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Structure of Observed Learning Outcomes (SOLO) Taxonomy as Learning Assessment in Grade 9 Earth and Space Science

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A B S T R A C T

The study aimed to develop a learning assessment worksheet based on Structure of Observed Learning Outcomes and determine its effect to the cognitive performance of students. The level of the students in terms of the Structure of Observed Learning Outcomes were identified. Moreover, it also determined if there is a statistically significant difference between the scores of the students before and after the use of the learning assessment worksheet to find out if there is a significant relationship between the perceived acceptability of the SOLO learning assessment worksheet and the student's performance.

Using a descriptive-developmental research design, it involved 125 Grade 9 students of Plaridel Integrated National High School enrolled during the academic year 2023-2024 chosen using purposive sampling. Prior to the use of the learning assessment worksheet, a cognitive test was administered as to remembering, understanding, applying, analyzing, evaluating, and creating to identify the learning gaps. The learning assessment worksheet was used by the students to assess their level of learning based on the Structure of Observed Learning Outcomes as to prestructural, unistructural, multistructural, relational and extended abstract. Pre and post assessment were utilized to measure the academic performance of the learners.

Results revealed that there is a significant difference in the cognitive performance of the students as evident in the results of the pre and posttest scores of the students which indicates that the performance of the students improved after the utilization of the SOLO learning assessment worksheet. It was also found that there is a significant relationship between the perceived acceptability of the SOLO Learning Assessment Worksheet and the students' cognitive performance.

Keywords: Structure of Observed Learning Outcomes, learning assessment worksheet, cognitive performance, perceived acceptability, learning

Introduction

Education plays a vital role in a country's economic growth and development. The right to quality education is considered as one of the basic human rights which aims to reduce poverty and ensure sustainable development among countries across the globe (UNESCO, 2023).

Science is a body of knowledge that is embedded in a person's everyday life and day-to-day activities. It is considered as a way of thinking that is developed so that people can understand the world. Science education aims to develop scientific inquiry skills such as observing, predicting, and communicating as well as critical thinking skills among students. Through science education, students can gain knowledge of the world and develop problem solving skills that could be of use in real-life situations. The impact of science education is targeted towards the betterment of the society and the global community through medicine, engineering, technology, and other fields of development.

With the effects of the recent COVID-19 pandemic, which forced schools to continue their classes virtually and even some to halt their operations, the difficulties in the country's education system have been found to be much deeper. According to World Bank, school closures and learning loss during the pandemic can have a long-term negative impact on the current cohort of school children, and these two factors are likely to affect the children's economic potential and productivity in adulthood (Coroza, 2022).

The Department of Education had been continuously finding ways to keep up to its promise that all Filipinos can realize their full potential and contribute meaningfully to a cohesive nation through the protection and promotion of the right to quality education. One of these ways is the adoption of the Basic Education Development Plan (BEDP) 2030 which provides a strategic roadmap for the department to follow to improve the delivery and quality of basic education and the experience of learners in the basic education learning environment.

In order to continuously strive in achieving the goals of the Department of Education, the MATATAG K-10 Curriculum will be launched during the beginning of the school year 2024-2025 starting with Kinder, Grades 1, 4 and 7 and to be followed by the other grade levels in the upcoming school years. This curricular framework aims to decongest the current curriculum by reducing the number of learning areas, focusing more on the development

of foundational skills. It also aims to strengthen the country's international performance in assessments especially in the field of Science, Technology, Engineering, and Mathematics (STEM) subjects.

The use of certain strategies to improve student performance in different learning areas particularly in Science is one of the necessities that could be addressed by teachers and learning institutions. Among the aspects that need to be improved is the Higher Order Thinking Skills (HOTS) among learners. One of the strategies to address the development of HOTS is the use of the Structure of Observed Learning Outcomes Taxonomy in teaching and learning assessment.

As described by Somani (2022) Kevin Collis and John Biggs devised the Structure of Observed Learning Outcomes as an alternative to Bloom's taxonomy. This framework serves to describe the levels of increasing complexity in a learner's understanding of subjects or performance tasks. It also provides a measure of cognitive learning outcomes or understanding of thinking. It can be used across different subjects and types of assignments. Furthermore, the framework represents student learning of diverse materials in stages of ascending structural complexity. Also, these stages exhibit a similar sequence across tasks.

The Structure of Observed Learning Outcomes taxonomy is geared towards developing the Higher Oder Thinking Skills of students. Higher Order Thinking Skills can be described by the classifications of learning outcomes identified by Benjamin Bloom in 1956. This taxonomy level was later on revised by Lorin Anderson in 2001 which brought significant changes on the levels previously identified by Bloom. It was later on named as the Revised Bloom's Taxonomy which consists of six levels namely - remembering, understanding, applying, analyzing, evaluating, and creating.

With the use of the Structure of Observed Learning Outcomes in learning assessment, the students will be able to assess themselves as they progress from learning the simplest concepts up to the complex ones. This will enable students to improve their critical thinking and learning of complex concepts by assessing their own level of learning and how they will be able to progress through learning the more complex concepts and topics.

The purpose of this study is to design a learning assessment worksheet based on Structure of Observed Learning Outcomes and determine its effect to the performance of students in in Earth and Space Science for Grade 9 students of Plaridel Integrated National High School, Nagcarlan, Laguna.

Objectives of the Study

This study aimed to design a learning assessment worksheet based on Structure of Observed Learning Outcomes and determine its effect to the performance of students in Earth and Space Science for Grade 9 students of Plaridel Integrated National High School, Nagcarlan, Laguna.

Research Methodology

This chapter presents a comprehensive discussion of how the research was conducted particularly the research design, population and sample, research instrument, validation of the questionnaire, the data-gathering procedure and the statistical tool employed.

Research Design

The researcher utilized descriptive-developmental research design involving the designing of a learning assessment worksheet based on the Structure of Observed Learning Outcomes. Descriptive research design provides a detailed and accurate description of the characteristics and behaviors of a particular population or subject. It is used to gain a deeper understanding of a specific issue and provides valuable insights that can inform future studies (Sirsilla, 2023).

Richey & Klein (2015) described developmental research design as the systematic study of the process and impact of specific instructional design and development efforts and evaluation process as a whole or of particular process components.

The research focused on designing a learning assessment worksheet based on the Structure of Observed Learning Outcomes and determining the effects of using this worksheet to the performance of Grade 9 students in Earth and Space Science.

Respondents of the Study

The student respondents of the study which were selected using purposive sampling included one hundred twenty-five (125) students comprising the three sections of Grade 9 level including Madre Xacao, Maulawin and Narra who were officially enrolled in Plaridel Integrated National High School for School Year 2023-2024. The students were given the Structure of Observed Learning Outcomes Learning Assessment Worksheets. Afterwards, the students took a pretest prior to testing, were taught using the same teaching strategy and answered a post-test after the treatment.

Expert respondents who corroborated in the validation of the SOLO worksheets and research instruments included two Master Teacher in Science, two Head Teachers – one from the Science Department and one from the English Department and four Science teachers from Plaridel Integrated National High School.

Sampling Technique

Out of the 472 Grade 9 learners enrolled at Plaridel Integrated National High School for school year 2023-2024, three sections comprising of 125 learners were selected as the respondents of the study. The researcher utilized a purposive sampling technique in this study. In this technique, respondents are intentionally chosen based on their characteristics, knowledge or experiences.

Research Instruments

The researcher made use of several instruments including a cognitive diagnostic test, pretest and posttest, Structure of Observed Learning Outcomes Learning Assessment Worksheets, lesson exemplar and survey questionnaire.

In order to assess the students' pre-cognitive performance, a 50-item standardized pen and paper test about the topic on volcanoes in terms of remembering, understanding applying, analyzing, evaluating and creating was administered at the beginning of the lesson.

The pretest and posttest was a 25-item multiple choice test which was administered to the students before and after the conduct of the study in order to determine if there would be a statistically significant difference in their performance.

The Structure of Observed Learning Outcomes Learning Assessment Worksheet comprised of five assessment activities representing each SOLO levels, graphics and information about the lesson on volcanoes. This was administered to the students during the course of the teaching and learning process.

A lesson exemplar about the topic was also prepared to serve as a guide in the execution of the lesson and the development of the SOLO Assessment Worksheets.

A survey questionnaire was given to the student respondents prior to the pilot implementation of the worksheets in order to determine their profiles as well as their learning preferences wherein the questions were adapted from the University of Texas Learning Center (2006). After the use of the SOLO Assessment worksheets, the students answered a survey about their perception of the use of the worksheets during the teaching-learning process.

There was also a survey questionnaire for the validation of the Structure of Observed Learning Outcomes Learning Assessment Worksheets that was administered to Master teachers, Head Teachers and teachers handling science classes.

Research Procedure

Before collecting data, the researcher requested the school principal's permission to conduct the study in February of School Year 2023-2024. The study was conducted after securing permission form the school principal.

A learning preference survey was conducted to find out the profile of the students in terms of quarterly grades, cognitive skills and learning styles in terms of visual, auditory, read/write and kinesthetic learning. Based on the result of the survey, the Structure of Observed Learning Outcomes Learning Assessment Worksheet was designed and administered to the students after teaching them using the same strategy.

In order to determine the least mastered competencies, a 50-item pre-cognitive diagnostic test was given to the learners prior to the conduct of the study as to remembering, understanding, analyzing, applying, evaluating and creating. The 25-item pretest was then administered to the students to determine their prior knowledge of the topic on volcanoes and its types and volcanic eruption.

The teacher-made lesson exemplar was made in accordance with the most essential learning competencies issued by the Department of Education. It was executed using the Structure of Observed Learning Outcomes Learning Assessment Worksheet.

After the execution of the lesson, the posttest was conducted, and results were organized for analysis and interpretation. This was then sent to the CTE-GSAR Statistics Center for statistical analysis.

Statistical Treatment of Data

To aid the researcher in presenting, analyzing, and interpreting the data collected, the data collected was exposed to several statistical measurements and techniques. This includes the use of frequency, percentage, mean, mean gain score, and standard deviation to determine the learners' profile and calculate the difference between the respondents' pre- and post-assessment test scores.

To find out whether the groups are significantly different in terms of their scores before and after the use of the activity sheet, a dependent samples t-test was utilized. In order to determine the correlation between the cognitive performance and the students' perceived acceptability of the SOLO Assessment worksheet, Pearson Product-Moment Correlation was utilized. All inferential statistics will be tested at a five percent (5%) level of significance.

Results and Discussion

This chapter includes tables that present statistical findings in this study with their respective interpretations. The data are analyzed and interpreted to draw conclusions and recommendations from the study.

Table 1. *Students' Quarterly Grade in Science*

Grade	First Quarter			Second Quarter		
	f	%	Level	f	%	Level
90 and above	46	36.8	O	58	46.4	O
85 to 89	25	20	VS	20	16	VS
80 to 84	23	18.4	S	21	16.8	S
75 to 79	31	24.8	FS	26	20.8	FS
Total	125	100		125	100	

Legend: 74 and below (Did Not Meet Expectations); 75-79 (Fairly Satisfactory) (FS) ; 80-84 (Satisfactory) (S); 85-89 (Very Satisfactory)(VS); 90 and above (Outstanding) (O)

The table shows that a total of 125 Grade 9 students were profiled using a grading scale with four categories. Out of this, it was found that majority of the students are in the Outstanding level equivalent to 36.8% during the first quarter and further increased to 46.4% on the second quarter. This signifies that these students demonstrated an understanding and performance that is regarded as excellent based on the curricular competencies executed by the teacher during the first and second quarter.

The data gathered also shows that the percentage of students classified as Very Satisfactory, Satisfactory and Fairly Satisfactory decreased during the Second Quarter. However, the percentage of students falling under Fairly Satisfactory is still higher than those under higher levels namely Very Satisfactory and Satisfactory. This implies that during the first and second quarter, 24.8% and 20.8% respectively, of the students was able to attain the minimum expected understanding and performance based on the set curricular standards by the teacher. This means that students had difficulties in catching up with the competencies due to several factors including lack of interest in studying and difficulty in understanding complex topics. During the first and second quarter, these students were only able to define terms related to the lessons on biology and chemistry but were unable to make connections among these terms that they defined. The table signifies that the overall performance of the students improved from the first to the second quarter based on their quarterly grades.

Table 2. *Students' Cognitive Skills*

Cognitive skills	f	%
1. frequently misplace or lose important items	79	63.2
2. easily get distracted by external stimuli or unrelated thoughts	78	62.4
3. experience difficulties in problem-solving or decision-making	75	60
4. experience challenges in staying focused on specific tasks or activities	69	55.2
5. feel overwhelmed or have difficulty managing multiple tasks at once	62	49.6
6. often struggle to recall recent events or conversations	62	49.6
7. find it challenging to stay organized and keep track of deadlines or appointments	47	37.6
8. frequently experience mental fatigue or mental exhaustion	43	34.4
9. have trouble understanding and following complex instructions or information	42	33.6
10. find it hard to retain new information or learn new things	37	29.6

Table 2 shows the frequency and percentage of the students who experience difficulties on the different cognitive skills including Attention abilities, Memory Skills and Information Processing Skills. It shows that out of the 10 indicators, 4 are being experienced by more than 50% of the students.

The data also reveals that indicator 1 with 63.2% have the highest value which means that students experience problems with their Memory skills making it difficult for them to hold onto information for instant access. It also shows that most of the students are having difficulties when it comes to Attention abilities as reflected by indicator 2 with 62.4% which implies that those students find it hard to keep their ability to focus with the presence of distractions around them. On the other hand, 60% of students experience difficulties in solving problems as indicated by indicator 6 meaning that they have problems with their information processing skills.

Overall, the data indicates that students experience problems with their cognitive abilities. Having problems with cognitive skills could greatly affect the performance of students during the teaching and learning process. Cognitive skills encompass the brain's remarkable capacity to process, store, and utilize information. These are the functions that the brain uses to think, pay attention, process information, and remember things (Perry, 2023). Cognitive skills are an integral part of one's brain capacity and is important in performing day-to-day tasks in social, personal, and professional setting including school-related tasks. (Cousera, 2023). With the presence of a number of distractions inside the classroom like unfavorable classroom situations caused by noise and other factors, this could have effects on how well they understand simple and complex concepts that are taught to them.

Table 3. *Learning Preference of the Students*

Visual	**M**	**SD**	**VI**
1. I prefer to see information written on the board and supplemented by visual aids and assigned readings.	3.92	0.99	P
2. I like to write things down or take notes for visual review.	3.88	1.01	P
3. I am skillful with and enjoy developing making graphs and charts.	3.09	0.92	MP
4. I can easily understand and follow directions on a map.	3.35	0.96	MP
5. I can understand a news article better by reading about it in the newspaper or online rather than by listening to a report about it on the radio or internet.	3.43	1.12	MP
MEAN	**3.54**	**0.61**	**P**
Auditory	**M**	**SD**	**VI**
6. I can remember best by listening to a lecture that includes information, explanations, and discussions.	3.90	1.05	P
7. I require explanations of diagrams, graphs, or visual directions.	3.61	1.11	P
8. I can tell if sounds match when presented with pairs of sounds	3.40	1.00	MP
9. I do best in academic subjects by listening to lectures and tapes.	3.71	0.96	P
10. I learn to spell better by repeating words out loud than by writing the words on paper.	3.65	0.98	P
MEAN	**3.62**	**0.63**	**P**
Read/Write	**M**	**SD**	**VI**
11. I learn best by reading and taking notes	4.29	0.94	P
12. I prefer reading by myself rather than have someone read to them to retain information	4.03	0.97	P
13. I excel at multiple-choice and essay tests	3.71	1.00	P
14. I like words that have interesting/unique meanings and backgrounds.	4.03	1.08	P
15. I tend to write detailed notes.	4.02	1.10	P
MEAN	**3.95**	**0.68**	**P**
Kinesthetic	**M**	**SD**	**VI**
16. I prefer to use posters, models, or actual practice and other activities in class.	3.61	1.14	P
17. I enjoy working with my hands or making things.	4.10	0.95	P
18. I learn more when I make a model for class projects.	3.38	0.97	MP
19. I learn best when I am shown how to do something, and I have the opportunity to do it.	4.02	1.08	HP
20. I think better when I have the freedom to move around.	4.13	1.11	P
MEAN	**3.73**	**0.67**	**P**

Legend: 1.0-1.49 (Not Preferred) (NP); 1.50-2.49 (Slightly Preferred) (SP); 2.50-3.49 (Moderately Preferred) (MP); 3.50-4.49 (Preferred) (P) 45.-5.0 (Highly Preferred) (HP)

The table presents the learning preference of the students. Based on the data gathered, the mean scores of all the learning styles indicate that they are all preferred by the students. However, the data shows that among the four learning styles, the Read/Write style of learning is most preferred by the students than the other learning styles, with a mean of 3.9 and SD of 0.68, meaning most of them learn better by means of using information displayed as text or words, reading textbooks and taking down notes. On the other hand, students least preferred the Visual learning style equivalent to a mean of 3.54 which means that they least prefer the use of visual aids such as pictures and other graphics.

The results obtained about the learning preferences of the learners were used in developing the SOLO Assessment Worksheets. The activities included in the worksheet were based on the learning preferences of the students by designing varied activities to ensure that all the learning preferences will be given emphasis and the students with varied learning styles will have equal learning experiences and opportunities which shall be assessed accordingly.

Table 4. *Diagnostic Test Mean Scores of the Students as to Cognitive Domain*

Grade	**Remembering**		**Understanding**		**Applying**		**Analyzing**		**Evaluating**		**Creating**	
	F	%	F	%	F	%	F	%	F	%	F	%
90 and above	0	0	0	0	0	0	0	0	0	0	0	0
85 to 89	0	0	0	0	0	0	0	0	0	0	0	0
80 to 84	10	8	2	1.6	0	0	0	0	0	0	0	0
75 to 79	28	22.4	12	9.6	0	0	0	0	0	0	0	0
below 75	87	69.6	111	88.8	125	100	125	100	125	100	125	100
	125	100	125	100	125	100	125	100	125	100	125	100
Mean	**72.30**		**66.47**		**63.63**		**63.50**		**61.65**		**61.28**	
SD	**4.46**		**5.58**		**3.31**		**3.28**		**1.86**		**1.74**	

Legend: 74 and below (Poor); 75-79 (Unsatisfactory); 80-84 (Satisfactory); 85-89 (Very Satisfactory); 90 and above (Outstanding)

This table presents the results of the mean scores of the diagnostic test administered to the students before the use of the SOLO Assessment Worksheet in terms of the cognitive domain. Results revealed that students were able to get the passing grade of 75 and above in the first two levels namely Remembering and Understanding. In the Remembering level, 69.6% of the students got a Poor rating while the remaining 8% and 22% of the students got a Satisfactory and Unsatisfactory rating respectively. This indicates that students are having difficulties in retrieving, recalling and recognizing relevant information about the lesson on volcanoes.

While in the Understanding level, 88% of the students have a poor rating and 1.6% and 9.6% got a Satisfactory and Unsatisfactory rating, respectively. This means that majority of the students was not able to demonstrate comprehension of the topic in one or more forms of explanation. They are not also able to express their understanding of the concepts and theories about volcanoes.

Moreover, students got a poor performance in the applying, analyzing, evaluating and creating level. This means that they are unable to use information or a skill in a new situation. They also have difficulty in breaking the concept of volcanoes into its constituent parts and determine how the parts relate to one another. Furthermore, they are unable to make judgments based on criteria and standards and reorganize elements into a new pattern or structure.

Longe (2024) stated that diagnostic assessment is important for teachers to quickly gauge students'understanding of a topic even before introducing it. The results of the diagnostic assessment were used in determining the critical points of the lesson and theactivities that could aid in the easy understanding of the topic about volcanoes.

Table 5. *Expert Respondents' Perception on the Extent of Acceptability of the SOLO Assessment Worksheets as to Content*

Criteria	MEAN	SD	VI
1. complete in scope without missing important information.	4.86	0.38	HA
2. valid and reliable information are provided and sufficient.	4.86	0.38	HA
3. clearly presented, organized and straight forward.	4.86	0.38	HA
4. parallel to the objectives of the module	5.00	0.00	HA
5. appropriate for the cognitive and linguistic level of the students in terms of scope and depth	5.00	0.00	HA
6. within a clear and understandable manner in terms of directions and the items	4.86	0.38	HA
7. presented and organized in logical manner	5.00	0.00	HA
8. designed to determine the skills that are supposed to be measured.	4.71	0.49	HA
9. inclusive of assessment items that are worded objectively.	5.00	0.00	HA
10. inclusive of response options adequately cover all significant alternatives	5.00	0.00	HA
Mean	4.91	0.36	HA

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

Table 5 summarizes the expert respondents' perception on the extent of the acceptability of the SOLO Assessment Worksheets as to content. The data reveals that with an overall mean of 4.91 (SD=0.36), the content of the worksheet is highly acceptable. This indicates that the content of the SOLO assessment worksheets parallel to the objectives of the module and appropriate for the cognitive and linguistic level of the students in terms of scope and depth. The lessons and activities included in the worksheet were presented and organized in logical manner allowing students to work on an increasingly difficult pacing. The worksheet is inclusive of assessment items that are worded objectively and inclusive of response options adequately cover all significant alternatives such as the questions found in the Let's Assess activity containing ten multiple choice questions.

During the conduct of the study, the utilization of the SOLO Assessment worksheet was able to help the students assess their own level of understanding and how deep their knowledge of the topic was. This is because the worksheets contained a series of assessment activities of increasing complexity which enabled students to assess their own performance during the course of the teaching and learning process which were given in between the discussion of the salient parts of the lesson. This is evident in the use of the different SOLO Taxonomy levels starting with the lowest level up to the highest one which is reflected in the five different assessment activities in the worksheet.

These activities were also aligned on the learning preference survey that was conducted prior to the development of the assessment worksheets making sure that all the learning preferences of the students were given emphasis on the selection of what activities to include in each levels of the SOLO taxonomy. For example, for the kinesthetic learners, a performance task involving the use of a volcano model was included in Learning Task 4 which is targeted towards simulating a volcanic eruption. The cognitive performance of the students also improved as evident in the significantly different results of the pre and post test scores of the students.

Table 6. *Expert Respondents' Perception on the Extent of Acceptability of the SOLO Assessment Worksheets as to Design*

Criteria	MEAN	SD	VI
1. dynamic, interesting, and exciting features.	4.71	0.49	HA
2. pleasing colors, well presented information and has been given emphasis.	4.86	0.38	HA
3. clear, effective and attractive illustrations.	4.71	0.76	HA
4. graphics and color which are appropriate to the learners.	4.57	0.79	HA
5. taken into consideration sizes of the objects such as pictures and other graphics.	4.43	0.79	A
Mean	**4.66**	**0.280**	**HA**

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

Table 6 summarizes the expert respondents' perception on the extent of the acceptability of the SOLO Assessment Worksheets as to design. Overall, the rating given by the expert respondents in terms of design got a mean score of 4.66 (SD=0.280) which means that the design of the worksheet is highly acceptable.

Based on the results, in terms of design, the worksheet used pleasing colors, illustrations and well-presented information. The illustrations and graphics included to aid the understanding of the contents of the worksheet were clear, effective, attractive and matches the learners' level of understanding. Moreover, the worksheet has been found out to possess dynamic, interesting, and exciting features that was able to capture the student's attention and

interest as they utilize the activity sheet during the course of the teaching and learning process. It is evident in the inclusion of pleasing colors, graphics and information. The worksheet also has varied activities that are suited for the different learning preferences of the students.

During the course of the experimentation, it was found out that the worksheet was able to increase the students' interest in studying the topics about volcanoes and volcanic eruption. Data from the student survey also revealed that the worksheet captured their attention and keep them engaged in learning the topic. Gramlick (2019) stated that one of the key advantages of using worksheets is that it helps in engaging and motivating students to understand difficult concepts. Thus, a purposefully and aesthetically designed worksheet helps in attaining this key advantage.

Table 7. *Student Respondents' Perception on the Extent of Acceptability of the Use of the SOLO Assessment Worksheets*

ACCEPTABILITY OF THE SOLO ASSESSMENT WORKSHEET	M	SD	VI
1. increases my interest in studying the topics about volcanoes and volcanic eruption.	4.34	0.65	A
2. motivates me in learning basic information about volcanoes and volcanic eruption.	4.34	0.72	A
3. captures my attention and keep me engaged	4.15	0.85	A
4. enables me to think critically on the learning competencies which was introduced by my teacher.	4.10	0.79	A
5. gets me more involved in learning activities that is needed in today's trend.	4.12	0.76	A
6. gives me learning experiences which are constructive and effective in the process.	4.29	0.72	A
7. helps me perform well in the teaching - learning process as a factor of my performance in the class.	4.19	0.85	A
8. makes me understand deeper and appreciate the importance of learning the topics on volcanoes	4.41	0.69	A
9. helps me assess my own level of understanding of the topics discussed by my teacher.	4.36	0.69	A
10. encourages me to reflect on my own level of performance in class.	4.21	0.78	A
MEAN	4.25	0.46	A

Legend: 1.0-1.49 (Not Acceptable) (NA); 1.50-2.49 (Slightly 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 student respondents' perception on the extent of acceptability of the use of the SOLO Assessment Worksheets during class discussion. The overall rating of 4.25 mean score (SD=0.46) indicates that the use of the worksheet is acceptable for the students.

This implies that the students perceive that the worksheet was able to help them assess their own level of understanding of the topics discussed by the teacher. It is because the learning tasks included in the worksheet are of increasing complexity thus one activity is checked right before moving on to the next task that represent the next level. The worksheet was also able to increase their interest and motivate them in studying the topics and learning basic information about volcanoes and volcanic eruption. It is evident in the inclusion of pleasing colors, graphics and information that aided the learning of the students while increasing their interest toward the lesson. It also included activities that are intended to cater each learning preference of the students – a written activity, a performance task, one that includes graphics and listening.

As stated by Wong, et.al. (2020), interest is a key component in learning. Learning is enhanced when students show interest in the subject matter. It was evident in the pre and posttest scores of the students that their understanding and performance significantly improved.

Table 8. *Performance of Students Based on the Structure of Observed Learning Outcomes Learning Assessment Worksheet*

Grade	Prestructural		Unistructural		Multistructural		Relational		Extended Abstract	
	F	%	F	%	F	%	F	%	F	%
90 and above	125	100	123	98.4	81	64.8	68	54.4	3	2.4
85 to 89	0	0	0	0	4	3.2	0	0	0	0
80 to 84	0	0	2	1.6	5	4	24	19.2	0	0
75 to 79	0	0	0	0	9	7.2	17	13.6	0	0
below 75	0	0	0	0	26	20.8	16	12.8	122	97.6
	125	100	125	100	125	100	125	100	125	100
Mean	99.60		99.36		87.40		87.84		60.89	
SD	1.98		3.04		12.17		12.59		5.77	

Legend: 74 and below (Poor); 75-79 (Unsatisfactory); 80-84 (Satisfactory); 85-89 (Very Satisfactory); 90 and above (Outstanding)

The table shows the performance of students on the SOLO learning assessment worksheet in terms of their grades on the different activities included. As the lesson progresses, the students answered the assessment activities included in the worksheet starting with the prestructural, lowest level, up to the exetended abstract, highest level.

The data shows that on the prestructural and unistructural level, 100% of the students was able to get the passing grade. This indicates that all of the students know a concept and is able to understand and grasp a basic understanding of the concept and task they were given about one concept which is the difference between active and inactive volcanoes. On the other hand, on the multistructural level, 79.2% of the students got the passing grade which indicates that they were able to gain an understanding of several independent concepts about the topic on volcanoes including the different types of volcanoes and their examples respectively. Moreover, in the relational level, 87.2% of the students were able to get the passing score which implies that they were able to connect concepts and ideas in order to understand these concepts as a whole. Students were able to relate the factors that affect the eruption of a volcano like pressure and gas build up in Learning Task 4 where they used a volcano model to simulate how a volcanic eruption takes

place. Finally, on the highest level, which is the Extended Abstract level, only 2.4% of the students were able to get a score higher than 75%. This implies that they were able to create connections beyond what is provided in the given task and what was discussed in relation to that task. Students who attained this level were able to give other types of volcanoes not included in the types that were discussed by the teacher. Main (2021) stated that SOLO Taxonomy is a valuable tool for assessing the depth of knowledge that students have achieved in a particular subject or task.

Table 9. *Test of Difference in the Cognitive Performance of Students Before and After the Use of the SOLO Assessment Worksheets as to Pre and Posttest Scores*

	Pre		Post		t	df	p
	M	SD	M	SD			
Cognitive Performance	74.37	0.37	89.45	0.59	-35.893	124	0.000

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

Table 9 compares the data gathered on the test of difference in the cognitive performance of students before and after the use of the SOLO Assessment Worksheet in terms of their pre and posttest scores. The results show a p value of 0.000 which revealed that there is a significant difference between the scores of the respondents before and after the use of the SOLO Assessment worksheets. It reveals that upon the discussion of the lesson with the use of the SOLO Assessment worksheets as the lesson progresses, the cognitive performance of the students significantly improved.

As the lesson progresses, the students participated actively in the discussion of the lesson. It was observed that students were able to gain a deeper understanding of concepts and facts about the lesson as supported by the statistically significant different results of the pretest and posttest. In between the discussion of the different parts of the lesson, the students answered the assessment activities included in the worksheet starting with the lowest up to the highest level. It is evident in the worksheet as it started with the lowest level which is the prestructural level by having a vocabulary activity and ended with the extended abstract level in the form of a drawing and describing activity about other types of volcanoes not discussed in the lesson. This aided in the self-assessment of the students as they are able to reach a certain level of the SOLO taxonomy as evident in the results of the survey conducted among them. This was supported by Greany (2024) who stated the importance of bite-sized learning in allowing learners to work through at a pace that suits them.

The worksheet was also able to help students understand the lesson as it contained not only the assessment activities but also information about the topic. Moreover, the assessment activities were not only limited to the paper and pen activities but also included a performance task in the form of an experiment to match each learning preference of the students although majority of them falls on the read/write learning style. Moussa (2024) stated that learning styles play a vital role in the learning process and contribute to the overall educational environment. The information gained from knowing the learning styles of learners provides researchers with knowledge that can be helpful in improving the overall quality of learning as well as the learning environment.

The worksheet also provided students with opportunities to self-assess as the lesson progresses like keeping track of their own understanding since they were able to assess themselves in between the course of the lesson. This was supported by the study of Abdullah-Masran (2021), stated in a study that students need to know their current levels of thinking and how to progress to the next level by self-assess themselves. Otherwise, they would constantly demand teachers to spoon-feed them to achieve a specific level. Moreover, in a study conducted by Dumaraos (2022), results showed that the use of Structure of Observed Learning Outcomes as an assessment tool can provide the teachers significant information about how well the pupils understand a topic thus allowing the teacher to provide appropriate remedial instructions or intervention program.

Table 10. *Test of Correlation between the Perceived Level of Acceptability of the SOLO Assessment Worksheet to the Students' Cognitive Performance*

	Cognitive performance	
	r	p
Acceptability	0.239	0.007

***Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).*

Table 10 presents the data gathered for the test of relationship between the perceived level of acceptability of the SOLO Assessment Worksheet to the students' cognitive performance. The p value of .007 indicates that there is a statistically significant correlation between the acceptability of the SOLO Assessment Worksheet and the cognitive performance of the students.

After the use of the SOLO Assessment Worksheet, it was observed that the performance of the students significantly improved based on the statistically significant results of the pretest and posttest. They were able to gain knowledge and understanding of the lesson about volcanoes while being able to assess themselves and how they perform based on the different assessment activities included in the worksheet. This is because the learning tasks in the worksheet was used in between the discussion of the lesson, starting with the prestructural activity up to the extended abstract. Moreover, the students were not only able to answer written activities but was also able to work collaboratively in the performance assessment task in learning task 4. Thus, based on the results of the correlational test, the worksheet was able to aid in improving the cognitive performance of the students.

As evident in the results of the acceptability survey, the worksheet helped in increasing the interest of the students and motivate them in studying the topics and learning basic information about volcanoes and volcanic eruption. This was because of the use of critical points in the worksheet such as the increasing level of complexity of the included activities, use of graphics and inclusion of important information and concepts. Notions of Torrefranca (2017) and Azar (2014) indicated that worksheets, as an integral part of the teaching and learning process, describe the role of teachers as one who encourages the growth of students and offers a facilitative mechanism enabling them to move beyond what they can do.

Conclusion

In light of the aforementioned findings, the following conclusions are hereby drawn:

1.The findings of the study indicate a significant difference in the cognitive performance of the students as evident in the results of the pre and posttest scores of the students. Thus, the null hypothesis is not supported.

2.Moreover, it was also found that there is a significant relationship between the perceived acceptability of the SOLO Learning Assessment Worksheet and the students' cognitive performance. Thus, the null hypothesis is not sustained.

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