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Misconceptions in biology among high school science teachers in Siargao Islands

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Abstract

Misconceptions are the instinctive notions, alternate frameworks, simplistic theories, and commonsense convictions that students have formed for themselves as a result of their contacts with the outside world (Baweja Manmeet Oberoi, 2017). Misconception can be phenomenological and vocabulary. This study aims to investigate and address certain biology misconceptions among high school science teachers. The study employed a qualitative descriptive research design. The study revealed that the level of the misconception of teachers is high in genetics (52.8%); moderate in ecology (38.25%), and zoology (26.3%); and low in botany (19.3%). The results suggested assessing teachers' existing knowledge of key biological concepts during the teaching-learning process in order to determine misconceptions and improve understanding in scientific phenomenon using engaging and creative methods. Teachers must read more researches, and take part in programs concerning the scientific community in general and the field of biology in particular while taking into consideration the study's findings.

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Introduction

Learning is the product of one's understanding gained from the environment and experiences. In ways that these factors are interacted have a crucial role in inculcating learning as these may draw misconceptions. Misconceptions refer to the intuitive notion, alternative framework, naive theories, and commonsense beliefs that students have created for themselves as a result of interactions with their physical world (Baweja Manmeet Oberoi, 2017). Misconceptions can be described in two types, such as phenomenological and vocabulary. Phenomenological misconceptions are linked to incorrect phenomena interpretation while the vocabulary misconceptions result through limited experience (Abu-Hola, 2004).

Some research indicates, students often have misunderstandings about the many disciplines of study, from the elementary school level to the college level. The concepts on the principles of osmosis, diffusion, photosynthesis, respiration, ecology, genetics, classification, and the human circulatory system are among those that appear to be frequently misunderstood by students (Susanti Rahmi, 2018).

Lack of relevant prior experience, inability to develop an adequate, cohesive mental representation of the phenomenon, or failure to recognize the connections between various concepts could all be contributing factors to one's inability to comprehend the concepts (Abu-Hola, 2004). In an interview, results revealed that abstract concepts, a wide range of unfamiliar words, a challenging language, students' lack of readiness to accept the information presented by lecturers, and the use of learning resources such as print media, print journals, social media, teaching staff, and colleagues are the main causes of misconceptions (Duda Hilarius Jago *et al.*, 2020).

While some of the misconceptions may be the result of bad item crafting, notably the failure to consider all the potential views that the students might see, it has been discovered via interactions with teachers that these are in fact held by some teachers (Kwen Boo Hong, 2005).

In the Philippines, certain elementary and secondary science reference books, mistakes and misconceptions have been discovered (Rogayan Jr. Danilo V. and Albino Michelle M., 2019); Raymundo, (2008). These misunderstandings are likely impossible for a teacher without a science background to clear things up, leading to an increase in mistakes. Nevertheless, Philippines fall behind other nations in terms of the caliber of science education (Rogayan Jr. Danilo V. and Albino Michelle M., 2019). According to the World Economic Forum (WEF, 2018) Global Competitiveness Report (2017-2018), the Philippines ranked 76th out of 137 participating countries in the quality of math and science. Additionally, the Philippines were placed last out of ten (10) participating countries in the Trends in International Mathematics and Science Study (TIMSS), (Tellermo ES and Gabasa CG, 2019). This suggests that the Filipino students have lower understanding on scientific and mathematical concepts due to the existing misconceptions.

A myriad of studies has indicated that educators' erroneous judgments may have contributed to students' misconceptions (Rogayan Jr. Danilo V. and Albino Michelle M. 2019; Larkin, 2012). It is particularly difficult to correct these beliefs when these make perfect sense to the students (Rogayan Jr. Danilo V. and Albino Michelle M. 2019; Allen 2010). Since, teachers are the facilitators of learning and the essential drivers for correcting students misconceptions; teachers must have a full grasp of the concept to avoid misconceptions. Thus, due to existing misconceptions, the researchers prompted to conduct this study to investigate and address misconceptions among high school science teachers in Siargao Islands.

Materials and methods

The current study was conducted to investigate and treat some misconceptions in biology concepts among high school science teachers.

The study employed a qualitative descriptive research design. A survey questionnaire adopted from the study of Rogayan Jr. Danilo V. and Albino Michelle M. (2019)

entitled "Filipino Students' Common Misconceptions in Biology: Input for Remedial Teaching", was used as the research instrument in gathering the data.

Part 1 consists of the demographic profile of the teachers such as name, program and major taken, and number of years in teaching science subjects. Part 2 consists of true-false questions covering the many branches of biology which consists of ten (10) questions in each field such as ecology, botany, zoology, and genetics with a total number of forty (40) items.

The researchers used convenience sampling in selecting the samples in which the respondents are the high school science teachers in schools under the Division of Siargao. A total of 40 high school science teachers are involved in the study who are handling science subjects. After collecting the data, it was treated and analyzed utilizing descriptive statistical tool such as percent analysis.

Table 1. Interpretation of the percent of misconception.

Percent Range	Verbal Description
75.50 – 100.0	Very High Misconception (VHM)
50.50 – 75.49	High Misconception (HM)
25.50 – 50.49	Moderate Misconception (MM)
1.00 – 25.49	Low Misconception (LM)

Each incorrect response to the question illustrates a misunderstanding. Each set's total number of incorrect responses is divided by the item total (n=10) times 100. The corresponding percent will be examined by using the table's data.

Results and discussion

The study looked into the widespread erroneous beliefs held by high school science teachers in Siargao Islands. The findings were presented in the tables and narratives below to demonstrate the degree to which science teachers' assumptions about the four branches of biology—ecology, botany, zoology, and genetics are true**.**

Misconceptions in Ecology

Table 2. Respondents level of misconception in ecology.

	Concept	% of mc	VD	Rank
1.	Plants have a range of defenses including external structures (sap, hairs, thorns, wax) and chemicals that either reduce digestibility or are toxic. (T)	0.0%	LM	10
2.	There are more herbivores than carnivores because of the decreasing amount of energy available at each level of the food web. (T)	35.0%	MM	5
3.	Food chains involve predator and prey, but not producers. (F)	22.5%	MM	8
4.	Decomposers release some energy that is cycled back to plants. (F)	87.5%	VHM	1
5.	While some carnivores may be larger and require more food than some herbivores, they do not have more energy or power. (T)	37.5%	MM	4
6.	Varying the population size of a species may not affect an ecosystem because some organisms are not important. (F)	27.5%	MM	7
7.	Ecosystems include not just the organisms but also the interactions between organisms and between the organisms and their physical environment. (T)	10.0%	LM	9
8.	Species coexist in ecosystems because of their compatible needs and behaviors; they need to *get al*ong. (F)	87.5%	VHM	1
9.	The relative sizes of predator and prey populations have no bearing on the size of the other. (F)	42.5%	MM	3
10.	Producers are an essential part of all food chains and webs. (T)	32.5%	MM	6
Overall		38.25%	MM	

Legend: VD- Verbal Description, MC- Misconception, T- True, F- False, VHM- Very High Misconception, HM- High Misconception, MM- Moderate Misconception, LM- Low Misconception

Table 2 shows that the teachers' level of misconceptions in the field of ecology. As shown in the table, teachers obtained moderate misconceptions about ecology, as indicated by the overall misconception percentage of 38.25%. In particular, teachers have very high misconceptions in decomposers' role in ecosystem (87.5%) and in the concept of ecological coexistence (87.5%). Meanwhile, teachers have a full understanding on the ranges of defenses of plants (0.0%).

The rest of the concepts in the field of ecology were found to be moderate misconception to low misconception. This implies that teachers are facing moderate misconception in ecology. Teachers are having a difficulty of understanding about the crucial part of decomposers in the cycle of life. Decomposers, such as fungus and bacteria, convert living things from large molecules into smaller ones, resulting in the formation of small molecules like carbon dioxide and water. Plants can utilize them again while photosynthesizing to create nourishment (glucose). This is the transfer of chemicals, not food or energy. Moreover, it is quite difficult for teachers to understand on the concept of ecological coexistence and the interaction of living organisms. Each species in an ecosystem competes with the others for resources and food. Because of shared environmental requirements and adaptations, species may coexist in the same habitat. Notably, teachers are having no difficulty in grasping the concept of the ranges of defenses attributed by plants. The results conform with many science education researches which stressed that the environmental misunderstandings about concepts like the food chain, food web, energy pyramid, and decomposers are observed (Eromosele Oghosa Eunice and Ekholuenetale Michael, 2016).

Misconceptions in Botany

Table 3. Respondents' level of misconception in botany.

	Concept	% of mc	VD	Rank
1.	Plants take in air through their leaves. (T)	5.00%	LM	8
2.	Plants get their energy from the soil through roots. (F)	30.0%	MM	2
3.	Sunlight helps plants grow by keeping them warm. (T)	27.5%	MM	3
4.	Some plants grow in soil-free environments. Plants take up water and minerals from the soil, but not "food." (T)	20.0%	MM	6
5.	While people often care for plants (especially those indoors), plants as a whole are not dependent on people for their needs. (T)	22.5%	MM	5
6.	Plants need "plant food" to eat. (F)	27.5%	MM	3
7.	Plants breathe by inhaling carbon dioxide and exhaling oxygen. (F)	47.5%	MM	1
8.	Energy from the sun allows the plant to carry out photosynthesis and produce sugars. Respiration breaks down these products and provides energy for the plant. (T)	7.5%	LM	7
9.	Chloroplasts in the plant absorb the sun's energy for use in photosynthesis. (T)	2.5%	LM	9
10.	Plants are not alive. (F)	2.5%	LM	9
Overall		19.3%	LM	

Legend: VD- Verbal Description, MC- Misconception, T- True, F- False, VHM- Very High Misconception, HM-High Misconception, MM- Moderate Misconception, LM- Low Misconception

The results presented in Table 3 indicate the level of misconception among teachers in the field of botany. It is evident that, overall, teachers have a relatively low level of misconceptions, with an average score of 19.3%. This suggests that teachers have a good understanding of botany concepts and are equipped with accurate knowledge to effectively teach the subject. The low level of misconceptions among teachers is a positive finding, as it implies that they are well-prepared to deliver accurate information to their students. This is crucial because teachers play a critical role in shaping students' understanding and interest in botany. When teachers possess a solid grasp of the subject matter, they can effectively communicate complex concepts and guide students in developing a strong foundation in botany. Examining the breakdown of misconceptions in the field of botany, it is noted that teachers have low to moderate misconceptions. This implies that while teachers generally possess accurate knowledge, there may still be areas where their understanding could be improved.

The results presented in Table 4 shed light on the level of misconception among teachers in the field of zoology.

The findings indicate that teachers have a moderate level of misconception, with an overall average score of 26.3%. This suggests that there are areas within zoology where teachers may have gaps in their understanding and knowledge. Two specific concepts stand out in which teachers demonstrated high misconceptions.

The first concept pertains to the discovery of the respiratory system, with 55.0% of teachers holding misconceptions in this area. The second concept where teachers exhibited high misconceptions relates to the average weight of a human's heart, with 52.5% of teachers having misconceptions in this area.

Misconceptions in Zoology

Table 4. Respondents' level of misconception in zoology.

	Concept	% of mc	VD	Rank
1.	Largest known vertebrate is whale. (T)	7.5%	LM	7
2.	Proteins are body builders. (T)	5.0%	LM	8
3.	William Harvey discovered the respiratory system of a man. (F)	55.0%	HM	1
4.	Ostrich is the largest living bird. (T)	5.0%	LM	8
5.	Ornithology is the study of fishes. (F)	35.0%	MM	5
6.	There are 235 bones in the adult human body. (F)	40.0%	MM	3
7.	The book origin of life was written by Charles Darwin. (T)	40.0%	MM	3
8.	Snake venom is used as medicine. (T)	17.5%	LM	6
9.	Citrus fruits are the source of vitamin C. (T)	5.0%	LM	8
10.	In man, the average weight of the heart is about 310 grams. (T)	52.5%	HM	2
Overall		26.3%	MM	

Legend: VD- Verbal Description, MC- Misconception, T- True, F- False, VHM- Very High Misconception, HM- High Misconception, MM- Moderate Misconception, LM- Low Misconception

This indicates that teachers may lack accurate information or have misconceptions about the historical background and understanding of respiratory system and circulatory system. Italian scientist Marcello Malpighi made outstanding contributions in a variety of fields, including the anatomical basis of breathing in amphibians, mammals, and insects while William Harvey discovered blood circulation. In addition, the average weight of the heart in males and females is 230-280 g and 280-340 g, respectively. The findings conform with the study of Kwen Boo Hong (2005), breathing and respiration, plant reproduction, human body systems, cell structures and mechanisms are the identified areas in biology to have common misconceptions that are found in the teacher-made science examination papers.

Misconceptions in Genetics

Table 5 displays the teachers' level of misconception in the field of genetics. As displayed in the table 5, teachers' level of misconceptions in genetics were interpreted as a high misconception as unveiled by the overall level of misconception of 52.8%.

Notably, teachers registered a very high misconception in the concept of genes as unique factors that determine traits (85.0%) and have a high misconception in the concept of most common traits in population (72.5%), mutation (52.5%), occurrence of disease genes among humans, (72.5) and probability of reduced risk in offspring (75.9%). The rest of the concepts in the field of genetics were found to be moderate misconception to low misconception.

This connotes that the teachers have high misconceptions in genetics. Most of the teachers have incorrectly interpreted that genes are the only unique factors that determine traits. Genes are not the single factor that determines traits. In fact, most traits are influenced by genetic and environmental factors. Additionally, dominant traits are not most likely to be found in population. The term dominant allele refers to the fact that a dominant allele is expressed over another allele. Thus, incomplete dominance pattern of inheritance is also a reason for this mechanism in which this produces an intermediate trait when dominant allele and recessive allele cross.

The misconception on mutation can be fixed is also notably acclaimed by some of the teachers. The majority of mutations are brought on by physical or chemical mutagens. However, these mutations can be corrected by removing the harmed nucleotide and then synthesizing a new section of DNA. Since we don't currently have the technology to fix this mistake. Mutations are still irreversible. Teachers do not quietly grasp the fact that most human traits are determined by numerous genes and the idea that everyone has hereditary disorders brought on by gene mutations. Nevertheless, some teachers have alternative conceptions on the interpretation of the hybrid cross in Punnett square. The "one-in-four" risk does not necessarily imply that a couple's subsequent offspring will have a certain disease in one out of every four children. The "one-in-four" risk means that there is a 25% chance that each child may contract a disease.

Table 5. Respondents' level of misconception in genetics

	Concepts	% of mc	VD	Rank
1.	Genes are the sole determinants of traits. (F)	85.0%	VHM	1
2.	Single genes code for most traits. (F)	47.5%	MM	6
3.	Dominant traits are the most common traits in a population. (F)	72.5%	HM	3
4.	The limiting factor to getting genetic information is the speed and/or cost of genome sequencing. (T)	30.0%	MM	8
5.	All mutations are harmful. (F)	25.0%	MM	10
6.	Once a mutation is discovered, it cannot be "fixed". (T)	52.5%	HM	5
7.	All genetic tests are not equally reliable and precise. (T)	40.0%	MM	7
8.	Only certain people have "disease genes". (F)	72.5%	HM	3
9.	If a couple has a "one-in-four" risk of having a child with a disease, and their firstborn has the disease, the next three children will have a reduced risk. (F)	75.0%	HM	2
10.	Only genetically modified food crops have genes. (F)	27.5%	LM	9
Overall		52.8%	HM	

Legend: VD- Verbal Description, MC-Misconception, T- True, F- False, VHM- Very High Misconception, HM- High Misconception, MM- Moderate Misconception, LM- Low Misconception

The findings conform with the study of Abu-Hola, (2004) that understandings of the link between environment and inheritance, chromosomes, genes, DNA, the sex of the baby, qualities impacted by sex, genotypes and phenotypes, sex-related genes, and inherited disorders, all reflect a real problem among students and teachers that affects at least 90% of both groups.

Table 6. Summary of the respondents level of misconceptions in biology.

Subfield	% of mc	Verbal Description	Rank
Ecology	38.25	Moderate Misconception	2
Botany	19.3	Low Misconception	4
Zoology	26.3	Moderate Misconception	3
Genetics	52.8	High Misconception	1

Table 6 provides a summary of the level of misconception in the four areas of biology. The results indicate that genetics has the highest level of misconception among the four areas, with a score of 52.8%. This suggests that teachers may have struggles in understanding and effectively teaching genetics concepts, indicating a high level of misconception in this field. It is crucial to address these misconceptions to ensure accurate and effective instruction in genetics. Ecology ranked second among the four areas, with a level of misconception of 38.25%.

This indicates a moderate level of misconception among teachers in the field of ecology. While not as high as genetics, it still points to the need for targeted professional development and support to enhance teachers' understanding and instructional practices in ecology. Zoology, on the other hand, obtained a level of misconception of 26.3%, which is also classified as

a moderate misconception. This suggests that teachers may have some gaps in their understanding of zoology concepts. To improve instruction in zoology, it is important to address these moderate misconceptions through professional development programs and collaborative efforts.

In contrast, botany had the lowest level of misconception among the four areas, with a score of 19.3%. This indicates a relatively low level of misconception among teachers in the field of botany. While this is a positive finding, it is still essential to continue supporting teachers' knowledge and understanding of botany concepts to ensure accurate instruction. Based on the findings in Table 6, it is clear that genetics poses a significant challenge for teachers, with the highest level of misconception. Efforts should be directed towards providing targeted professional development programs and resources to improve teachers' understanding and teaching effectiveness in genetics. Additionally, addressing the moderate misconceptions in ecology and zoology is also important to enhance instruction in these areas.

In addition, the results emphasize the need for ongoing professional development and support in all four areas of biology. By equipping teachers with accurate and up-to-date knowledge, misconceptions can be addressed, and students can receive high-quality instruction in genetics, ecology, zoology, and botany.

Conclusions, recommendations, implications

The conducted study found out the common misconceptions among the science teachers in Siargao Islands. The study showed the level of misconception of the science teachers is low in botany, moderate in zoology, and ecology while high misconception was found in genetics. This concludes that genetics has the highest misconception among the areas of biology.

In the field of botany, it is worth noting that the low overall level of misconceptions among teachers in botany is a promising result. However, regular assessment and evaluation of teachers' understanding of botany should be conducted to ensure ongoing professional growth and improvement. This will contribute to the overall quality of botany education and benefit students' learning outcomes.

In addition, to address these misconceptions and enhance teaching in genetics as the highest level of misconception, ecology and zoology with a moderate level of misconception, targeted professional development programs should be implemented. These programs should focus on specific areas where teachers have high misconceptions, providing teachers with accurate and up-to-date information through these programs can help them improve their understanding and instructional practices.

Moreover, fostering collaboration between educators, genetics, ecology and zoology experts, and educational institutions is important. Creating platforms for knowledge sharing, such as workshops and conferences, can facilitate meaningful discussions, idea exchange, and professional growth. This collaborative approach encourages teachers to stay informed about the latest research and developments in genetics, ecology and zoology, ultimately aims to enhance their teaching effectiveness.

Thus, the findings suggest that during the teaching-learning process, teachers should be evaluated for their current grasp of fundamental biological concepts in order to identify misconceptions and enhance conceptual comprehension through engaging and innovative teaching strategies. Taking into consideration on the findings of this study, teachers can also read, explore and participate in some programs about the scientific community in general and the area of biology in particular. Botany, zoology, ecology, and genetics are the only four main branches of biology covered in the study, hence it is suggested that more branches be added to examine teachers' mistakes. The structure of the study's questions, which only allow for binary responses, is another limitation of the study. The results of the study will be useful for teachers, students, and all other educators, particularly curriculum designers, textbook writers, trainers, parents, and the academe as a whole, for the continuous improvement of the quality education that we offer to our dear students.

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