Application of investigation through Cooperative Problem Solving (ITCPS) learning model to improve science process skills

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Abstract
This study aims to determine the application of the Investigation Through Cooperative Problem Solving (ITCPS) learning model in class VIII in terms of the implementation of the ITCPS learning model syntax, and to determine the improvement of science process skills of class VIII students with the application of the ITCPS learning model in science learning. The research method used is Classroom Action Research (CAR) which consists of two cycles. The subjects of this study were students of class VIII 4 SMPN 3 Surakarta in the academic year 2023/2024, totaling 31 students. The data collection method in this study used instruments in the form of written test questions, observation sheets, and interview guidelines. The data analysis technique used in this study used qualitative descriptive analysis. The aspects of science process skills that were assessed were observing, formulating hypotheses, experimenting, interpreting data, inferring, and communicating. Based on the results of the study, it can be concluded that the syntax of ITCPS learning model including problem identification, problem formulation, investigation, explanation, and reflection. The level of implementation increased from 91.30% in the first cycle to 100% in the second cycle. The application of the ITCPS model improves the science process skills of students in class VIII 4 SMP Negeri 3 Surakarta, after students carry out a series of learning processes through practicum related to vibrations and waves because practicum provides direct experience for students. In addition, the application of the ITCPS learning model can also create an interactive and collaborative learning environment.

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1. Introduction

The 21st century is characterised by rapid and significant advances in technology, information and communication in every aspect of life including education, which plays an important role in preparing each individual to face the challenges and demands of the 21st century, namely in the complex world of industry, work and social life (Nopiani et al., 2023; Sanjayanti et al., 2020; A. K. Sari & Trisnawati, 2019). The Indonesian government has attempted to change the education system by updating education policies to face the challenges of the 21st century and improve student quality (Indarta et al., 2022; Mahmudi & Masturoh, 2023). One of the efforts made is presenting the 'Merdeka Belajar' program which emphasises academic freedom, known as the independent curriculum, which is based on the concept of 21st century education (Indarta et al., 2022; Simanjuntak & Ivana, 2022). Science learning in the curriculum includes two elements, namely science understanding and science experiments to train students' thinking by conducting research and investigation of a theory or concept (Fitra, 2022).

Science learning has a nature that can be categorised into three dimensions, namely science as a product, science as a process, and science as an attitude (Muliadi et al., 2022). Science is not only knowledge about nature presented in the form of facts, concepts, principles, and laws (science as a product), but also methods or ways to find out and understand natural phenomena (science as a scientific process) and efforts to foster scientific attitudes (science as an attitude) (Barus, 2022). Science learning can be said to be a product and process that cannot be separated because they are closely related to each other in observations to form a scientific attitude (Santiawati et al., 2022).

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Science learning emphasises process skills, because it involves active participation of students in learning experiences that include science process skills (Santiawati et al., 2022).

Science process skills (SPS) are complex skills that are usually applied by scientists in conducting scientific investigations, which are integrated into various stages of the learning process (Setiya Rini et al., 2022). Science process skills are considered important as skills to understand the phenomena that occur, as well as to develop and apply concepts, principles, and laws related to science (Pratiwi et al., 2019) through a series of practical activities or experiments. Science process skills are important to develop because they are the foundation for the formation of students' scientific attitudes and their ability to solve problems so that they will form a positive personality, creative, analytical, open to new ideas, innovative, and prepare them to compete in a competitive global environment (Bahri et al., 2022).

Students' science process skills in Indonesia are still relatively low (Mahmudah et al., 2019; Santiawati et al., 2022). Factors causing low science process skills include students not being encouraged to solve problems independently, lack of direct student involvement, and lack of practice to work together and find their own concepts in analysing a problem, learning tends to be teacher-centred resulting in a lack of student activeness and independence, as well as tenacity and accuracy in solving problems that are not good, resulting in students' ability to solve problems is still low (Jaya et al., 2022). In addition, the Student Worksheet (LKPD) used still does not contain student activities that can develop science process skills and does not support the learning process in the classroom (Safitri et al., 2022).

Based on the results of observations and interviews with science teachers on Thursday, 5 October 2023 at SMP Negeri 3 Surakarta, it shows that students in class VIII 4 have low science process skills. The cause of the low science process skills at SMP Negeri 3 Surakarta is caused by the learning that takes place is still teacher-centred with conventional learning methods in the form of lectures so that students become passive. In addition, practicum activities are still rarely carried out. Laboratory equipment is also still incomplete so that it slightly hampers practicum activities because when practicum only uses makeshift tools. Students in class VIII 4 had very low to moderate science process skills in the aspects of observing, formulating hypotheses, experimenting, interpreting data, inferring, and communicating. The low science process skills of students in class VIII 4 are supported through pretest activities with an average value in the observing aspect of 47.8% with a moderate category, the aspect of formulating hypotheses of 48.4% with a moderate category, the experimenting aspect of 17.2% with a very low category, the aspect of interpreting data of 28.5% with a low category, the inferring aspect of 22.6% with a low category, and the communicating aspect of 19.4% with a very low category. Furthermore, 3.2% of students have science process skills in the very high category, 22.6% of students in the high category, 12.9% of students in the medium category, 16.1% of students in the low category, and 45.2% of students in the very low category. Previous research conducted by Santiawati et al. (2022) showed that students' science process skills were classified in the poor category with an average of 39.7%. The percentage of each indicator of students' science process skills, namely observation indicators of 37.5%, prediction indicators of 34.5%, communication indicators of 43.75%, and conclusion indicators of 42.9%. A total of 15% of students who have science process skills are in the high category, 45% are in the medium category, and 40% are in the low category.

Science process skills can be improved through the learning process by using the right learning model. Therefore, teachers must create active interactions and diverse learning experiences that show how scientists conduct experiments to obtain new information and solve problems. A learning model that encourages students' active participation in the experimental process is the cooperative learning model (Hasanah & Himami, 2021). The cooperative learning model is a learning approach where students work in heterogeneous small groups and support each other in understanding and learning the material (Avisya et al., 2019). During the learning process, students must work together and help each other in mastering and understanding the material. The cooperative learning model has many advantages, namely it can improve cooperation between students, have good interaction and communication skills in teams, improve students‘ academics, deepen students’ understanding, and develop skills that will be useful for their future (Ali, 2021). Research conducted by Avisya et al. (2019) showed that science process skills in cycle I with good criteria (observing), sufficient criteria (concluding and communicating) and poor criteria (predicting) increased in cycles II and III to good and very good criteria after the application of the cooperative learning model.

In addition to cooperative learning models, problem solving learning models can also increase student activeness in the experimental process (Mulyo, 2023; Pahlevi et al., 2020). The problem solving learning model is a teaching method that involves training students to face various problems, either individually or in groups, with the aim of solving these problems independently or collaboratively (Liska et al., 2021). The problem solving learning model emphasises structured problem solving activities from easy to difficult, from simple to complex, so that it is expected to stimulate students' thinking processes, so that gradually their thinking skills can develop (Ratumanan & Ayal, 2021). The problem solving learning model has advantages, namely that it can train students in discovering a concept, increase student understanding, train problem solving skills, increase student participation, and improve students' thinking and analysis skills (Makiyah et al., 2021; Pahlevi et al., 2020). Research conducted by Delita et al. (2020)shows that the problem solving learning model has a positive effect on junior high school students' science process skills in science learning.

Creating learning conditions in accordance with the independent curriculum requires innovative learning models that actively involve students (student-centered) (Putri, 2023; Sari et al., 2024), especially in the use of scientific methods in solving problems. The Investigation Through Cooperative Problem Solving (ITCPS) learning model is an innovative learning model that can improve students' science process skills. This model integrates the steps of the problem solving learning model by applying the principles of cooperative learning where students work collaboratively in groups with the aim of increasing student activeness in solving problems and helping each other understand the material by using different strategies and techniques between groups so that students' critical thinking skills will increase (Utami et al., 2023).

The ITCPS learning model requires students to play an active role in solving problems formulated by the teacher using different strategies in the classroom (Utami et al., 2019). Through this ITCPS model, students can freely confer with other friends during the problem solving process (Utami et al., 2019). Research conducted by Utami et al. (2019) showed that the ITCPS learning model is effective in improving affective aspects and social interactions in chemistry learning. The ITCPS learning model has five stages, namely problem identification, formulating problems, investigating, explaining, and reflecting, which can improve students' thinking processes and participation in scientific activities through fun, experiential and meaningful learning activities to improve students' science process skills. Furthermore, Utami et al. (2021a) conducted another research on the development of the ITCPS learning model to strengthen students' critical thinking skills. There are aspects of critical thinking skills used in this study including interpretation, analysis, explanation, evaluation, conclusion and self-regulation. The results showed that the application of the ITCPS model can strengthen students' critical thinking skills in learning chemistry on chemical equilibrium material. Research on the ITCPS model was also conducted by Aliyah (2023) which resulted in the effect of this model on critical thinking, written communication, and science learning outcomes. Furthermore, research from (Prasadityo, 2023) explains that this model affects science learning outcomes, problem solving, and critical thinking skills.

The study aims to determine the application of the Investigation Through Cooperative Problem Solving (ITCPS) learning model in science learning class VIII 4 at SMPN 3 Surakarta in terms of the implementation of the syntax of the learning model, as well as to determine the improvement of science process skills of students in class VIII 4 at SMPN 3 Surakarta using the Investigation Through Cooperative Problem Solving (ITCPS) learning model in science learning.

2. Method

The research was conducted in class VIII 4 SMPN 3 Surakarta in the academic year 2023/2024 with a total of 31 students. The type of research is Classroom Action Research (CAR). The research used the Kemmis and MC.Taggart model which consists of four stages: planning, action implementation, observation, and reflection (Juhji, 2016), which was carried out in two cycles. The second cycle was stopped if students had achieved classical learning completeness. Each cycle involved all four stages of CAR.

Data collection was carried out using written tests in the form of description questions to measure the initial profile of science process skills, observations to measure science process skills in each cycle, and interviews using interview guidelines to find out information related to students' science process skills. The data validity test technique used was data triangulation. The data obtained were then analyzed by following the interactive model data analysis technique developed by Miles & Huberman (1994), which consists of data reduction, data presentation, and verification or conclusion drawing. The data analysis technique used was qualitative descriptive technique. Data analysis of observation results and written tests used quantitative descriptive statistical analysis.

The target of increasing the final achievement of the research is (1) Each aspect of students' science process skills increased from pre-cycle to cycle 1 and from pre-cycle to cycle 2. (2) The results of science process skills experienced an increase in value of 10 from pre-cycle to cycle . (3) The results of science process skills had an increase in value of 20 from pre-class to cycle 2. (4) At least 65% of students in the class have achieved individual mastery with at least high category.

3. Results and Discussion

3.1. Pre-Cycle

The research was conducted in class VIII 4 of SMP Negeri 3 Surakarta in the academic year 2023/2024, which consisted of 31 students. Before entering cycle 1, a pre-cycle stage was carried out as an initial step in research design. This pre-cycle involved a number of activities, including a written test of science process skills consisting of 12 questions designed to cover six aspects of science process skills, namely observing, formulating hypotheses, experimenting, interpreting data, inferring, and communicating. Each two questions represented one aspect, so a total of six aspects were covered in the test. In addition to the test, this stage also involved teacher and student observations and interviews.

Based on the results of observations and interviews with teachers at SMP Negeri 3 Surakarta, it is known that practicum activities are still rarely carried out. In the previous semester, only one practicum was conducted, namely on addictive substances, while practicum for other materials was not carried out. The results of interviews with students also get the same thing, namely rarely done practicum. In addition, the use of LKPD has also not been implemented, students more often write answers on blank sheets. According to students, the learning method used by teachers is more likely to use the lecture method which is dominated by the teacher. Learning with the lecture method will have an impact on student activeness which tends to be more passive during learning (Allanta & Puspita, 2021). In addition, practicum activities that are rarely carried out result in students‘ low science process skills (Rohana et al., 2021), as reflected in the results of the written test of students’ process skills at the pre-cycle stage.

The average value of achievement for each aspect of science process skills shows varying results. Here are the lowest to highest values in order, namely in the experimenting aspect of 17.2% with a very low category, the communicating aspect of 19.4% with a very low category, the inferring aspect of 22.6% with a low category, the interpreting data aspect of 28.5% with a low category, the observing aspect of 47.8% with a medium category, and the formualting hypotheses aspect of 47.8% with a medium category. Thus, the class average score was 30.4% with a low category. The low value of students‘ science process skills in the pre-cycle was caused by learning activities that still applied conventional learning methods and still used teaching materials that still focused on material and theory so that students’ science process skills were less honed (Jumaniar et al., 2024).

Students who scored in the very high category were 3.2%, high category was 22.6%, medium category was 12.9%, low category was 16.1%, and very low category was 45.2%. The data shows that only 8 out of 31 students achieved individual completeness with a minimum high category, or about 25.8% of students.

Based on the data from the pre-cycle, it is necessary to have cycle 1 to see the improvement of the profile of science process skills of students in class VIII 4 SMP Negeri 3 Surakarta. This pre-cycle data is useful as a baseline in cycle 1 and cycle 2. The research was conducted in two cycles, with the determination of the next cycle depending on the achievement of the set indicators. The ITCPS learning model will be applied, with the hope of improving students' science process skills.

3.2. Cycle 1

Classroom action research was conducted by applying the ITCPS learning model in class VIII 4 SMP Negeri 3 Surakarta which consisted of two cycles. Cycle 1 was conducted in two meetings on January 16 and 18, 2024. The time to complete cycle 1 was 5 lesson hours (5 x 40 minutes). Learning activities are carried out with the aim of improving students' science process skills by applying the ITCPS learning model. The ITCPS learning model is a model that integrates two main learning models, namely cooperative learning models and problem solving learning models (Utami et al., 2021b). The learning process in the classroom was carried out for four meetings with a total duration of ten lesson hours. The ITCPS learning model involves five stages, including (1) problem identification, (2) problem formulation, (3) investigation, (4) explanation, and (5) reflection (Utami et al., 2021b). The ITCPS model is based on the theories of cognitivism and constructivism. From the perspective of cognitivism, learning activities emphasize the learning process rather than the learning outcome itself (Widyatmoko, 2023). By using the ITCPS learning model, students are given the opportunity to be actively involved during the learning process, as happens in the practicum, where in experimenting activities students will be more focused on the learning process than the results of the practicum itself, so that it can significantly improve their science process skills. Meanwhile, from the viewpoint of constructivism, learning is seen as a process of constructing knowledge through practical experience (Rohmaniyah, 2021). This theory emphasizes the importance of student activeness in learning, where students construct their own understanding through active interaction with learning materials and the learning environment (Pramana et al., 2024). The main goal of the ITCPS learning model is to increase students' engagement by involving them in practical experiences, such as practicum, which allows them to build deeper conceptual understanding and improve their science process skills.

3.2.1. Action Planning

The action planning stage is carried out with several preparations that support the actions that will be taken as a solution to learning problems. This planning stage is a very important first step. This planning action is in the form of preparing learning instruments and research instruments.

3.2.2. Action

First Meeting

The learning activities began with the introduction, namely the teacher opened the learning activities by giving greetings to the students then continued with praying together led by the class leader. Next, the teacher took attendance and conditioned the class to be orderly, and asked about students' learning readiness. The teacher gives apperception to students to remember the previous material, namely effort, energy, and simple aircraft and relates it to vibration material. Next, the teacher invites students to conduct an experiment by holding the base of each throat silently and audibly. Students are asked to think about their experience doing the activity. Furthermore, the teacher guides students to express learning objectives, but students cannot convey learning objectives so that the teacher explains the learning objectives and benefits of learning vibration material. Furthermore, the teacher conveyed the activities that would be carried out, namely in the form of vibration practicum.

The next activity is the core activity which consists of the ITCPS learning model syntax. The first ITCPS learning model syntax is problem identification. In this syntax, the activities carried out by the teacher are forming groups consisting of 5-6 members heterogeneously and distributing LKPD to each student. Next, the teacher displays the video in the power point that has been prepared by the teacher. The video is a pendulum wave video. Students are asked by the teacher to observe and analyse the frequency and period of vibration of the pendulum wave. The observations made by students will bring out the observing aspect of science process skills.

After observing the pendulum wave video, students are asked to write down the formulation of problems and hypotheses that might occur. This syntax will bring out the science process skills of the formulating hypotheses aspect. The formulation of the problem is obtained from the results of students' observations on the pendulum wave video. Based on the facts that students found in the video, they wrote the problem formulation in the form of questions. Furthermore, each group was asked to write the answers to the problem formulation in front of the class, then the teacher checked the answers one by one. After all the answers are written, the teacher determines the problem formulation that will be used in this first meeting so that each student has the same perspective of the answer so as to produce the same conclusion in the simple pendulum practicum activity.

Investigation activities began with the distribution of simple pendulum props and materials. The tools and materials used include a pendulum, mattress rope, stopwatch, pencil / nail, pendulum (eraser), stationery, and ruler. The tools and materials used by students have been provided by the teacher, to anticipate if there are students who forget to bring them. After all the tools and materials were distributed to each group. Students were asked to write the control variable, independent variable, and dependent variable in this simple pendulum experiment. After all variables are written by students, the next activity is that students are asked to read the work steps that need to be done by students. Students arrange tools and materials to form the desired props. Then proceed with the activity of swinging a simple pendulum according to the instructions given. During this experimental activity, there are experimenting aspects of science process skills.

After the experiment is carried out, students write down the results obtained in the column that has been provided on the LKPD. Then, students answer all discussion questions consisting of four questions based on the results of the experiments that have been carried out. This activity contains science process skills aspects of interpreting data and communicating. Students are asked to make a graph of the relationship between time, number of vibrations, period, and frequency based on the results that have been obtained. After all questions are answered by students, then students are asked to make conclusions based on the results of the experiment and must be in accordance with the formulation of the problem that has been agreed upon. Making this conclusion contains the communicating aspect of science process skills.

The closing activity was carried out by the teacher giving directions and explaining the activities at the next meeting, namely continuing the syntax of the ITCPS learning model. Furthermore, closing learning activities with a prayer together led by the class leader.

Second Meeting

The activity begins with an introduction in the form of greetings from the teacher and praying together led by the class leader. Then, the teacher took attendance, conditioned the class, and asked students about their readiness to learn. Next, the teacher gives apperception to students by remembering the previous material, namely vibration, then the teacher invites students to continue the activities in the previous meeting by presenting the results of the experiments that have been carried out with their respective groups.

The core activities began with 2 groups presenting their results in front of the class. Students explained the results of the experiments that had been carried out. Then, the teacher opened a question and answer discussion between students, and input and suggestions for those who did not understand. Groups that are not selected to present are required to pay attention, take notes, and ask questions to the group that is presenting. At this stage of explaining there are aspects of science process skills aspects of communicating when presenting the results of their experiments.

The teacher reflects to the whole class with some questions related to the vibration practicum activity. Then, the teacher provides clarification to students on the learning outcomes. Then, the teacher guides students to make conclusions about the learning that has been done, but students do not answer, so it is the teacher who conveys the learning conclusions in cycle 1. At this reflection stage, there are science process skills in the inferring aspect when expressing learning conclusions, but it is not optimal. In the activity of expressing conclusions, students' answers did not match the teacher's expectations.

At the end of the second meeting, before the learning ended, the teacher distributed posttest questions to students about vibration, 12 items in the form of description questions. After the posttest ended, the teacher gave assignments in the form of individual practicum reports with a deadline of 1 week. The teacher explains what needs to be written in the practicum report. Then, the teacher ends the learning activity by praying together and giving greetings.

3.2.3. Observation

During the learning process, observation was conducted by two observers. Observers were provided with teaching modules, observation guidelines, scientific process skills observation sheets, and syntax implementation sheets. The observation process during learning was recorded as supporting data in the form of photos and videos using a cell phone camera.

Syntax of Problem Identification

The first syntax in the ITCPS learning model is problem identification. The problem identification stage is an important and crucial initial stage in the problem solving process (Nasution, 2021). Problem identification is done by students by observing a phenomenon in a pendulum wave video. At this stage, students must define and understand the problem to be studied in depth. Clear and specific problem identification allows students to focus on the given problem. The indicator of science process skills seen at the problem identification stage is the observing aspect. The observing aspect showed a significant increase with an initial percentage of 47.8% increasing to 62.5%.

The activities carried out by students are observing and observing the effect of rope length on the period and frequency of the pendulum during the presentation of the problem in the form of a pendulum wave video. Students use all their senses in this observation process. The observing aspect is a fundamental aspect of scientific inquiry because it allows students to collect data and make observations that can be used to test hypotheses and draw conclusions (Council, 2012). However, in this study, some students still had difficulty in connecting the results of observations with relevant scientific concepts. This can occur due to students' lack of experience in making scientific observations systematically (Putri et al., 2022).

Syntax of Formulating the Problems

The next stage is formulating the problem. Formulating problems is an activity carried out by students to determine the problems that occur after observing certain phenomena or objects. The formulation of the problem becomes the basis for formulating research objectives, which must be appropriate and consistent with the identified problem. (Rahardjo, 2023). The activity of formulating problems takes place after students identify problems in the pendulum wave video. After formulating the problem students will formulate a hypothesis. A hypothesis is a temporary conjecture or assumption made by a researcher regarding the relationship between two or more variables that will be tested through a study (Yam & Taufik, 2021).

In the syntax of formulating problems, the aspect of formulating hypotheses can be seen when students write the formulation of problems and hypotheses after observing the pendulum wave video. Students write down possible questions as a basis for conducting experiments. The competencies expected from the activity of formulating hypotheses are the ability to develop creativity, curiosity, and the ability to formulate questions that form critical thinking, all of which are important for intelligent life and lifelong learning (Liana, 2020). The aspect of formulating hypotheses showed a significant increase with an initial percentage of 48.4% increasing to 78.8%. However, in this study, some students still had difficulty in formulating focused and relevant hypotheses. This can occur due to students' lack of understanding of the structure and purpose of hypotheses in the scientific process.

Syntax of Investigation

The next stage is the investigation stage. Investigation is the phase where curiosity is transformed into action to answer the set research question or hypothesis, consisting of several phases namely exploration, experimentation, and data interpretation. (Pedaste et al., 2015). Dalam tahap ini, siswa melakukan eksplorasi atau pengamatan, merancang berbagai eksperimen dengan mengubah nilai variabel, membuat prediksi, serta menafsirkan hasil yang diperoleh (Pedaste et al., 2015). Investigation activities take place after students formulate hypotheses based on their observations of the pendulum wave video. During the investigation stage, there are several aspects of science process skills that will be formed, namely aspects of experimenting, interpreting data, inferring, and communicating.

In the investigation syntax, the experimenting aspect can be seen when students conduct experiments to test their hypothesis after observing the pendulum wave video. They conduct experiments to answer questions that arise from initial observations. The competencies expected from investigative activities are the ability to design and carry out experiments, as well as the ability to collect and analyze data, all of which are important for the development of science process skills (Putri et al., 2022). Indicators of science process skills showed a significant increase in the experimenting aspect with an initial percentage of 17.2% increasing to 79.8%. The experimenting aspect can be seen when students do simple pendulum practicum activities in groups with LKPDs that are filled out individually. Each group uses the same tools and materials during the practicum. The experimenting aspect increased due to the practicum procedures used during learning activities (Purnamasari, 2020), so that students get hands-on experience. This hands-on experience is important because it allows students to understand concepts more deeply through real practice.

After the practicum is carried out, students write the results in the LKPD and process the data to answer the questions contained in the LKPD. Through the LKPD, all aspects of students' science process skills can be measured by answering the questions contained in the LKPD (Syafi'ah & Laili, 2020). The aspects assessed when processing and analyzing data are the aspects of interpreting data, inferring, and communicating. The aspect of interpreting data has increased with an initial percentage of 28.5% to 68.3%. Students interpret data based on their findings during practicum activities. Data interpretation activities involve a systematic process of analyzing, organizing, and understanding data to extract meaningful patterns, trends, and relationships (Gizaw & Sota, 2023). However, some students still need help in identifying patterns and trends independently.

The inferring aspect showed an increase with an initial percentage of 22.6% to 47.1%. Students still do not understand enough to connect the conclusion with the purpose of the experiment. To overcome this, the teacher gave passive students the opportunity to play an active role in the discussion to determine the conclusion (Tanti et al., 2020). Furthermore, the communicating aspect has increased with an initial percentage of 19.4% to 59%. Students showed a fairly good ability to convey their results and findings. However, some students still have difficulty in conveying information in a clear and structured manner.

Syntax of Explaining

After conducting investigative activities, students explain their findings through presentation activities in front of the class with their group. Presentation activities will develop students' speaking skills. Speaking ability has an important value and is a must for students because it allows students to express desires, convey information, share thoughts and ideas, as well as influence, convince, ask, and entertain others, and reflects one's ability to think (Patongai et al., 2023). When making presentations, students still feel less confident because they are not used to it. They still feel shy, nervous, and tense when seen by many people, so that the delivery of ideas, opinions, and discussion results becomes less smooth. Confidence is very important because it can affect the use of language when conveying ideas, opinions, and discussion results (Pratiwi et al., 2022). After the presentation, there was a question and answer session guided by the teacher. Nevertheless, students seemed to remain enthusiastic and excited during the learning. At this stage, the communicating aspect of students will appear. This shows that the ITCPS learning model can increase the value of students' science process skills in cycle 1.

Syntax of Reflection

Reflection activities took place smoothly, where the teacher provided reflection and clarification of the material regarding the practicum that had been carried out. Reflection is the final stage of the learning process which aims to correctly understand the learning concepts that have been learned (Utami et al., 2021b). Students still have difficulty in summarizing practicum activities because they do not fully understand the meaning of inferring in the context of experiments. At this stage, students' inferring skills began to appear, although they still need to be improved. Teachers help students understand this concept by providing additional explanations and concrete examples, so it is hoped that students can be better at inferring experimental results in the future.

3.2.4. Action Reflection

After completing the learning activities in cycle 1, the teacher reflects on the learning process that has been carried out. Learning reflection is the teacher's action in reviewing the learning process that has been carried out, which includes planning, implementation, and managed learning outcomes (Ismayanti et al., 2020). The results of this reflection aim to identify existing shortcomings so that an improvement plan can be developed that can be applied in cycle 2. Based on the results of research in cycle 1, 91.30% of syntax was well implemented. During practicum activities, students are given the freedom to carry out practicum independently, the teacher only acts as a facilitator. However, this freedom caused some students to feel unsupervised and difficult to condition (Hamidah, 2022). In addition, there are several aspects that have not improved in accordance with the learning achievement indicators, namely aspects of observing, formulating hypotheses, inferring, and communicating. These four aspects have not yet reached mastery. In addition, the target achievement indicator has not been achieved, which is only about 54.8% of students who reached individual completeness in cycle 1 according to Table 1. Therefore, it is necessary to adjust the learning strategy to ensure the smooth implementation of the ITCPS learning model and improve students' science process skills in cycle 2.

Table 1. Percentage Score of Students' Science Process Skills Cycle 1

Value Interval	Frequency	Percentage (%)	Category
81-100	1	3.2	Very High
61-80	16	51.6	High
41-60	9	29	Moderate
21-40	0	0	Low
0-20	5	16.1	Very Low
Total	31	100	

3.3. Cycle 2

Cycle 2 was conducted in two meetings on January 23 and 25, 2024. The time to complete cycle 2 is 5 lesson hours (5 x 40 minutes). Cycle 2 was carried out because of the reflection of learning in cycle 1 as a learning evaluation. Learning in cycle 2 went smoothly and all the syntax of the ITCPS learning model could be implemented optimally on wave material. Based on the results of interviews with teachers and students showed that after cycle 2, learning activities became more interactive and interesting. Learning is no longer dominated by the teacher centered approach, but has changed to student centered. Student-centered activities are able to increase student activeness (Putri, 2023). Student-centered activities in the implementation of this research are practicum activities and group discussions. The use of practicum method in learning has been proven to be able to train students' science process skills (Putri et al., 2022). Through practical experience, students are given the opportunity to observe, measure and experiment, which in turn enriches their understanding of science principles. This process includes developing practical skills, increasing students' motivation and interest in learning, facilitating concept understanding, and strengthening the connection between theory and practice (Nuai & Nurkamiden, 2022). Students looked enthusiastic during the practicum activities. The improvement of students' science process skills in cycle 2 compared to the pre-cycle and cycle 1 showed significant progress. This may be due to students' habits and experiences in undergoing practicum activities in the classroom that have been carried out previously in cycle 1.

3.3.1. Planning Action

The reflection results in cycle 1 show that there are aspects that have not improved and learning activities are still not optimal. Therefore, the teacher planned corrective actions so that in cycle 2 all learning activities could run optimally so as to produce satisfactory and optimal results. The learning tools and research instruments were adjusted to the aspects and indicators of science process skills.

3.3.2. Action

First Meeting

The learning activity begins with the introduction, namely the teacher opens the learning activity by greeting the students then continues with a prayer together led by the class leader. Next, the teacher took attendance and conditioned the class to be orderly, and asked about students' learning readiness. The teacher gives apperception to students to remember the previous material, namely vibration and relate it to wave material. Furthermore, the teacher invites students to argue about their experiences with waves that have been encountered. Next, the teacher guides students to express the learning objectives and students answer them. The teacher conveys the benefits of learning waves, then conveys the activities that will be carried out in the form of wave practicum.

In the problem identification syntax, the activities carried out by the teacher are forming groups of 5-6 members heterogeneously and distributing LKPD to each student. Next, the teacher displays a power point that has been prepared by the teacher. Students are asked to observe two different images, then continued with a video of water waves and springs. Students are asked by the teacher to observe and analyze the differences between the two waves. The observations made by these students will bring out the science process skills of the observing aspect. In this observation activity, students are asked to write down anything that students encounter and want to ask in the column provided on the LKPD.

After observing the images and videos of waves, students are asked to write down the formulation of problems and hypotheses that might occur. This syntax will bring out the science process skills of the formulating hypotheses aspect. The formulation of the problem is obtained from the results of student observations. Based on the facts that students found in the video, they wrote the problem formulation in the form of questions. Furthermore, each group was asked to write an answer to the problem formulation in the form of a hypothesis.

After formulating the hypothesis, the next activity was an investigation that began with the distribution of tools and props in the form of slinki. The tools and materials used by students have been provided by the teacher, to anticipate if there are students who forget to bring them. After all the tools and materials were distributed to each group. Students are asked to write the control variable, independent variable, and dependent variable in the slinki experiment. After all variables are written by students, the next activity is that students are asked to read the work steps that need to be done by students. Students conduct the experiment according to the instructions given. During this experimental activity, there are experimenting aspects of science process skills.

After the experiment is carried out, students write down the results obtained in the column that has been provided on the LKPD. Then, students answer all discussion questions consisting of four questions based on the results of the experiments that have been carried out. This activity contains science process skills aspects of interpreting data and communicating. Students are asked to sketch transverse and longitudinal wave images based on the experiments that have been carried out. Students are asked to answer all questions. Then students are asked to make conclusions based on the results of the experiment and must be in accordance with the formulation of the problem that has been agreed upon. Making this conclusion contains the communicating aspect of science process skills.

The closing activity is carried out by the teacher giving directions and explaining the activities at the next meeting, namely continuing the syntax of the ITCPS learning model. Furthermore, closing learning activities with a prayer together led by the class leader.

Second Meeting

The activity begins with an introduction in the form of greetings from the teacher and praying together led by the class leader. Then, the teacher took attendance, conditioned the class, and asked students about their readiness to learn. Next, the teacher gives apperception to students by remembering the previous material, namely waves, then the teacher invites students to continue the activities in the previous meeting by presenting the results of the experiments that have been carried out with their respective groups.

The core activities began with two groups presenting the results of their experiments in front of the whole class. The students explained the process and results of the experiments they had done. After that, the teacher facilitated a question and answer discussion session between students, as well as providing input and advice to students who may not fully understand the material. Groups that are not selected to make presentations are required to pay attention, take notes, and ask questions to the group that is presenting. At this stage of explaining, there are science process skills aspects of communicating when they convey the results of their experiments to the class.

The teacher gave a reflection to the whole class in the form of questions. Then the teacher clarified the learning outcomes to the students. Then, the teacher guides students to make conclusions about the learning that has been done and answered by students.

At the end of the second meeting, before the learning was closed, the teacher distributed 12 posttest questions to students regarding wave material. The questions were in the form of description questions. After finishing, the teacher gave an assignment in the form of an individual practicum report that must be completed within one week. The teacher provides an explanation of the components that must be included in the practicum report. Next, the learning activity ended with a prayer together and giving greetings.

3.3.3. Observation

Action observation activities in cycle 2 are still the same as in cycle 1.

Syntax of Problem Identification

Problem identification is an important first step in a research (Nasution, 2021). Problem identification can guide the research process by providing a clear focus and direction. Problem identification focuses on stimulating interest and curiosity related to the problem at hand (Pedaste et al., 2015). In addition, problem identification helps in formulating appropriate research questions and hypotheses, which are critical for empirical testing and validation (Lund, 2022). At this stage, the aspect of science process skills that appears is the observing aspect. The observing aspect can be seen when students observe and observe videos and pictures of the differences between transverse and longitudinal waves. The observing aspect in cycle 2 showed a significant increase from 47.8% to 86.7%. The increase occurred because students already understood how to observe a phenomenon. Observing activities lead to more meaningful learning because students directly observe events in their environment (Fitriana et al., 2019).

Syntax of Formulating the Problems

Formulating problems is an important step that must be done clearly and unambiguously in the form of questions. Formulating problems can be done after researchers have identified a problem carefully (Nirmala & Hendro, 2021). Research problems must be solvable by scientific methods and must not be moral or social in nature that cannot be researched directly (Lund, 2022). In addition, the research problem must have several possible solutions or answers, which can then be broken down into more specific hypotheses. Hypotheses should be based on the research problem that has been identified and clearly formulated (Lund, 2022). At this stage, the formulating hypotheses aspect will be assessed. Students are asked to write down the problem formulation and possible hypotheses after observing the transverse wave and longitudinal wave videos. Based on the research results, the formulating hypotheses aspect has increased from 48.4% to 90%.

Syntax of Investigation

The next stage is an investigation that is carried out through a series of experimental activities. Experiments can improve students' academic performance through practical experiences that strengthen their understanding of theoretical concepts, can also improve students' critical thinking and problem-solving skills, as well as their overall academic performance (Kotsis, 2024). The investigation stage is carried out to prove the hypothesis that students have previously compiled. The activities carried out by students are conducting experiments on transverse and longitudinal waves using slinki according to the guidelines written in the LKPD. This experimental activity will improve the experimenting aspect of students. The experimenting aspect has increased from 17.2% to 96.25%.

After conducting experiments, students are asked to process the data obtained in the LKPD according to the results of their experiments. A good LKPD must present activities that expand students' understanding, avoid multiple interpretations, use images or illustrations, and present examples that are appropriate to the context and accuracy of terms (Khaeriyah et al., 2022). The aspects assessed when processing and analyzing data are interpreting data, inferring, and communicating. The aspect of interpreting data has increased from 28.5% to 68.3%. The inferring aspect showed an increase in value from 22.6% to 83.3%. Meanwhile, the communicating aspect increased from 19.4% to 84.7%. Students showed a fairly good ability to convey their results and findings.

Overall, the final and average achievement of science process skills in cycle 2 showed a significant increase, from 30.4% to 85.1%. In this cycle, as many as 96.8% of students had achieved mastery in their science process skills scores. This increase shows the effectiveness of the applied learning method as well as students' ability to understand and apply science concepts in practice. The use of LKPD based on good and appropriate science process skills can significantly improve students' science process skills (Bestari et al., 2022).

Syntax of Explaining

Explaining activities are filled with presentations of randomly selected practicum results, consisting of two groups. Each group was given the opportunity to present the results of their experiments in front of the class. Students have begun to get used to presenting in front of the class, without direct guidance from the teacher. This presentation involved an explanation of the experimental procedure, data obtained, data analysis, and conclusions drawn based on the results of the practicum. After the presentation was completed, a question and answer session was held guided by the teacher. In this session, other students were given the opportunity to ask questions related to the presentation that had been delivered, while the group that presented the results of their practicum was responsible for answering these questions. The teacher acts as a facilitator, ensuring the discussion goes well and providing clarification if needed (Biruni et al., 2021). At this stage, the communicating aspect of students will emerge clearly. Students not only learn to convey their ideas and findings clearly and systematically, but also learn to listen and respond to questions from their peers. This activity helps students develop effective communication skills, which is one of the important skills in the science process (Fitriah et al., 2020).

Syntax of Reflection

The last stage of learning is reflection. The purpose of reflection is to provide an explanation or a comprehensive picture of what students have learned (Ismayanti et al., 2020). The reflection activity took place smoothly and structured, where the teacher provided in-depth reflection to students regarding the practicum that had just been carried out. The teacher provided constructive feedback, identified strengths and weaknesses in the implementation of the experiment, and provided suggestions for future improvements. In addition, a material clarification session was also conducted to clarify students' understanding. In this session, the teacher re-explained concepts that might still be poorly understood by students, provided additional examples, and answered questions that arose during the practicum and presentation. The teacher ensures that all students get a clear and comprehensive understanding of the material that has been learned.

The conclusion of the learning activity is made together by students and teacher through interactive discussion. The teacher invites students to contribute their thoughts on the experimental results, data obtained, and conclusions that can be drawn from the activity. This process involves not only the teacher providing guidance, but also students actively participating in formulating conclusions. Through this discussion, students are encouraged to remain active during the learning process (Rahmat & Meilani, 2023). When concluding, the inferring aspect will appear clearly. Students learn to make conclusions based on the data and evidence they have collected during the experiment. This process is very important in developing students' science process skills.

3.3.4. Reflection

After completing cycle 2, the teacher conducted an in-depth learning reflection on the entire learning process that had been carried out, with a special focus on evaluating the implementation of the improvement plan that had been prepared previously. Learning reflection is carried out as a form of analyzing the results that arise as a result of the treatment carried out, including recording problems that arise during the learning process, interpretation, analysis, and drawing conclusions from the observation results (Wibowo, 2021). In this stage, the teacher conducts a thorough analysis related to the implementation of each planned improvement step, and evaluates the extent to which the plan is successfully implemented in the classroom. The reflection results show that all the improvements planned by the teacher were successfully implemented. The entire syntax of the ITCPS learning model in cycle 2 was 100% implemented. All aspects of science process skills namely observing, formulating hypotheses, experimenting, interpreting data, inferring, and communicating have met the learning achievement indicators. In addition, more than 65% of students have reached the minimum high category and met the research achievement indicator of 96.8% presented in Table 2. The research was stopped in cycle 2 because all learning achievement indicators had been met, so the ITCPS learning model could improve the science process skills of students in class VIII 4 SMP N 3 Surakarta. This success reflects the commitment and hard work of teachers in preparing and implementing effective learning strategies to improve the quality of student learning (Sulaeha, 2022).

Table 2. Percentage of Students' Science Process Skills Value Cycle 2

Value Interval	Frequency	Percentage (%)	Category
81-100	28	90.3	Very High
61-80	2	6.5	High
41-60	0	0	Moderate
21-40	0	0	Low
0-20	1	3.2	Very Low
Total	31	100	

3.4. Comparison of Pre-Cycle, Cycle 1, and Cycle 2

Based on the results of observations of science process skills, the percentage of students who experienced an increase in grades in the observing aspect of cycle 1, which amounted to 41.9% of students. While in cycle 2, students who experienced an increase in value amounted to 71% of students. The results of research on the aspect of formulating hypotheses in cycle 1, students who experienced an increase in value amounted to 54.8% of students. While in cycle 2, students who experienced an increase in value amounted to 61.3% of students. The results of research on the experimenting aspect of cycle 1, students who experienced an increase in value amounted to 83.9% of students. While in cycle 2, students who experienced an increase in value amounted to 96.8% of students. The results of research on the interpreting data aspect of cycle 1, students who experienced an increase in value amounted to 74.2% of students. While in cycle 2, students who experienced an increase in value amounted to 80.6% of students. The results of research on the inferring aspect of cycle 1, students who experienced an increase in value amounted to 67.7% of students. While in cycle 2, students who experienced an increase in value amounted to 93.5% of students. The results of research on the communicating aspect of cycle 1, students who experienced an increase in value amounted to 64.5% of students. While in cycle 2, students who experienced an increase in value amounted to 96.8% of students. Comparison of observation results for each aspect of science process skills at pre-cycle, cycle 1, and cycle 2 is presented in Figure 1.

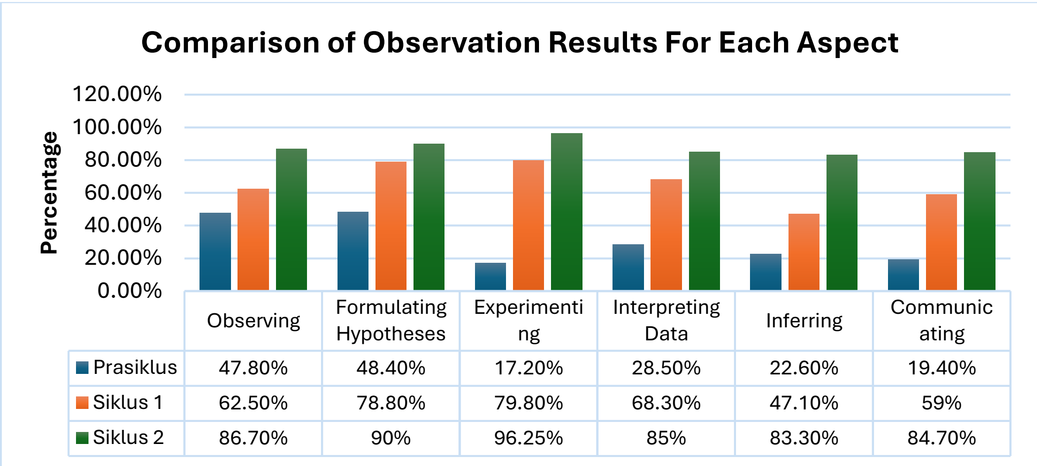

Figure 1. Comparison of Results of Each Aspect of Science Process Skills Between Cycles

Based on Figure 1, the average value of each aspect of science process skills has increased from pre-cycle to cycle 1 and pre-cycle to cycle 2. These results show that the increase in the value of each aspect is in accordance with the research achievement indicators. Based on Figure 4.6, the observing aspect experienced an increase in value from 47.8% to 62.5% in cycle 1, and to 86.7% in cycle 2. In the formulating hypotheses aspect, the score increased from 48.4% to 78.8% in cycle 1, and to 90% in cycle 2. In the experimenting aspect, the score increased from 17.2% to 79.8% in cycle 1, and to 96.25% in cycle 2. In the interpreting data aspect, the score increased from 28.5% to 68.3% in cycle 1, and to 85% in cycle 2. In the inferring aspect, the score increased from 22.6% to 47.1% in cycle 1, and to 83.3% in cycle 2. In the communicating aspect, the score increased from 19.4% to 59% in cycle 1, and to 84.7% in cycle 2.

The average observation value of science process skills has increased from pre-cycle to cycle 1, namely from 30.4% to 65.9% so that the amount of increase is 29%, then from pre-cycle to cycle 2, namely from 30.4% to 85.1% so that it has increased by 71%. These results show that the research achievement indicators have been met. The comparison value is presented in Figure 2.

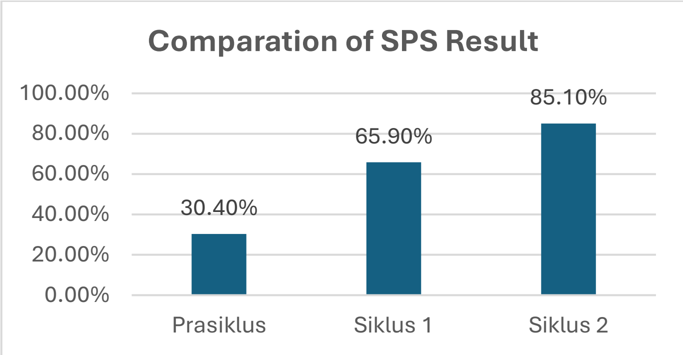

Figure 2. Comparison of Science Process Skills Values Between Cycles

Based on Figure 4.7, the observation value of science process skills in 13 students did not increase the value of science process skills, namely students number 3, 5, 6, 9, 14, 15, 16, 17, 18, 21, 24, 26, and 29 so that students who experienced an increase in value were 18 students or 58.1% of students. Furthermore, in cycle 2, students who did not experience an increase in the value of science process skills amounted to 6 students, namely students number 3, 6, 11, 14, 26, and 29. Therefore, students who experienced an increase in value amounted to 80.6% of students

3.5. Conclusion

The ITCPS learning model can be implemented in two cycles for four meetings. Each cycle is implemented in two meetings. Each cycle was able to accommodate the five syntaxes of the ITCPS learning model in two meetings. In the first meeting, the three syntaxes applied were problem identification, problem formulation, and investigation. In the second meeting, the two applied syntaxes are explaining and reflection. The level of implementation of the ITCPS learning model syntax reached 91.30% in the first cycle and increased to 100% in the second cycle after learning reflection supported by learning instruments in the form of observation sheets.

The science process skills of students in class VIII 4 SMP Negeri 3 Surakarta can increase after the application of the ITCPS learning model which was carried out for 2 cycles. The improvement in science process skills is seen after students carry out a series of learning processes through practicum related to vibrations using a simple pendulum and waves using slinki because practicum provides direct experience for students. In addition, the application of the ITCPS learning model can also create an interactive and collaborative learning environment. Each aspect of science process skills can increase from pre-cycle to cycle 2. Each syntax of the learning model plays a role in improving aspects of science process skills. The results showed that the observing aspect increased from 47.8% to 86.7%. The formulating hypotheses aspect increased from 48.4% to 90%. In the experimenting aspect, it increased from 17.2% to 96.25%. In the aspect of interpreting data increased from 28.5% to 85%. In the aspect of inferring increased from 22.6% to 83.3%. In the communicating aspect, it increased from 19.4% to 84.7%. With an increase in the average value of SPS from 30.4% to 85.1%.

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