WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Customizing Strategic Intervention Material Utilizing Cognitive Load Theory

Maritoni M. Fuentes, Dr. Elisa N. Chua*

Laguna State Polytechnic University – San Pablo City Campus, San Pablo City, Laguna, 4000, Philippines

Faculty, College of Teacher Education, Graduate Studies of Applied Research, Laguna State Polytechnic University – San Pablo City Campus, San Pablo City, Laguna, 4000, Philippines

A B S T R A C T

This study addresses the customization of a Cognitive Load Based Strategic Intervention for improving students' cognitive skills and basic science process skills. The study uses a cognitive load based strategic intervention material to improve cognitive skills and basic science process skills of students. The descriptive developmental research design is employed since a strategic intervention material was created. The respondents of the research are 90 Grade 8 students of three sections in Dayap National High School. Diagnostic Exam, Cognitive Load Survey Questionnaire, Pre-test and Post Test and Cognitive Load Based Strategic Intervention Material were created and pilot-tested for implementation. All the three sections answer a pre-test exam before the use of the SIM and to test if there is an improvement, a post test was given. A questionnaire survey on the use of SIM was also carried out to provide student feedback. Statistical analysis was done on results to identify how effective the SIM was. Results show that there is an improvement in the cognitive skills and basic science process skills since the post test score increases. The study shows that using a cognitive load based strategic intervention material is an effective tool in enhancing cognitive skills as well as the basic science process skills of students. Educators are suggested to develop SIMs based on the needs of the students to improve specific skills that the students needed.

Keywords: Cognitive Load Theory, Strategic Intervention Material, cognitive skills, basic science process skills

1. Introduction

The Philippine government implemented the K–12 Basic Education Program in stages. The program's ability to seamlessly integrate learning when it comes to science topics (spiral progression) is one of its most important features. Within the life sciences, physics, chemistry, and earth sciences, a variety of skills and knowledge are provided with complexity to better understand basic concepts. A spiral curriculum produces positive cognitive learning outcomes (Perez,2020).

Science education is a key component of the national educational system and is charged with giving students the knowledge and abilities they need to succeed in a world that is becoming more scientific and technological. Science education covers a variety of courses from elementary school through secondary school, according to the Department of Education's curriculum. By encouraging critical thinking, inquiry-based learning, and practical experimentation, this curriculum aims to give students a comprehensive understanding of a variety of scientific subjects (Dagasaan, 2022). Additionally, to guarantee its students' competitiveness on the worldwide scene, the Philippines has pledged to match its science education regulations with international norms.

The level of education in the Philippines is lower than in other nations, especially when it comes to science (Millanes et al., 2017; Rogayan Jr & Dollete, 2019). According to Schwab and Sala-i-Martín (2016), the World Economic Forum placed the Philippines 70th out of 144 participating nations in terms of the quality of scientific and math education. Results from the study made by trends in international mathematics and science studies indicated that the Science Process Skills proficiency of students in many countries is not satisfactory (Mullis et al., 2020).

According to the National Achievement Tests (NAT), the Third International Mathematics and Science Study (TIMSS), and the Second International Science Study (SISS), the Philippines performs poorly. With an average mean percentage score of 37.44 in Grade 10 NAT, the nation has the lowest score in DepEd's history. Only 23% of Filipino students achieved Level 2 or higher, the minimal level of proficiency in Science Literacy, in the Programmed for International Student Assessment (PISA) 2022, ranking the nation 77th out of 81 participating nations. Poor performance may be caused by low spending per student and pupils' unpreparedness for computer-based assessments.

Therefore, it is reasonable to search for strategies to enhance students' SPS. Several studies were executed on the strategies for the development of SPS, factors affecting the development of SPS, and the importance of SPS in the teaching and learning of science contents. This study focuses on reviewing strategies that exist in literature which are relevant for the development of SPS among students.

Because the Philippine education system is dealing with so many problems and difficulties, evaluating its performance is a difficult undertaking. The Philippines' abject bottom score on the Programme for International Student Assessment (PISA)—78/78 in 2018 and 77/81 in 2022—is one measure of the nation's basic education status (OECD PISA, 2018 and 2022).

Issues with students' level of expertise in science process skills are not limited to the Philippines; they also occur internationally. According to studies, a lot of students struggle with these abilities, which can make it difficult for them to learn science (Kuiper, 2018). This issue is especially severe in underdeveloped nations since there are fewer resources available for science education and instructors do not have the support or training, they need to properly teach science process skills (Abdullahi, 2019).

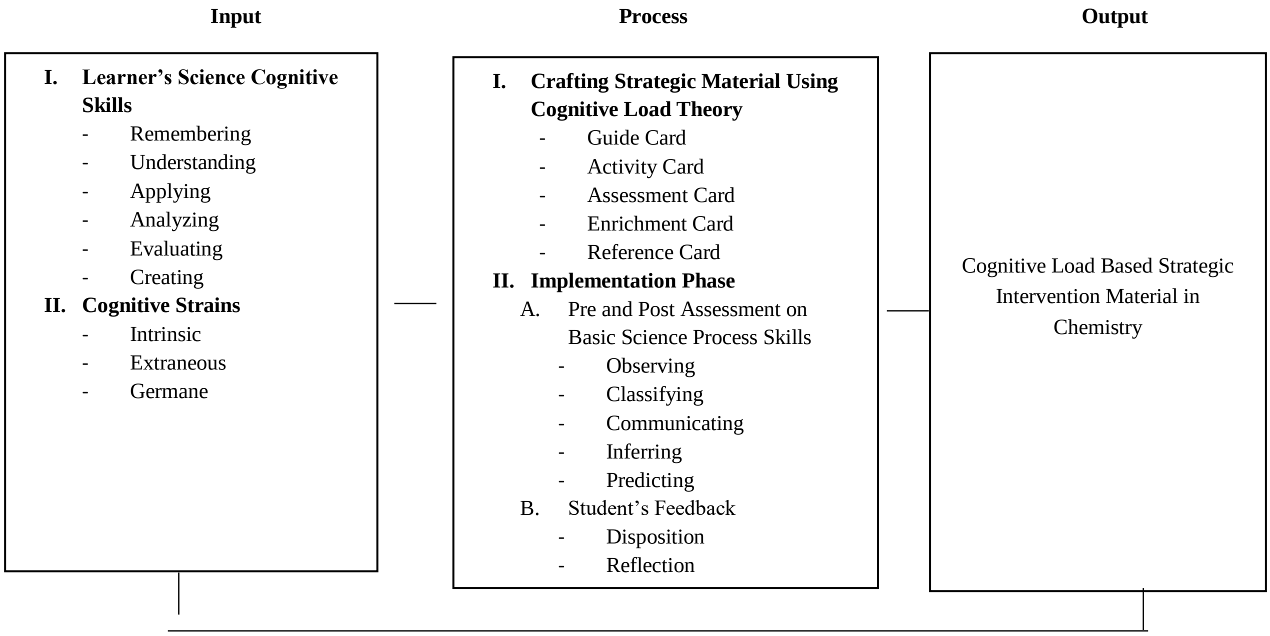

Figure 1: Research Framework

2. Research Problem

This study sought to answer the following questions:

1. What is the learner's science cognitive skills as to:

   1.1. remembering;

   1.2. understanding;

   1.3. applying;

   1.4. analyzing;.

   1.5. evaluating; and

   1.6. creating?

2. To what extent is cognitive strain experienced by the students as to:

   2.1. intrinsic;

   2.2. extraneous; and

   2.3. germane?

3. What is the pre- and post-test score of the students before and after expose to SIM as to:

3.1 observing;

3.2 classifying;

3.3 communicating;

3.4 inferring; and

3.5 predicting?

4. Is there a significant relationship in the experience cognitive strains and the basic science process skills of students?

5. Is there a significant difference in the pre and post-test scores of the students on the use of strategic intervention material?

6. What is the feedback of the students on the use of SIM based on their:

6.1 disposition; and

6.2 reflection?

3. Materials and Methods

The study utilized descriptive developmental research which is a type of research methodology that focuses on documenting and describing the patterns, characteristics, and changes in behaviour, skills, or abilities over time. (McCombes,2023) Through this approach, the researcher creates an instructional tool and track and describe patterns of improvement in students' abilities—such as cognitive skills and basic science process skills—across the stages of learning before and after the intervention.

The respondents are 90 Grade 8 students from three sections in Dayap National High School, this using a cognitive load based strategic intervention material to enhance the cognitive skills and basic science process skills of students. In this study, three sections answer a diagnostic test and a cognitive load survey to identify what topic and cognitive skills that will be used in the strategic intervention material. The topic was classified which is the development of the periodic table and periodic trends so from this, the researcher makes a cognitive load based strategic intervention material.

The following day, students answer a cognitive load-based questionnaire to know what cognitive strain is highly experienced and a pre-test assessment which is based on their basic science process skills. After that, students read the guide card and answer activities comprising every part of the strategic intervention material (Activity Card, Assessment Card and Enrichment Card). On the first day of answering the activity card, students finished Activity 1 by which they label the parts of an element specifically its properties. Activity 2, which they arrange the scientist who contributed to the development of the periodic table. And Activity 3 by which using the periodic table, they identify the group and period the elements belong.

The next day, students answer Activity 4 by answering the questions based on the illustration of the periodic table. On Activity 5, students analyze each statement and answer it if it is true or false, if false they need to modify it to make it correct. After answering the activity cards, students answer also the assessment card, by which they match the correct answer to column b. On the next day, students answer Enrichment Card 1 by giving the elements that can be found in the products given. And on Enrichment Card 2, they give 5 elements and its uses in our daily life. After that, they answer the reflection on the SIM. 4 To assess if there is an improvement with the students' performance, a post-test was administered, and a reflection and disposition questionnaire were also answered by the students.

The instruments used in the study was a 50-item multiple choice assessment that is based on student's cognitive skills (remembering, understanding, analyzing, applying, evaluating and creating) with corresponding table of specification. The mean score of cognitive skills was identified using the scale in Appendix B Section 2. A cognitive load questionnaire was also created which is composed of 5 indicators per cognitive strain (Intrinsic, Extraneous and Germane) to identify which cognitive strain was experienced by the students. Additionally, a 30-item pretest and posttest assessment were also created containing 6 multiple choice questions per basic science process skills. To improve the cognitive and basic science process skills of students, a strategic intervention material was created which is based on cognitive load theory. The strategic intervention material is composed of different parts, the guide card, activity card, assessment card, enrichment card and reference card. The guide card contains the lecture of the topic, the activity card is composed of 5 activities which has notes on the skills to be develop, the assessment card contains 1 activity and 2 activities for the enrichment card. Lastly, for the reflection of the students, a questionnaire was created which is composed of 5 questions for the reflection and 5 questions for their disposition. It was all created to evaluate the variable(s), or information on the effectiveness of Cognitive Load Based Strategic Intervention Material on the Cognitive Skills and Basic Science Process Skills of Grade 8 Students on Science. All the instruments were validated by Head Teacher and Master Teachers in Science, and it was submitted and consulted to the researcher's adviser.

Frequency distribution, mean and standard deviation was used for the scores in cognitive skills and basic science process skills. The respondents' perceptions of their cognitive strain experience were described using descriptive statistics like mean and standard deviation.

Significant relationships were tested at 5% level of significance and Pearson Product-Moment Correlation (Pearson r) is used to determine the relationship in the experience cognitive strains and the cognitive skills of students. Paired T-test were employed to determine if there is a significant difference between the pre-test and post-test scores.

4. Result and Discussions

Table 1

Frequency Distribution for Cognitive Skill as to Remembering

Score	Frequency	Percent	Verbal Interpretation
7-8	3	3.3	O
5-6	13	14.4	VS
3-4	54	60.0	S
1-2	17	18.9	NI
0	3	3.3	DME
Total	90	100.0	

Mean: 3.34 SD: 1.43 VI: Satisfactory

Scale: 7-8- Outstanding (O); 5-6-Very Satisfactory (VS); 3-4- Satisfactory (S); 1-2- Needs Improvement (NI); 0-Did Not Meet Expectations (DME)

Table 1 indicates that most pupils' cognitive abilities in terms of remembering are at a satisfactory level. These findings clarify how students are able to locate, recognize, and remember relevant details from scientific ideas. They showed the capacity to recall important concepts, such as definitions, information, and famous people related to subjects like matter, atomic structure, and the creation of the periodic table, when tested. Nonetheless, the information also shows that some students had trouble telling the difference between closely related scientific words.

The Strategic Intervention Material was created in response with the purpose of strengthening and enhancing students' memory recall. Activities like "LABEL ME," "MATCH IT," and "ELEMENTS IN MY LIFE" were used to use a variety of teaching techniques to address the remembering domain. Repetition, visual aids, and real-world connections are used in these activities to help students remember the material. Furthermore, the enrichment cards promote the application of recalled information to real-world situations, strengthening retention through engagement and relevance. Together, these techniques aid in the consolidation of fundamental knowledge, which is necessary to promote higher-order cognitive abilities in science education.

Students feedback supports this data, as several of them especially the scientists who worked on the periodic table's creation acknowledged having trouble remembering key specifics. Some students specifically mentioned in their disposition feedback that they needed to work on their language and recollection, while others raised concerns about their inability to comprehend and remember electron configurations. In the remembering domain, these self-reported difficulties are consistent with lower-tier performance and highlight the need for focused instructional help.

Table 2

Frequency Distribution for Cognitive Skill as to Understanding

Score	Frequency	Percent	Verbal Interpretation
7-8	1	1.1	O
5-6	19	21.1	VS
3-4	50	55.5	S
1-2	19	21.1	NI
0	1	1.1	DME
Total	90	100.0	

Mean: 3.53 SD: 1.39 VI: Satisfactory

Scale: 7-8- Outstanding (O); 5-6-Very Satisfactory (VS); 3-4- Satisfactory (S); 1-2- Needs Improvement (NI); 0-Did Not Meet Expectations (DME)

Table 2 shows the frequency distribution of students' performance in the cognitive skill of Understanding, where a majority scored within the Satisfactory level (score range 3–4), with a mean score of 3.53. This reveals that most students demonstrated a foundational grasp of scientific concepts and were able to construct meaning from various forms of representations, such as diagrams, models, and written content. They successfully identified states of matter, interpreted particle arrangements, and showed a basic understanding of the Periodic Law, including how elements are organized and the contributions of scientists like Mendeleev and Moseley.

This performance aligns with several student reflections that noted clearer understanding of how the periodic table evolved and how it is organized based on atomic number and chemical properties. After using the SIM, it effectively helped many students construct and internalize scientific ideas, particularly through historical context and logical progression.

However, the data also reveals that 21.1% of students fell within the Needs Improvement range, and 1.1% did Not Meet Expectations, indicating persistent difficulties with deeper conceptual aspects. Student disposition feedback supports this, as some learners admitted challenges in analyzing information, maintaining focus, and understanding complex concepts such as electron configuration and scientific relationships. These difficulties may have hindered their ability to fully interpret the implications of the Periodic Law or understand behavior at the molecular level, such as in gas laws explained by kinetic molecular theory.

To address these learning gaps, the Strategic Intervention Material (SIM) incorporated carefully structured activities, all aimed at deepening conceptual understanding. These tasks encouraged students to go beyond memorization by organizing knowledge through timelines, concept maps, and analogical thinking, helping them make meaningful connections.

In summary, while most students showed satisfactory understanding of key scientific concepts, the combined insights from performance data and student feedback shows that the SIM was successful in scaffolding learning through inquiry-based and visually supported activities. Nevertheless, further emphasis on differentiated instruction and extended conceptual practice may be needed to support students still struggling to fully interpret and explain scientific phenomena.

Table 3

Frequency Distribution for Cognitive Skill as to Applying

Score	Frequency	Percent	Verbal Interpretation
9-11	0	0.00	O
7-8	2	2.22	VS
5-6	11	12.22	S
3-4	46	51.1	NI
0-2	31	34.4	DME
Total	90	100.0	

Mean: 3.10 SD: 1.47 VI: Needs Improvement

Scale: 7-8- Outstanding (O); 5-6-Very Satisfactory (VS); 3-4- Satisfactory (S); 1-2- Needs Improvement (NI); 0-Did Not Meet Expectations (DME)

Table 3 presents the distribution of students' performance in the cognitive domain of Applying, with results indicating that the majority fell within the Needs Improvement category (score range 3–4). The mean score of 3.10 and standard deviation of 1.47 further confirm that most students struggled with transferring learned concepts to practical or unfamiliar contexts.

This difficulty was most evident when students were asked to identify properties of elements, such as determining good conductors based on their classification as metals or nonmetals. Many were unable to apply conceptual knowledge such as periodic trends or atomic structure to real-life materials and scenarios. Nonetheless, a smaller group of students performed within the Satisfactory level and demonstrated competency in procedural applications like calculating subatomic particles and interpreting atomic structure from provided data.

Student reflections and disposition feedback reinforce this interpretation. Several students noted that critical thinking and analysis were areas in need of development. These statements reveal students' awareness of their struggles in applying knowledge beyond rote learning. Similarly, difficulties in memorizing, time management, and focusing during independent work may have also impeded their ability to engage in higher-order thinking tasks.

In light of these challenges, the Strategic Intervention Material (SIM) was specifically designed to support students application skills through real-world, contextualized, and inquiry-based tasks. Activities were structured to simulate real-life decision-making, such as selecting materials based on properties or interpreting the use of elements in everyday products. These hands-on and reflective learning experiences encouraged students to bridge the gap between abstract knowledge and concrete application.

Student reflections provide promising evidence that the SIM had a positive influence. Some noted that the SIM's interactive format made learning fun and encouraged them to think and not just memorize, suggesting that the shift toward active engagement and context-based instruction was effective in fostering application.

In summary, while the data clearly indicates a need for improvement in the domain of applying knowledge, the alignment between the students' self-identified challenges and the SIM's targeted strategies suggests that the groundwork has been laid for growth. Continued exposure to application-based learning and explicit instruction on how to connect classroom content to real-world contexts will be crucial in elevating students' cognitive performance from procedural familiarity to functional scientific literacy.

Table 4

Frequency Distribution for Cognitive Skill as to Analyzing

Score	Frequency	Percent	Verbal Interpretation
8	0	0.00	O
6-7	9	10.00	VS
4-5	14	15.5	S
2-3	56	62.2	NI
0-1	11	12.2	DME
Total	90	100.0	

Mean: 2.91 *SD: 1.47* *VI: Needs Improvement*

Scale: 7-8- Outstanding (O); 5-6-Very Satisfactory (VS); 3-4- Satisfactory (S); 1-2- Needs Improvement (NI); 0-Did Not Meet Expectations (DME)

Table 4 presents the frequency distribution of students' performance in the cognitive domain of analyzing, revealing that most learners scored within the Needs Improvement range (score 2–3). The mean score of 2.91 and further reinforce that a significant portion of students struggled with analytical tasks. Only a small group demonstrated Satisfactory or Very Satisfactory performance, and none reached the Outstanding level.

These findings reveals that many students had trouble with examining relationships, organizing and interpreting scientific patterns, and distinguishing between relevant and irrelevant information. During assessment, students commonly misinterpreted scientific evidence or were distracted by scientifically correct but unrelated data. Confusion between closely related scientific terms and processes highlighted a blend of conceptual and procedural misunderstandings.

Student feedback and disposition data further affirm this challenge. Several students expressed a need to improve critical thinking and analysis skills. Some students noted difficulty in interpreting instructions and managing time effectively, which are key skills when breaking down complex tasks or identifying patterns across data sets core elements of analytical thinking.

Despite these challenges, a few students demonstrated the capacity to draw logical inferences and recognize limitations of scientific models, showing the potential for development with the right support. To address this, the Strategic Intervention Material (SIM) included scaffolded, analysis-focused activities specifically designed to help students compare, differentiate, and interpret scientific information. These included tasks involving the evaluation of periodic trends, distinguishing between element families, and critically examining scientific contributions through chronological and conceptual mapping.

Reflections on the SIM suggest that these activities encouraged deeper engagement. Some students commented that the exercises made them think and connected ideas better, which indicates that while analytical skills remain underdeveloped for many, the SIM is beginning to foster the necessary cognitive engagement to strengthen this domain.

In summary, the results indicate that students' performance in the Analyzing domain is an area of concern, with a large majority requiring further support. However, the design of the SIM featuring scaffolded tasks, structured comparisons, and interpretive exercises directly targets these gaps. Moving forward, continued emphasis on inquiry-based learning, frequent opportunities for data interpretation, and explicit teaching of analysis strategies will be essential to help students progress beyond superficial understanding and toward more complex cognitive engagement in science learning.

Table 5

Frequency Distribution for Cognitive Skill as to Evaluating

Score	Frequency	Percent	Verbal Interpretation
5	1	1.1	O
4	3	3.3	VS
3	7	7.8	S
1-2	68	34.4	NI
0	11	53.3	DME
Total	90	100.0	

Mean: 1.52 *SD: 0.99* *VI: Needs Improvement*

Scale: 7-8- Outstanding (O); 5-6-Very Satisfactory (VS); 3-4- Satisfactory (S); 1-2- Needs Improvement (NI); 0-Did Not Meet Expectations (DME)

Table 5 shows that student performance in the cognitive domain of Evaluating is notably low, with the majority falling into the Did Not Meet Expectations (DME) category. The mean score of 1.52 confirm that most students struggled significantly with higher-order thinking tasks related to making judgments, drawing conclusions, or defending decisions based on scientific evidence and reasoning.

The test results revealed that students found it particularly difficult to assess stability and predict properties of elements based on classification patterns within the periodic table. Errors commonly involved misinterpretation of related concepts, confusion between structural and compositional relationships, and failure to connect modern scientific knowledge with foundational or historical frameworks. Students who relied heavily on memorized facts appeared unable to apply those facts in a critical or comparative context, especially when evaluating scientific claims or principles.

These performance outcomes are closely aligned with the students' own reflections and reported dispositions. Several students openly identified challenges in critical thinking, analyzing, and memorization. These statements indicate a recognition of the gap between factual recall and evaluative reasoning—skills that are essential for scientific judgment and evidence-based decision-making.

To address this, the Strategic Intervention Material (SIM) incorporated targeted activities which demanded more than surface-level knowledge. These tasks challenged students to justify their answers, correct false statements, and explain scientific reasoning, thereby promoting critical evaluation in a scaffolded and supported way. Additionally, SIM activities that integrated real-world contexts, such as analyzing everyday uses of elements or assessing stability trends across groups and periods, helped situate evaluative thinking within meaningful applications.

Feedback from students indicates that the SIM's active and inquiry-based approach helped make abstract concepts more accessible. While many still showed limited success in evaluative tasks, some students demonstrated emerging skills in comparing properties and identifying observable patterns. This indicates that, although students are currently underperforming in this domain, the SIM's focus on guided reasoning, real-life relevance, and cognitive scaffolding is helping lay the foundation for growth.

In conclusion, the data illustrates that evaluating remains the most challenging cognitive skill for the students, but the thoughtful integration of evaluative reasoning into the SIM's structure provides a viable path forward. Continued emphasis on justification of responses, analysis of claims, and structured comparisons combined with reflection on thinking processes will be essential in developing students' scientific evaluation skills and elevating their overall cognitive performance in science education.

Table 6

Frequency Distribution for Cognitive Skill as to Creating

Score	Frequency	Percent	Verbal Interpretation
9-10	0	0.00	O
7-8	5	5.56	VS
5-6	16	17.78	S
3-4	56	62.22	NI
0-2	13	14.44	DME
Total	90	100.0	

Mean: 3.50 *SD: 1.46* *VI: Needs Improvement*

Scale: 7-8- Outstanding (O); 5-6-Very Satisfactory (VS); 3-4- Satisfactory (S); 1-2- Needs Improvement (NI); 0-Did Not Meet Expectations (DME)

Table 6 shows that students' performance in the creating domain is mostly at the Needs Improvement (NI) level, with 62.22% of students scoring within the 3–4 range. The mean score of 3.50 support this, indicating that while some students demonstrate moderate creative capacity, most experience difficulty in applying higher-order thinking skills such as synthesizing information, reorganizing concepts, and developing original ideas or solutions.

When the assessment was administered, a significant number of students struggled to group or classify elements according to observable and theoretical characteristics. Misunderstandings about periodic trends such as reactivity, density, and metallic character affected their ability to differentiate between element types, particularly between reactive and less reactive metals.

However, a minority of students showed emerging proficiency in organizing elements based on periodic trends, an indicator of conceptual application and creative problem-solving. These students demonstrated the capacity to use patterns and properties to construct new classifications—an essential component of scientific creativity.

Feedback from student reflections provides context for these outcomes. Several students admitted needing improvement in areas like focus, grammar, critical thinking, and memorization of scientific contributors skills that support the creation of scientifically sound outputs. These dispositions underline the importance of foundational cognitive skills that feed into the creative process.

To address these challenges, the Strategic Intervention Material (SIM) deliberately incorporated open-ended, real-life anchored activities which invited students to reflect on how scientific concepts apply in everyday situations. Such activities not only aimed to bridge the gap between abstract science and lived experience but also nurtured creativity by prompting learners to analyze, connect, and express scientific ideas in meaningful contexts. The SIM also used visual scaffolds and guided prompts to reduce cognitive overload, allowing students to engage more confidently in generative tasks.

While students ability to create remains underdeveloped, the SIM's design offers an effective framework to promote creative thinking. With continued practice in integrative thinking, concept reorganization, and real-world application, students can be gradually equipped to move from basic understanding to inventive, original engagement with science content advancing not only their knowledge but their ability to use it creatively and meaningfully.

Table 7

Extent of Cognitive Strain Experienced by Students as to Intrinsic Cognitive Load

Indicator	Mean	SD	Verbal Interpretation
1. The topics I study are naturally complex and challenging.	3.20	0.68	ME
1. 2. I often need additional resources (e.g., books, videos) to understand difficult topics.	3.33	0.70	ME
3. The concepts I study require a lot of effort to understand.	3.23	0.72	ME
4. I can relate new information to what I already know.	2.99	0.76	ME
5. The amount of information in a topic feels overwhelming.	2.98	0.82	ME
Mean	3.15	0.74	ME

Scale: 3.50-4.00 Highly Experienced (HE); 2.50-3.49 Moderately Experienced (ME); 1.50-2.49- Minimally Experienced (MIE); 1.0-1.49 Not Experienced (NE)

Table 7 presents the cognitive strain experienced by students in terms of Intrinsic Cognitive Load. With an overall mean score of 3.15, students are found to moderately experience intrinsic cognitive load. The highest mean score of 3.33 under indicator 2 which indicates that students are moderately dependent on supplemental learning materials. Many students expressed in their reflections that traditional classroom instruction alone was insufficient for them to grasp the nuances of complex topics like periodic trends, atomic structure, or the classification of matter.

This student disposition was a driving force in the design of the Strategic Intervention Material (SIM). The SIM was intended to act as both a primary and auxiliary instructional aid, addressing not only knowledge gaps but also cognitive strain by offering structured, focused, and visually rich content. Through engaging activities. students were guided through abstract ideas using visual aids, timelines, charts, and step-by-step inquiry tasks reducing mental load and enhancing understanding.

Interestingly, Indicator 5 recorded the lowest mean score of 2.98, still within the Moderately Experienced range. This reveals that while complexity of content is challenging, quantity is less of an issue. Students are generally capable of handling large volumes of information as long as it is well-organized and segmented. Reflections highlight their appreciation for chunked content delivery and visual organization, which are essential strategies in managing intrinsic cognitive load.

Additionally, Indicator 4 had a mean of 2.99. This implies that students are still developing their ability to connect prior knowledge with new scientific concepts, a crucial cognitive strategy for managing intrinsic load. Students' comments reflect the need for instructional materials like the SIM that provide relevant, contextualized learning experiences.

While the students cognitive levels are not so favorable and the cognitive strains are moderately experience, intrinsic load mirrors the complexity of the ideas students will be working with which in science subjects such as the periodic table or observation techniques can include working with multiple interrelated ideas at once. Because students are still building basic knowledge, the SIM was design to control intrinsic cognitive load by breaking up difficult information into manageable, step-by-step pieces that are less difficult to learn. This is done by concentrating on a single fundamental idea at a time, with good explanations, and examples that progressively increase in difficulty. Balancing carefully the intrinsic load enables learners to allocate their mental resources efficiently towards learning and comprehension, as opposed to getting overwhelmed down, which aids in their steady progress in cognitive functioning.

Overall, the data and student feedback reinforce the appropriateness of the SIM's design in minimizing unnecessary cognitive load while facilitating deeper comprehension. By prioritizing clarity, organization, interactivity, and relevance, the SIM serves as a bridge between content complexity and student capability transforming science learning from a cognitively overwhelming task into a more accessible and meaningful experience.

Table 8

Extent of Cognitive Strain Experienced by Students as to Extraneous Cognitive Load

Indicator	Mean	SD	Verbal Interpretation
1. I am often distracted by unrelated content while using the internet for studying.	2.83	0.78	ME
2. 2. The study materials or instructions I use are sometimes unclear or confusing.	2.86	0.74	ME
3. My club activities sometimes conflict with my study schedule.	2.37	0.98	ME
4. Social media usage affects my ability to focus while studying.	2.83	0.75	ME
5. My study environment (e.g., noise level) makes it difficult to concentrate.	3.01	0.85	ME
Mean	2.78	0.82	ME

Scale: 3.50-4.00 Highly Experienced (HE); 2.50-3.49 Moderately Experienced (ME); 1.50-2.49- Minimally Experienced (MIE); 1.0-1.49 Not Experienced (NE)

Table 8 shows the result of the extraneous cognitive strain which has an overall mean of 2.78 and it is moderately experience by students. The highest mean score was given to indicator 5 which states that their study environment makes it difficult for them to concentrate. In school, classrooms can be noisy due to external factors like chatter from peers, sounds from adjacent rooms, or general classroom activity. This disrupts students' ability to focus on the material being taught, leading to difficulty in processing and retaining information.

In response, the Strategic Intervention Material (SIM) was intentionally designed to minimize extraneous cognitive load and enhance students' focus during learning activities. The SIM provides clear, step-by-step instructions, visually organized content, and well-structured activity cards that guide students through tasks with minimal confusion. By presenting content in a clean, intuitive layout—using color-coded sections, boxed definitions, and visual references—the SIM eliminates unnecessary visual or cognitive clutter that could overwhelm or distract learners.

Additionally, indicator 1 (mean = 2.83) and indicator 4 (mean = 2.83) show that internet distractions and social media are also moderate contributors to extraneous cognitive load. Since many students may use online resources to supplement learning, they are often prone to drifting away from academic tasks. To counter this, the SIM was developed as an offline, printed or teacher-facilitated resource, eliminating the need for continuous internet use and reducing exposure to online distractions. This ensures students can concentrate fully on their learning tasks without competing digital stimuli.

On the other hand, club activities conflicting with study schedules received the lowest mean of 2.37, which still borders on "moderately experienced" but indicates a relatively less frequent source of cognitive interference compared to digital and environmental distractions. Since Dayap National High School proposes different club activities, sports or other extracurricular every month, some of the students lead to a packed schedule that leaves them with limited time for academic work.

When taking into consideration extraneous cognitive moderately experienced by students with not so favorable cognitive levels and average cognitive limitations, the Strategic Intervention Material (SIM) was concentrated on reducing unnecessary mental effort due to the way information is displayed as opposed to its content. To minimize this burden, the SIM was developed with simple, clear explanations,

effective layouts, and pertinent visuals that serve the learning needs directly. Through reducing unnecessary load, the SIM ensures students' cognitive resources are spent on meaningful learning instead of struggling with confusing or distracting information, hence enhancing overall understanding and engagement.

In summary, the moderate level of extraneous cognitive strain reported by students underscores the importance of well-designed instructional materials. The SIM effectively responds to this need by offering structured, distraction-free, and visually clear content that minimizes unnecessary mental effort, helping students focus more efficiently on learning science concepts.

Table 9

Extent of Cognitive Strain Experienced by Students as to Germane Cognitive Load

Indicator	Mean	SD	Verbal Interpretation
1. I frequently relate what I learn in school to real-life situations.	3.19	0.79	ME
3. 2. My club activities help me develop skills relevant to my studies.	2.91	0.93	ME
3. I use study techniques (e.g., summarizing, note-taking) to improve my understanding.	3.19	0.80	ME
4. The internet provides useful tools (e.g., videos, forums) that support my learning.	3.18	0.78	ME
5. I enjoy exploring new ways to apply my knowledge outside the classroom.	3.11	0.80	ME
Mean	3.12	0.82	ME

Scale: 3.50-4.00 Highly Experienced (HE); 2.50-3.49 Moderately Experienced (ME); 1.50-2.49- Minimally Experienced (MIE); 1.0-1.49 Not Experienced (NE)

Table 9 indicates that students moderately experience germane cognitive strain with an overall mean of 3.12. These results indicate that students are engaged in processing, understanding, and integrating new information into their existing knowledge. The highest mean score which is 3.19 are seen in items that likely reflect tasks requiring sustained mental effort or complex understanding.

The strategic intervention material appears to effectively support germane cognitive load by providing well-structured content and interactive activities—such as those found in the activity card, assessment card, and enrichment card—that promote meaningful learning. This approach encourages students not only to receive information but also to actively process and organize it, helping them form meaningful connections between new concepts and prior knowledge.

Concerning germane cognitive load, or the cognitive effort applied to processing, building, and automating knowledge, students with less favorable cognitive abilities and moderate cognitive limitations need strategic assistance to achieve meaningful learning. For this, the Strategic Intervention Material (SIM) was specifically devised to facilitate deeper thinking and understanding, not mere rote memorization. These help students actively reorganize and incorporate new material into what they already know. As the students are already putting in moderate effort, the SIM needs to present just enough challenge to induce useful thinking without inducing overload. Prompting students to justify their solutions, contrast ideas, or use knowledge in diverse contexts assists in reinforcing the learners' cognitive structures.

Table 10

Frequency Distribution of Pre and Post Test Score for Basic Science Process Skill as to Observing

Score	**Pre Test**		**Post Test**		**Verbal Interpretation**
	Frequency	Percent	Frequency	Percent	
6	2	2.2	7	7.8	O
5	9	10.0	12	13.3	VS
3-4	25	27.8	43	47.8	S
1-2	44	48.9	25	27.8	NI
0	10	11.1	3	3.3	DME
Total	90	100.0	90	100.0	

Mean: 2.34 SD:1.49 VI: Needs Improvement Mean: 3.27 SD: 1.51 VI: Satisfactory

Scale: 6- Outstanding (O); 5-Very Satisfactory (VS); 3-4- Satisfactory (S); 1-2- Needs Improvement (NI); 0-Did Not Meet Expectations (DME)

Table 10 shows the pretest and post-test score of students for basic science process skills as to observing. Based on the mean scores, students initially demonstrated a "Needs Improvement" level of performance during the pre-test with a mean of 2.34. However, after using the strategic intervention material, their performance increased to a "Satisfactory" level with a mean of 3.27. In the pre-test, a large portion of the students (48.9%) were classified under "Needs Improvement", and 11.1% did not meet expectations. However, after the implementation of the SIM, the percentage of students in the "Satisfactory" category increased to 47.7%, while those in the "Needs Improvement" and "Did Not Meet Expectations" categories decreased notably. Additionally, more students reached the higher performance levels of "Very Satisfactory" and "Outstanding".

Observing as a science process skill aligns most closely with the understanding level and begins to move toward applying when students use their observations to describe phenomena or make simple classifications. However, the pre-test results where 48.9% of students scored only 1–2 and 11.1% scored 0 which reveals that many were unable to consistently make accurate or meaningful observations, implying difficulty even at the lower cognitive levels. Without mastery of observing skills at the understanding and applying levels, students are unlikely to progress analyzing or evaluating, where they would be expected to compare observations, recognize relationships, or draw conclusions from patterns in data.

With this, the SIM activities are designed to enhance observation skills through tasks that require close attention to detail and visual analysis. For instance, students identify and label the parts of the periodic table entry for Calcium, which demands focused observation. They also examine pictures to identify elements present in various products, engaging their visual observation and prior knowledge. These exercises effectively contributed to the observed improvement in students' ability to observe scientific phenomena, as reflected in the post-test scores.

In their feedback, students emphasized how the SIM helped them better understand the periodic table through activities that encouraged visual analysis and attention to detail. For instance, tasks like identifying the parts of a periodic table entry or examining images to recognize elements in products required focused observation skills that are essential to scientific inquiry. Additionally, the students' positive dispositions such as being attentive, following instructions, and asking questions for clarification also contributed to this development. While some students acknowledged areas for improvement, particularly in maintaining focus and critical thinking, the overall progress in post-test scores suggests that the SIM effectively addressed previous challenges in observation skills and fostered a more focused and engaged learning environment.

Table 11

Frequency Distribution of Pre and Post Test Score for Basic Science Process Skill as to Classifying

Score	**Pre Test**		**Post Test**		**Verbal Interpretation**
	Frequency	Percent	Frequency	Percent	
6	2	2.2	6	6.7	O
5	3	3.3	9	10.0	VS
3-4	31	34.5	46	51.1	S
1-2	46	51.1	29	32.2	NI
0	8	8.9	0	0.00	DME
Total	90	100.0	90	100.0	

Mean: 2.23 SD:1.33 VI: Needs Improvement Mean: 3.17 SD: 1.32 VI:Satisfactory

Scale: 6- Outstanding (O); 5-Very Satisfactory (VS); 3-4- Satisfactory (S); 1-2- Needs Improvement (NI); 0-Did Not Meet Expectations (DME)

Table 11 shows the pretest and post-test score of students for basic science process skills as to classifying. Based on the mean scores, students initially demonstrated a "Needs Improvement" level of performance during the pre-test with a mean of 2.23. However, after using the strategic intervention material, their performance increased to a "Satisfactory" level with a mean of 3.17. During the pre-test, majority of the students (51.1%) scored within the 1–2 range, while 8.9% of them did not meet expectations. Only a small number achieved higher levels of performance, with just 2.2% reaching the "Outstanding" level and 3.3% achieving "Very Satisfactory". In contrast, the post-test results reflect significant gains on the number of students performing at higher levels, with 10.0% achieving "Very Satisfactory" and 6.7% reaching "Outstanding". The proportion of students in the "Satisfactory" category rose from 34.5% to 51.1%, while those needing improvement dropped from 51.1% to 32.2%. Notably, no students remained in the "Did Not Meet Expectations" category.

From a cognitive standpoint, classifying corresponds primarily to the understanding and applying levels of Bloom's Taxonomy. At the understanding level, students are expected to compare and contrast items based on observable characteristics, while at the applying level, they use this knowledge to group or sort information according to specific criteria. The low pre-test performance indicates that many students had difficulty engaging with these tasks, often relying on surface-level knowledge without being able to apply it effectively in novel contexts. This limited their progression to higher-order cognitive skills such as analyzing, which would require them to examine classification systems or justify groupings based on properties or patterns.

The SIM activities that likely contributed to this include tasks where students organize information such as scientists and their contributions in chronological order an exercise requiring grouping based on time and nature of work. Additionally, matching terms with their correct definitions or associations helped students practice sorting and categorizing based on familiar characteristics. These activities support the development of the classifying skill and are reflected in students' improved post-test performance.

This progress aligns with feedback gathered through student reflections and dispositions. Several students noted that the SIM helped them better understand the structure and development of the periodic table, a task inherently tied to classifying elements based on properties, groups, and periods.

Table 12

Frequency Distribution of Pre and Post Test Score for Basic Science Process Skill as to Communicating

Score	Pre Test		Post Test		Verbal Interpretation
	Frequency	Percent	Frequency	Percent	
6	4	4.4	3	3.3	O
5	2	2.2	13	14.4	VS
3-4	30	33.3	51	56.6	S
1-2	48	53.3	23	25.6	NI
0	6	6.7	0	0.00	DME
Total	90	100.0	90	100.0	

Mean: 2.30 SD:1.53 VI: Needs Improvement Mean: 3.28 SD: 1.25 VI: Satisfactory

Scale: 6- Outstanding (O); 5-Very Satisfactory (VS); 3-4- Satisfactory (S); 1-2- Needs Improvement (NI); 0-Did Not Meet Expectations (DME)

Table 12 shows the pretest and post-test score of students for basic science process skills as to communicating. Based on the mean scores, students initially demonstrated a "Needs Improvement" level of performance during the pre-test with a mean of 2.30. However, after using the strategic intervention material, their performance increased to a "Satisfactory" level with a mean of 3.28. In the pre-test, students had a mean score of 2.30, which falls under the "Needs Improvement" category. A large portion of the students (53.3%) scored in the 1–2 range, indicating that many had difficulty clearly expressing their observations or scientific understanding. Additionally, 6.7% of the students scored 0, showing they did not meet expectations at all. After the implementation of the SIM, more than half of the students (56.6%) scored in the 3–4 range, demonstrating improved ability to organize and share scientific ideas effectively. The number of students achieving higher performance levels also increased, with 14.4% reaching "Very Satisfactory" and 3.3% achieving an "Outstanding" score. Importantly, no students remained in the "Did Not Meet Expectations" group.

Communicating aligns primarily with the understanding and applying levels. At the understanding level, students are expected to summarize, describe, or explain scientific concepts in their own words. At the applying level, they should be able to present data, construct arguments, and share findings in coherent and relevant ways. The pre-test scores reveals that most students were functioning below these levels, often unable to restate or represent scientific ideas meaningfully, which hindered their ability to engage in deeper cognitive tasks like analyzing or evaluating.

Based on this, the activities in the SIM let students to clearly rewrite and explain corrected statements, as well as describe the everyday uses of certain elements. These tasks help strengthen their basic science process skills, particularly in communicating, by encouraging them to express scientific ideas accurately and meaningfully. As a result, these activities contribute to their improved performance in answering related questions in the post-test. The SIM includes activities that require students to rewrite and explain corrected statements clearly and describe everyday uses of certain elements. These tasks support the enhancement of communicating skills by encouraging students to express scientific ideas accurately and meaningfully. Such engagement likely contributed to the improved post-test scores in communicating scientific knowledge.

Student reflections and dispositions also provide insight into this improvement. Many students expressed that the SIM helped them understand the material more clearly and encouraged them to actively participate. Positive dispositions further demonstrate students' growing confidence and willingness to communicate and clarify their understanding.

Table 13

Frequency Distribution of Pre and Post Test Score for Basic Science Process Skill as to Inferring

Score	Pre Test		Post Test		Verbal Interpretation
	Frequency	Percent	Frequency	Percent	
6	1	1.1	8	8.9	O
5	3	3.3	15	16.7	VS
3-4	32	35.5	47	52.2	S
1-2	43	47.8	16	17.8	NI
0	11	12.2	4	4.4	DME
Total	90	100.0	90	100.0	

Mean: 2.14 SD:1.36 VI: Needs Improvement Mean: 3.53 SD: 1.51 VI: Satisfactory

Scale: 6- Outstanding (O); 5-Very Satisfactory (VS); 3-4- Satisfactory (S); 1-2- Needs Improvement (NI); 0-Did Not Meet Expectations (DME)

Table 13 presents the results for the inferring science process skill. In the pre-test, it has a mean of 2.14 and a standard deviation of 1.36 which is interpreted as poor. Nearly half of the students (47.8%) were in the "Needs Improvement" category, while an additional 12.2% scored 0, meaning they did not meet expectations at all. Only 1.1% of students achieved an "Outstanding" score, and 3.3% reached the "Very Satisfactory" level and about 35.5% were rated "Satisfactory", which still indicates a basic level of competence in the skill. In the post-test, the mean rose to 2.14 interpreted as good. The "Needs Improvement" group dropped significantly to 17.8%, and the "Did Not Meet Expectations" group decreased to just 4.4%. At the same time, the number of students achieving "Satisfactory" scores rose to 52.2%. Furthermore, there was a substantial increase in higher-performing students: 8.9% reached the "Outstanding" level and 16.7% scored "Very Satisfactory", compared to only 1.1% and 3.3% respectively in the pre-test.

Inferring lies at the analyzing level, where students are expected to distinguish between relevant and irrelevant information, identify relationships, and draw conclusions based on evidence. This skill also involves elements of evaluating, especially when students are required to justify corrections or assess the validity of a scientific claim. The low pre-test scores reveals that most students had difficulty reaching these higher-order thinking skills, remaining limited to lower levels such as Remembering or Understanding, where inference is not yet required.

In the SIM, students infer the correct group and period based on the element's position on the periodic table, drawing conclusions from their understanding of the table's structure. They also identify errors in statements and justify corrections. Additionally, students determine how elements relate to their functions. in their post test score. The SIM activities designed to enhance inferring skills included tasks such as determining the correct group and period of an element based on its position in the periodic table, identifying errors in statements and justifying corrections, and relating elements to their functions. These exercises encourage students to draw logical conclusions and make informed inferences, which are reflected in their improved post-test scores.

This growth is also reflected in the students' reflections and dispositions. Many students noted that the SIM helped them better understand how elements are organized and how their properties relate to their position in the periodic table. Furthermore, student dispositions show a shift toward more reflective and independent thinking. For instance, some recognized their need to enhance critical thinking and improve their focus during independent work, which are key aspects of developing inference skills.

Table 14

Frequency Distribution of Pre and Post Test Score for Basic Science Process Skill as to Predicting

Score	Pre Test		Post Test		Verbal Interpretation
	Frequency	Percent	Frequency	Percent	
6	1	1.1	3	3.3	O
5	2	2.2	13	14.4	VS
3-4	27	29.9	47	52.2	S
1-2	49	43.5	25	27.8	NI
0	11	12.2	2	2.2	DME
Total	90	100.0	90	100.0	

Mean: 2.07 SD:1.25 VI: Needs Improvement Mean: 3.14 SD: 1.39 VI: Satisfactory

Scale: 6- Outstanding (O); 5-Very Satisfactory (VS); 3-4- Satisfactory (S); 1-2- Needs Improvement (NI); 0-Did Not Meet Expectations (DME)

Table 14 shows the results for the basic science process skill as to predicting which shows a significant improvement from the pre-test to the post-test. In the pre-test, it has a mean of 2.07 and a standard deviation of 1.25 interpreted as poor. A large portion of students (43.5%) scored within the "Needs Improvement" range, and 12.2% of students did not meet expectations (score of 0), showing that more than half of the class struggled with making accurate scientific predictions. Only 1.1% of students achieved an "Outstanding" score, and 2.2% were "Very Satisfactory". In contrast, the post-test has a mean of 3.14 and a standard deviation of 1.39 The number of students in the "Needs Improvement" category dropped to 27.8%, and those who did not meet expectations fell to only 2.2%. At the same time, there was a significant increase in higher scores: 52.2% of students achieved a "Satisfactory" score, and those scoring "Very Satisfactory" jumped to 14.4%. Notably, the percentage of students achieving "Outstanding" performance increased to 3.3%, showing that some students mastered the skill.

Predicting aligns with the applying and analyzing levels. Students must use learned concepts (like trends in the periodic table or chemical reactivity) to forecast possible outcomes, which requires the application of knowledge in new contexts and the analysis of patterns or trends. The low pre-test scores show that most students were operating at lower cognitive levels remembering or understanding where recall and comprehension do not yet translate into prediction-making.

When answering the activities in the SIM, students analyze trends in reactivity and use that knowledge to predict the order or properties of elements. Additionally, they locate elements, which involves observing and interpreting data. The SIM includes activities where students analyze trends in elemental reactivity and use this knowledge to predict properties and order of elements. They also engage in locating elements on the periodic table by observing and interpreting data. These tasks enhance students' ability to make accurate scientific predictions, which is reflected in their improved post-test performance.

Many expressed that the SIM helped them connect concepts like atomic number and chemical properties, making the periodic table more understandable and less reliant on memorization. Furthermore, students also acknowledged areas for personal growth, such as enhancing critical thinking and time management, both of which are essential for making accurate predictions in scientific tasks.

Table 15

Test of correlation between cognitive strains experienced by students and their basic science process skills

Cognitive Strain	**Basic Science Process Skills**				
	Observing	Classifying	Inferring	Predicting	Communicating
Intrinsic	0.195	0.242	0.202	-0.074	0.204
Extraneous	-0.110	-0.033	-0.223	-0.175	-0.064
Germane	0.128	0.085	0.193	0.131	0.062

Table 15 presents the correlation coefficients between three types of cognitive strain intrinsic, extraneous, and germane and the basic science process skills. These correlations help elucidate how different types of cognitive load influence students' engagement with fundamental scientific thinking skills, especially in the context of strategic interventions in science education.

Although the correlations between cognitive strains and basic science process skills were generally weak and not statistically significant, there was still a clear improvement in students' performance from the pre-test to the post-test. This indicates that learning occurred even without a strong direct relationship between the types of cognitive strain and the specific skills being measured. One possible explanation is that students became more familiar with the test format and content over time, allowing them to perform better during the post-test. Additionally, the intervention itself may have been effective in guiding students toward better understanding and application of science process skills, even if the impact was not directly measurable through correlation. It's also possible that the improvement was due to a combination of increased focus, repeated practice, and better engagement with the material.

According to Leppink et al. (2015), learning can still progress effectively when instructional materials are structured in a way that reduces extraneous cognitive load and promotes germane processing, even if cognitive load does not significantly correlate with immediate performance measures. In the present study, the strategic intervention material may have fostered such processing by focusing attention on essential learning elements and minimizing distractions.

Moreover, improvements in post-test scores could be influenced by test familiarity and repeated exposure, which enhance recall and application skills without necessarily being tied to load measures (Van Merriënboer & Sweller, 2018). This aligns with the perspective of Ayres and Paas (2020), who emphasize that instructional design has a delayed but measurable impact on learning efficiency and cognitive resource allocation. Thus, the observed improvements likely reflect a combination of meaningful learning, practice effects, and optimized cognitive conditions, even if statistical correlations were not significant.

Overall, the results suggest that while the relationship between cognitive strain and skill development may not be strong, students can still show progress when provided with structured learning experiences and opportunities to reinforce their understanding.

Table 16

Test of significant difference in the pre and post-test of the students on the use of strategic intervention material

Basic Science Process Skills	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
				Lower	Upper			
Observing	.922	1.630	.172	.581	1.264	5.368	89	.000
Classifying	.933	1.585	.167	.601	1.265	5.586	89	.000
Inferring	1.389	1.404	.148	1.095	1.683	9.386	89	.000
Predicting	1.078	1.588	.167	.745	1.410	6.438	89	.000
Communicating	.978	1.709	.180	.620	1.336	5.428	89	.000
Pretest – Post-test	5.300	3.310	.349	4.607	5.993	15.192	89	.000

Table 16 shows the results of the paired samples t-test reveal a statistically significant difference between the pre-test and post-test scores of students across all Basic Science Process Skills. Each BSPS component observing, classifying, inferring, predicting, and communicating showed a positive mean difference, indicating improvement in post-test scores.

The mean difference in students' scores on observing skills is 0.922, with a t-value of 5.368 and a Sig. (2-tailed) value of 0.000, indicating a highly significant improvement. The 95% confidence interval ranges from 0.581 to 1.264, suggesting that the true mean difference is consistently above zero. While in classifying, the mean difference is 0.933, with a t-value of 5.586 and a Sig. (2-tailed) value of 0.000. This again indicates a statistically significant improvement after the intervention. The confidence interval (0.601 to 1.265) confirms that the SIM helped students improve their ability to group and categorize data meaningfully, a crucial process skill in science learning. With the highest mean difference of 1.389, inferring shows substantial improvement, supported by a strong t-value of 9.386 and a Sig. (2-tailed) value of 0.000. The confidence interval (1.095 to 1.683) lies well above zero, indicating high confidence in the result. This demonstrates that the SIM effectively enhanced students' skills in making logical conclusions and interpretations based on evidence.

Students showed a mean gain of 1.078 in predicting, with a t-value of 6.438 and a Sig. (2-tailed) of 0.000. The confidence interval (0.745 to 1.410) suggests a consistent and reliable gain. This indicates that the SIM significantly improved students' ability to make forecasts based on trends and data patterns, an essential skill for scientific inquiry.

For communicating, the mean difference is 0.978, the t-value is 5.428, and the Sig. (2-tailed) is 0.000, with a confidence interval ranging from 0.620 to 1.336. This reveals a significant improvement in students' ability to express and explain scientific information clearly.

The overall gain across all basic science process skills shows a mean difference of 5.300, a very high t-value of 15.192, and a Sig. (2-tailed) of 0.000, with a tight confidence interval (4.607 to 5.993). This confirms that the SIM had a statistically significant and substantial positive impact on the students' performance in all measured process skills. These results demonstrate that the SIM successfully enhanced students' science process skills. This is consistent with the findings of Leppink et al. (2017), who emphasized that instructional materials aligned with CLT can significantly improve learners' problem-solving abilities and conceptual understanding by managing cognitive demands efficiently.

Additionally, Adebayo and Shonowo (2020) found that targeted instructional materials, particularly those that are interactive and student-centered, lead to significant gains in science achievement by enhancing students' cognitive engagement and hands-on learning. These materials allow learners to actively construct knowledge through observation, classification, and inference skills that improved substantially in this study.

The SIM's success can be attributed to its alignment with the principles of Cognitive Load Theory (CLT), which emphasizes the importance of reducing unnecessary cognitive demands and structuring information in a way that supports learning. By focusing on specific BSPS, the SIM allowed learners to actively construct knowledge through concrete, hands-on tasks and interactive content. For example, observing and classifying tasks likely helped students practice noticing details and organizing information, while inferring and predicting activities required them to apply reasoning and logic based on patterns or evidence.

In summary, the significant increase in BSPS from pre- to post-test validates the effectiveness of the SIM and affirms that cognitively informed instructional strategies can positively influence students' scientific thinking and performance. These findings highlight that cognitively informed, process-skill-oriented interventions can play a crucial role in strengthening students' scientific thinking and performance. The strategic design of the SIM, grounded in CLT and targeted toward specific process skills, provided structured and meaningful learning experiences that led to measurable academic gains.

Table 17

Verbatim Feedback for Students Reflection

Emerging Theme	Verbatim Feedback
Factual Recognition	"The periodic table evolved from atomic mass to atomic number."
	"Mendeleev predicted elements by spotting patterns."
	"Moseley improved the table using atomic number."
	"Element symbols are challenging to memorize."
Conceptual Familiarity	"I learned how the periodic table evolved through scientific discoveries."
	"The SIM showed me the link between atomic number and properties."
	"The SIM clarified how elements are arranged and grouped."
	"Learning its history showed me that science keeps improving."

Active Learning	"The SIM helped me remember through fun activities and examples."
	"Practice exercises helped me recall groups and periods easily."
	"The SIM made me think, not just memorize, through engaging exercises."

Table 17 reveals the students' reflections which shows a progression in their learning, beginning with factual recognition and advancing toward deeper conceptual understanding and active engagement. Initially, students demonstrated clear recall of specific facts about the periodic table, such as its historical development and key contributors like Mendeleev and Moseley. Many students showed a deepened appreciation for the evolution of the periodic table, noting how it transitioned from being organized by atomic mass to atomic number. This indicates that the SIM successfully highlighted the dynamic nature of scientific knowledge. They recognized Mendeleev's predictive work and Moseley's refinement of the table, suggesting that historical context was effectively integrated into instruction. However, some also mentioned the difficulty of memorizing element symbols, suggesting that while factual knowledge was acquired, it still posed certain challenges.

Building on this foundation, students expressed a growing conceptual familiarity with the periodic table. Their reflections show that the SIM facilitated an understanding of how the table is structured and why it is organized in a particular way. Through the integration of historical context and scientific development, students were also able to appreciate the evolving nature of scientific knowledge and how discoveries shape our understanding over time. Others noted how the historical evolution of the periodic table helped them appreciate the dynamic nature of science. This indicates that the SIM was effective not only in presenting information but also in fostering deeper comprehension.

This deeper understanding was reinforced through active learning, as students highlighted the value of the SIM's interactive components. Activities and practice exercises were frequently mentioned as effective tools that made learning more engaging and enjoyable. The ability to recall concepts like groups and periods even after the lesson indicates that active learning not only enhanced engagement but also supported long-term retention. Overall, the students' feedback reflects a learning experience that progressed from acquiring factual knowledge to developing conceptual clarity through meaningful and engaging activities facilitated by the SIM.

Table 18

Verbatim Feedback for Student Disposition

Positive Disposition	**Negative Disposition**
Helping my classmates when they are struggling.	I need to enhance my critical thinking skills to analyze information.
I actively listen to the instructions and answer the activities.	I need to improve my focus during independent work and avoid distraction.
Always listening to my teacher for instructions in answering the activities.	I need to improve in memorizing specifically the persons who contributed in the arrangement of the periodic table.
Being quiet and listening to the teacher so that I can understand better.	I need to improve on my grammar specially for those activities that needs explanation.
Paying attention to the teacher and engaging with the material being discussed.	I need to enhance critical thinking skills to analyze information and developed conclusions.
Answering the activities based on the instructions given by my teacher.	I need to improve on my time management skills to complete the activities on time.
I participated actively and listened attentively.	Listening carefully to instructions to answer activity sheets correctly.
Reading the instructions to answer the activity sheets correctly.	I need to improve my memorizing skills since there are persons involved in the development of the periodic table.
I asked questions if I needed clarifications.	Practicing my grammar to answer questions.
Being focus helps me learn better and helps my classmates stay engaged.	Understanding electron configuration was a bit challenging.

Table 18 shows the verbatim feedback of students by which it reflects a combination of positive and negative dispositions regarding student behavior and learning experiences in class. Many students emphasized their efforts to stay engaged and active in the learning process. Several students noted that they are helping their classmates when needed, showing collaboration and teamwork. Listening attentively to the teacher and actively participating in discussions were common themes, suggesting a willingness to learn and engage with the material. A few students mentioned the importance of being quiet and focused, as well as reading instructions carefully to ensure they understand what is being asked. Furthermore, some students highlighted their proactive approach, such as asking questions when they needed clarification. These positive behaviors show that students are generally motivated to understand the material and support both their own learning and that of their peers. Despite the positive attitudes, some students recognized areas for improvement. Focus during independent work was noted as a challenge for several students, indicating that maintaining attention without external guidance might be difficult. There were also concerns about memorization, particularly in recalling names of scientists and contributors to the periodic table, as well as understanding electron configurations, which a few students found challenging. Critical thinking skills were identified as an area for growth, with some students noting that they needed to analyze information more deeply and develop stronger conclusions. Additionally, time management was highlighted as an area where students could improve to better complete activities on time, and grammar was mentioned as a point of difficulty, particularly for tasks that require explanations. These comments suggest that students are aware of the areas where they need to grow to enhance their learning outcomes. Overall, the feedback shows a mix of engagement and self-awareness. Students appear to be actively participating in class and supporting each other but also recognize the need to develop more independent study habits, time management, and memorization skills. The recognition of challenges such as critical thinking and understanding complex concepts like electron configuration shows that while students are engaged, they face hurdles that will require additional support or strategies. These areas of improvement, if addressed, could further enhance their learning experience and academic success.

5. Conclusions

The study revealed that there is no significant relationship in the experience cognitive strains and the basic science process skills of students. And, there is no significant difference in the pre and post test scores of the students before and after the use of the strategic intervention material.

6. Recommendations

Educators may implement SIMs as a part of remediation teaching programs for students who struggle with higher order thinking skills and basic concepts in science. Teachers may apply and investigate how cognitive load-based SIM can be adapted to more effectively meet the unique needs of the students.

Acknowledgements

This research would not have been possible without the invaluable guidance, support, and assistance of various individuals and institutions. The researcher wishes to take this opportunity to extend her heartfelt gratitude to the following:

To God, first and foremost, for granting me the wisdom, strength, and perseverance to complete this academic endeavor. His divine guidance has been my source of courage and clarity, enabling me to overcome the challenges encountered throughout this study.

Dr. Mario R. Briones, University President, for his invaluable contributions to the institution and for making a lasting impact on the lives of countless students.

Atty. Rushid Jay S. Sancon, Vice President for Academic Affairs, for his unwavering support and guidance in championing the endeavors of Graduate Studies and Applied Research students, which has inspired the researcher to persevere despite numerous challenges.

Mr. Joel M. Bawica, Campus Director, for his support and words of encouragement.

Dr. Edilberto Z. Andal, Dean of Graduate Studies and Applied Research, for his exceptional leadership, wisdom, and guidance, which have been instrumental in the successful completion of this thesis.

Dr. Elisa N. Chua, research adviser, for her invaluable insights, unwavering encouragement, and steadfast support throughout the conduct of this research. Her knowledge, patience, and guidance have been instrumental in shaping and directing this work to its successful completion.

Mr. Albert Andry E. Panergayo, for his invaluable support in refining and enhancing the technical content of this research.

Mrs. Angela L. Reginaldo, statistician, for generously sharing her time, knowledge, and expertise in statistics, which greatly contributed to the clarity and accuracy of this research. Her patience, dedication, and valuable suggestions have been vital in upholding the integrity of this study.

Ms. Cyrell N. Ate, subject specialist, for her valuable expertise and insightful advice. Her deep knowledge and understanding of science have greatly contributed to the depth and accuracy of this study.

Mrs. Juliet M. Bulahan, Head Teacher of Dayap National High School, for her generous assistance and valuable insights during the validation of the research instrument.

Mrs. Lisette B. Quinay, Master Teacher I of Dayap National High School, for his indispensable support in the evaluation and validation of the research instrument.

Mrs. Maria Corazon D. Zarate,Teacher III of Dayap National High School, for the gift of his time and effort in piloting the research instrument.

Ms. Aron G. Tatlonghari, Teacher III of Dayap National High School, whose support was instrumental in the pilot testing of the research instruments used in this study.

Mrs. Jennelyn D. Latayan, Master Teacher I of Dayap National High School for her time, wisdom, and critical inputs that immensely contributed to this study.

Mrs. Ma. Gemma Z. Monserrat, Teacher III of Dayap National High School, for his indispensable support in the evaluation of the research instrument.

To Mr. Ben Mark Joy Cuvinar, Teacher III of Dayap National High School, for generously sharing his time and effort in the validation of the research instrument.

To Dr. Evelyn P. Navia, Principal IV of Dayap National High School, for granting permission to conduct this study within the school.

To the Grade 8 students of Dayap National High School, who served as the respondents, for generously giving their time and effort in completing each activity, thereby providing valuable data essential to this study.

Co-teachers, for their invaluable support, encouragement, and collaboration throughout the course of this research.

Arlene A. Suaze and Dianne Cyrill B. Bautista, who have been a constant source of encouragement and strength throughout the course of this academic journey.

The researcher's family, Ma. Gemma and Antonio Monserrat, sister and brother and in-laws, in appreciation for their unconditional love, emotional support, encouragement, and understanding throughout my studies.

The researcher's husband, John Paulo and daughters, Kelly and Kaia for their unwavering support, patience, understanding, constant encouragement, even in the most challenging moments. Also, for unconditional love and for being my source of joy and inspiration. This achievement would not have been possible without their love and belief.

Finally, to all those who, in whatever way, assisted in the completion of this research thank you for your kindness, encouragement, and support.

Thank you all for being part of this journey.

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