, and 2.7 with standard deviation of 1.6, 1.6, 1.6 and 1.6 are above cut off point of 2.5, therefore agreed that students find it difficult to draw samples of axial skeleton, most students hardly comprehend the composition of the human skeletal system and find it difficult to comprehend the metabolic function of the bones in the skeletal system which items 18, 19 and 21 with the mean scores of 1.4, 1.4 and 1.6 with standard deviation 1.1, 1.1, and 1.2 are below the cutoff point therefore, rejected. It is observed that students who harbor misconceptions have difficulty grasping the concept of the human skeletal system. This study is in line with Khosla, (2015) that students who have misconceptions about the human skeletal system usually have poor performance in biology, he emphasized that misconceptions adversely affect students' academic performance in sciences, particularly in biology.

Research Question Four: What are the teaching strategies for demystifying misconceptions among senior secondary school students?

The findings of this study revealed that teaching strategies such as project method, discussion, gamification, demonstration, inquiry-based method, hand-on activities and the use of 3D model or visual aid are helpful and effective in demystifying misconception about the human skeletal system. From the table 4, responses from item 23, 24, 25, 26, 27, 28 and 29 with the mean scores of 3.7, 3.9, 2.9, 3.8, 3.9, 3.5, and 3.7 with the standard deviation of 1.9, 1.9, 1.7, 1.9, 1.9 and 1.8 are about the cut-off point therefore agreed that project method is helpful in demystifying misconception about the human skeletal system, hand-on activities in teaching and learning are helpful in demystifying misconception about the human skeletal system, gamification in teaching is helpful in demystifying misconception, demonstration method in teaching and learning is helpful in demystifying misconception about the human skeletal system, the use of visual aids in teaching is helpful in demystifying misconception about the human skeletal system, group discussion is helpful in demystifying misconception about the human skeletal system and that inquiry teaching method is useful in demystifying misconception about the human skeletal system. The findings of this study is supported by Chamisjatin, et al. (2020) which state debunking about the human skeletal system and positive impact on students' interest and performance in the human anatomy and biology depends largely on the instructional approach used by teachers.

In line with the findings of the study, the educational implications of the findings were highlighted and recommendations were made, that teachers should make use of practical manual, 3D models and innovative instructional strategies to demystify misconception about the human skeletal system.

Conclusion

In conclusion, this study examined the influence of misconceptions about human skeletal system on students' interest and performance in biology. The study found out that secondary school students habour misconceptions about the human skeletal

system and this influences students' interest and performance in biology negatively.

The study found out that instructional material such as 3D mode and practical manuals on the human skeletal system alongside innovative teaching strategies such as project method, discussion, gamification, demonstration, hand-on activities, are effective in teaching and demystifying misconceptions about the human skeletal system. The findings of this study highlighted the need to use educators to address and debunk misconception about the human skeletal system.

Recommendations

The following recommendations are made:

1. The school administrators should take the lead to emphasize the essential role of using practical models, 3D model and a model of the human skeletal system in teaching and learning the skeletal system. This will require the schools to procure and provide interactive technologies used in skeletal system lessons which will in turn demystify misconceptions, contribute to increase in student interest, comprehension, retention.
2. Teachers should guide students on how to use practical model in learning the human skeletal system.
3. Students who wish to pursue career in science especially healthcare should make effort to develop interest in learning the skeletal system to improve their performance in biology.
4. There should be a combination of various materials be used to enhance students' engagement and comprehension.
5. Further research should be made to explore the efficacy of specific interventions in correcting misconceptions about the human skeletal system and enhancing student learning outcomes.
6. The study should be replicated in biological systems like muscular system and nervous system.
7. More researcher should be carried out on misconceptions in science subjects particularly biology, chemistry and physics to inform curriculum design, reduce confusion, promote critical thinking and accurate scientific knowledge.

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