Learners' Misconceptions in Biology and Chemistry: Input to Learning Material Enhancement

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ABSTRACT

A solid foundation in science is necessary to comprehend more complicated concepts in Biology and Chemistry. The study aimed to determine the misconceptions of grade 6 learners in Biology and Chemistry; the practices of science teachers in addressing the misconceptions of the learners; the challenges being experienced by the science teachers in correcting the misconceptions of the learners; and the supplementary learning materials in Biology and Chemistry that can be designed. The study utilized the survey research design with a validated survey questionnaire as the data gathering instrument. The respondents were 112 grade 6 learners and 32 science teachers from two National Elementary Schools in Nasugbu. The study's findings revealed that in Biology, the purpose of respiration is to deliver carbon dioxide and expel oxygen is the greatest misconception among learners. On the other hand, filtration can separate solutions is a significant misconception among learners in Chemistry. It also revealed that providing an appropriate illustration of examples in a particular topic has always been practiced in addressing misconceptions. Furthermore, most respondents found it easy to utilize creative teaching methods to mediate misconceptions. Consequently, the learning guide in grade six science as the supplementary learning materials in Biology and Chemistry was designed.

Keywords: Misconceptions, Biology and Chemistry, learning materials, practices, challenges

INTRODUCTION

Learning science in the elementary grades requires a solid foundation to understand more complex ideas in science subjects, particularly Biology and Chemistry. High-quality science instruction makes students curious and interested and improves reasoning. This could help them to understand every concept in science widely.

Per Commission on Higher Education, Memorandum Order No. 74 s. 2017 defined Teaching Science in the Primary Grades (Biology and Chemistry) as the understanding and learning of every learner in the basic spiral concepts of science and the application of scientific inquiry in Chemistry and Biology. It also includes the use of elementary science teaching methodologies and approaches, as well as the creation of instructional materials tailored to the needs of students and assessments. Therefore, learners can understand the most basic concepts as their foundation to understand more complex concepts about science.

The National Science Teachers Association (NSTA) emphasizes the importance of successful elementary science education. It encourages all education stakeholders to collaborate to offer effective and equitable instruction, materials, environments, and opportunities for all students. It promotes how learners learn science effectively so that misunderstandings will not arise.

Several studies asserted that misconception is a barrier for students to learn science. It is a hindrance to learning science concepts comprehensively. This makes it challenging to correct ideas that they have used as their initial understanding of the science concepts.

Moreover, misconceptions have a significant impact on student learning. These misconceptions are deeply ingrained and can be carried over from course to course, having a long-term and cross-disciplinary impact on students (Coll & Treagust, 2003; Yong & Kee, 2017).

Some misconceptions may arise in students, such as preconceived notions, nonscientific beliefs, conceptual misunderstanding, vernacular misconceptions, and factual misconceptions. The strategies should be aligned with what kind of misconceptions the students had.

Therefore, teaching plays a vital role in how learners learn the lesson. So, teachers should be aware of students' misconceptions during instruction. Thus, students can construct new knowledge related to their prior knowledge to attain meaningful learning.

The researchers considered it necessary to determine elementary learners' misconceptions in science, particularly in Biology and Chemistry, because it serves as an obstacle in learning science comprehensively. This may provide quality science teaching to avoid misconceptions in science learning. Therefore, this may serve as input in enhancing learning materials.

Objectives

This study aimed to determine elementary learners' misconceptions in Biology and Chemistry as input to an enhanced learning material.

Specifically, it sought answers to the following questions:

1. What are the misconceptions of the learners in Biology and Chemistry?

2. What are the science teachers' practices in addressing the learners' misconceptions?

3. What are the challenges being experienced by the science teachers in correcting the misconceptions of learners?

4. What supplementary learning materials in Biology and Chemistry can be designed?

METHODOLOGY

Survey research was used in the study. It is a quantitative method that asks many survey questions to a group of people to collect information. This study aimed to know the elementary learners' misconceptions in Biology and Chemistry, the science teachers' practices in addressing misconceptions, and the challenges of correcting misconceptions. Therefore, survey research is the most appropriate research design for this study.

The respondents of the study were the grade six pupils and science teachers from two National Elementary Schools in Nasugbu. The researchers believed that this group of people would supply them with all the knowledge and information needed for this investigation.

The researchers used a validated survey questionnaire as the primary data-gathering instrument in this study to discover learners' misconceptions about science, notably Biology and Chemistry. The survey questionnaire included statements and questions to determine learners' misconceptions, science teachers' practices in addressing misconceptions, and their challenges in correcting them.

The gathered data was tabulated and processed to determine the precise interpretation of the results. Data were accumulated, tabulated, and analyzed. The statistical tools used in the analysis of data were frequency, Likert scale, percentage, ranking, and weighted mean.

RESULTS AND DISCUSSION

Misconception of Elementary Learners in Biology and Chemistry

Table 4.1 Misconceptions of Elementary Learners in Biology

Statements	Frequency			
	Strongly Agree	Agree	Disagree	Strongly Disagree
1. Respiration serves to deliver carbon dioxide and expel oxygen.	33	59	15	5

2. The process that releases energy is digestion.	37	51	19	5
3. The blood is constantly in motion. It starts in the heart, travels throughout your body and then returns to the heart.	50	44	15	3
4. The respiratory and circulatory systems cooperate to deliver oxygen to the organism and remove carbon dioxide.	49	43	14	6
5. Muscles are in the arms. They are not found all over the body.	26	29	34	23
6. All animals have a backbone.	21	30	39	22
7. All small animals are invertebrates.	22	30	39	21
8. Vertebrates have limbs and necks.	24	38	33	17
9. Animals with a vertebral column can run fast but tortoises move very slowly.	29	55	24	4
10. Snakes and turtles are invertebrates. The former because of their motion and the latter because of the hard shell.	23	50	26	13
11. Living things and non-living things do not interact; they coexist separately.	27	43	23	18
12. Soil, air, sun, wind, water, and other creatures provide energy to plants.	52	45	14	1
13. There are more herbivores than carnivores because people keep and breed herbivores.	35	48	20	9
14. Sunlight is not the most significant abiotic component for marine ecosystems.	52	43	14	3
15. The relative sizes of predator and prey populations have no bearing on the size of the other.	26	51	27	8

In the statement *"Respiration serves to deliver carbon dioxide and expel oxygen,"* 33 *strongly agree*, 59 *agree*, 15 *disagree*, and five *strongly disagree*, as shown in the results. 59 out of 112 respondents, or 52.68%, agreed with the statement. This result indicates that the respondents are unaware of the purpose of respiration in the body.

"The process that releases energy is digestion" this statement got 37 *strongly agree*, 51 *agree*, 19 *disagree*, and five *strongly disagree*. It showed that 51 out of 112 participants, or 45.54%, agreed that digestion is the energy-releasing process. This result confirmed that participants were unaware of the process of digestion.

Additionally, the statement obtained 50 *strongly agree*, 44 *agree*, and 15 *disagree. Three strongly disagree* "*The blood is constantly in motion. It starts in the heart, travels throughout your body, and then returns to the heart"*. It demonstrated that 50 of 112 respondents, or 44.64%, acknowledged the misconception about the blood circulation in the body.

The statement "*The respiratory and circulatory systems cooperate to deliver oxygen to the organism and remove carbon dioxide"* gained a response of 49 *strongly agree*, 43 *agree*, 14 *disagree*, and six *strongly disagree.* Hence, 49 out of 112 participants, or 43.75%, strongly agreed with the statement. The result exposed that participant did

not understand the collaboration of the respiratory and circulatory systems in providing oxygen and ridding the body of carbon dioxide.

Based on the learners' responses, *"Muscles are in the arms. They are not found all over the body,"* 26 *strongly agree*, 29 *agree*, 34 *disagree*, and 23 *strongly disagree*. Resultantly, 34 out of 112 respondents, or 30.36% of respondents, disagreed that muscles are in the arms and are not found all over the body. It revealed that the learners knew where the muscles could be found.

The statement *"All animals have a backbone"* gained 21 *strongly agree*, 30 *agree*, 39 *disagree*, and 22 *strongly disagree.* As indicated in the results, 39 out of 112 respondents, or 34.82% of the respondents, disagreed that all animals have a backbone. It implied that learners did not have misconceptions regarding the presence of backbone in all animals.

Additionally, the statement obtained 22 *strongly agreed*, 30 *agreed*, 39 *disagreed*, and 21 *strongly disagreed "All small animals are invertebrates*." It demonstrated that 39 of 112 respondents, or 34.82%, believed that all small animals are invertebrates. This proved that the respondents have a clear understanding of the characteristics of all small animals and so as the classifications of invertebrates.

Based on the pupils' responses, the statement *"Vertebrates have limbs and necks."* received 24 *strongly agree*, 38 *agree*, 33 *disagree*, and 17 *strongly disagree*. Resultantly, 38 out of 112 respondents, or 47.32% of respondents, agreed that all vertebrate animals have limbs and necks. This result explains that the learners need to be aware of vertebrates' classifications.

Moreover, *" Animals with a vertebral column can run fast, but tortoises move very slowly."* obtained 29 *strongly agree*, 55 *agree*, 24 *disagree*, and four *strongly disagree*. Consequently, 55 of 112 participants, or 49.11%, agreed that animals with vertebral columns could run fast, but tortoises move very slowly. It illustrated that learners have the misconception that tortoises have vertebral columns and can move faster.

"Snakes and turtles are invertebrates. The former because of their motion and the latter because of the hard shell" this statement got 23 *strongly agree*, 50 *agree*, 26 *disagree*, and 13 *strongly disagree*. It showed that 50 out of 112 participants, or 44.64% of participants, agreed that snakes and turtles are invertebrates because of their motion and hard shell. This revealed that the participants were unaware that snakes and turtles are vertebrates.

The statement *"Living things and non-living things do not interact; they coexist separately"* gained a response of 27 *strongly agree*, 43 *agree*, 23 *disagree*, and 18 *strongly disagree.* Hence, 43 out of 112 participants, or 38.39%, agreed that living and non-living things do not interact. The result showed that participants misunderstood the interaction between non-living and living things.

Based on the pupils' responses, the statement *"Soil, air, sun, wind, water, and other creatures provide energy to plants"* received 52 *strongly agree*, 45 *agree*, 14 *disagree*, and one *strongly disagrees*. Resultantly, 52 out of 112 respondents, or 46.43%, strongly agreed that plants get their energy from soil, air, sun, wind, water, and other animals. This revealed that learners are unaware that the statement is a misconception.

In the statement, "There are more herbivores than carnivores because people keep and breed herbivores," 35 *strongly agree*, 48 *agree*, 20 *disagree*, and nine *strongly disagree*. As indicated in the result, 48 out of 112 respondents, or 42.86% of the respondents, agree that there are more herbivores than carnivores because people keep and breed herbivores. It revealed that learners are unaware that people are not just keeping and breeding herbivores but also carnivores.

"Sunlight is not the most significant abiotic component for marine ecosystems" obtained 52 *strongly agree*, 43 *agree*, 14 *disagree*, and three *strongly disagree*. Thus, 52 out of 112 participants, or 46.43%, strongly agreed that sunlight is not considered the most important abiotic factor for marine ecosystems. It showed that most participants have misconceptions and that sunlight is not the most important abiotic factor for marine ecosystems.

Last, *"The relative sizes of predator and prey populations have no bearing on the size of the other"* obtained 26 *strongly agree*, 51 *agree*, 27 *disagree*, and eight *strongly disagree*. Therefore, 51 out of 112 respondents agreed with the statement or 45.54% of the total respondents. This result implies that the pupils did not know enough about the relative sizes of predator and prey populations towards the sizes of the other.

Table 4.2 Misconceptions of Elementary Learners in Chemistry

Statements	Frequency			
	Strongly Agree	Agree	Disagree	Strongly Disagree
1. Mixtures are the same as compounds	28	47	34	3
2. All mixtures are solutions.	30	49	27	6
3. The mixture of water and oil is a homogeneous mixture.	30	53	19	10
4. In notions involving elements, compounds, mixtures, solutions, and substances, particles are misrepresented and are not differentiated.	33	58	17	4
5. When a substance dissolves, it disappears.	30	51	19	12
6. All mixtures are separated using only one separating technique.	22	44	33	13
7. Evaporation and boiling are the same thing.	23	43	37	9
8. Filtration can separate solutions.	29	61	19	3
9. A solution is a single substance.	32	48	22	10
10. Boiling point increases as the substance is heated.	36	56	11	9

In the statement, *"Mixtures are the same as compounds,"* 28 *strongly agree*, 47 *agree*, 34 *disagree*, and three *strongly disagree*. As indicated in the result, 47 out of 112 respondents, or 41.96% of the respondents, agreed that mixtures are similar to compounds. It revealed that learners need clarification about the difference between mixtures and compounds.

"All mixtures are solutions" this statement got 30 *strongly agree*, 49 *agree*, 27 *disagree*, and six *strongly disagree*. It showed that 49 out of 112 participants, or 43.75% of participants, agreed that all mixtures are solutions. Thus, most of the respondents needed more understanding regarding the concepts of mixtures.

Additionally, the statement obtained 30 *strongly agreed*, 53 *disagreed*, 19 *disagreed*, and ten *strongly disagreed*. *"The mixture of water and oil is a homogeneous mixture*." It demonstrated that 53 of 112 respondents, or 47.32%, believed that the mixture of water and oil was homogeneous. It expressed that learners need clarification about the types of mixtures.

The statement *"In notions involving elements, compounds, mixtures, solutions and substances"* gained a response of 33 *strongly agreed*, 58 *agreed*, 17 *disagreed*, and four *strongly disagreed*. Hence, 58 out of 112 participants, or 51.79%, agreed with elements, compounds, mixtures, solutions, and substances that are not differentiated in concepts. The result showed that participants needed more knowledge concerning concepts between elements, compounds, mixtures, solutions, and substances.

Based on the pupils' responses, the statement *"When a substance dissolves, it disappears"* received 30 *strongly agree*, 51 *agree*, 19 *disagree*, and 12 *strongly disagree*. Resultantly, 51 out of 112 respondents, or 45.54%,

agreed that a substance disappears when it dissolves. It revealed that learners have misconceptions about the dissolving process of a substance.

Moreover, *"All mixtures are separated using only one separating technique"* obtained 22 *strongly agree*, 44 *agree*, 33 *disagree*, and 13 *strongly disagree*. Consequently, 44 of 112 participants, or 39.29%, agreed that there is only one separating technique in separating mixtures. It illustrated that learners need to be aware of other separating techniques used in mixtures.

The statement *"Evaporation and boiling are the same things"* gained 23 *strongly agree*, 43 *agree*, 37 *disagree*, and nine *strongly disagree.* As indicated in the results, 43 out of 112 respondents, or 38.39% of the respondents, agreed that evaporation and boiling are the same. It implied that learners have misconceptions about the difference between evaporation and boiling.

"Filtration can separate solutions" obtained 29 *strongly agree*, 61 *agree*, 19 *disagree*, and three *strongly disagree*. Thus, 61 out of 112 participants, or 54.46%, agreed that filtration could separate solutions. It showed that most of the participants needed more understanding of filtration as one of the methods of separating mixtures.

Added to that, the statement *"A solution is a single substance"* gained 32 *strongly agree*, 48 *agree*, 22 *disagree*, and ten *strongly disagree*. Hence, 48 out of 112 respondents, or 42. 86% of the respondents agreed that the solution is a single substance. It only expressed that the respondents need clarification about solutions.

Last, *"Boiling point increases as the substance is heated,"* obtained 36 *strongly agree,* 56 *agree*, 11 *disagree*, and nine *strongly disagree*. Therefore, 56 out of 112 respondents, or 50% of the total respondents, agreed with the statement. This implied that the learners did not have enough knowledge about boiling point.

Science Teacher's Practices in Addressing Misconception

The table shows the various practices in addressing misconceptions in teaching science, and the respondents rated them depending on how they were addressed.

Table 4.3 Practices of Science Teachers in Addressing Misconceptions

Statements	**W.M.**	**V.I.**	**R**
1. The teacher provides learners-cantered activities in which they can explore their misconceptions.	3.78	Always	9.5
2. The teacher determines the pupil's interest to easily get the idea.	3.78	Always	9.5
3. The teacher uses comprehensive and up-to-date ideas and examples.	3.84	Always	3.5
4. The teacher asks questions or does a demonstration that engages the learners where they bring up their own misconceptions about the topic.	3.72	Always	13.5
5. The teacher is mindful of all the information and terminologies provided among learners.	3.84	Always	3.5
6. The teacher provides a concise and exact explanation.	3.78	Always	9.5
7. The teacher employs different instructional materials.	3.78	Always	9.5
8. The teacher assesses the learner's knowledge of a particular topic.	3.72	Always	13.5
9. The teacher utilizes different and appropriate learning strategies.	3.81	Always	6.5
10. The teacher utilizes creative teaching methods.	3.84	Always	3.5
11. The teacher provides information and experience that is relevant to the lesson.	3.81	Always	6.5

12. The teacher knows the student's level of knowledge and about a particular lesson.	3.75	Always	12
13. The teacher has a clear explanation in every scientific process	3.84	Always	3.5
14. The teacher provides an appropriate illustration of examples in a particular topic.	3.88	Always	1
GENERAL WEIGHTED MEAN	3.80	Always	

Legend: W.M. – Weighted Mean V.I. – Verbal Interpretation R - Rank

The participants' responses to the practices of addressing misconceptions in teaching science obtained a general weighted mean of 3.8, interpreted as *Always.* This result indicates that the science teachers always practiced the statements addressing pupils' misconceptions.

The statement *"The teacher provides an appropriate illustration of examples in a particular topic."* got the first rank with a weighted mean of 3.88 and was verbally interpreted as *Always.* This result shows that the respondents have always provided an appropriate illustration of examples in particular topics that greatly help teachers address pupils' misconceptions.

Based on the science teachers' responses, the statements "*The teacher uses comprehensive and up-to-date ideas and examples" and "The teacher is mindful of all the information and terminologies provided among learners.", "The teacher utilizes creative teaching methods." and "The teacher has a clear explanation in every scientific process"* are placed in the 2nd to the fifth spot. They all got a weighted mean of 3.84, interpreted as *Always.* The respondents used those practices at all times, which is effective for pupils to have a deeper understanding of science concepts and may avoid misconceptions.

The statements "*The teacher utilizes different and appropriate learning strategies."* and *"The teacher provides information and experience relevant to the lesson."* ranked 6.5 and got a weighted mean of 3.81. They are verbally interpreted as *Always.* It means that utilizing different and appropriate learning strategies and providing information and experience relevant to the lesson are the practices that are invariably used and presented.

Furthermore, the respondents repeatedly practiced the statement, *"The teacher provides learners-centered activities in which they can explore their misconceptions.", The teacher determines the pupil's interest to get the idea easily.", "The teacher provides a concise and exact explanation."* and *"The teacher employs different instructional materials."* obtained a weighted mean of 3.78, verbally interpreted as *Always.* It means that giving learners-centered activities, considering their interest, providing a concise and exact explanation, and employing different instructional materials can address misconceptions as approved by the respondents.

The statement *"The teacher knows the student's level of knowledge and about a particular lesson."* got a weighted mean of 3.75 and was interpreted as *Always*. It shows that teachers continuously practice checking the learner's level of understanding so misconceptions will not arise.

Lastly, the statements *"The teacher asks a question or does a demonstration that engages the learners where they bring up their misconceptions about the topic" and "The teacher assesses the learner's knowledge of a particular topic"* both got a weighted mean of 3.72, verbally interpreted as *Always.* This result implies that respondents always ask questions and assess learning among learners.

Challenges of Science Teachers in Correcting the Misconceptions

Table 4.4 Challenges of Science Teachers in Correcting Misconceptions

Statements	**W.M.**	**V.I.**	**R**
1. I do not check pupils' alternate conceptions to improve their scientific literacy.	2.03	Disagree	3.5
2. I find it difficult to assess pupils' prior knowledge to increase their conceptual	1.98	Disagree	10

comprehension through creative and engaging methods.			
3. I barely know who and what influences the students in learning.	1.98	Disagree	10
4. I find it hard to communicate abstract concepts in an acceptable manner either through visualization for pupils to comprehend the information.	1.97	Disagree	12
5. I face difficulties in solving what pupils thought about phenomena	1.96	Disagree	13.5
6. I am not aware of when to choose activities that allow pupils to solve issues and develop concepts from their experiences.	1.96	Disagree	13.5
7. I find it difficult to fill the gap between the sensory input and prior knowledge by giving them the information and experiences they need.	2.00	Disagree	6
8. I have difficulties in finding opportunities that expand their knowledge about how to support and guide pupils with various interests, abilities, and experiences.	2.00	Disagree	6
9. I find it difficult to detect pupils' misconceptions to rectify them.	1.99	Disagree	8
10. I am not aware of the potential misconceptions that may occur during instruction.	1.98	Disagree	10
11. I struggle in using technology to engage pupils and help them overcome common misconceptions about science.	2.03	Disagree	3.5
12. I find it hard to employ appropriate teaching aids to pupils aligned with their science misconceptions.	2.04	Disagree	2
13. I suffer due to lack of adherence and misconceptions while designing the lessons.	2.00	Disagree	6
14. I find it difficult to utilize creative teaching methods with pupils to help them mediate their misconceptions.	2.10	Disagree	1
GENERAL WEIGHTED MEAN	2.00	Disagree	

Legend: W.M. – Weighted Mean V.I. – Verbal Interpretation R - Rank

The participant's responses to teachers' challenges in correcting misconceptions obtained a general weighted average of 2.00 and were verbally interpreted as *Disagree,* as shown in the results. This result indicates that teachers have enough skills and do not experience any challenges correcting the students' misconceptions.

Based on the result of this study, the statement *"I find it difficult to utilize creative teaching methods with pupils to help them mediate their misconception"* ranked at the top with a weighted mean of 2.10 and was interpreted as *Disagree*. This means it is easy for science teachers to use creative teaching methods with pupils to handle their misconceptions. They are aware that they have to use various forms to avoid misconceptions in their pupils.

The statement *"I find it hard to employ appropriate teaching aids to pupils aligned with their science misconception"* ranked second with a weighted mean of 2.04 and was interpreted as *Disagree,* which means the teachers know how to apply appropriate aids or materials in science to correct misconceptions among learners.

The statement *"I do not check pupils' alternate conceptions to improve their scientific literacy"* and *"I struggle in using technology to engage pupils and help them overcome common misconceptions about science"* got the third in ranking with a weighted mean of 2.03 and interpreted as *Disagree*. It only shows that the teachers always examine the alternate conceptions of the pupils to develop their scientific literacy. They also have enough knowledge in incorporating technology to captivate pupils in learning science and overcome misconceptions.

Twelfth in the rank is the statement, *"I find it hard to communicate abstract concepts acceptably through visualization for pupils to comprehend the information,* with a weighted mean of 1.97 and interpreted as *Disagree.*

In the result, rank 13.5 is the statement *"I face difficulties in solving what pupils thought about phenomena,* and the statement *"I am not aware of when to choose activities that allow pupils to solve issues and develop concepts from their experiences"* got a weighted mean of 1.96 and interpreted as *Disagree.* It shows that elementary teachers could easily solve what the pupils thought about the phenomena. They know what activities should be used to solve the problem and develop skills from the pupils' experiences.

The Designed Supplementary Learning Materials in Biology and Chemistry

The Learning Guide in Grade Six Science (Biology and Chemistry) as the supplementary learning materials in Biology and Chemistry designed by the researchers includes factual information with regards to the targeted lessons based on the result of the study. The information will help correct the learners understanding about Biology and Chemistry concepts.

CONCLUSIONS

The following conclusion was made based on the findings of the study:

1. Respiration serves to deliver carbon dioxide and expel oxygen is the greatest misconception among elementary learners in Biology. On the other hand, filtration can separate solutions is a significant misconception among elementary learners in Chemistry.

2. Most respondents revealed that providing an appropriate illustration of examples in a particular topic has always been practiced in addressing pupils' misconceptions.

3. Most respondents did not find it challenging to utilize creative teaching methods to mediate pupils' misconceptions.

4. The learning guide was based on the study's results as the designed supplementary learning materials in Biology and Chemistry in dealing with the pupils' misconceptions.

RECOMMENDATIONS

Based on the analysis and conclusions of the study, the following recommendations are hereby endorsed:

1. To avoid misconceptions, elementary learners should be involved in science activities and explore ways to understand science concepts, particularly in Biology and Chemistry, fully.

2. Science teachers may consider the researcher's designed learning guide for grade six science (Biology & Chemistry) that highlights misconceptions and provides scientific information.

3. Future researchers may conduct research that seeks more practices and strategies used by science teachers to address pupils' misconceptions.

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