Formosa Journal of Science and Technology (FJST)
Vol. 4, No. 3, 2025: 987-1004

Utilization and Validation of SOLO-Based Learning Activity Sheet (LAS) in Science

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A R T I C L E I N F O

Keywords: Structure of Observed Learning Outcomes (SOLO), Learning Activity Sheet (LAS), Validation, Utilization, Learners' Performance

Received : 3, March
Revised : 17, March
Accepted: 31, March

A B S T R A C T

This study aimed to design and validate the SOLO-Based Learning Activity Sheet (LAS) and utilize it to determine its effects on the performance of learners in Science. The SOLO-Based Learning Activity Sheet (LAS) served as the instructional material which contains different activities representing each SOLO level as to 'unistructural, multistructural, relational, and extended abstract'. It used a descriptive developmental research design participated by 185 Grade 10 learners. Using the 'mean score' and 'standard deviation', the results revealed that the expert validation of SOLO-based learning activity sheet (LAS) was highly acceptable in terms of "components and characteristics". The learners were subjected to pretest and posttest to measure any significant changes in performance before and after implementing the SOLO-Based Learning Activity Sheet (LAS). Using a 'paired T-test', the results show a significant difference between the pretest and posttest. It shows that the performance of learners has improved after the utilization of the SOLO-Based Learning Activity Sheet (LAS).

ISSN-E: 2964-6804
DOI: https://doi.org/10.55927/fjst.v4i3.48
https://traformosapublisher.org/index.php/fjst

INTRODUCTION

The "Program for International Student Assessment" (PISA) is an "International Large-Scale Assessment" (ILSA) that measures 15-year-old learners' literacy in reading, mathematics, and science administered by the 'Organization for Economic Co-operation and Development' (OECD). In the 2018 assessment, the Philippines scored 357 in science (OECD, 2019). This trend persisted in 2022, with a slight decline to 356 (OECD, 2023). These scores indicate that most 15-year-old Filipino learners fall below basic proficiency levels. Hence, the results of the assessment led to a stronger "reform initiative" to improve teachers' content knowledge and pedagogical skills to enhance learners' performance (Department of Education, 2022).

To enhance PISA competencies among Filipino learners, the Department of Education (DepEd) encourages the integration of the "Structure of Observed Learning Outcomes" (SOLO) framework in the 'teaching-learning process', especially in the assessment (Diwa, 2024). The SOLO model is utilized within the 'K to 12 Science Curriculum framework', which is structured around the three domains of science learning (Department of Education, 2016).

In the 21st century, a key focus area for improvement is to enhance the "Higher-Order Thinking Skills" (HOTS) among learners. "HOTS" are critical elements that teachers want their students to develop (Malanog & Aliazas, 2021). The main goal of 'science education' is to develop the 'higher-order thinking skills' of learners to prepare them to face the challenges in life (Saido, Siraj, Nordin, Amedy, 2015). However, it is crucial and imperative to develop 'higher-order thinking skills' to achieve improved learner performance. As emphasized in the teacher's resource of the Department of Education (2022), one effective approach to promote 'higher-order learning' among learners is to incorporate the 'principles of the Structure of the Observed Learning Outcomes (SOLO) taxonomy'.

There were studies indicated the success of 'SOLO model' in creating science learning material. Dong and Zhang (2024) emphasized that using SOLO in planning science lesson can enhance understanding of concepts and supports differentiated teaching. In their study, SOLO-based materials encourage learners to progress through cognitive levels specifically from unistructural to extended abstract.

Similarly, a study by Adeniji et al. (2022) indicates that "SOLO-based assessments" provide a more structured process of analyzing learning progress in science subjects, particularly in physics and biology. The SOLO-based teaching materials such as learning activity sheets, and worksheets have been systematically reviewed, affirm these materials to reduce gaps in comprehension among learners by guiding learners progressively through learning tasks.

THEORETICAL REVIEW

As stated by Martin (2011), "the Structure of Observed Learning Outcomes (SOLO) Taxonomy was developed by John Biggs and Kevin Collis during the 1970s and 1980s". It is a cognitive (brain-based) framework for assessing learning. It categorizes observable levels of thinking, which progressively increase in complexity and difficulty. He also stated that the SOLO

Taxonomy serves as a framework applicable to various 'teaching and learning' contexts. It facilitates the creation of progressively challenging learning objectives, providing educators and students with a clear understanding of the intended learning outcomes.

The 'SOLO framework' was created to categorize 'learning outcomes' based on their complexities. It enables teachers to evaluate learners 'learning outcomes' and serves as a tool to outline the 'levels of complexity in higher-order thinking skills' (Department of Education, 2022). Additionally, Matanguihan & Chua (2024), stated that 'higher-order thinking skills' are categorized in the learning outcomes framework initially established by Benjamin Bloom in 1956. The new model organizes cognitive skills into "six hierarchical levels such as remembering, understanding, applying, analyzing, evaluating, and creating".

The SOLO Levels are the key component of the SOLO framework, consisting of five stages such as "pre-structural, unistructural, multistructural, relational, and extended abstract" (Biggs & Collis, 1982). "These levels describe the increasing sophistication (increasing quality) of responses in handling certain tasks or questions relevant to a particular activity or domain" (Department of Education, 2022). The use of the SOLO levels in learning activities helps learners evaluate their understanding as they move from basic ideas to more advanced ones. This approach allows them to develop 'critical thinking' and handle complex topics by recognizing their current level of understanding and identifying ways to advance to higher levels of learning.

According to Ghunaimat and Alawneh (2023), there is a significant improvement in student engagement when they utilize the developed and validated 'SOLO-based learning materials' in STEM education. Additionally, it helped students retain complex scientific concepts more effectively. Similarly, Hasırcı Aksoy (2021) explored the use of 'SOLO-based learning sheets' in teaching scientific literacy. The study found that structured activities which is based on 'SOLO' promote "deeper inquiry" and "problem-solving skills".

The integration of SOLO-based LAS in science instruction has been shown to improve students' ability to analyze, synthesize, and evaluate scientific information. Huang et al. (2024) stated that the SOLO-based materials support students in developing hierarchical cognitive skills which is necessary for scientific reasoning. This suggest that students who are exposed to SOLO-based activity sheet demonstrates higher achievement in complex problem-solving tasks compared to those who are using traditional learning sheets.

The impact of SOLO-based educational interventions that are well-validated provides a structured approach to knowledge acquisition which makes it an effective tool for improving science education learning outcomes (Dong & Zhang, 2024).

Objectives of the Study

The aim of this study is to design and validate the SOLO-Based learning activity sheet (LAS) and utilize it to determine its effect on the performance of Grade 10 learners in Science at Jose Abad Santos High School, Manila.
Specifically, it sought answers to the following questions:

(1) What is the validity level of the SOLO-Based Learning Activity Sheet (LAS) as to its component including the content; organization, presentation, and language; illustrations and images; and design and layout?
(2) What is the validity level of the SOLO-Based Learning Activity Sheet (LAS) as to its characteristics including utilization; runtime; appeal; and comprehensiveness?
(3) What is the performance of grade 10 learners as to the results of pretest and post-test?
(4) Is there a significant difference in the Grade 10 learners' performance based on the result of the pretest and posttest?

Scope and Limitation

The study was focused on the utilization and validation of SOLO-Based Learning Activity Sheets (LAS) in Grade 10 Science at Jose Abad Santos High School. Specifically, it determines its effect on the performance of Grade 10 learners in science.

The developed learning activity sheet was validated by one (1) Science Head Teacher, four (4) science master teachers, and four (4) science teachers using questionnaire. Also, the study was conducted among 185 learners using pretest and posttest.

While the study demonstrates significant improvements in learner performance, its scope is limited to one topic which is about Menstrual Cycle. The researcher utilized the ADDIE (Analysis, Design, Development, Implement, Evaluate) Model in developing the SOLO-Based Learning Activity Sheet (LAS) on the topic Menstrual Cycle, as shown in Figure 1.

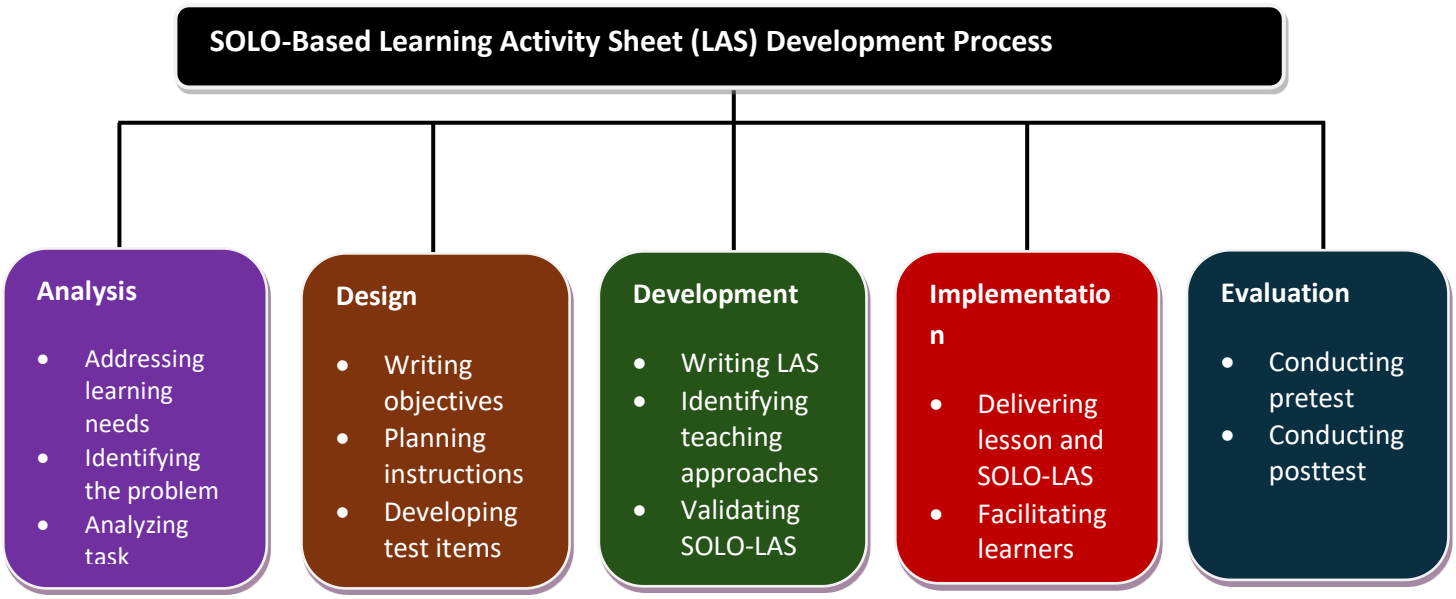

Figure 1. SOLO-Based Learning Activity Sheet (LAS) Development Process

METHODOLOGY

Research Design

This study employed a combination of developmental research design and descriptive research design. This involves creating and validating the Learning Activity Sheet (LAS) based on the Structure of Observed Learning Outcomes (SOLO) Levels. 'Richey & Klein' (2005) defined "developmental research as the systematic study of designing, developing, and evaluating instructional programs, processes, and products that must meet criteria of internal consistency and effectiveness". Similarly, Gaña (2022) described the "descriptive developmental method as a systematic study of putting into the design, development, and careful evaluation of instructional programs, processes, and products that must meet the standard or criteria".

Respondents of the Study

The learner respondents of the study were selected using purposive sampling including 'one hundred eighty-five' (185) learners comprising the four sections of the Grade 10 level who are officially enrolled in Jose Abad Santos High School for the School Year 2024-2025.

The expert respondents who will validate the SOLO-Based learning activity sheet (LAS) will be the Science Department Head Teacher, four Science Master teachers, and four Grade 10 Science teachers from Jose Abad Santos High School.

Research Instruments

The researcher utilized various instruments, including (1) a SOLO-Based Learning Activity Sheet with a Lesson Plan; (2) Experts' Validation Checklist of the SOLO-Based Learning Activity Sheet (LAS); (3) Pretest and Posttest; (4) Learners' Perception Checklist of the SOLO-Based Learning Activity Sheet (LAS).

1. The SOLO-Based Learning Activity Sheet (LAS) served as the instructional material which contains different activities representing each SOLO level on the topic Menstrual Cycle. This was given to the learners during the 'teaching and learning' process.
2. Experts' Validation Checklist of the SOLO-Based Learning Activity Sheet (LAS) was administered to the Science Department Head Teacher, Science Master Teachers, and Grade 10 Science Teachers. This instrument was a five-point Likert checklist adapted from the study of Laurel (2022).
3. The 'Pretest and Posttest' consist of 30-item 'multiple-choice questions' that were administered to measure any significant changes in learners' performance before and after implementing the SOLO-Based Learning Activity Sheet (LAS). The researcher followed the established procedures for test development and validation.

Research Procedure

The conduct of the study involved four phases: I) Development and Validation of Research Instruments, II) Administration of the Pretest, III) Implementation of the SOLO-Based Learning Activity Sheet, IV) Administration

of the Posttest and Learner Respondents' Perception, and lastly, V) Analysis and Interpretation of Data.

Phase I *involved the development and validation of research instruments*. The researcher used four research instruments. First is the SOLO-Based Learning Activity Sheet (LAS) which serves as the main instructional material and contains different activities representing each SOLO level following the most essential learning competency on the Menstrual Cycle. This was guided by the prepared lesson plan about the topic which served as a guide in the lesson delivery. Secondly is the development of survey questionnaires for the validation of the SOLO-Based Learning Activity Sheet by the experts and teachers. Lastly is the development of the 30-item Pretest and Posttest multiple-choice questions to measure any significant changes in learners' performance before and after implementing the SOLO-Based Learning Activity Sheet (LAS).

The research instruments developed were validated and evaluated by the expert respondents such as the Science Department Head Teacher, Science Master Teachers, and Grade 10 Science Teachers. The feedback, suggestions, and recommendations from the evaluators were taken into account in making changes and revisions to the draft to produce the final version.

Before implementing the next Phase, the researchers sought approval from the school head of Jose Abad Santos High School to conduct the study during the third quarter grading period. When the approval was granted, the instruments were administered to the respondents.

Phase II *involved the administration of a 30-item Pretest*. This is to determine the prior knowledge of Grade 10 learners before implementing the SOLO-Based Learning Activity Sheet (LAS).

Phase III *is the implementation of the SOLO-Based Learning Activity Sheet (LAS).* The teacher-made lesson plan was developed based on the DepEd Most Essential Learning Competency (MELC). It was implemented using the SOLO-Based Learning Activity Sheet (LAS).

Phase IV *involved the administration of a 30-item Posttest*. This is to measure any significant changes in learners' performance after implementing the SOLO-Based Learning Activity Sheet (LAS).

Phase V *involved the analysis and interpretation proper*. The data gathered from the conducted survey questionnaires and other research instruments were statistically treated using 'descriptive statistics' such as the use of 'frequency, percentage, mean, and standard deviation'. The 'paired t-test' was performed to see if there was a 'significant difference' in the learners' pretest and posttest science competency scores. Furthermore, in accordance with the country's data privacy policies, the researchers maintained the confidentiality of the gathered data by presenting it anonymously.

Statistical Treatment

The 'statistical treatment' used in analyzing and interpreting the data includes the use of 'mean and standard deviation' to determine the level of validation of the SOLO-Based Learning Activity Sheet (LAS) in terms of components and characteristics. Also, the frequency, percentage, mean, and SD were used to calculate the level of learners performance in the pretest and post

test. To determine the 'significant difference in terms of their scores before and after the use' of the SOLO-based learning activity sheet (LAS), a 'paired t-test' set at a 0.05 level of significance was utilized.

RESEARCH RESULT

This chapter presents tables that display the results and analysis of data related to the questions raised on the 'validation and utilization of the SOLO-Based Learning Activity Sheet' (LAS). The data are examined and interpreted to form 'conclusions' and provide 'recommendations' based on the study.

Validation of the SOLO-Based Learning Activity Sheet (LAS) by Component

The first section aimed to determine the Components of a SOLO-Based Learning Activity Sheet (LAS). The assessment was based on the overall mean and standard deviation.

Table 1. Validity of the SOLO-Based LAS Content

Statement	Mean	SD	VI
1. **The LAS are accurate and free from conceptual, factual, and typographical errors.**	4.88	0.35	HA
2. **The LAS are clearly aligned with the intended learning objectives.**	4.88	0.35	HA
3. **Instructions and tasks are clearly stated, logically sequenced, and easy to follow.**	4.63	0.74	HA
4. **Activities are developmentally appropriate, inclusive, and culturally responsive.**	4.75	0.71	HA
5. **The content effectively addresses the Most Essential Learning Competencies (MELCs).**	4.88	0.35	HA
Overall	4.80	0.50	HA

Legend: 1.0-1.49 (Not Acceptable) (NA); 1.50-2.49 (Less Acceptable) (SA); 2.50-3.49 (Moderately Acceptable) (MA); 3.50-4.49 (Acceptable) (A) 4.5-5.0 (Highly Acceptable) (HA)

Table 1 shows the validity of the SOLO-based LAS Components as to Content. Among the above statements, 1, 2, and 5 resulted in the highest average score of *(M=4.88, SD=0.35)* and were interpreted as Highly Acceptable. This is followed by statement 4 with a 'mean score' of *(M=4.75, SD=0.71)* and was also interpreted as Highly Acceptable. On the other hand, statement 3 obtained the lowest average score of *(M=4.63, SD=0.74)* yet was also interpreted as Highly Acceptable.

In general, the validity level on the 'components' of the SOLO-Based learning activity sheet (LAS) in terms of "content" obtained a 'mean score' of 4.80 and a 'standard deviation' of 0.50 and was interpreted as Highly Acceptable. This means that the content of the SOLO-Based Learning Activity Sheet (LAS) is

aligned with the curriculum, meets the required competency, and is appropriate for the learners.

Tomlinson, (2001) defined content as "the input of teaching and learning. It's what the teachers teach or what the students want to learn". According to Taba (1962), instructional materials should be conceptually accurate, free from errors, and relevant to the learners' needs to enhance understanding and engagement. Ensuring that activities are accurate, objective-driven, and culturally relevant also promotes inclusivity and applicability to diverse learners (Banks & Banks, 2016).

Table 2. Validity of the SOLO-Based LAS Components as to Organization, Presentation, and Language

Statement	Mean	SD	VI
1. **Learning activities progresses logically from simple to complex tasks.**	4.88	0.35	HA
2. **LAS statements and phrases are coherent and aligned with the MELCs.**	4.88	0.35	HA
3. **Sentence length is appropriate for the learners' reading level.**	4.63	0.74	HA
4. **Vocabulary and word choices are suitable for the target learners.**	4.75	0.71	HA
5. **Spelling is accurate and free from errors.**	4.88	0.35	HA
6. **Punctuation marks are correctly used and appropriately placed.**	4.88	0.35	HA
7. **Capitalization and hyphenation rules are properly followed.**	4.88	0.35	HA
8. **Ideas and concepts are logically arranged and easy to follow.**	4.88	0.35	HA
9. **The headings and titles are appropriate and clearly related to the content.**	4.88	0.35	HA
Overall	4.83	0.44	HA

Legend: 1.0-1.49 (Not Acceptable) (NA); 1.50-2.49 (Less Acceptable) (SA); 2.50-3.49 (Moderately Acceptable) (MA); 3.50-4.49 (Acceptable) (A) 4.5-5.0 (Highly Acceptable) (HA)

Table 2 shows the validity of the SOLO-based LAS Components as to Organization, Presentation, and Language'. Among the above statements, 1, 2, 5, 6, 7, 8, and 9 resulted in the highest everage of *(M=4.88, SD=0.35)* and were interpreted as Highly Acceptable. This is followed by statement 4 with a 'mean score' of *(M=4.75, SD=0.71)* and was also interpreted as Highly Acceptable. Moreover, statement 3 obtained the lowest average score of *(M=4.63, SD=0.74)* yet was also interpreted as Highly Acceptable.

In general, the validity level on the 'components' of the SOLO-Based learning activity sheet (LAS) in terms of "Organization, Presentation, and Language" obtained a 'mean score' of 4.83 and a 'standard deviation' of 0.44 and was interpreted as Highly Acceptable. This means that the language organization

of the SOLO-Based LAS are well-structured, logically sequenced, and suitable for the learners.

According to Gagne et. al., (2005), the logical sequencing and clear structure of instructional content help learners understand and retain information more effectively where activities must be arranged from simple to complex to allow learners to build on prior knowledge. Biggs and Collis (1982) highlight that clear and appropriate language aligned with the SOLO taxonomy helps students progress through different levels of cognitive complexity.

Table 3. Validity of the SOLO-Based LAS Components as to Illustrations/ Images

Statement	Mean	SD	VI
1. **LAS illustrations and images are age-appropriate, contextually relevant, and suitable for the learners' experience.**	4.75	0.46	HA
2. **Illustrations and images are clear, high-quality, and not pixelated.**	4.88	0.35	HA
Overall	4.81	0.41	HA

Legend: 1.0-1.49 (Not Acceptable) (NA); 1.50-2.49 (Less Acceptable) (SA); 2.50-3.49 (Moderately Acceptable) (MA); 3.50-4.49 (Acceptable) (A) 4.5-5.0 (Highly Acceptable) (HA)

Table 3 shows the validity of the SOLO-based LAS Components as to Illustrations/ Images. Among the above statements, 2 resulted in the highest average score of *(M=4.88, SD=0.35)* and were interpreted as Highly Acceptable. On the other hand, statement 1 obtained the lowest average score of *(M=4.75, SD=0.46)* yet was also interpreted as Highly Acceptable.

In general, the validitation on the 'components' of the SOLO-Based LAS as for "Illustrations/ Images" obtained a 'average score' of 4.81 and a 0.41 standard deviation and was interpreted as Highly Acceptable. This means that the illustrations or images of the SOLO-Based LAS are clear and suitable to the age and learners experience.

According to Mayer (2001), visuals can help learners better understand complex concepts by providing concrete representations of abstract ideas. Visual aids, such as diagrams and images, can improve memory retention and facilitate deeper comprehension of the content (Sweller, van Merriënboer, & Paas, 2019).

Table 4. Validity of the SOLO-Based LAS Components as to Design and Layout

Statement	Mean	SD	VI
1. **The layout of the activity sheets is well-structured and organized.**	5.00	0.00	HA
2. **Questions and tasks are clearly numbered or labeled for easy reference.**	5.00	0.00	HA
3. **Fonts used are legible and adhere to standard sizing for readability.**	5.00	0.00	HA

4. **Designated spaces are provided for the learner's name, grade level, date, and score.**	5.00	0.00	HA
5. **Standardized icons are consistently used throughout the activity sheets.**	5.00	0.00	HA
6. **The activity sheets are digitally designed for easy editing, storage, and printing.**	5.00	0.00	HA
Overall	5.00	0.00	HA

Legend: 1.0-1.49 (Not Acceptable) (NA); 1.50-2.49 (Less Acceptable) (SA); 2.50-3.49 (Moderately Acceptable) (MA); 3.50-4.49 (Acceptable) (A) 4.5-5.0 (Highly Acceptable) (HA)

Table 4 shows the validity of the SOLO-based LAS Components as to the Layout and Design. All the statements above yielded the 'same mean score' of *(M=5.00, SD=0.00)* and were interpreted as Highly Acceptable.

In general, the validation on the 'components' of the SOLO-Based LAS in as for "Layout and Design" obtained a 'mean score' of 5.00 and a 0.00 standard deviation and was interpreted as Highly Acceptable. This means that the design and layout of the SOLO-Based LAS are user-friendly and properly structured which enhances learners' learning experience.

According to Chen and Huang (2019), the importance of organized layout in digital and print-based educational resources is helpful to the learners to easily locate ideas or information. Thus, a well-designed activity sheet helps in attaining the learning objectives.

Validation of the SOLO-Based Learning Activity Sheet (LAS) as to Characteristics

Table 5. Validity of the SOLO-Based LAS Characteristics as to Utilization

Statement	Mean	SD	VI
1. **The LAS instructions are clear, concise, and easy to follow.**	4.88	0.35	HA
2. **The directions are well-written and easy to understand.**	4.88	0.35	HA
3. **The worksheet supports learners in understanding difficult concepts.**	4.88	0.35	HA
4. **It provides direct and structured knowledge for better comprehension.**	4.75	0.46	HA
5. **It includes routine activities that reinforce learning while answering the worksheets.**	4.75	0.71	HA
Overall	4.83	0.45	HA

Legend: 1.0-1.49 (Not Acceptable) (NA); 1.50-2.49 (Less Acceptable) (SA); 2.50-3.49 (Moderately Acceptable) (MA); 3.50-4.49 (Acceptable) (A) 4.5-5.0 (Highly Acceptable) (HA)

Table 5 shows the validity of the SOLO-based LAS Characteristics as to Utilization. Among the above statements, 1, 2, and 3 resulted in the 'highest

average score' of *(M=4.88, SD=0.35)* and were interpreted as Highly Acceptable. Moreover, statements 4 and 5 obtained the 'lowest average score' of *(M=4.75, SD=0.46, SD=0.71)* yet were also interpreted as Highly Acceptable.

In general, the validity level on the 'characteristics' of the SOLO-Based learning activity sheet (LAS) as for "Utilization" obtained a 'average score' of 4.83 and a 0.45 standard deviation and was interpreted as Highly Acceptable. This means that the utilization of the SOLO-Based LAS is essential for enhancing learning outcomes.

Learning Activity Sheets (LAS) are supplementary learning materials that learners can use, such as individualized exercises designed to enhance the knowledge and skills they are gaining from various lessons. These activities allow students to explore different learning opportunities and expand their learning experiences, helping them master the foundational knowledge and skills outlined in the K to 12 Basic Education Curriculum (DO. 036 s., 2021).

Table 6. Validity of the SOLO-Based LAS Characteristics as to Runtime

Statement	Mean	SD	VI
1. **I can estimate the time required to complete a task, even if I have never attempted it before.**	4.75	0.46	HA
2. **My time estimates are usually accurate within one-third of the actual duration.**	4.75	0.46	HA
3. **I can accurately evaluate the time needed for a task I have previously completed.**	4.88	0.35	HA
4. **I can break down a task into smaller parts and estimate the time required for each.**	4.88	0.35	HA
5. **I can precisely predict the time needed for a task based on my past experience.**	4.88	0.35	HA
Overall	4.83	0.40	HA

Legend: 1.0-1.49 (Not Acceptable) (NA); 1.50-2.49 (Less Acceptable) (SA); 2.50-3.49 (Moderately Acceptable) (MA); 3.50-4.49 (Acceptable) (A) 4.5-5.0 (Highly Acceptable) (HA)

Table 6 shows the validity of the SOLO-based LAS Characteristics as to Runtime. Among the above statements, 3, 4, and 5 yielded the 'highest average score' of *(M=4.88, SD=0.35)* and were interpreted as Highly Acceptable. Moreover, statements 1 and 2 obtained the 'lowest average score' of *(M=4.75, SD=0.46)* yet were also interpreted as Highly Acceptable.

In general, the validition on the 'characteristics' of the SOLO-Based LAS in terms of 'Runtime' obtained a 'average score' of 4.83 and a 0.40 standard deviation and was interpreted as Highly Acceptable. This means that the SOLO-Based Learning Activity Sheet (LAS) facilitates the learners in real-time prediction and evaluation, which ensures the completion of the tasks or activities within a given timeframe. This aligns with the idea of "time on task," which

enhances learners' academic achievement by giving them opportunities for meaningful engagement (Fisher et al., 2020).

Table 7. Validity of the SOLO-Based LAS Characteristics as to Appeal

Statement	Mean	SD	VI
1. **The activity sheets are visually well-presented and neatly organized.**	5.00	0.00	HA
2. **They are free from errors, including misspellings and grammatical mistakes.**	5.00	0.00	HA
3. **All text is clear, readable, and easy to understand.**	5.00	0.00	HA
4. **There are no overlapping elements or superimposed text and images.**	5.00	0.00	HA
5. **The worksheets are visually appealing and engaging for learners.**	4.88	0.35	HA
Overall	4.98	0.07	HA

Legend: 1.0-1.49 (Not Acceptable) (NA); 1.50-2.49 (Less Acceptable) (SA); 2.50-3.49 (Moderately Acceptable) (MA); 3.50-4.49 (Acceptable) (A) 4.5-5.0 (Highly Acceptable) (HA)

Table 7 shows the validity of the SOLO-based LAS Characteristics as to Appeal. Among the above statements, 1, 2, 3, and 4 resulted in the 'highest average score' of *(M=5.00, SD=0.00)* and were interpreted as Highly Acceptable. Moreover, statement 5 obtained the 'lowest average score' of *(M=4.88, SD=0.35)* yet was also interpreted as Highly Acceptable.

In general, the validation on the 'characteristics' of the SOLO-based LAS as to "Appeal" obtained a 'average score' of 4.98 and a 0.07 standard deviation and was interpreted as Highly Acceptable. Delos Reyes and Caballes (2021) implied that instructional material should be creative and appealing to increase learners' interest.

Table 8. Validity of the SOLO-Based LAS Characteristics as to Comprehensiveness

Statement	Mean	SD	VI
1. **I find it easy to study using the Learning Activity Sheets.**	4.75	0.71	HA
2. **I am able to understand new concepts with ease.**	4.75	0.71	HA
3. **I start and complete my tasks on time.**	4.75	0.71	HA
4. **I follow instructions accurately when working on the activities.**	4.63	0.74	HA
5. **I have a clear and full understanding of the concepts presented.**	4.75	0.71	HA
Overall	4.73	0.71	HA

Legend: 1.0-1.49 (Not Acceptable) (NA); 1.50-2.49 (Less Acceptable) (SA); 2.50-3.49 (Moderately Acceptable) (MA); 3.50-4.49 (Acceptable) (A) 4.5-5.0 (Highly Acceptable) (HA)

Table 8 shows the validity of the SOLO-based LAS Characteristics as to Comprehensiveness. Among the above statements, 1, 2, 3, and 5 resulted in the 'highest average score' of *(M=4.75, SD=0.71)* and were interpreted as Highly Acceptable. Moreover, statement 4 obtained the 'lowest average score' of *(M=4.63, SD=0.74)* yet was also interpreted as Highly Acceptable.

In general, the validitation on the 'characteristics' of the SOLO-Based LAS as for "Comprehensiveness" obtained a 'average score' of 4.73 and a 0.71 standard deviation and was interpreted as Highly Acceptable. This implies that Learning Activity Sheets are easily understood by learners.

Table 9. Summary of Expert Respondents' Validation of SOLO-Based LAS as to Components

Statement	Mean	SD	VI
1. **Content**	4.80	0.50	HA
2. **Organization, Presentation, and Language**	4.83	0.44	HA
3. **Illustrations/Images**	4.81	0.41	HA
4. **Design and Layout**	5.00	0.00	HA
Overall	4.86	0.34	HA

Legend: 1.0-1.49 (Not Acceptable) (NA); 1.50-2.49 (Less Acceptable) (SA); 2.50-3.49 (Moderately Acceptable) (MA); 3.50-4.49 (Acceptable) (A) 4.5-5.0 (Highly Acceptable) (HA)

Table 9 summarizes the expert respondents' validation of the SOLO-Based Learning Activity Sheet (LAS) in terms of "Components". It can be shown that the 'overall mean' is 4.86 (SD=0.34), which was interpreted as Highly Acceptable. This means that the SOLO-Based Learning Activity Sheet (LAS) was aligned with the target learning intentions and supported scientific content that was integrated across SOLO levels. The learning activity sheet was organized to guide the learners through tasks to deepen understanding and develop skills from unistructural level to the extended abstract level.

Table 10. Summary of Expert Respondents' Validation of SOLO-Based Learning Activity Sheet (LAS) as to Characteristics

Statement	Mean	SD	VI
1. **Utilization**	4.83	0.45	HA
2. **Runtime**	4.83	0.40	HA
3. **Appeal**	4.98	0.07	HA
4. **Comprehensiveness**	4.73	0.71	HA
Overall	4.73	0.71	HA

Legend: 1.0-1.49 (Not Acceptable) (NA); 1.50-2.49 (Less Acceptable) (SA); 2.50-3.49 (Moderately Acceptable) (MA); 3.50-4.49 (Acceptable) (A) 4.5-5.0 (Highly Acceptable) (HA)

Table 10 summarizes the expert respondents' validation of the SOLO-Based Learning Activity Sheet (LAS) in terms of "Characteristics". It can be shown that the 'overall mean' is 4.73 (SD=0.71), which was interpreted as Highly Acceptable. This means that the SOLO-Based Learning Activity Sheet (LAS) is suitable for independent or collaborative learning wherein the SOLO levels allow the learners to manage their time effectively in answering the tasks. The LAS is designed to capture learners' interest through creative activity names, engaging illustrations, and relatable contexts that encourage explorations and critical thinking at each level of SOLO. It also addresses all aspects of the topic by including tasks that progress from basic identification to complex application and analysis to ensure learners achieve a deep understanding of the topic.

Performance of the Learners

The Grade 10 learners' performance was measured as to pretest and posttest before and after using the SOLO-based learning activity sheet (LAS). The results are shown in Table 11 along with the frequency, percentage, mean, and standard deviation.

The pretest consists of 30 items about the Menstrual Cycle, and this was administered before the use of the SOLO-Based Learning Activity Sheet (LAS). The data table shows that out of one hundred eighty-five (185) learners, eighty-three (83), or 44.9% gained the scores of 13 to 18 which was "satisfactory". The same frequency and percentage were in the range of 7 to 12 which was "fairly satisfactory". This means that most learners scored within the "satisfactory" and "fairly satisfactory" levels. This was followed by the score range of 19 to 24 with a frequency of ten (10) or 5.4% of the total population performing "very satisfactorily". On the other hand, nine (9) learners "did not meet expectations", and no one gained 25 to 30 "outstanding points".

In general, the level of performance as to the results of pretest conducted on four sections of grade 10 learners was "satisfactory" with a 'mean score' of 12.48, a 'standard deviation' of 3.36, and a total 'mean percentage score' of 41.6%.

Table 11. Performance of the Learners as to Pretest and Posttest Scores

Range	**PRETEST**		**POSTTEST**		**Remarks**
	f	%	f	%	
25 to 30	0	0	74	40	Outstanding
19 to 24	10	5.4	97	52.43	Very Satisfactory
13 to 18	83	44.9	11	5.95	Satisfactory
7 to 12	83	44.9	3	1.62	Fairly Satisfactory
0 to 6	9	4.9	0	0	Did not Meet Expectations
Total	185	100	185	100	
Mean	12.48		22.95		
SD	3.63		3.9		

VI	Satisfactory	Very Satisfactory
MPS	41.6%	76.5%

Meanwhile, the posttest which is parallel to the pretest consists of 30 items about the Menstrual Cycle and was administered after the use of the SOLO-Based Learning Activity Sheet (LAS). The results of the posttest were "very satisfactory" with an 'average score' of 22.95, a 3.0 standard deviation, and a total 'mean percentage score' of 76.5%. This shows that the majority of the scores increased in the posttest and most of the learners belong to a very satisfactory level as to frequency and scores percentage which indicates the positive impact of the SOLO-Based Learning Activity Sheet (LAS) in engaging learners and enhancing their understanding of the topic. Dwikoranto et. al., (2020) explains that the student activity sheet (SAS) improved students' scientific creativity, learning outcomes, and responses to the learning process.

Significant Difference in Grade 10 Learners' Performance Based on the Results of Pretest and Posttest

Table 12. Significant Difference in Grade 10 Learners' Performance Based on Pretest and Posttest Results

Performance	t-value	p-value	Analysis
Pretest Posttest	41.508	0.000	Significant

Legend: p > 0.05 Not Significant; p < 0.05 Significant

Table 12 presents the difference in the Grade 10 learners' performance as to their pretest and posttest scores. The results indicate a "p-value" of 0.000, which revealed a "significant difference" between the pretest and posttest scores of learner respondents before and after the use of the SOLO-Based Learning Activity Sheet (LAS). This shows that the learning activity sheet helped the learners to improve their cognitive performance as evidenced by the marked increase in scores from pretest to posttest.

CONCLUSION

Based on the results of the study, the following are the conclusions:

1. After the experts validated the SOLO-Based Learning Activity Sheet (LAS) as to components including the content, organization, presentation and language, illustrations/images, and design and layout, it showed that the developed SOLO-based learning activity sheet (LAS) was "highly acceptable".
2. The validated SOLO-Based Learning Activity Sheet (LAS) as for characteristics including utilization, runtime, appeal, and comprehensiveness was also rated as "highly acceptable".
3. It was observed that upon utilizing the SOLO-Based Learning Activity Sheet (LAS) in teaching Science, there is a significant improvement in the

level of performance of Grade 10 learners as to the results of their pretest and post test. Thus, the results indicated a positive implication.

4. Based on the data presentation and analysis, it was also found that there is a significant difference between the pretest and posttest . This study suggested that the use of the SOLO-Based Learning Activity Sheet (LAS) was proven to be effective in enhancing the performance of Grade 10 learners in Science.

RECOMMENDATION

Based on the findings, the following recommendations are proposed:

1. Since the utilization of the SOLO-Based Learning Activity Sheet (LAS) in teaching Science has an impact on the performance of the learners, other teachers may also utilize it in their classes.
2. The SOLO-Based Learning Activity Sheets (LAS) should be constantly reviewed and improved based on students' feedback and learning outcomes.
3. Teachers may consider to incorporate technology and interactive elements into SOLO-Based Learning Activity Sheets (LAS) to enhance student engagement and comprehension.
4. It is suggested that the SOLO-Based Learning Activity Sheet (LAS) should be integrated into other Science topics aligned with the DepEd curriculum.
5. Since this framework was already presented in the DepEd training which focuses on the assessment, it is suggested to enhance the training in designing or creating the SOLO-Based Learning Activity Sheet (LAS) across different learning contexts.
6. The school administrators can assist by allocating time and resources for educators to create and apply SOLO-Based Learning Activity Sheets (LAS) in an effective manner.

FURTHER STUDY

It is recommended to conduct further studies to explore the long-term results of "SOLO-Based Learning Activity Sheets (LAS)" on critical thinking and problem-solving skills of the learners.

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