# Enhancing Skills in Controlling Variables and Defining Operationally Through 'InKooNik'

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***Abstract-*** Conventional teaching and learning methods, along with memorization, lead to weak mastery of scientific process skills (SPS), resulting in students becoming passive, disinterested, and discouraged with SPS. Most of them struggle with mastering skills such as controlling variables and defining them operationally. Therefore, an action research study was conducted on 16 students in a school in Kuala Lumpur to improve these two SPS through the 'InKooNik' intervention. 'InKooNik' is a series of teaching and learning activities consisting of three experimental activities and worksheets related to these two SPS. This intervention incorporates the concepts of inquiry, cooperation, and mnemonics. The research instruments used included pre- and post-tests to measure the effectiveness of the intervention, a questionnaire about students' views on learning through the intervention, and observations of student engagement in experimental activities, discussions, and worksheet tasks. The pre- and post-test and questionnaire data were analyzed descriptively using tables, while the observations were analyzed thematically based on transcriptions. The findings of the study indicate that the 'InKooNik' intervention was effective in improving the skills of controlling variables and defining them operationally in Year 5 students. It is suggested that the findings of this study can be referred to as a guide in developing science modules and diversifying science teaching and learning methods in the classroom.

***Index Terms***- skills in controlling variables, skills in defining operationally, inquiry, cooperative, mnemonic

## I. Introduction

In Malaysia, science is a subject that has received special attention from the government. In 1967, the Malaysian government set a target of a 60:40 ratio, meaning the participation of students in the science stream compared to the arts stream (Pusat Asasi Sains Universiti Putra Malaysia, 2022). This 60:40 policy has been consistently implemented in the national education system up to the present day. The Ministry of Education Malaysia (MOE) also aims to achieve this target through the Malaysia Education Development Plan 2013-2025 (Kementerian Pendidikan Malaysia, 2013).

The Malaysian school science curriculum not only aims to impart science knowledge to students but also to develop skills, attitudes, and values. The Primary School Standard Curriculum Science is designed to foster interest and develop students' creativity through experiences and investigations to master scientific knowledge, scientific skills, thinking skills, scientific attitudes, and positive values (Bahagian Pembangunan Kurikulum, 2021). In line with the National Philosophy of Education, the science curriculum emphasizes producing individuals who are balanced intellectually, spiritually, emotionally, and physically (Pusat Perkembangan Kurikulum, 1988).

To assess students comprehensively, the MOE introduced a holistic assessment method in the form of both formative and summative assessments. Through Classroom Assessment (PBD), teachers will monitor students' progress and mastery levels in learning, then plan appropriate teaching methods (BPK, 2019). PBD can assess students not only in the application of science knowledge but also in the cultivation of scientific skills, attitudes, and values in daily life. At the same time, the MOE has introduced the End-of-Academic-Session Test (UASA) for upper primary school students and lower secondary school students. One of the key science constructs emphasized in the UASA is SPS (Salinah Maskan, 2022). Therefore, students are required to answer two SPS-related questions in the form of written tests in Section C of the UASA Science exam.

### Research Problem

In this study, the researcher found that some Year 5 students who were taught at school struggled with SPS. They tended to be quiet or answered SPS questions without deep thinking, with a common example being copying the question or phrases from the question instructions as their answer. Among them, the skill of controlling variables was the most frequently overlooked by the students. They responded by saying that they had forgotten certain SPS and admitted to a lack of understanding of the SPS content taught in the previous year. They believed that too much memorization had confused them.

Through interviews, it was found that they learned SPS through memorizing answers to experimental questions and repetitive practice. This led to feelings of fatigue and a decreasing interest in learning science. The negative attitudes that emerged were like those observed in the study by Eshetu Desalegn Alemneh (2022) because of conventional learning. They found memorization-based learning boring and acknowledged the difficulty of memorizing all the keywords for each SPS. At times, they misused the keywords when answering SPS questions. Therefore, learning techniques for memorizing and answering SPS questions accurately are emphasized in this study.

In Khalidah's (2002) study, science teachers believed that the main factors influencing the effectiveness of students' mastery of SPS were the teachers' knowledge and skills, teaching strategies, and students' discipline during practical sessions. Therefore, the researcher conducted interviews with science teachers from the previous year to gain a more comprehensive understanding of their learning situation. According to the teacher, she taught SPS orally through experiment demonstrations in videos. She believed that the students had not mastered the skill of operational definition due to their recent exposure to the integrated SPS content in Year 4. The students felt confused when identifying experimental variables to answer questions on the skill of operational definition.

Additionally, she also believed that the students were quick to give up when answering questions, whether orally or in writing, in class. Based on the UASA taken by the students, she found that they faced difficulties in answering experimental questions in Section C due to weak mastery of SPS. During the UASA, they struggled to find relevant experimental information to answer SPS questions due to their lack of hands-on experimental experience. The conventional learning methods contributed to the weak mastery of SPS because the students did not have the opportunity to engage in activities that could enhance their SPS (TAT Nugroho & H D Surjono, 2019; Nurul Azmy Rustan, Retno Winarni & Sri Yamtinah, 2020).

Additionally, the researcher provided PBD for experimental questions. Most students left the SPS questions unanswered. During the answer discussion session for the PBD questions, they simply waited to copy the answers from the teacher. Weak students were also marginalized by high-achieving students in the class. Eventually, they became passive toward questions they did not understand. The findings of the study by Ang and Lee (2021) show that students' attitudes are the most dominant internal factor influencing students to learn science in primary school. Therefore, cooperation between students is emphasized in this study to foster positive attitudes towards SPS once again.

Therefore, the 'InKooNik' intervention was designed to address this issue. This intervention consists of a series of teaching and learning sessions that incorporate group inquiry activities and mnemonic techniques. Students will have the opportunity to conduct three experiments in groups. Each experiment is followed by a session to answer specific SPS questions, such as the skills of controlling variables or operational definitions, in writing. Students will actively learn these two SPS throughout the intervention process. They will also be given time to collaborate and work together in groups to complete the SPS questions provided.

**Research Objective**

i. To investigate the effectiveness of 'InKooNik' in improving the skills of controlling variables and defining operationally for Year 5 students.

## II. Literature Review

Several studies have shown a positive relationship between students' SPS and their achievement in science (Robert & Bybee, 2015; Padilla, 2004; Walters & Soyibo, 2001). This helps students understand scientific concepts more deeply while developing critical thinking, creativity, and scientific thinking skills. Therefore, SPS is very important in science teaching and learning. Throughout the investigative process, students' interest and engagement in learning science occurs naturally. The application of SPS in teaching and learning is a pedagogical approach to spark students' interest and enjoyment in actively participating in the learning process (BPK, 2012). Furthermore, SPS also helps improve students' science achievements and 21st-century skills (Robert & Bybee, 2015; Nuratiqah Aziemah & Muhammad Nor Syafiq, 2020). As a result, students will not only have a deeper understanding of scientific concepts but will also become more skilled in applying scientific thinking to explore the world around them.

### a. Factors Affecting Mastery of Science Process Skills

The mastery of students' SPS can be influenced by six main factors, which are the attitudes of both teachers and students, teaching styles, learning techniques, computer knowledge, laboratory facilities or materials, and views on science. According to a study by Ang and Lee (2021), it was found that students' attitudes are the most dominant internal factor, while teachers' attitudes are the most important external factor influencing students' mastery of science. Here, we can see that the attitudes of both teachers and students are interrelated. Additionally, the location factor was also studied in research by M.D. Nurhafizah (2022), which showed that the level of mastery of SPS by students is not influenced by the school's location, whether urban or rural. Furthermore, the results of various studies indicate that the teaching and learning methods affect the mastery of students' SPS (Norazizah et al., 2018; Fazilah, Othman & Azraai, 2016; TAT Nugroho & HD Surjono, 2019).

The way teachers deliver science lessons significantly affects students' development in the field of science. Some teachers prioritize science concepts to the extent that they overlook the teaching of SPS in the classroom. According to Lee (2021), the emphasis on students' mastery of SPS is not considered a crucial element in the science teaching and learning process. Students who have limited or no exposure to SPS find it challenging to apply these skills in their daily lives. Additionally, some schools lack adequate facilities, tools, or laboratory materials, restricting students' opportunities to conduct scientific investigations. This situation hampers the support for students' SPS development, as the use of tools and materials is essential for students to form new ideas. This issue was observed among students in the study by Gunawan et al. (2019).

According to a study conducted by TAT Nugroho and HD Surjono (2019), students in Indonesia primarily learn from textbooks that use abstract media with limited variation. This situation may lead students to memorize scientific knowledge or skills based solely on the textbook without a proper understanding. Over time, students may become bored and find it difficult to memorize all the information. Nadia Abdul Rahum et al. (2021) state that students tend to become bored and less interested in science because it requires them to maintain constant focus. Additionally, students' interest diminishes due to a teacher-centered education system (Rika Novayanti Marpaung, Ady Frenly Simanullang, and Fine Eirene Siahaan, 2022). Therefore, teachers need to employ appropriate teaching approaches to cultivate students' interest in science during the learning process. When students are interested in learning, their attitudes toward SPS will also change.

**b. Inquiry Approach**

Science inquiry learning is a better indicator in fostering SPS, such as observation, problem formulation, hypothesis formulation, and communication (J.H. Nunaki et al., 2020). Through direct experience in research and experiments, students are encouraged to hone their SPS in ways that allow them the freedom to explore, ask questions, and try out ideas. Chinese philosopher Confucius stated, "I hear and I forget, I see and I remember, I do and I understand" (Lau, 2017). Experiences in research help students become more adept at formulating meaningful scientific questions, developing evidence-based hypotheses, critically analysing data, and effectively communicating results to others.

The inquiry approach is one of the tools under constructivist theory. According to Teresa Coffman (2017), inquiry is the process of engaging with the surrounding world by asking good questions to discover the knowledge and skills needed. Inquiry learning can satisfy students' curiosity and stimulate them to find meaningful ways to engage in learning. Through a constructivist-based approach, the roles of teachers and students become balanced, and teachers do not speak from beginning to end (Voon & Amran, 2021). Students are given opportunities to make discoveries and conduct their own research on scientific concepts. In this process, students will think critically to question, analyse, and interpret the data they collect.

A study by Eshetu Desalegn Alemneh (2022) shows that theoretical science teaching in Woldia primary schools leads to negative attitudes towards science among students. Teachers and students in these schools are less enthusiastic about engaging in 'hands-on', 'minds-on', and 'hearts-on' activities due to a lack of laboratories, chemicals, and appropriate equipment. In this context, the lack of practical activities and experiments becomes a barrier to effective learning in promoting SPS.

Students will face difficulties in following manuals and conducting experiments because they are more accustomed to listening to explanations from teachers and taking notes during lectures without directly engaging in experiments (Özlem ATEŞ & Ali ERYILMAZ, 2011). Students require practical handling to apply the SPS learned in direct experiences. They will be motivated to actively receive information and stimulated to think and ask questions while learning facts or concepts relevant to their lives.

In a study by Fitriyah, Affriyenni & Hamimi (2021), a guided inquiry model is necessary for students with low critical thinking skills. In this case, students exposed to inquiry learning take time to be stimulated to think in an inquiry manner. Vygotsky's Zone of Proximal Development (ZPD) theory (1986) emphasizes the gap between existing knowledge and what is yet unknown to students. Therefore, assistance from teachers becomes crucial in the inquiry learning process. This is because students may experience frustration and disappointment when trying to understand tasks given to them, especially when they are not provided with clear instructions as they are accustomed to receiving previously.

**c. Group Activities**

According to Nadia Abdul Rahim et al. (2021), cooperative learning styles can attract the interest and understanding of Year 4 to 6 students in science subjects. For high-achieving students, they gain a deeper understanding of SPS and learn more when involved in group activities by providing explanations to and receiving explanations from other members (Ataman Karacop & Emine Hatun Diken, 2017). Communication skills are essential when students explain concepts or topics to their peers. This involves the ability to express understanding clearly and understandably to others. Conversely, receiving explanations from others encourages students to evaluate, analyze, and critically consider the information received.

In Malaysia, it has been found that students tend to be more interested and find learning more enjoyable when using cooperative learning methods (Nadia Abdul Rahim et al., 2021). Learning SPS through this approach not only attracts students' interest but also encourages a deeper understanding and enhances their SPS achievement. In a study by Chai and Siew (2023), productive interactions occurred among students with different knowledge backgrounds during SPS learning, where intelligent and proactive students acted as experts. Thus, students skilled in SPS can serve as examples and guide their peers who need assistance within the group.

The use of cooperative learning strategies enables students to form their own opinions and arguments, analyze, synthesize, and make decisions collaboratively with group members throughout the learning process (Azieyana Aziz & Christina Andin, 2018). In this context, students indirectly apply SPS when engaged in group activities. Meanwhile, through cooperative learning, teachers demonstrate focus on learning, appreciate students' efforts, and maintain a friendly attitude, which positively impacts students' comfort and learning (Fransiska Purwantini Soedimardjono & Pratiwi P, 2021). Cooperative learning not only enhances group interactions but also improves bilateral interactions between teachers and students. Consequently, teachers can provide appropriate guidance and emphasize the SPS aspects that each student needs to improve.

SPS is a crucial element in science education that forms the foundation for deep understanding in science and strengthens critical thinking. Students proficient in SPS can apply science in their daily lives. With the provided strategies, educators can deliver SPS knowledge more effectively and provide suitable platforms for students to practice SPS. By prioritizing the development of SPS, individuals will become more adept at conducting scientific research and understanding scientific phenomena more profoundly, contributing to the advancement of science and society.

## III. Methodology

This study is action research aimed at examining the effectiveness of 'InKooNik' in enhancing students' skills in controlling variables and operationally defining concepts. According to the model by Kemmis and McTaggart (1988), action research operates in a continuous cycle involving four steps: reflecting, planning, acting, and observing. The researcher reflected on the students' mastery of SPS through classroom observations, document analysis, and interviews with both teachers and students. The findings revealed weaknesses in two specific KPS: controlling variables and operationally defining concepts. Subsequently, the researcher developed the 'InKooNik' solution, integrating inquiry-based group activities and mnemonic techniques. Students were guided to implement 'InKooNik', and the researcher observed the outcomes of these actions.

### Sample and Research Location

This study was conducted at Sekolah Jenis Kebangsaan (Cina) Tsun Jin, Kuala Lumpur. A total of 16 Year 5 students were selected as the sample based on reflections from interviews, document analysis, and classroom observations. Thirty students involved in the pilot study were not chosen for the actual research sample. The study sample comprises six male students (37.5%) and 10 female students (62.5%), indicating a higher number of female students. Most of the sample are of Chinese ethnicity, totaling 14 students (87.5%). One student (6.25%) is Malay, and one (6.25%) is Indian. The predominance of Chinese students in this study is due to the research being conducted at a Chinese primary school, where most students are of Chinese descent.

### 'InKooNik' Intervention

Throughout the intervention process, students engaged in group activities during each session. They were divided into groups comprising students with varying levels of mastery in SPS and collaborated to conduct experiments. Three experiments were provided: the sugar solution experiment, the pulse rate experiment, and the material properties experiment. Before conducting the experiments, students were asked to answer questions posed by the teacher based on the provided experiment scenarios. Their responses served as a foundation for considering the variables that would influence the experimental outcomes. Students utilized their senses during the experimental steps while receiving information throughout the process. They also had the opportunity to manipulate and control the variables themselves and ultimately observe the experimental results. Direct experience in the experiments enabled them to find answers to questions related to controlling variables and defining them operationally.

To comprehend and remember the experimental variables, the researcher taught students a mnemonic technique that associates the experimental variables with a story about a fried rice competition. In Chinese, 'frying' is 炒 (chao), 'rice' is 饭 (fan), and 'story' is **故事** (gu shi). The manipulated variable is **操** (cao) 纵性变数, the responding variable is **反** (fan) 应性变数, and the controlled variable is **固** (gu) **定性**变数. In this story, the researcher introduced the three variables with their corresponding symbols.

Additionally, the word order in the Chinese term for fried rice, 炒饭 (chao fan), is used to remember that the manipulated variable (**操**, cao) occurs first, followed by the responding variable (**反**, fan). This sequence of variables begins from left to right or top to bottom in a table: 'left cao right fan' and 'top cao bottom fan'. Similarly, the sentence structure for the operational definition formula follows the pattern: manipulated variable first, then responding variable. Formulas are generated to answer questions related to both skills:

i) Variables: (main subject) (noun)
ii) Operational Definition: (cao: what you do), based on (fan: what you observe) to identify (the science concept in question)

After learning this mnemonic technique, students will complete worksheets in groups. They will discuss within their groups to find answers to the SPS questions. Meanwhile, the researcher will act as a facilitator to assist groups facing difficulties. Each group representative will present their answers once the discussion time ends. Then, the researcher will provide feedback and guide students to write the correct SPS answers. Each student is required to complete their individual worksheet.

### Research Instruments

This study employs three primary instruments for data collection: pre-test and post-test, questionnaires, and observational checklists. The pre-test and post-test consist of three experimental questions designed to assess students' skills in controlling variables and defining concepts operationally. Each skill is scored out of nine, totaling 18 marks. These tests aim to evaluate the effectiveness of the 'InKooNik' intervention.

A questionnaire is administered to gather students' perspectives on the intervention's effectiveness in learning both SPS. It comprises 15 items using a 5-point Likert scale. An observational checklist is utilized to monitor student interactions during the experiment, group discussions, and the completion of experimental worksheets.

### Validity and Reliability

The validity of the pre-test and post-test was conducted, where all three experimental questions were reviewed by two lead trainers from the Kuala Lumpur State (JUN) specializing in Science for Chinese Primary Schools (SJK(C)), experts in the field of item contribution for UASA. The instructions and questions on controlling variables and defining operationally were reviewed to ensure that the language and meaning were communicated accurately. For the questionnaire, all items were reviewed by the translation panel from the Curriculum Development Division, experts in language accuracy and comprehension, ensuring suitability for the language proficiency level of the study sample. As for the observational checklist, the researcher consulted with two experienced primary school Science teachers to ensure it was appropriate for the study's purpose.

To test the reliability of the questionnaire, a pilot study was conducted with 30 Year 5 students to obtain the Cronbach's alpha value. The researcher used the Statistical Package for Social Science (SPSS) version 27.0 to analyze the questionnaire items. A value of 0.862 was obtained, indicating that the Cronbach's alpha reliability of the pilot questionnaire instrument exceeded the minimum value of 0.60 (Creswell, 2012). The items on the questionnaire were highly reliable, and thus, the pilot instrument was retained and can be used in the actual field study.

The validity and reliability of the instruments can be examined using the data triangulation method. In this study, quantitative data from the pre-test, post-test, and questionnaire were compared. Qualitative observational data, from the checklist, were analyzed thematically to support the quantitative data. Data triangulation helps to verify the credibility of the collected data in answering the research questions.

**Data Analysis Technique**

Descriptive analysis methods were used to analyze the data from the pre-test and post-test. The data were computed and analyzed using the mean, mode, and median values. A comparison of students' achievements in the pre-test and post-test was also conducted and analyzed. Finally, the standard deviation of the score differences was analyzed. To gather students' perspectives on learning through the 'InKooNik' intervention, this study measured the mean score based on the mean score measurement and interpretation by Nunnally and Bernstein (1994). Data from the observational checklist were analyzed thematically based on transcriptions. The data were examined in terms of mastery of the two SPS skills studied, student engagement, and student attitudes towards the SPS throughout the 'InKooNik' intervention.

## IV. FINDINS

The research findings are reported based on the research question: *Is the 'InKooNik' intervention effective in improving Year 5 students' skills in controlling variables and defining operationally?*

**Pre-test and Post-test**

The pre-test and post-test were designed based on three experiments: the speed of a toy car, the volume of marbles, and plant growth. These experiments were used to assess the students' proficiency in controlling variables and defining concepts operationally. Table 1 shows the results of the pre-test and post-test data for the variables control skill (i) and the operational definition skill (ii). Table 2 presents the mean, mode, median, and standard deviation of the score differences for the pre-test and post-test.

TABLE 1: Pre-test and post-test data

| **Stu-dent** | **Pre-test scores** | | | **Pos-test scores** | | | **Difference** | | |
|---|---|---|---|---|---|---|---|---|---|
| | **i** | **ii** | | **i** | **ii** | | **i** | **ii** | |
| **A** | 4 | 0 | 4 | 8 | 7 | 15 | 4 | 7 | 11 |
| **B** | 0 | 0 | 0 | 4 | 0 | 4 | 4 | 0 | 4 |
| **C** | 5 | 0 | 5 | 5 | 4 | 9 | 0 | 4 | 4 |
| **D** | 0 | 0 | 0 | 4 | 3 | 7 | 4 | 3 | 7 |
| **E** | 6 | 0 | 6 | 8 | 6 | 14 | 2 | 6 | 8 |
| **F** | 5 | 0 | 5 | 5 | 5 | 10 | 0 | 5 | 5 |
| **G** | 5 | 0 | 5 | 5 | 4 | 9 | 0 | 4 | 5 |
| **H** | 0 | 0 | 0 | 5 | 0 | 5 | 5 | 0 | 5 |
| **I** | 1 | 1 | 2 | 7 | 2 | 9 | 6 | 1 | 7 |
| **J** | 4 | 0 | 4 | 8 | 5 | 13 | 4 | 5 | 9 |
| **K** | 6 | 0 | 6 | 8 | 7 | 15 | 2 | 7 | 9 |
| **L** | 4 | 0 | 4 | 6 | 2 | 9 | 2 | 2 | 5 |
| **M** | 5 | 0 | 5 | 7 | 7 | 14 | 2 | 7 | 9 |
| **N** | 5 | 0 | 5 | 6 | 7 | 13 | 1 | 7 | 8 |
| **O** | 5 | 0 | 5 | 7 | 8 | 15 | 2 | 8 | 10 |
| **P** | 4 | 0 | 4 | 8 | 4 | 12 | 4 | 4 | 8 |

TABLE 2: Mean, mode, median, and standard deviation of the difference between pre-test and post-test scores

| | Min | Mod | Median | Standard deviation of the difference |
|---|---|---|---|---|
| Pre-test | 3.75 | 5 | 4.5 | 2.217 |
| post-test | 10.81 | 9 | 11 | |

Overall, all study samples showed improvement after the 'InKooNik' intervention. Among the students, Student A and O exhibited significant improvement, with score increases of 11 and 10 points, respectively. Students J, K, and M demonstrated high improvement, with an increase of 9 points each, while Students E and N showed a moderate improvement of 8 points. In this study, two students showed progress in controlling variables only, while three students showed progress in defining operationally only. However, the mean score for the pre-test was 3.75, whereas the mean score for the post-test increased to 10.81. This reflects a significant improvement in the overall performance of the students after the intervention. Additionally, the mode score increased from 5 in the pre-test to 9 in the post-test, while the median score increased from 4.5 to 11. These statistical changes indicate a general shift towards higher performance across the student sample. Thus, the data analysis clearly shows that the 'InKooNik' intervention was effective in helping students master the skills of controlling variables and defining operationally. Furthermore, the standard deviation of the differences was calculated to be 2.217, which is relatively small. This indicates that most students experienced a similar level of improvement in their scores, suggesting consistency in the effectiveness of the intervention across the sample.

**Questionnaire**

A total of 15 questions using a five-point Likert scale were prepared and distributed to the study sample to be answered. The analysis results indicate that the highest mean score was 4.06, with 10 students (62.5%) agreeing or strongly agreeing with the statements "I enjoy learning science process skills through hands-on experiments" and "I find it fun to learn science process skills through hands-on experiments." The second highest mean score was 3.88, with 10 students (62.5%) agreeing or strongly agreeing with the statements "I can identify manipulated variables and respond more easily using 'left cao right fan' and 'top cao bottom fan' on the table." The third highest mean score was 3.81, with 10 students (62.5%) agreeing or strongly agreeing with the statement "I prefer conducting activities in groups rather than individually." These items reflect a combination of learning methods—guided inquiry, mnemonic techniques, and group activities—that align with the 'InKooNik' intervention. This suggests that 'InKooNik' effectively captures students' attention and interest in learning SPS.

An item recorded the lowest mean score of 3.06, which is considered moderately high. Only 5 students (31.3%) agreed or strongly agreed with the statement "I am more confident answering science process skills questions in a group." In this context, students tend to prefer using formulas to answer questions, as supported by items 12, 13, 14, and 15, which have mean scores of 3.31. Therefore, students can learn science process skills through a combination of storytelling, group inquiry processes, and then apply formulas to answer questions. Finally, the overall mean score was 3.75, which is considered moderately high. This indicates that the students' perspectives on the 'InKooNik' intervention are positive, and the intervention is suitable for helping students master the skills of controlling variables and defining them operationally.

**Observation Checklist Findings**

The observation checklist results revealed three key themes regarding the effectiveness of the 'InKooNik' intervention in enhancing students' mastery of controlling variables and defining them operationally.

**a. Students Can Identify Answers Step-by-Step Based on Experimental Experience**

Students demonstrated the ability to identify variables that could affect experimental outcomes in Stations 1 and 2. Station 3, which focused on material properties, posed a greater challenge; however, with teacher guidance, students recognized that the type of paper used was a critical variable to control. Reflecting on the inquiry process, students could more easily identify manipulated and responding variables. For operational definitions, they were able to articulate their observations and actions during the experiments based on firsthand experience.

**b. Students Can Write SPS Answers After Using Formulas and Stories**

The fried rice competition story helped students understand the concept of variables, enabling them to identify variables more quickly and accurately apply the provided formulas. Correctly identified variables facilitated accurate responses in operational definition questions. For instance, in Station 3, students completed the answer "Dipping litmus paper into liquid can indicate material properties through colour change" with assistance from the provided formula.

**c. Active Student Engagement in Group Activities Throughout the Intervention**

Initially passive students became more willing to answer questions after group discussions. In Station 1, they attempted answers despite initial uncertainty, expressing surprise upon discovering their correctness. Over time, students became more active and fully engaged in group experiments, collaborating to conduct experiments and complete worksheets. By the end of the intervention, students exhibited increased confidence and satisfaction when answering questions correctly.

## V. DISSCUSSION

The study indicates that the 'InKooNik' intervention effectively enhances Year 5 students' skills in controlling variables and defining them operationally. Analysis of pre- and post-test data reveals a significant improvement across all samples, with the mean score increasing by seven points. The mode shifted from 5 to 9, and the median rose to 11 in the post-test.

Post-intervention, students demonstrated the ability to identify task requirements for both SPS and determine necessary experimental information from question stimuli. For controlling variables, most students could identify manipulated and responding variables when provided with observation tables, while approximately half identified controlled variables. Even without observation tables, many students identified at least two experimental variables.

Observational analysis revealed that students could sequentially identify variable answers, starting with the main subject followed by the noun. Notably, in the post-test, students no longer left operational definition questions unanswered. The majority provided responses detailing 'what was done,' 'what was observed,' and 'the scientific concept related to the question,' based on learned formulas. Only three students omitted one piece of information in their operational definitions. Questionnaire results corroborate these findings, with students reporting a moderate to high understanding of variables, ability to identify them, recall writing methods, and competence in writing definitions.

This suggests that the intervention successfully facilitated understanding of the three types of variables through engaging encoding techniques, such as the fried rice story, keywords, word sequences, and mnemonic formulas. Through this mnemonic technique, the information that students receive is not only understood at a surface level but is also stored in their long-term memory. Mnemonics help students recall what they have learned and strengthen their memory (Elly Fatmasari, 2019). This aligns with the researcher's observations throughout the intervention, where it was found that students were able to more easily remember and relate the knowledge they had acquired to real experimental situations. They were able to adapt the knowledge gained to the experimental questions presented, enabling them to more accurately identify the variables involved in each experiment. This demonstrates that the encoding approach through engaging and relevant stories can significantly enhance students' understanding and mastery of the concept of variables.

Previously, students found science lessons monotonous and passive due to rote memorization and conventional teaching methods. This situation caused them to lose interest in learning SPS and ultimately fail to master them. The lack of science laboratories and incomplete equipment hindered active experimentation. Typically, students observed teacher demonstrations or videos, making it challenging to apply SPS in varied experimental contexts. Consequently, they struggled to answer SPS-related questions in assessments based on imagination. This is in line with the findings of the study by Özlem ATEŞ and Ali ERYILMAZ (2011). In their study, the inquiry-based teaching and learning method was used to provide students with the opportunity to build SPS knowledge through real-life experiences.

However, the observation results show that the attitude of the study samples towards SPS changed positively. The implementation of experiments helped integrate SPS and manipulative skills into the students. (Nur Raihana et al., 2020). Throughout the intervention process, they were engaged and enthusiastic about the experimental activities that involved their senses and hands-on experiences. The sensory stimulation during the experiments successfully sparked students' interest in delving deeper into the world of science, motivating them to actively participate in learning. They were given the opportunity to revisit the steps of the experiments they went through and reflect on what they had observed and done during the experiments. As a result, they were able to answer questions more accurately and easily, naturally, without feeling burdened by abstract concepts.

Furthermore, the responsibility of being a group representative made them feel valued and enhanced their sense of ownership and commitment to the learning process. According to Ade Hasanudin, Ade Aprianto, and Citra Wati (2024), students in small groups collaborate in an active, creative, and enjoyable learning environment. They are responsible for the success of all group members. Initially, they may have felt pressure and anxiety about learning, but the support from active group members encouraged them to take step-by-step actions toward achieving the group's goals. In this environment, they did not feel alone in facing challenges; instead, they had the opportunity to help each other and engage in discussions. Group members also played a crucial role by reminding the study samples of the formulas taught by the researcher and guiding them to correct their answer structures. The formulas provided not only helped them understand how to answer questions but also motivated them to answer experimental questions more effectively and accurately.

In this regard, the researcher also provided positive reinforcement to the study participants when their answers were nearly correct, which further boosted their confidence. With this reinforcement, they became more confident and motivated to provide accurate answers, while also feeling a sense of satisfaction with their achievements in the experimental activities. This situation demonstrates that the social support and scaffolding received throughout the learning process can help enhance self-confidence, which in turn aids students in understanding the concepts of SPS. The findings from Nur Fatihah and Faridah Mydin Kutty's study (2022) suggest that there is a relationship between self-motivation and social support in promoting students' well-being. Therefore, self-motivation and social support can help students achieve psychological well-being, while also encouraging them to embrace challenges and build a positive school life.

## VI. CONCLUSION

Overall, 'InKooNik' improved the mastery of both SPS among the study sample. The experimental activities successfully attracted the interest of passive participants in science skills, as they were able to engage directly. They also received support and assistance from other group members to think of the correct answers for the variables and how to define them operationally. In this regard, the study sample was selected to represent the group in presenting the discussion results. Gradually, the study sample became more prepared to answer the questions posed and was able to provide complete and correct answers. Additionally, the stories, keywords, word sequences, and formulas presented also stimulated the participants to strive to answer the experimental questions more effectively.

Students' perception that SPS are difficult to learn, along with the low participation in the science stream among secondary school students due to abstract concepts, has become a serious issue that is being closely addressed nationwide. Research on SPS issues in primary schools is still limited compared to secondary schools or universities. The results of this study indicate that the mastery of SPS among primary school students is low. Pedagogical practices, social interactions, and learning techniques will influence the mastery of SPS in primary school students. This suggests that primary school teachers should receive training to improve their teaching skills, while primary school students should be given opportunities to learn through inquiry in groups, using appropriate memorization techniques. In this way, they will be able to interact effectively to achieve educational goals.

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