

# Development of Contextualized Strategic Intervention Materials (CSIMs) in Photosynthesis and Cellular Respiration for Grade 9 Learners

Cheenie Mae A. Dacula<sup>1</sup>, Monera A. Salic-Hairulla<sup>2</sup>, Douglas A. Salazar<sup>3</sup>, Angeline C. Dinoro<sup>4</sup>, and Liza A. Adamat<sup>5</sup>

<sup>1,2,3,4</sup>Department of Science and Mathematics Education, College of Education

<sup>5</sup>Department of Science and Mathematics Education, College of Science and Mathematics

<sup>1,2,3,4,5</sup>MSU- Iligan Institute of Technology, College of Education

Email: <sup>1</sup>[cheeniemaedacula@g.msuiit.edu.ph](mailto:cheeniemaedacula@g.msuiit.edu.ph) and <sup>2</sup>[monera.salic@g.msuiit.edu.ph](mailto:monera.salic@g.msuiit.edu.ph)

**Abstract**— This study aimed to develop Contextualized Strategic Intervention Material (CSIMs) to improve the conceptual understanding of Grade 9 learners in Photosynthesis and Cellular Respiration. The developed CSIMs focused on the topics in Photosynthesis and Cellular Respiration for Grade 9 learners, aligned with the Most Essential Learning Competencies of the K-12 Curriculum. It consists of activities infused with targeted reading strategies. The development of the contextualized strategic intervention material utilized the Successive Approximation Model (SAM) of Allen (2014). The panel of evaluators rated the developed Contextualized Strategic Intervention Materials “Passed” description across all evaluation factors (content, format, presentation, accuracy and up-to-datedness) based on the established rubric from the Department of Education (DepEd). The “Passed” ratings in all categories signify that the material is ready for implementation to help students improve their performance and mastery of the competencies in Photosynthesis and Cellular Respiration..

**Keywords**— contextualized, SIM, conceptual understanding, photosynthesis, cellular respiration.

## 1. INTRODUCTION

The onset of the K-12 basic education program aims to erase students' poor academic achievement in different subject areas. One of the important goals of teaching is to help students understand the main concepts in a subject, rather than simply remembering isolated facts (Manurung et al., 2021). Understanding concepts is very important for students because by understanding a concept, students will more readily associate one concept with another (Yuliassari et al., 2022). However, misconceptions are one of the main barriers that students encounter as they seek to understand a concept. Various research in education revealed that many students make common errors or hold many misconceptions or alternative conceptions during learning many concepts (Deshmukh, 2016).

Biology contains many abstract concepts, which may cause students difficulty constructing knowledge (Malones, 2022). In the Philippines, photosynthesis and cellular respiration are taught from primary to

secondary education and in much greater detail in the Senior High School. Since the two processes serve as a foundation for many other topics in Biology, the Grade 9 learners need to understand them. However, teaching this complex concept effectively can be challenging due to its abstract nature and the intricate biochemical processes involved (Rani, 2024). Generally, science consists of intangible concepts, and students find it difficult to embody these concepts in their heads (Ozcan et al., 2022). Critical thinking and problem-solving skills are vital for science compared to other classes. On the other hand, memorization and mimicry are not necessarily critical to becoming successful in this subject (Akbash, 2016). Reading comprehension is a crucial skill that students must develop to learn science (Meneses et al., 2018). Few researchers indicate that reading comprehension significantly improves students' learning in science. While not all strategies were equally effective, evaluation studies consistently found significant gains in reading proficiency in science.

The main objective of this study was to develop a Contextualized Strategic Intervention Material (CSIMs) on the topics Photosynthesis and Cellular Respiration for Grade 9 learners. To achieve the general objective, this study aimed to: (1) Assess the needs of the teachers and students in teaching the concepts of photosynthesis and cellular respiration, and (2) Develop a contextualized strategic intervention material in Photosynthesis and Cellular Respiration for Grade 9 learners.

## 2. METHOD

The development of the Contextualized Strategic Intervention Materials (CSIMs) utilized the Successive Approximation Model (SAM) proposed by Michael Allen (2014). The Successive Approximation Model (SAM) is an instructional design model that can serve as a framework in developing an agile and rapid instructional tool (Quero & Bacio, 2025).

### 2.1. Participants

The study involved three (3) groups of participants: expert evaluators, teachers, and learners. A panel of evaluators consisting of five (5) in-service science teachers who were purposively selected to validate the following instruments: (1) the needs assessment questionnaire and (2) developed strategic intervention materials. In addition, another five (5) in-service teachers were purposively selected to complete the needs assessment questionnaire. Lastly, two (2) groups/sections of Grade 9 learners were assessed through a pretest.

### 2.2. Instrumentation

The study utilized both researcher-made and standardized instruments to assess learning outcomes and gather supporting data:

- **Needs Assessment Questionnaire:** The researcher adapted and modified a needs survey from Allonar et al. (2023). The survey questionnaire used by the researcher was based on the work of Bontilao et al. (2021). It is used to assess the need for the development of a contextualized strategic intervention material for the topics photosynthesis and cellular respiration. Furthermore, it was validated by five

(5) experts who have Master's or Doctorate degrees in professional education.

- **Standardized Rubric for Contextualized Learning Packets:** The researcher used a standardized rubric from the Department of Education (DepEd, 2015) to ensure that the feasibility of the developed intervention material was accurate and acceptable before implementation
- **Achievement Test:** The researcher adapted a 30-item multiple-choice achievement test from the Department of Education's existing self-learning modules, specifically Self-Learning Module 5 for Grade 9 Learners: First Quarter. This served as a pretest to assess the needs of learners in the said topic.

### 2.3. Procedure

To guarantee the credibility of the study, necessary permissions were secured from the school authorities, and informed consent was obtained from the learners and their guardians. The researcher adapted and modified a needs assessment questionnaire for teachers from the study of Allonar et al. (2023) to assess the need for contextualization of the Strategic Intervention Materials (SIMs). In addition, it was validated by five (5) experts who have Master's or Doctorate degrees in professional education. Moreover, the questionnaire was administered to the science teachers of the participating school. The teachers served as the key informants of the study. Furthermore, an achievement test was adapted from the Department of Education's existing self-learning modules, specifically Self-Learning Module 5 for Grade 9 Learners: First Quarter. This was administered to the learners, which served as a pretest to assess the needs of learners in the said topic. The results of the two questionnaires administered were used as input in developing the CSIMs. The developed CSIMs were then evaluated using the standardized rubric from the Department of Education (DepEd, 2015).

### 2.4. Data Analysis

The study utilized both quantitative and qualitative analyses. Mean was used to analyze the ratings in the needs assessment questionnaire, the result of the

administered pretest, and the developed contextualized SIMs on Photosynthesis and Cellular Respiration. In

addition, standard deviation was used to measure how spread out data points are from the average (mean).

**Table 1.** *Scaling Evaluators' Ratings on Needs Assessment Questionnaires*

| Mean Rating | Descriptor        |
|-------------|-------------------|
| 3.25-4.00   | Excellent         |
| 2.50-3.24   | Very Good         |
| 1.75-2.49   | Good              |
| 1.0-1.74    | Needs Improvement |

Table 1 shows the criteria for evaluating the efficacy of a modified needs assessment questionnaire based on the study by Bontilao et al. (2021).

**Table 2.** *Performance Classification and Scoring Rubric for the Learning Packet Evaluation*

| Total Points                                                                              | Descriptor    |
|-------------------------------------------------------------------------------------------|---------------|
| <b>a. Content</b>                                                                         |               |
| Resource must score at least 21 points out of a maximum 28 points to pass this criterion  | Passed/Failed |
| <b>b. Format</b>                                                                          |               |
| Resource must score at least 54 points out of a maximum 72 points to pass this criterion  | Passed/Failed |
| <b>c. Presentation and Organization</b>                                                   |               |
| Resource must score at least 15 points out of a maximum 20 points to pass this criterion. | Passed/Failed |
| <b>c. Accuracy and Up-to-datedness of Information</b>                                     |               |
| Resource must score 24 out of a maximum 24 points to pass this criterion                  | Passed/Failed |

**Table 3.** *Level of Proficiency Descriptor Adapted from the Department of Education*

| Level of Proficiency    | Equivalent Numerical Value | Score Interval |
|-------------------------|----------------------------|----------------|
| Advanced                | 90-100%                    | 27-30          |
| Proficient              | 85-89%                     | 26             |
| Approaching Proficiency | 80-84%                     | 24-25          |
| Developing              | 75-79%                     | 23             |
| Beginning               | 0-74%                      | 0-22           |

The table above shows the Department of Education Level of Proficiency Descriptors classifying the learners' performance into categories based on the percentage scores and their equivalent numerical values. Furthermore, content analysis was used to discuss the response of the key informants on the needs of the teachers.

### 3. RESULTS AND DISCUSSION

This study aimed to develop Contextualized Strategic Intervention Materials to improve the Grade 9 learners' conceptual understanding of Photosynthesis and Cellular Respiration. This section presents the findings on the needs assessment and the development of the contextualized SIMs.

#### 3.1. Data Analysis on Needs Assessment

**Table 4.** *Evaluators' Rating of the Modified Needs Assessment Questionnaire*

| Components                          | Mean Rating | Descriptor |
|-------------------------------------|-------------|------------|
| Content and Development             | 3.22        | Very Good  |
| Format, Organization, and Structure | 3.18        | Very Good  |
| Grammar                             | 3.23        | Very Good  |

Table 4 shows the criteria for evaluating the developed CSIMs. This rubric was adapted from the standardized rubric for contextualized learning packet by the Department of Education.

The table above reveals the results of the teacher evaluators' rating of the modified needs assessment questionnaires.

The rubric was composed of different components, which include Content and Development, Format, Organization and Structure, and Grammar.

As presented, the needs assessment questionnaire rated Very Good in all components. Thus, this implied that the questionnaire was valid and could be used as an instrument.

During the implementation of the needs assessment questionnaires for the key informants, it was found out that there is a need to develop Contextualized Strategic Intervention Materials (CSIMs) in Photosynthesis and Cellular respiration. It is evident in the key informants'

responses that they were having difficulty in teaching topics in Biology, especially in Photosynthesis and Cellular Respiration.

One of the key informants said, "It is impossible to show the learners how the actual process takes place."

It is difficult because the important parts are invisible, which means the teacher can't show to the learners what's happening.

Aside from that, another identified reason for difficulty teaching includes weak foundational understanding and deficient reading comprehension.

Through all of these difficulties, the teachers have insufficient training and exposure on contextualized and localized instruction and strategic intervention materials.

However, the teachers acknowledged the possible positive effects of the Strategic Intervention Materials to the academic performance of the learners.

**Table 5. Raw Scores of Learners**

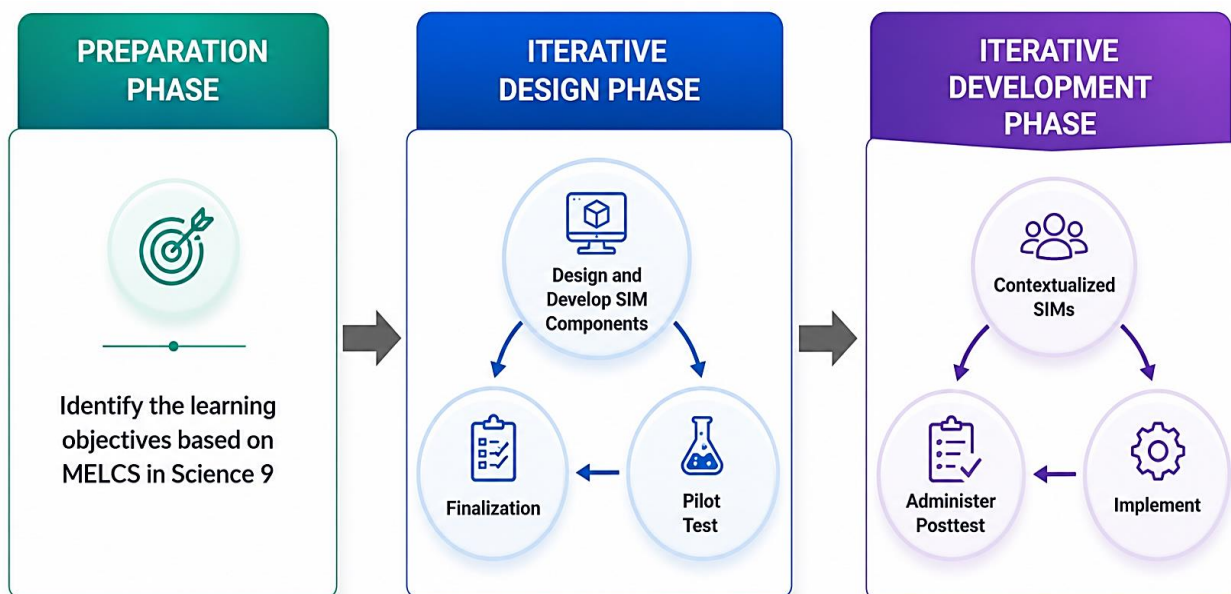
| Gain Score Ranges   | Control Group |     |                |
|---------------------|---------------|-----|----------------|
|                     | f             | %   | Interpretation |
| 27-30               | 0             | 0   | A              |
| 26                  | 0             | 0   | P              |
| 24-25               | 0             | 0   | AP             |
| 23                  | 0             | 0   | D              |
| 0-22                | 56            | 100 | B              |
| <b>Total (Mean)</b> | 56            | 100 | B (13.63)      |

Legend: A-Advanced; P-Proficient; AP- Approaching Proficiency; D- Developing; B-Beginning

Table 5 presents the raw scores of the learners during the pre-test. Results show all of the learners were categorized under the 'Beginning' level (score range: 0-20). The result suggests that the learners exhibited relatively low conceptual understanding of the topics of photosynthesis and cellular respiration.

### 3.2. Development of Contextualized Strategic Intervention Materials (CSIMs) in Photosynthesis and Cellular Respiration

The development of the contextualized SIM utilized the Successive Approximation Model (SAM) Instructional Design Model of Allen (2019).



**Figure 1.** Steps in the Development of a Contextualized STEM Module in Photosynthesis and Cellular Respiration

### 3.2.1. Selection of Topics MELCS from DepEd

Table 3 below presents the content standard, learning competencies, duration, and K to 12 CG code used in

the study. This was also used as the basis for developing the CSIMs.

**Table 6.** Selection of Topics in Most Essential Learning Competencies (MELCs) from DepEd

| Quarter | Content Standard The learners demonstrate an understanding of:                      | Performance Standard The learners should be able to:                                               | Most Essential Learning Competencies                                          | Duration | K to 12 CG Code |
|---------|-------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|----------|-----------------|
| 1st     | The structure and function of plant parts and organelles involved in photosynthesis | Design and conduct an investigation to provide evidence that plants can manufacture their own food | Differentiate basic features and importance of photosynthesis and respiration | Week 7   | S9LT-Ig-j-31    |
|         | The structure of mitochondrion as the main organelle involved in respiration        |                                                                                                    |                                                                               | Week 8   |                 |

In fact, there are lots of topics for Science in Grade 9 level. Photosynthesis and Cellular Respiration are one of these topics.

The study conducted by Cantere and Nabua (2024) revealed that photosynthesis and cellular respiration are considered one of the least mastered topics, together with three (3) other topics.

In addition, the study focused particularly on one most essential learning competency: “differentiate basic features and importance of photosynthesis and respiration” which covers two (2) weeks of instruction.

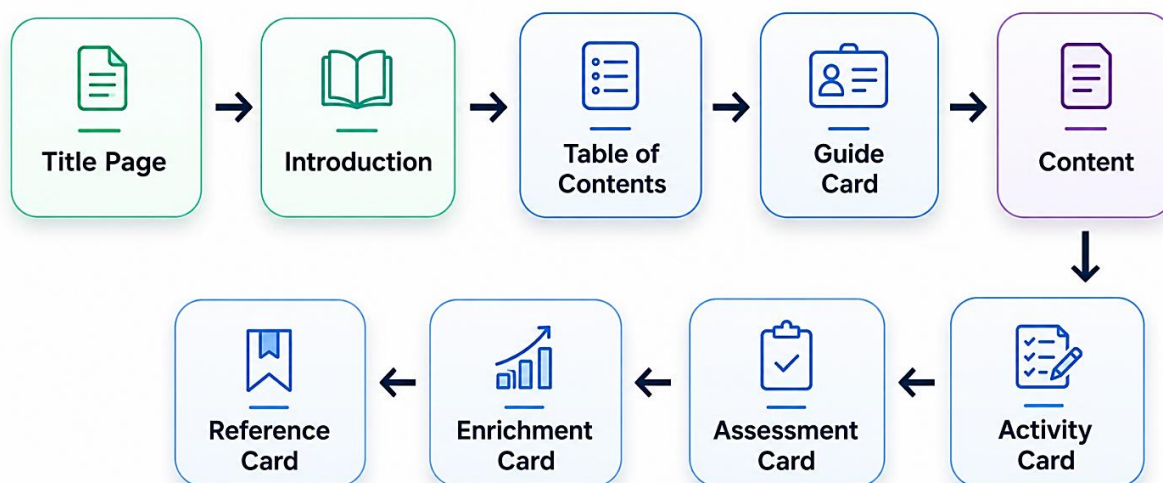
**Table 7.** Summary of the Teachers Response to the Learners' Difficulty among the identified MELCs

| Competency                                                                                                             | Frequency (n) | Percentage (%) | Comments/Remarks                                                                                                                                                                                | Interpretation                                                                                                                             |
|------------------------------------------------------------------------------------------------------------------------|---------------|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| Relate the species extinction to the failure of populations of organisms to adapt to abrupt changes in the environment | 0             | 0              | No responses indicating difficulty in this competency                                                                                                                                           | Not identified as a major difficulty                                                                                                       |
| Differentiate basic features and importance of photosynthesis and cellular respiration                                 | 5             | 100            | "The process was somewhat complicated."<br><br>"The learners need to go back to the basic knowledge about cells because the last time that they encountered the topic was way back in grade 7." | Identified as a difficult competency due to the complicatedness of the topic and weak foundational understanding of learners to the topic. |

The table above shows that all of the key informants (100%) identified competency B (Differentiate basic features and importance of photosynthesis and cellular respiration (S9LT-Ig-j-31) as the most essential learning competency for the learners. Since all of the key informants chose competency B, it was used as the basis for the development of the contextualized strategic intervention materials (CSIMs).

### 3.2.2. Designing Contextualized Strategic Intervention Materials (CSIMs)

In developing and designing Contextualized Strategic Intervention Materials (CSIMs), the components involved in developing a SIM were taken from DepEd (2009). The CSIMs were organized sequentially as follows: (1) Title Page (2) Introduction (3) Table of Contents (4) Guide Card (5) Content (6) Activity Card (7) Assessment Card (8) Enrichment Card (9) Reference Card.



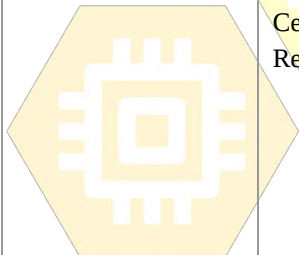
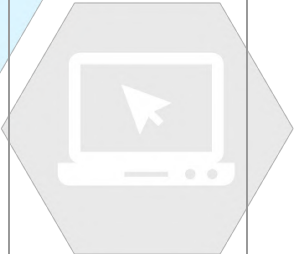
**Figure 2.** Nine Elements in Designing Contextualized Strategic Intervention Materials (CSIMs) in Photosynthesis and Cellular Respiration

The developed CSIMs were divided into three lessons. The first lesson focuses on photosynthesis, the second lesson on Cellular Respiration, and the third lesson focuses on the difference and importance of the two

vital processes. Each of the CSIMs were integrated with targeted reading strategies as shown in Table 4.4 below.

*Table 8. Learning Competency Mapping, Learning Activities and the Targeted Reading Activity employed in the CSIMs*

| Learning Competency                                                                           | Topic                                                                   | Specific Learning Objectives                                                                                                                                                                        | Activities                                                                                                                                                                                                                                                                             | Targeted Reading Activity                                                                                                                                                             |
|-----------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Differentiate basic features and importance of photosynthesis and cellular respiration</b> | Lesson 1<br>The Structure and Function of Plant Parts in Photosynthesis | Identify the and describe the parts of a plant involved in photosynthesis<br><br>Explain how each structure helps the plant make food                                                               | Activity Card 1<br>Photosynthesis in Action<br><br>Worksheet 1<br>Label the Diagram<br><br>Worksheet 2<br>Describing Plant Parts<br><br>Worksheet 3<br>Puzzle Time<br><br>Assessment Card 1<br>Match the Plant Parts to their Function!<br><br>Enrichment Card<br>Why Leaves are Green | Collaborative Reading and Annotation<br><br>Diagram Labeling and Contextual Identification<br><br>Categorization and Descriptive Writing<br><br>Text Sequencing and Summary Synthesis |
|                                                                                               | Lesson 2<br>Fueling the Body: How Cells Turn Food into Energy           | Identify the part of the cell where cellular respiration takes place and describe its role in energy production.<br><br>Explain the process of cellular respiration and identify its key components | Activity 1<br>Meet the Mitochondrion<br><br>Worksheet 1<br>Label the Diagram                                                                                                                                                                                                           | Collaborative Reading and Inferential Thinking<br><br>Structural Mapping and Fact Retrieval                                                                                           |

|                                                                                                                                                                                                                                                                  |                                                                                  |                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                  |                                                                                                                                                           |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                                                                                                                                  |                                                                                  | Determine the cause-and-effect relationships involved in cellular respiration (e.g., glucose + oxygen → ATP + carbon dioxide + water).                                                                                           | Activity 2 and Worksheet 2<br>Cellular Respiration: Journey Through the Cell<br>Worksheet 3<br>The Cause-and-Effect Flow of Cellular Respiration                                                                                                 | Narrative Cloze Activity and Multimodal Expression<br><br>Cause-and-Effect Matching and Graphic Data Analysis                                             |
| <br><br> | Lesson 3<br>Difference and Importance of Photosynthesis and Cellular Respiration | Compare the raw materials (reactants) and products of photosynthesis and cellular respiration.<br><br>Identify the cell organelles where these two vital processes take place.<br><br>Understand the importance of the processes | Activity Card 1<br>The Cell Detective<br><br>Worksheet 1<br>The Mystery Matrix<br><br>Worksheet 2<br>The Molecular Puzzle<br><br>Worksheet 3<br>The Chemical Notation<br><br>Assessment Card<br>Finding the Common Ground<br><br>Enrichment Card | Information Extraction<br><br>Information Mapping and Graphic Scaffolding<br><br>Information Mapping and Graphic Scaffolding<br><br>Comparative Synthesis |

### 3.2.3. Validation of Contextualized Strategic Intervention Materials (CSIMs)

Table 9. Comments and Suggestions of the Thesis Adviser and Panel Members on the Developed Contextualized Strategic Intervention Materials (CSIMs) in Photosynthesis and Cellular Respiration

| Comments and Suggestions | Parts of the CSIM |
|--------------------------|-------------------|
|--------------------------|-------------------|

|                                                        |                                |
|--------------------------------------------------------|--------------------------------|
| <b>Provide figure number and title to all figures.</b> | Guide Card                     |
| <b>Provide table number and title to all figures.</b>  | Worksheet 2, Assessment Card 1 |

Table 9 summarizes the comments and suggestions made by the panel members, thesis adviser and in-service teachers to the developed CSIMs. As shown, most of the suggestions were more about adding

numbers and titles to all of the tables and figures in the material.

**Table 10.** Teacher's Rating of the Developed Contextualized Strategic Intervention Material (CSIMs)

| Factors                      | Mean | Description |
|------------------------------|------|-------------|
| Content                      | 25.6 | Passed      |
| Format                       | 56.2 | Passed      |
| Presentation                 | 15.6 | Passed      |
| Accuracy and Up-to-datedness | 24   | Passed      |

As shown in Table 10, the developed CSIM garnered a "Passed" description across all evaluation factors based on the established rubric from the Department of Education (DepEd).

In terms of Content, the material garnered a mean score of 25.6, falling within the 21–28 "Passed" range. This indicates that the subject matter is well-aligned with the DepEd K-12 learning competencies for Grade 9 Science and effectively covers the essential concepts of how producers capture light energy and how organisms utilize that energy through respiration.

The Format of the CSIM received a mean score of 56.2, surpassing the minimum passing threshold of 54.

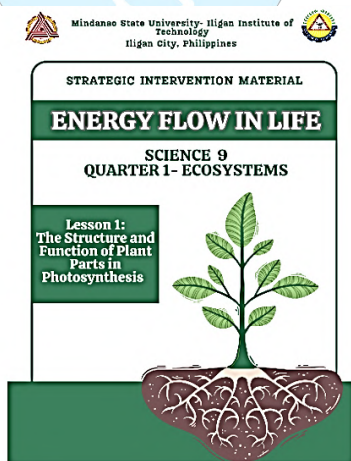
This suggests that the physical layout, font size, and overall design are appropriate for Grade 9 learners, ensuring that the material is user-friendly and aesthetically engaging without distracting from the instructional goals.

Regarding Presentation and Organization, the experts gave a rating of 15.6, which meets the passing criteria (15–20). This reflects that the flow of lessons—from the "Guide Card" to the "Assessment Card"—is logical and follows a pedagogical structure that supports independent learning.

Finally, the factor of Accuracy and Up-to-datedness of Information achieved a perfect passing score of 24. This confirms that the scientific facts, diagrams, and chemical equations presented in the CSIM are correct and reflect current scientific understanding of metabolic processes.

The results in Table 1 demonstrate that the developed CSIM is a valid and reliable instructional tool.

The "Passed" ratings in all categories signify that the material is ready for implementation to help students improve their performance and mastery of the competencies in Photosynthesis and Cellular Respiration.



## ....ACTIVITY CARD 1

**The Role of Leaves, Chloroplasts, Stomata, and Roots in Photosynthesis**

Plants are like tiny factories that make their own food through a process called photosynthesis. This process mainly takes place in the leaves, which contain special structures called chloroplasts.

Figure 1. The Process of Photosynthesis in Plants

Inside the chloroplasts, a green pigment called chlorophyll absorbs sunlight, providing the energy needed to convert carbon dioxide and water into food. To get the needed carbon dioxide, plants use tiny openings in their leaves called stomata. These stomata allow gases to enter and exit the plant, making sure that enough oxygen is released as a byproduct of photosynthesis. Meanwhile, the roots absorb water and important minerals from the soil, which are transported up to the leaves to help in food production. Without chloroplasts and stomata, photosynthesis would not be possible!

**To Do:**  
With your partner, highlight or underline the key terms in the passage above.

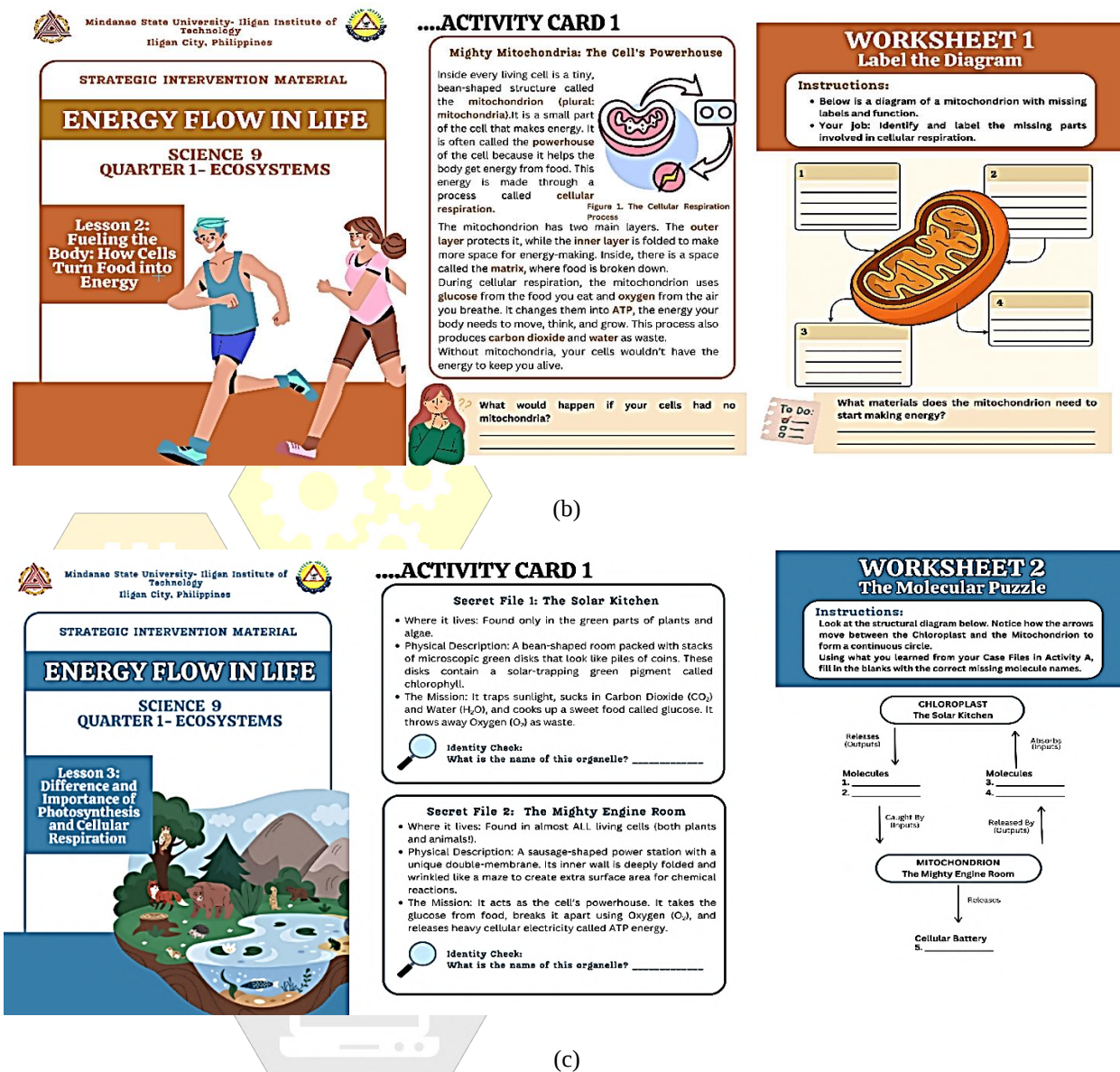
**WORKSHEET 2**  
**Describing Plant Parts**

**Instructions:**  
Write one sentence describing the function of each part in photosynthesis.

**Table 1. Roles of Plant Parts in the Process of Photosynthesis**

| Plant Parts  | Function in Photosynthesis |
|--------------|----------------------------|
| Leaves       |                            |
| Stem         |                            |
| Roots        |                            |
| Chloroplasts |                            |
| Stomata      |                            |

(a)



#### 4. CONCLUSION

During the conduct of the needs assessment for the science teachers, it was found that they encountered problems in teaching topics in Biology, specifically Photosynthesis and Cellular Respiration, due to weak foundational knowledge, complexity of the topic, and poor reading comprehension. In addition, it is revealed that the teachers lack familiarity with Strategic Intervention Material and received insufficient training in contextualization and localization.

Moreover, the conducted pretest on learners exhibited relatively low conceptual understanding of the topics of photosynthesis and cellular respiration. The results revealed the need to develop Contextualized Strategic Intervention Materials (CSIMs). Furthermore, the developed CSIMs were rated “Passed” in all factors by all the experts in terms of Content, Format, Presentation, Accuracy, and Up-to-datedness.

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