

RESEARCH ARTICLE

## Perceptions of Genetics Difficulty Among Science Students

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### ABSTRACT

This study examines the perceptions of genetics difficulties among science students in senior secondary schools. This became imperative due to the incessant poor performance of students in genetics, whose study holds tremendous promise for disease diagnosis, treatment, and prevention among men, animals and plants. Moreover, studies of this nature are scarce in Nigeria, hence the need to fill the existing research gap. To carry out the study, the descriptive survey research design was adopted. The sample comprised 351 biology students. Data was collected using “The Genetics Perceptions Questionnaire (GPQ) ( $r = .70$ ). Descriptive statistical analysis of the data collected shows that while the majority (312, 88.9%; >11.1%, 39) of science students perceived genetics to be interesting, yet, they listed a lack of Biology laboratory for practical classes ( $x = 1.66$ , rated 1), not enough time to learn ( $x = 1.60$ , rated 2), and teacher’s poor teaching method ( $x = 1.56$ , rated 3), as factors affecting effective learning of Genetics. We concluded that modern and innovative instructional approaches can be leveraged by teachers to fully motivate and engage students in the study of genetics, while policymakers should also provide an enabling environment for the teaching and learning of genetics in secondary schools.

**Keywords:** Genetics, perceptions, science students, secondary schools, Nigeria

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### 1. INTRODUCTION

Historically, advances in science have brought about healthier living and longevity; have led to wealthier and more productive lives, and have ensured that more advanced technologies, through the application of scientific knowledge, are developed for the betterment of mankind (Anaeto et al., 2016). One of the major fields of science which has led to this is biology. In Nigerian secondary schools, biology is taught in senior secondary schools. As a natural science, it is a unique branch of science, with many branches including genetics, which is the focus of this study. Genetics is taught as a topic in biology in the terminal class (sixth year) of senior secondary school. It is a topic that frequently intertwines with many other life sciences, and its knowledge is essential for biological and life scientists (Ajayi and Adelana, 2020). Advances in biotechnology, which involves the exploitation of biological processes or cellular

components for the development of new technologies, and genetic engineering, which is the precise manipulation of genetic materials using biotechnology, including gene therapy, exon skipping, or gene editing, among others, need advanced knowledge of genetics, and the foundation of this knowledge starts from the secondary to high school. In the 4IR, experts in fields related directly to the study of genetics are needed to tackle over 10,000 human diseases and more to come, all of which are caused by genetic mutations (Goy et al., 2019). Furthermore, the knowledge of Genetics is essential in cloning, DNA testing, genetically modified organisms (GMOs), and disease identification (Choden and Kijkuakul, 2020).

The above points to the need to hype genetics literacy presently in secondary schools, especially among the science students of the 21<sup>st</sup> century (Boerwinkel et al., 2017). This is because, the more scientifically skilled and knowledgeable the citizens of a nation are, the higher the chances that such a nation will experience unprecedented scientific and technological development (Odufuwa et al., 2022). However, despite the importance of genetics in raising biological and life scientists, reports have shown that science students dread it and perceived it as one of the most difficult aspects of biology to learn. Hence, the topic is perceived as challenging. In addition to this, several reports, including those of Onowugbeda (2020), Sakiyo and Badau (2015), Abimbola (2015), Olorundare (2014) and Auwalu et al. (2014), among others, have shown that the concepts of Genetics are misunderstood by science students, and therefore avoid attempting questions on them while writing their terminal examinations in biology (Adelana et al., 2021). In addition, the WAEC Chief Examiners Reports (2008 to 2015), over the years have shown that students could not properly explain pure breeding and nucleotides; they forgot to represent genes for the required crossing, and performed poorly in genetic crossings. Moreover, students' weaknesses in Genetics include the poor spelling of technical terms, for example, 'garmet' for 'gamete', 'fertilizer' for 'fertilization', inability to give details in their description of terms, description of genetic processes in non-sequential order, not drawing to specification, inability to define test cross correctly, the poor crossing of generic expressions, and general poor response to questions on Genetics, among others. In addition, the Chief Examiner's Reports (2002 to 2021) of the West African Examinations Council (WAEC), have shown that students find the concept of Genetics difficult and have issues with it every year (Adelana et. al., 2021).

Researchers have argued that finding out students' perceptions about their learning provides important insights into the most important foundation for ruminating about and taking steps to make the teaching and learning of perceived difficult topics in biology easier (Etobro and Fabinu, 2017). Studies reported that the difficulties students encountered in learning topics or units in biology include those of Buah and Akuffo (2017), who reported many biology topics as perceived to be very difficult by science students. Also, Fauzi and Mitalistiani (2018) reported Genetics, Cell Division, and Cell Metabolism, as considered difficult by students. Students also find mitosis and meiosis, genetic code, and deoxyribonucleic acid (DNA) structure difficult in Biology as well. These researches have discussed more students' views on the complexity of biological topics (Salleh et al., 2021). Researchers such as Fauzi and Mitalistiani (2018), Topcu and Sahin-Pekmez (2009), and Tekkaya et al. (2001), have reported that students' difficulty in studying biological topics around the world. On the factors responsible for science students' perceived genetics difficulties, Etobro and Fabinu (2017) report students' attitudes, teaching methods, lack of instructional resources, and learning habits as some of the factors. Cimer (2004) reports five main reasons why science students find topics in Biology difficult. He stated teaching methods, nature of the topic, learning styles and habits, attitude towards concepts in biology such as genetics, and unavailability of instructional materials.

A study by Retnawati (2022) reports teacher-centred methods, low learning intensity, and lack of teaching and learning infrastructure as some of the factors responsible for students'

negative perceptions of topics in biology claimed as being difficult (Fauzi and Mitalistiani, 2018). According to Retnawati (2022), science students' perceptions of their biology teachers are also likely to influence their perceived genetics difficulties. This is so since the teacher is a vital component in the creation of quality education and in the development of students' scientific skills. It has also been empirically reported that students' perceptions of their teachers' competence influence their performance (Shin and Shim, 2021; Adediwura and Tayo, 2007). The study by Cipkova et al. (2018) reports that the majority of students showed positive interest in biology, but this was among those who prefer active participation and direct involvement in the process of acquiring knowledge in the subject.

The threat to concrete understanding of biology is serious because while it might not be hard to identify and redress some misunderstandings in the case of simple ideas, such as the fact that all blood vessels have valves, it might be difficult to unlearn misconstrued mental models, for instance, that the human circulatory system is single-looped rather than double-looped. Singer et al. (2013), call for the need for science instructors to be aware of the misconceptions of their students, since the goal of learning, in summary, is to assist students in achieving expert-like understandings of biology. Based on the literature search and our observations, very few studies have examined science students' perceptions of genetics difficulties among senior secondary schools in Nigeria. This study was carried out to fill this gap in research. Given this, we answered the following questions in this study: (1) What is science students' perception of genetics based on interest? (2) What are the factors hindering science students' learning of Genetics? (3) What mode of instruction do science students prefer to learn genetics?

## **2. METHODOLOGY**

### ***2.1. Research design, population and research sample***

The study adopts the descriptive survey research design. This study was carried out to determine students' perceptions of genetics in biology among science students at senior secondary schools in Ijebu-Ode, Ogun State, Nigeria, using the descriptive survey approach. The target population comprised final year Biology students in the science class at the senior secondary school in Ijebu-Ode Local Government Area, Ogun State, Nigeria. The sample, which was selected using a random sampling technique, comprised three hundred and fifty-one (351) science students, made up of 262 males and 89 females. These were spread across four senior secondary schools in the Local Government Area of study. The voluntary consent of the students was sought before being allowed to participate in the study. Finally, those who took part in the study showed interest and readiness.

### ***2.2. Research instrument***

The instrument of data collection was adapted (Ezechi, 2021) with a Cronbach Alpha reliability coefficient of .70. The instrument was further checked for validity by experts in Science Education and Educational Technology to ensure that the items meet the objectives of the study, and to also ensure that it measures what it was designed for. The instrument was divided into two sections, with section one asking for the demographic status of the students, while section two was further divided into three units, with each unit containing items based on the research questions of the study. Unit one asked what science students' perceptions of genetics are based on interest. The two options provided are "yes" and "no". Unit two asked students to rate the factors (16 factors were provided) hindering their learning of genetics and the options to select from are "yes" or "no", while unit three asked the students their preferred

mode of learning genetics. The three options given are “Through the Biology teachers only”, “Through Computer-Assisted packages only”, and “Through the Biology teacher combined with Computer-Assisted packages”, respectively. Data analysis was done using descriptive statistical approaches of mean, standard deviation, rank, order, frequency, counts, and percentages. The data collected were coded appropriately in Microsoft Excel and later exported into SPSS version 26 for analysis.

### **3. RESULTS AND DISCUSSION**

#### **3.1. Expert validity**

The instrument used for data collection in the study was adapted from similar works by Ezechi (2021). To ensure that the adapted items are valid, they were given to experts in Science Education and Educational Technology at a university in Nigeria for scrutiny. The expert opinions were factored into the final instrument before data collection commenced.

#### **3.2. Reliability**

Ensuring that the instrument used for data collection in a research study is reliable is essential. In this study, the adapted items were subjected to reliability examination before final usage. The reliability index of the instrument shows a Cronbach Alpha reliability coefficient of .70, which makes the instrument reliable for data collection.

#### **3.3. Students' perception**

Science students were asked if genetics is an interesting topic in biology. The results of their responses are shown in Table 1. The results show that the majority of the students, 88.9% (312) responded in the affirmative that genetics is an interesting topic in biology. However, 11.1% (39) of the students responded negatively, implying that genetics is not interesting to learn. The result implies that the majority of science students find genetics interesting to learn in biology.

The students were asked to state the factors they perceived as affecting their learning of genetics in biology. Their responses are tabulated in Table 2. Their response, in order of significance, reveals lack of biology laboratory for practical classes in genetics ( $\bar{X} = 1.66$ ; S.D = .476; Rank = 1), not enough time to learn the topic ( $\bar{X} = 1.60$ ; S.D = .492; Rank = 2), teacher's poor teaching method which make the topics difficult to learn ( $\bar{X} = 1.56$ ; S.D = .497; Rank = 3), concepts not explained with local examples ( $\bar{X} = 1.45$ ; S.D = .498; Rank = 4), teacher's poor knowledge of the topic ( $\bar{X} = 1.44$ ; S.D = .497; Rank = 5), student's poor study habits ( $\bar{X} = 1.36$ ; S.D = .482; Rank = 6), lack of instructional materials to support the teaching/learning ( $\bar{X} = 1.30$ ; S.D = .460; Rank = 7), lack of relevant textbooks in school library and for private studies ( $\bar{X} = 1.29$ ; S.D = .456; Rank = 8), lack of Computer-Assisted Packages to learn the topic ( $\bar{X} = 1.25$ ; S.D = .432; Rank = 9), student's lack of interest in the topic ( $\bar{X} = 1.22$ ; S.D = .416; Rank = 10), too many concepts packed into one topic ( $\bar{X} = 1.21$ ; S.D = .406; Rank = 11), genetics is too abstract and requires much thinking ( $\bar{X} = 1.21$ ; S.D = .450; Rank = 11), some teachers show no interest in some topic and in the subject in general ( $\bar{X} = 1.20$ ; S.D = .398; Rank = 13), too many similar vocabularies and terminologies ( $\bar{X} = 1.14$ ; S.D = .350; Rank = 14), the topic is not interesting ( $\bar{X} = 1.08$ ; S.D = .276; Rank = 15), and too many calculations in the topic ( $\bar{X} = 1.03$ ; S.D = .158; Rank = 16). According to the results, the three most important hindering factors to the effective learning of Genetics are the lack of a biology laboratory for practical classes ( $\bar{X} = 1.66$ ; S.D = .476; Rank = 1), followed by not enough time

to learn the topic ( $\bar{X} = 1.60$ ; S.D = .492; Rank = 2), and teacher’s poor teaching method which makes the topics difficult to learn ( $\bar{X} = 1.56$ ; S.D = .497; Rank = 3).

**Table 1.** Science students’ responses to whether genetics is an interesting topic in biology

Responses	Frequency	%	Remark
Yes	312	88.9	Genetics is interesting
No	39	11.1	
Total	351	100.0	

When asked how the best science students feel they could learn genetics, the results in Table 3 show their responses. According to Table 3, 38.7% (136) of the science students stated that they prefer to learn Genetics through their Biology teacher only, while 6.3% (22) stated that they prefer to learn Genetics using Computer-Assisted packages only. However, the majority of the students responded that they will prefer to learn genetics through a combination of their biology teacher and the use of relevant computer-assisted packages. The study has shown that while the majority of science students perceived genetics to be an interesting topic, yet there are factors perceived as making the subject difficult to learn. Out of the 16 factors presented in the study, it is interesting to note that only three are perceived as the major and most influencing factors. These factors, which are presented in descending order are “lack of a biology laboratory for practical classes in genetics”, “not enough time to learn the topic” during Biology classes, and “teacher’s poor teaching method” which makes the topic difficult to learn. It is interesting to note from this finding that, at this time that pedagogical approaches are being refined globally to meet 21<sup>st</sup> century teaching and learning, teaching methods and the lack of laboratories for carrying out practical classes on genetics could still be contributing to science students’ difficulty in learning such an important topic. This is even coming up at a time that there are virtual laboratories that could be deployed in the absence of physical ones. It is also noteworthy that in the 21st century, self-paced learning is being encouraged. Hence, that students are not having enough time to learn in school should not be an issue as there are other 21st-century pedagogies such as blended and flipped approaches that could enhance students’ learning of genetics outside the walls of the classroom. This finding aligns with the position of Etobro and Fabinu (2017) who report that teaching methods and lack of instructional resources are some of the factors hindering the study of science. The finding also supports Çimer (2012) who reports that teaching methods and unavailability of instructional materials are factors that affect the learning of genetics and it's been perceived as difficult by students. In addition, the finding corroborates the work of Salleh et al. (2021), Fauzi and Mitalistiani (2018) and Retnawati (2017) who report teacher-centred methods, and a lack of teaching and learning infrastructure as factors contributing to learning difficulties in genetics.

From the three approaches to learning, genetics presented to the science students- “Biology teacher only”, “Computer-Assisted packages only”, and “a combination of Biology teacher and computer-assisted packages” - the students responded that they prefer to learn genetics through the combination of their biology teacher, and supported by computer-assisted packages. On one part, this finding shows that the conventional mode, classroom-based-only approach to presenting genetics content to students could have had a serious negative influence on their perception and learning of genetics. On the other hand, it shows that the students need educational/software that could assist in making the abstract concepts of genetics more concrete for them to learn and assimilate effectively, in addition to the explanations given by their teachers. This tends toward the deployment and use of appropriate technologies in supporting the pedagogical activities of teachers. This finding supports the works of Retnawati (2022), Shin and Shim (2021), Aeni and Supadi (2020), Cipkova et al. (2018), Cimer (2004),

and Adediwura and Tayo (2007), who linked instructional approaches to factors influencing students' perceived science difficulty.

**Table 2.** Science students' responses to the factors hindering the learning of genetics

Factors	Yes (%)	No (%)	$\bar{X}$	S.D	Ranking
Lack of Biology laboratory for practical classes in Genetics.	230 (65.5)	121 (34.5)	1.66	.476	1
Not enough time to learn the topic.	209 (59.5)	142 (40.5)	1.60	.492	2
Teachers' poor teaching method which makes the topics difficult to learn.	198 (56.4)	153 (43.6)	1.56	.497	3
Concepts are not explained with local examples.	158 (45.0)	193 (55.0)	1.45	.498	4
Teacher's poor knowledge of the topic.	155 (44.2)	196 (55.8)	1.44	.497	5
Students' poor study habits.	128 (36.5)	223 (63.5)	1.36	.482	6
Lack of instructional materials to support teaching/learning.	106 (30.2)	245 (69.8)	1.30	.460	7
Lack of relevant textbooks in the school library and for private studies.	103 (29.3)	248 (70.7)	1.29	.456	8
Lack of Computer-Assisted Packages to learn the topic.	87 (24.8)	264 (75.2)	1.25	.432	9
Student's lack of interest in the topic.	78 (22.2)	273 (77.8)	1.22	.416	10
Too many concepts are packed into one topic.	73 (20.8)	278 (79.2)	1.21	.406	11
Genetics is too abstract and requires much thinking.	75 (21.4)	276 (78.6)	1.21	.450	11
Some teachers show no interest in some topics and the subject in general.	69 (19.7)	282 (80.3)	1.20	.398	13
Too many similar vocabularies and terminologies.	50 (14.2)	301 (85.8)	1.14	.350	14
The topic is not interesting.	29 (8.3)	322 (91.7)	1.08	.276	15
Too many calculations on the topic.	9 (2.6)	342 (97.4)	1.03	.158	16

**Table 3.** Science students' preferred mode of learning genetics

Through	Frequency	%	Rank	Remark
Biology teacher only	136	38.7	1	Combination of biology teachers and computer-assisted packages
Combination of Biology Teacher and Computer-Assisted Packages	193	55.0	2	
Computer-Assisted Packages only	22	6.3	3	
Total	351	100.0		

This study has also shown the importance and need for determining the factors ascribed to making genetics perceived as difficult by science students, and looking for solutions to them. Based on the consequences that could result from training science students with poor genetics understanding, the need arises for biology instructors, science education policymakers, and other stakeholders, especially in science education, to urgently switch to novel instructional approaches that are effective in mitigating the misconceptions or negative perceptions that science students have toward Genetics. This is urgent because a significant number of science students are expected to major in biological, life and medical sciences, and expected to contribute to the development of, and advancement of the biological sphere of the 4IR, and beyond. In this regard, approaches that can adjust the task demands of genetics to be cognitively

motivated by the students are required, since the topic requires a higher-order level of thinking to learn and fully understand.

Aside from dealing with the factors perceived as making genetics difficult for science students to learn, there is also a need to ensure that the students are motivated in every way possible to learn genetics through a motivation-focused approach in which biology instructors identify, nurture, and develop students' inner motivational resources, thereby making students perceive themselves as the initiator of their learning. This will assist students to take the initiative in their learning and learning at their own pace. This will also mitigate the issue of "not having enough time to learn genetics among the students. While it may not be easy for biology instructors to completely take care of the learning needs of students while learning genetics, it is advised that they embrace autonomy-supportive strategies (Reeve, 2009), which can encourage and assist their students to relate their interests and preferences to learning activities in genetics. It is believed that this will likely assist in facilitating students' the inner motivational resources and competencies required for tackling difficult tasks in their learning, especially about the learning of genetics.

#### **4. CONCLUSION**

Science students are most likely to find learning genetics easier if the three most limiting factors to the effective study of the topic are effectively managed. In essence, students will likely find the topic more interesting to learn by adopting and using 21st-century teaching and learning approaches in a highly engaging and motivating environment in which they strongly believe in their capacity to learn the topic, regardless of being a difficult one in biology. It is recommended that the practical aspects of genetics be taught in the laboratory, either physical or virtual, to aid understanding and lesson study difficulties. In addition, while it might be difficult to increase the instructional time setup for learning genetics in biology in schools, yet innovative instructional approaches such as blended and flipped learning, among others, could be leveraged by biology instructors to further engage science students in genetics.

#### **Declaration of Interest**

The authors declare that there is no conflict of interest.

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