



Philippine Educational Measurement  
and Evaluation Association



# SCIENCE NOVEL ASSESSMENT PROBES SUPPORTING HIGHER-ORDER THINKING SKILLS (SNAPSHOTS): IMPACT ON LEARNERS' COGNITIVE LEARNING OUTCOMES

PRESENTER

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NATIONAL CONFERENCE ON  
EDUCATIONAL MEASUREMENT  
AND EVALUATION  
(NCEME2024)



# INTRODUCTION

## SCIENCE LEARNING

Poor ranking in academic proficiency in the fields of reading, science, and mathematics (*TMSS 2019, PISA 2018, & NAT 2018*)

Learning losses across learning areas and grade levels (*Regional Diagnostic Assessment/ Division Exit Assessment*)

At the school level, Only 0.16% or one learner out of 639, reached the minimum proficiency level.

80% to 86.5% of the 639 Grade 10 learners had poor acquisition of the learning competencies from the previous science grade.

Inadequate development and acquisition of cognitive process skills (higher-order thinking skills)



# RESEARCH FRAMEWORK

Inquiry-based  
Science Education

## Cognitive Learning Outcomes

- Formative Development of Concepts in Students
- Achievement
- Higher-Order Thinking Skills (HOTS)

# RESEARCH QUESTIONS

How does Science Novel Assessment Probes Supporting Higher-Order Thinking Skills (SNAPSHOTS), embedded as a formative assessment strategy in teaching science, impact students' achievement and higher-order thinking skills (HOTS)?



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# SPECIFIC RESEARCH QUESTIONS

1. How may the formative development of concepts be described during science instructions with SNAPSHOTS?

2. How may science instruction with SNAPSHOTS affect the cognitive learning outcomes in terms of:

- formative achievement;
- summative achievement; and
- higher-order thinking skills (HOTS)?

3. How may the overall experience and perceptions of the students toward the SNAPSHOTS be described at the end of the intervention program?

## Science Novel Assessment Probes Supporting Higher-Order Thinking Skills or SNAPSHOTS

*Using alternative questioning styles in written tasks through THINK-GROUP-SHARE Strategy incorporated with class feedbacking and explicit corrective instruction*



# SNAPSHOTS

## 7E Learning Model

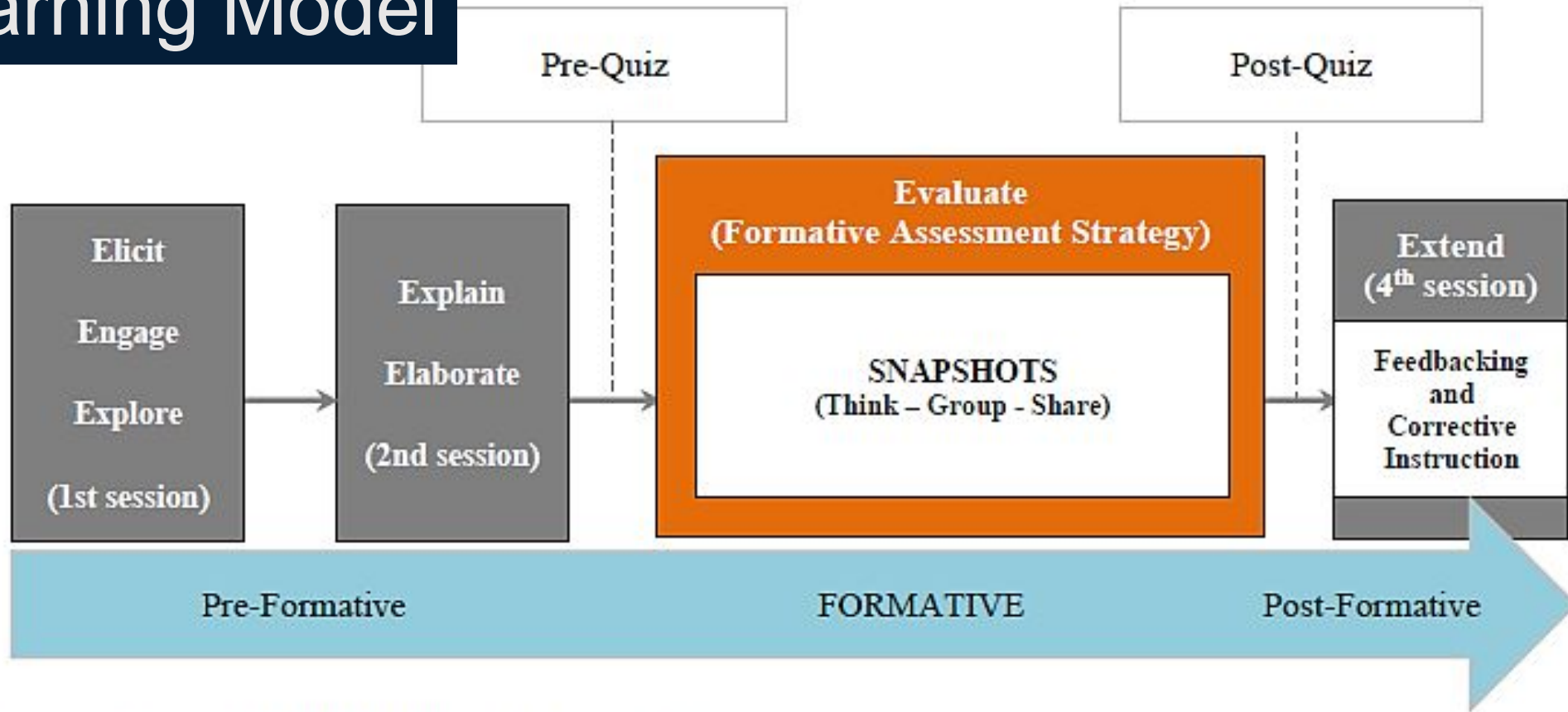


Figure 4. The SNAPSHOTS instruction flow.

# SNAPSHOTS



GROUP STEP 

- Think about each question individually for 10-15 minutes.

- Discuss your answers within the group for 10-15 minutes.

- Share your group's work with the class for 15 minutes.

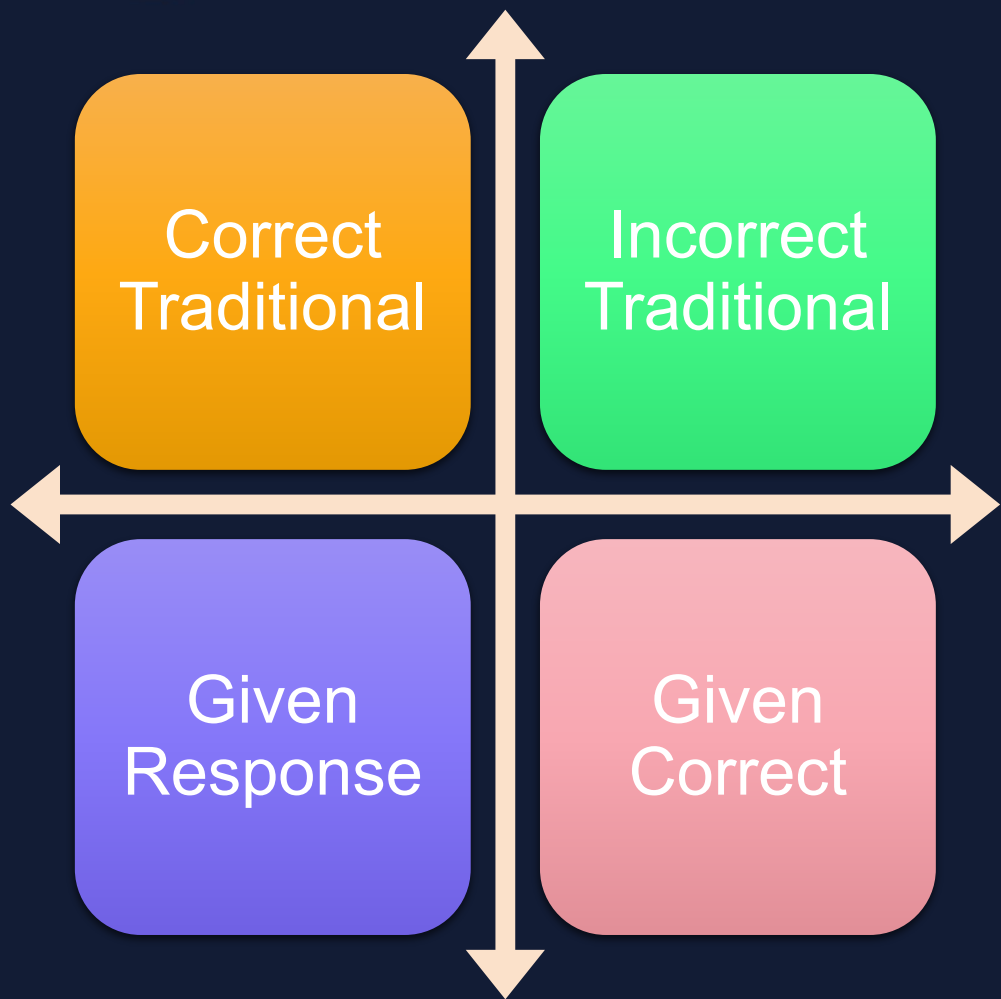
THINK STEP 

SHARE STEP 





# SNAPSHOTS



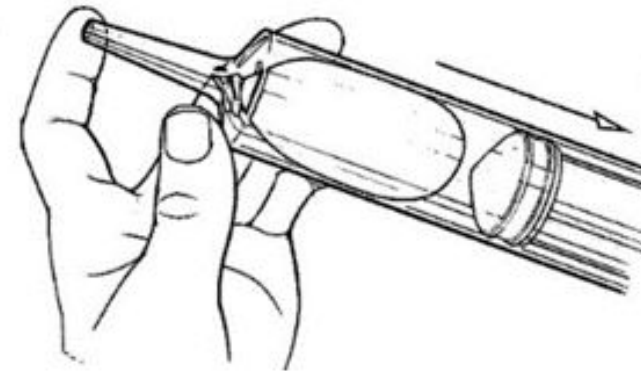
## Novel Questioning Styles:

1. Correct Traditional
2. Incorrect Traditional
3. Given Response
4. Given Correct

## 1. Correct Traditional

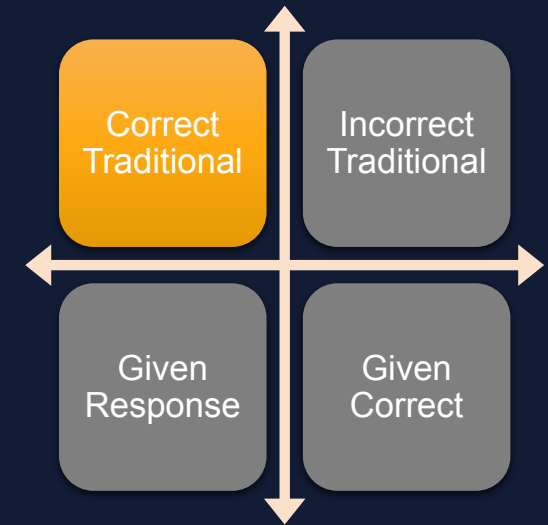
### Correct Traditional (CT)

1. An air-filled balloon is placed inside a syringe. The tip of the syringe is closed with one finger, and the plunger is pulled back, as shown in the picture. How does the balloon change when the plunger is pulled all the way back?



*Choose the CORRECT answer. Explain your answer.*

- The balloon expands and becomes bigger.
- The balloon shrinks and becomes smaller.
- The balloon does not expand nor shrink.
- The balloon slides in the same direction as the plunger.



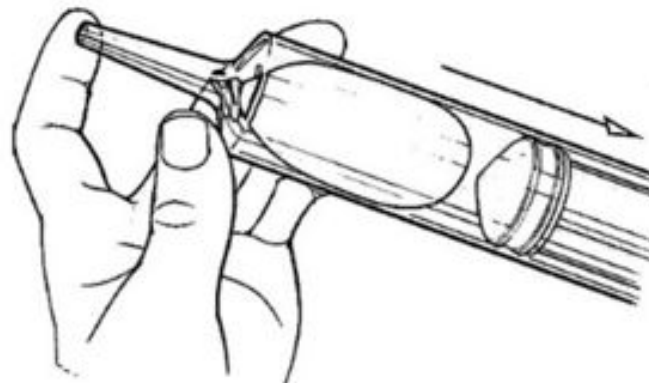
This is the conventional multiple-choice item where tier 1 consists of a stem and a set of alternatives consisting of a correct answer and three or more distractors.

The learners are asked to give their reasoning for their answer in tier 2.

## 2. Incorrect Traditional

### Incorrect Traditional (CT)

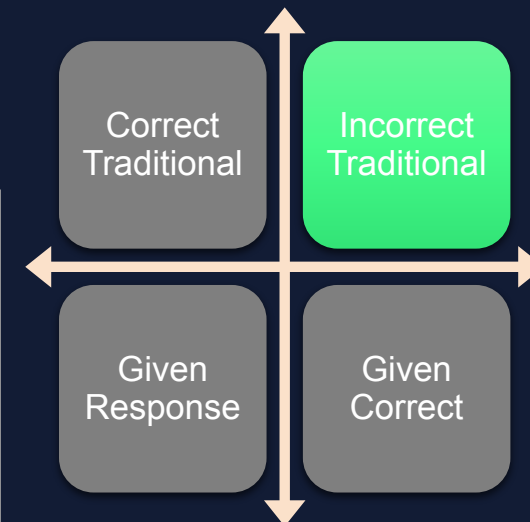
1. An air-filled balloon is placed inside a syringe. The tip of the syringe is closed with one finger and the plunger is pulled back, as shown in the picture. How does the balloon change when the plunger is pulled all the way back?



*Eliminate one response you are pretty sure is INCORRECT. Which response will you eliminate?*

*Why is that response the best to eliminate?*

- a. The balloon expands and becomes bigger.
- b. The balloon shrinks and becomes smaller.
- c. The balloon does not expand nor shrink.
- d. The balloon slides in the same direction as the plunger.



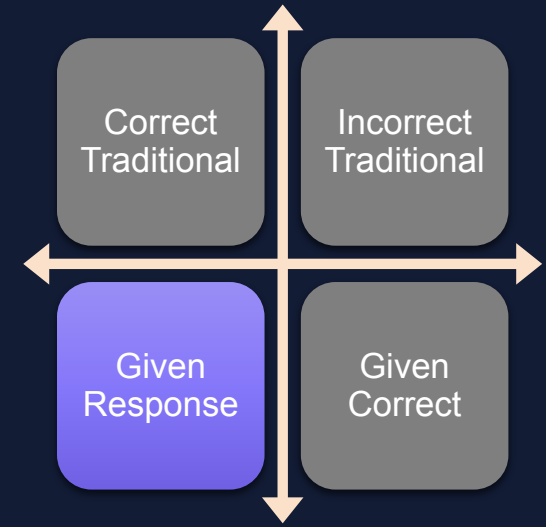
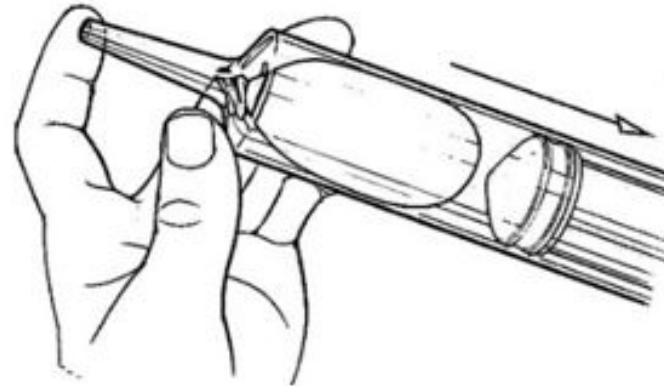
This item has the same construction as that of CT, but with an opposite command, and instead of selecting the correct answer, learners should choose what they think is incorrect and best to eliminate. This item probes into what learners think to be incorrect and reveals why they disbelieve them.

## 3. Given Response

### Given Response (GR)

1. An air-filled balloon is placed inside a syringe. The tip of the syringe is closed with one finger and the plunger is pulled back, as shown in the picture.

*When the plunger is pulled all the way back, would the balloon expand and become bigger? Explain.*



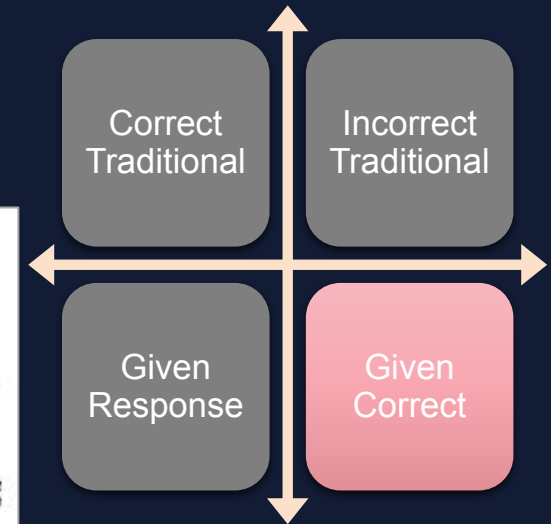
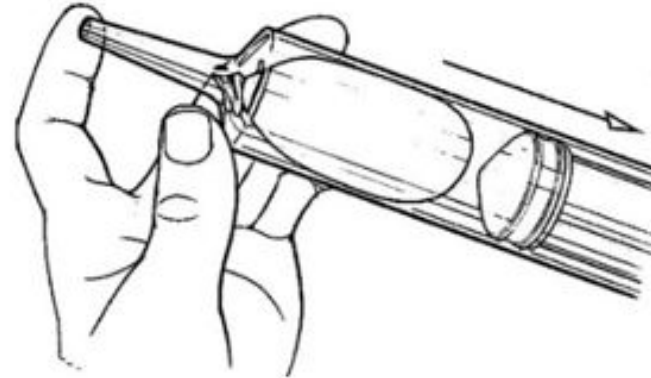
The item specifies a possible response to a question that the learners should agree or disagree with. Hawkins et al. (2011) posited that the item could show what the learners think about that answer even if they would not have selected it as the correct one.

## 4. Given Correct

### Given Correct (GC)

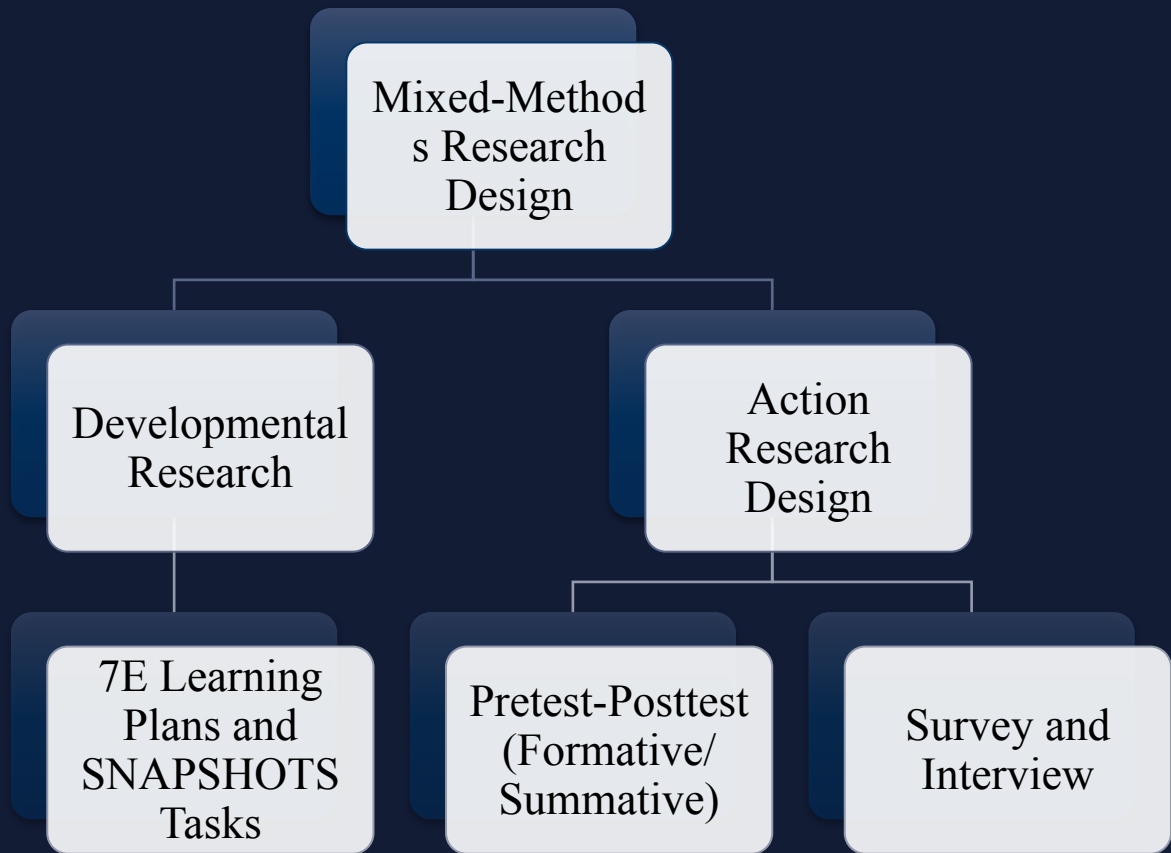
1. An air-filled balloon is placed inside a syringe. The tip of the syringe is closed with one finger, and the plunger is pulled back, as shown in the picture.

*When the plunger is pulled all the way back, the balloon expands and becomes bigger. Explain why.*



The correct answer is explicitly given, and the learners are asked to justify why it is correct. This question surveys whether the learners have sound scientific reasoning for why the answer is correct, even if they did not believe it was the correct answer at the beginning.

# METHODS



## Participants

Seventy-Eight (78) Grade 10 Learners

Fourth Quarter of School Year 2022-2023

A single treatment group; no control group

## Instruments

Validation Questionnaires

Short quizzes

Achievement test

Student attitude toward the SNAPSHOTS questionnaire

Interview Guide/Protocol

# DATA COLLECTION



## Development Phase

- 1. Designing and developing the lesson plans and the SNAPSHOTS
- 2. Validation of the instructional materials

## Implementation Phase

- Implementation of 7E -based instructions with embedded SNAPSHOTS (Think-Group-Share Steps), feedbacking, and corrective instruction

## Evaluation Phase

- 1. Describing the formative development of concepts
- 2. Determining the impact of the SNAPSHOTS lessons on cognitive learning outcomes in terms of student achievement, higher-order thinking skills, and perceptions



# RESULTS

## SOP 1: Formative Development of Concepts

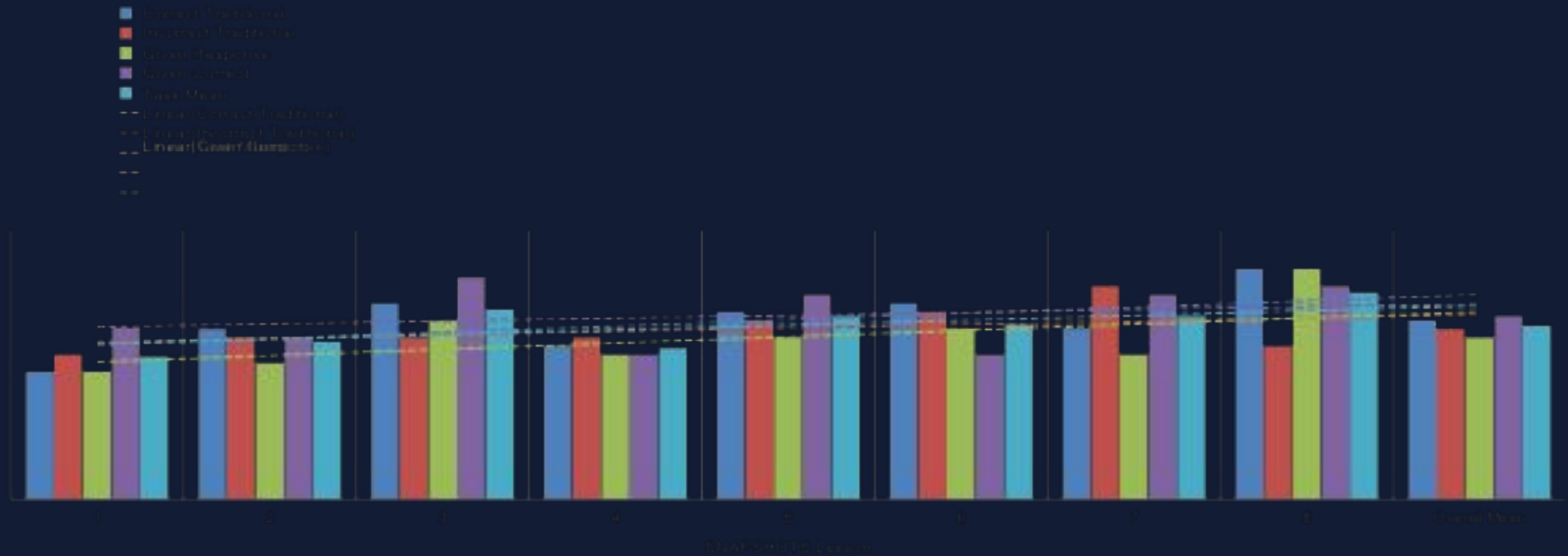


Figure 7. Summary of SNAPSHOTS item and task mean scores

Overall, the graph shows the **increasing trends of progress** in both the item and task mean scores obtained by the learners across the question types and the eight SNAPSHOTS assessment tasks.



# RESULTS

## SOP 2: Cognitive Impact (Formative Level)

*Wilcoxon Signed Rank Test for the Difference between Pre- and Post- Formative Evaluations*

	Topic	N	PRE	POST	z	Asymp. Sig. (2-tailed)	d
1.1	Boyle's Law	72	2.784	3.216	-3.356 <sup>b</sup>	.001*	0.480
1.2	Charles' Law	70	2.437	3.054	-1.723 <sup>b</sup>	.085	0.285
1.3	Kinetic Molecular Theory	68	2.514	2.622	-.141 <sup>c</sup>	.888	0.011
2.1	Biomolecules	73	2.035	2.243	-1.137 <sup>b</sup>	.256	0.172
3.1	Chemical Reactions	69	2.054	2.243	-1.602 <sup>b</sup>	.109	0.231
3.2	Law of Conservation of Mass	70	1.595	2.595	-4.756 <sup>b</sup>	.000*	0.848
3.3	Rates of Chemical Reactions	52	2.189	3.189	-2.705 <sup>b</sup>	.007*	0.565
3.4	Chemical Reaction Applied in Food Preservation...	48	2.595	3.189	-2.254 <sup>b</sup>	.024*	0.360

1. Post-evaluation scores of the learners were **higher overall across the eight lessons**
2. **Four out of 8 evaluations** showed significant mean differences with small to large effect sizes.

*Note: No. of items = 5; \*significant at  $\alpha = 0.05$ ; effect size (Cohen's  $d$ ) value 0.20 (small effect), 0.50 (medium effect), and 0.80 (large effect); a. Wilcoxon Signed Ranks Test; b. Based on negative ranks; c. Based on positive ranks.*



# RESULTS

## SOP 2: Cognitive Impact (Summative Level)

### *Wilcoxon Signed Rank Test for the Difference between Pre- and Post- Summative Evaluations*

Topic	PRE	POST	z	Asymp. Sig. (2-tailed)	d
1.1 Boyle's Law	1.85	3.04	-5.113 <sup>b</sup>	.000*	0.939
1.2 Charles' Law	1.86	2.53	-3.113 <sup>b</sup>	.002*	0.498
1.3 Kinetic Molecular Theory	2.21	2.17	-.301 <sup>c</sup>	.763	-0.034
2.1 Biomolecules	2.08	1.99	-.326 <sup>c</sup>	.744	-0.078
3.1 Chemical Reactions	1.81	2.65	-4.019 <sup>b</sup>	.000*	0.649
3.2 Law of Conservation of Mass	1.59	2.62	-4.498 <sup>b</sup>	.000*	0.836
3.3 Rates of Chemical Reactions	1.55	2.44	-3.769 <sup>b</sup>	.000*	0.687
3.4 Chemical Reaction Applied in Food Preservation...	1.56	2.91	-6.183 <sup>b</sup>	.000*	1.013
<i>Overall</i>	14.50	20.33	-6.231 <sup>b</sup>	.000*	1.110

*Note: No. of items = 5;  
\*significant at  $\alpha = 0.05$ ;  
effect size (Cohen's d) value  
0.20 (small effect), 0.50  
(medium effect), and 0.80  
(large effect); a. Wilcoxon  
Signed Ranks Test; b. Based  
on negative ranks; c. Based  
on positive ranks.*

- (1) There was a **significant difference** ( $z = -6.231$ ,  $p < 0.001$ ) between the overall mean scores in the summative evaluations at the end of the study. (2) Summative achievement is **significantly improved in six out of 8 topics** covered within 8 weeks. (3) Large positive effect size ( $d = 1.110$ )



# RESULTS

## SOP 2: Cognitive Impact (HOTS – Blooms Taxonomy)

*Wilcoxon Signed Rank Test for the Difference between the Cognitive Process Dimensions for Formative and Summative Achievement*

	No. of items	PRE	POST	z	Asymp. Sig. (2-tailed)	d
<b>FORMATIVE (N = 40)</b>						
Remembering	3	2.03	2.12	-1.005 <sup>b</sup>	.315	0.109
Understanding	10	2.96	4.10	-4.735 <sup>b</sup>	.000*	0.551
Applying	12	4.36	4.88	-1.949 <sup>b</sup>	.051	0.220
Analyzing	8	2.49	3.42	-4.643 <sup>b</sup>	.000*	0.616
Evaluating	7	2.61	2.80	-1.289 <sup>b</sup>	.197	0.142
<b>SUMMATIVE (N = 50)</b>						
Remembering	10	3.31	4.88	-5.106 <sup>b</sup>	.000*	0.829
Understanding	11	2.47	4.24	-5.374 <sup>b</sup>	.000*	0.979
Applying	13	4.26	5.46	-3.842 <sup>b</sup>	.000*	0.628
Analyzing	9	2.22	3.53	-4.909 <sup>b</sup>	.000*	0.886
Evaluating	7	2.24	2.22	-.027 <sup>b</sup>	.979	-0.016

1. Cognitive process skills, namely **understanding** and **analyzing** indicated a significant change in the formative evaluations.
2. **Remembering**, **understanding**, **applying**, and **analyzing** had substantial improvement for the summative evaluation.
3. **Moderate** to **large** effect sizes across thinking skills.

Note: \*significant at  $\alpha = 0.05$ ; effect size (Cohen's *d*) value 0.20 (small effect), 0.50 (medium effect), and 0.80 (large effect); a. Wilcoxon Signed Ranks Test; b. Based on negative ranks; c. Based on positive ranks.

# RESULTS

## SOP 2: Cognitive Impact (SOLO TAXONOMY)

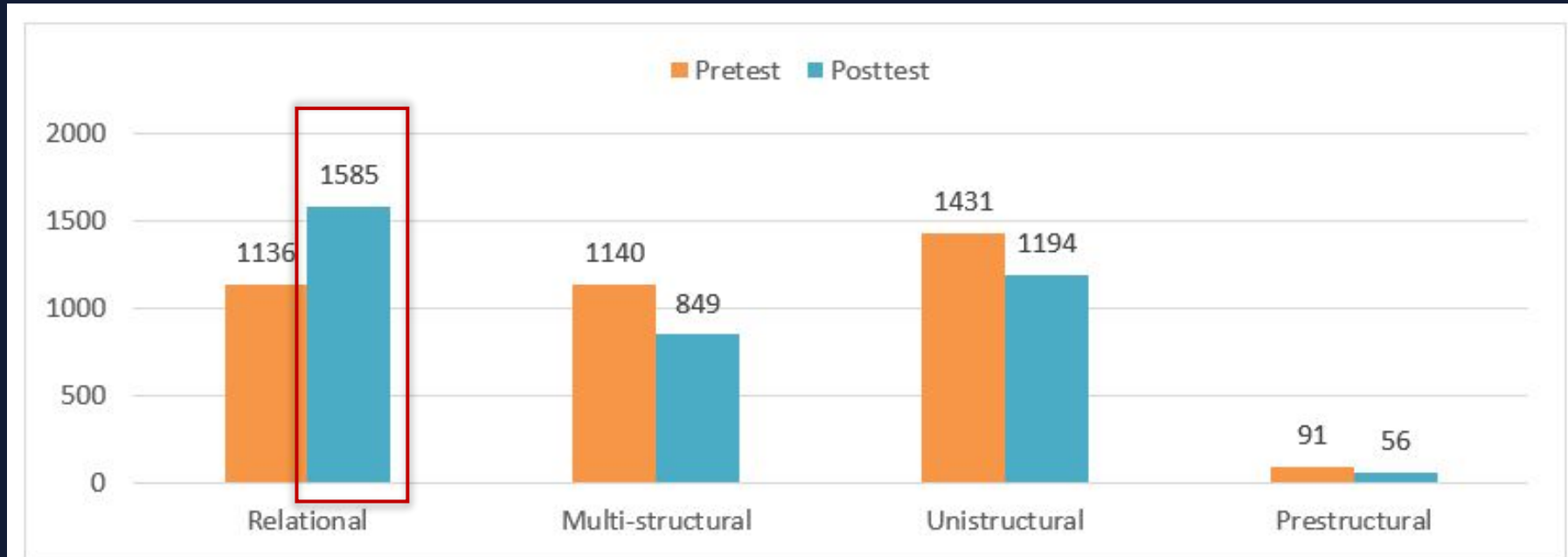


Figure 13. Cognitive impact of the SNAPSHOTS in terms of SOLO Taxonomy.

There were more learners under the **relational level by 39.5% up**, and lower number of learners under **multi-structural (25.5% decrease)**, **unistructural (16.56% decrease)**, and **pre-structural (38.5% decrease)** after the SNAPSHOTS program. Observed shifts to the relational level indicate that students began to show an understanding of the science concepts.

# RESULTS

## SOP 3: Overall Experience/Perceptions toward SNAPSHOTS

*Learners' Attitude toward the SNAPSHOTS (N=78)*

Statements	Mean	Remark
I like the tasks more than any common questions I answered before.	4.04	A
I find the tasks interesting as a way to test my understanding of Science concepts.	4.24	A
I tried harder with the tasks as I needed to explain the reason for my answer.	3.95	A
I think the tasks showed better what I learned about the Science lessons.	4.23	A
I think the tasks increased my interest in Science.	3.94	A
I feel confident as the tasks helped me prepare for the test.	4.01	A
I studied harder because I knew I could hardly make a guess.	3.65	A
I liked the tasks because I improved my thinking skills.	4.49	A

*Note:* 1.0-1.49=strongly disagree, 1.5-2.49= disagree, 2.5-3.49 = neutral, 3.5-4.49=agree, 4.5-

5.0=strongly agree

The learners expressed **optimistic** and **favorable attitudes** toward the formative assessment strategy.



# RESULTS

## SOP 3: Overall Experience/Perceptions toward SNAPSHOTS

### *Perceived Effects of the SNAPSHOTS (Interview Response)*

N=30	Yes	No	Somewhat yes (%)
	(%)	(%)	
Affected interest in learning science	96.7	3.3	0.0
More curious to know science application	96.7	3.3	0.0
Improved confidence/ability in mastering science concept	96.7	0.0	3.3
Improved confidence/ability in taking test/doing tasks	96.7	1.0	3.3
Excellent technique to learn science	100.0	0.0	0.0
Helped make meaning out of equations/calculations	80.0	20.0	0.0
Did have grade motivation to do well on SNAPSHOTS	80.0	16.7	3.3

The learners expressed **optimistic and favorable attitudes and perceptions** toward the formative assessment tool.



# RESULTS

## SOP 3: Overall Experience/Perceptions towards SNAPSHOTS

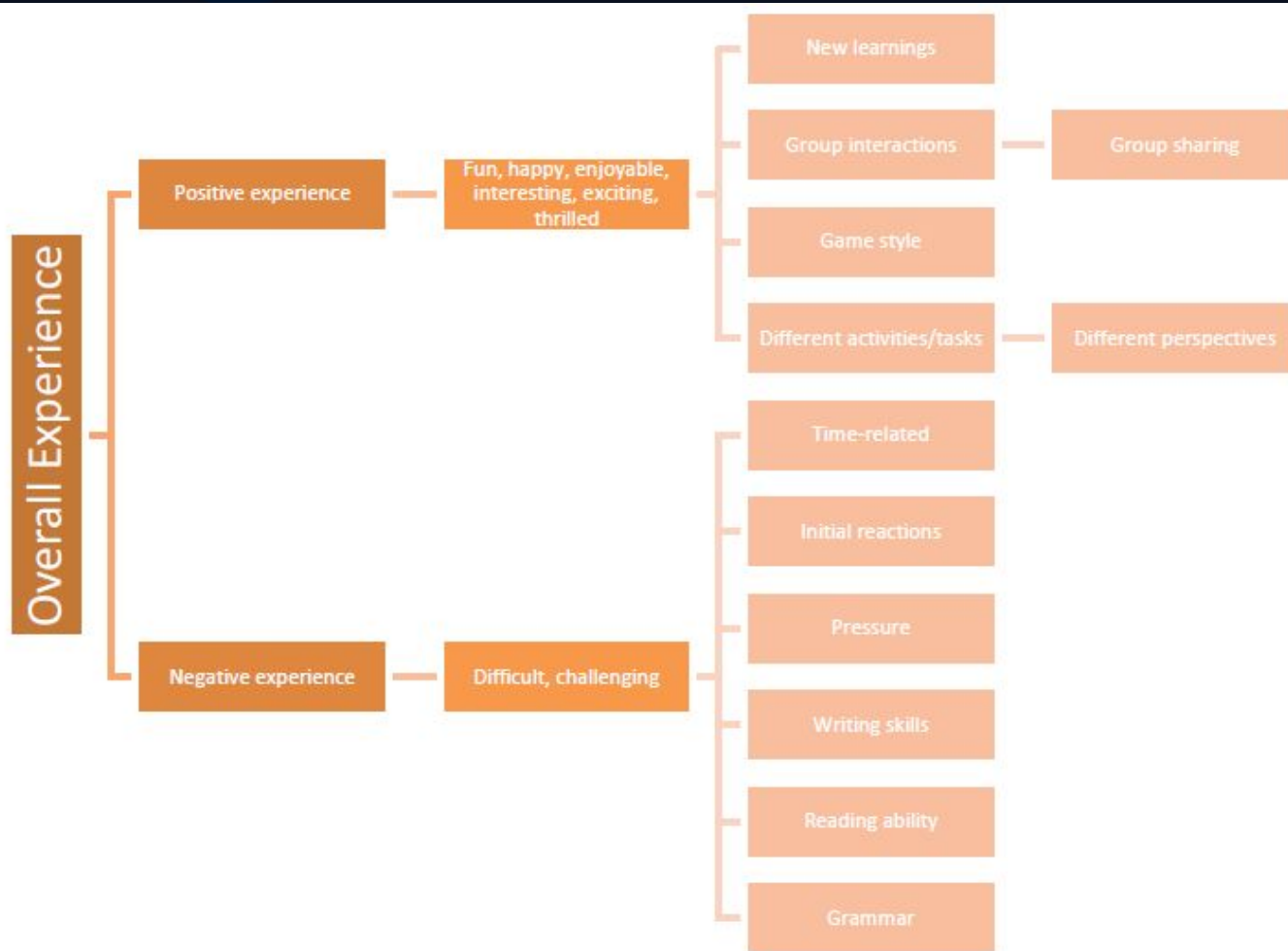


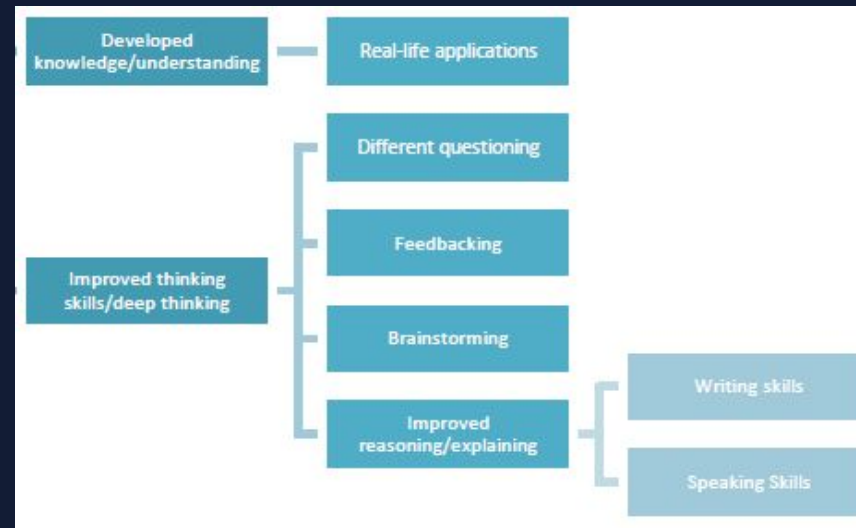
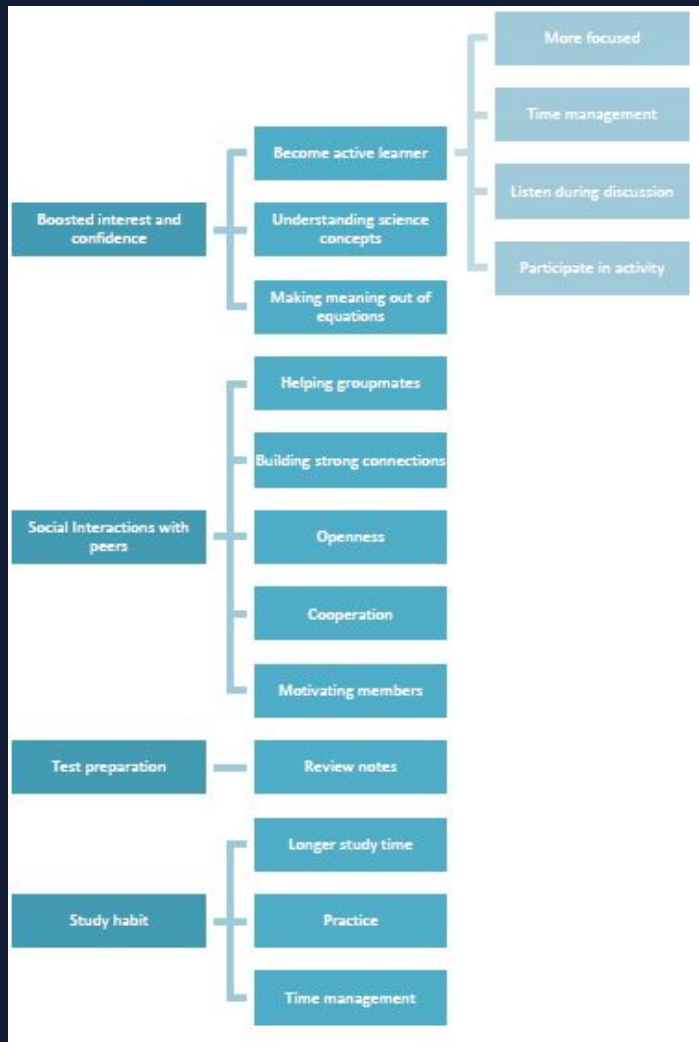
Figure 14. Learners' overall experience with SNAPSHOTS.

The learners have **mixed feelings of excitement, enjoyment, and being thrilled** with the SNAPSHOTS while others remarked that the tasks are also **difficult and challenging** especially as their initial reactions toward the task.

*“My experience in SNAPSHOTS was great. I enjoy the activity and the quizzes because it has a little thrill it has an enjoyable thrill. It just like a playing a game because of the group sharing the answer.”*

# RESULTS

## SOP 3: Overall Experience/Perceptions toward SNAPSHOTS



The perceived effects of the SNAPSHOTS include **developed knowledge and understanding, improved thinking skills, boosted interest and confidence, social interaction with peers, test preparation, and study habits.**

*“It is very useful for me because SNAPSHOTS improved my thinking skills. All the lessons in SNAPSHOTS are very fun, especially the group step. Brainstorming is very difficult but it's fun to do.”*



# CONCLUSIONS



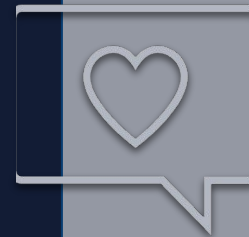
Embedding SNAPSHOTS in inquiry-based science instruction significantly improved cognitive learning outcomes.



The study supports formative assessment efficacy in fostering learning and conceptual understanding.



Results suggest enhanced achievement and reduced achievement gaps.



SNAPSHOTS positively influenced students' attitudes and perceptions toward science.

# RECOMMENDATIONS

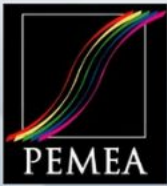
Science teachers should adopt and apply novel formative assessment techniques such as the SNAPSHOTS to enhance student learning as well as favorably affect their attitude and perceptions toward science learning.

Corrective Feedbacking created an effective classroom interaction that helped the students clarify and modify their conceptions.

Formative perspective of assessment in science teaching to produce learning gains and success.

Extend the use of SNAPSHOTS lessons across grade levels and across science areas in high school and senior high school.





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# Thank You!

**SCIENCE NOVEL ASSESSMENT ROBES SUPPORTING HIGHER-ORDER THINKING SKILLS (SNAPSHOTS): IMPACT ON LEARNERS' COGNITIVE LEARNING OUTCOMES**

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