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The Use of Inquiry Learning Model on Plant Growth and Development Material to Improve Students' Science Process Skills

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Abstract: The purpose of the study was to improve the science process skills of students by using an inquiry learning model on the material of growth and development in plants. This type of research uses quasi experimental in the form of Nonequivalent Control Group Design. The population in this study were all XII IPA classes. The samples were class XII IPA 1 and class XII IPA 2 with a total of 28 students. The sampling technique used in this study was Purposive Sampling. The data collection technique used is in the form of a test of students' science process skills. The results of the t test analysis research can be obtained sig value. (2-tailed) of 0.033 <0.05, then according to the basis for decision making in the independent sample t-test, it can be concluded that H_0 is rejected and H_a is accepted, meaning that the application of the inquiry learning model on the material of growth and development in plants can improve the science process skills of students at SMA Negeri 1 Tapa. Suggestions from researchers require further research on the application of inquiry learning models on other subjects, so that it can be seen the consistency of the effect of applying these learning models on improving science process skills.

Keywords: Inquiry Model; Plant Growth; Science Process Skills

Introduction

Education is a conscious and planned effort to create a learning atmosphere and learning process so that students actively develop their potential to have religious spiritual strength, self-control, personality, intelligence, noble character and skills needed by themselves and society (Rahman et al., 2022). To achieve educational goals, an innovation or improvement in the learning process is needed.

The learning process is an activity designed with the aim of teaching students. The learning process is an interaction activity between teachers and students. According to Vasmin et al. (2020) The biology teaching and learning process in the 2013 curriculum is learner-centered, where they are guided to be able to experiment and make observations, and demand critical thinking, so as to improve students' skills.

The learning process at this time is only fixated on mastering concepts but cannot train students to have process skills. The teacher-centered learning process only involves students as listeners and note-takers so that the process skills possessed by students cannot develop and tend to go unnoticed.

Science Process Skills (known with KPS) is a process in learning that prioritizes the ability to gain knowledge and communicate what has been obtained. Skills to obtain knowledge can use mental (psychological) abilities or action (physical) abilities. Learners will appreciate an activity more when going through the process, so that to be able to develop science process skills is needed through direct experience. These skills involve intellectual, manual and social skills. Learners can perform science process skills activities provided that thinking involves their intellect. In addition, manual skills are also involved during the learning process when they will use tools and materials and assemble tools. In the learning process, students interact with their peers using social skills, for example asking questions, discussing their observations, and communicating them (Wiratman et al., 2021). According

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to Janah et al. (2018) The application of science process skills in learning will obtain optimal learning outcomes.

Science learning essentially includes two dimensions, namely science as a process (science process skills) and science as a product (Rahardjo, 2019). Science process skills have an influence in science education because they help learners to develop intellectual skills, manual skills and social skills. Science learning is closely related to scientific performance that can be developed through hands on or direct experience with investigations and experiments to train science process skills to produce minds on knowledge. According to Senisum (2021) Science process skills in the field of teaching science are important to empower because in addition to improving problem-solving skills it is also useful for improving rational thinking skills for students. According to Asy'ari & Fitriani (2019), SPS are defined as skills that help in learning, provide variations in methods and ways to conduct experiments make students active, increase student responsibility, help students understand practically, and increase their sense of responsibility for selflearning.

Biology is the study of living things and their environment from various aspects of the problem and the level of organization. Biology learning is learning based on conceptual understanding and direct involvement. According to Hasan et al. (2018) Biology learning should be applied in accordance with the nature of biology as science including minds on (cognitive), hearts on (affective) and hands on (psychomotor), namely the ability to use the mind to build concepts through direct experience accompanied by a scientific attitude.

Growth and development material in plants is one of the Basic Competencies taught in biology learning that requires direct experiments. The material of growth and development in plants is not enough to just apply concepts to students but need to do treatment to prove existing concepts or theories so that students more easily understand the material being taught. How many problems often arise during the learning process, namely most students are more passive, afraid, and reluctant to be embarrassed to express their opinions, this will certainly affect the smooth learning and creativity of students during the learning process.

Based on the results of observations and interviews with class XII biology subject teachers, it was found that the psychomotor scores of students in biology subjects, especially in the material of growth and development in plants, had not shown satisfactory results. This can be seen from the presentation of the psychomotor scores of students who scored below the KKM standard of 75 or categorized as incomplete. In the learning process, the process skills activities (Psychomotor) of students are still lacking, students are still reluctant to express opinions, ask questions or answer questions. Students are still accustomed to the teacher-centered learning process so that the activity of science process skills is not optimal. Some students still have difficulty in formulating problems, do not understand the instruments under study, and cannot find facts based on observations. Learners are also not yet active in communicating the results of learning either in the form of conclusions in a report or giving explanations in front of the class.

According to Guswita et al. (2018) Development of Science Process Skills, requires adjustments between the learning methods used and the Science Process Skills to be developed. The selection of the right method is expected to have an influence to bring out the ability of students' science process skills. The learning method requires students to be active.

Based on how to develop students' science process skills, it is necessary to have a learning model that can support the emergence and improvement of students' science process skills, one of which is the inquiry learning model. According to Putri et al. (2014) the inquiry learning model is student-centered learning, so that it can train students' mental processes and metacognitive skills. in line with the opinion of Gunawan et al. (2019) that the inquiry is a process for obtaining information. The information comes from the process of observation or experiment to find answers and solve problems using critical and logical thinking skills. The inquiry learning model provides more opportunities for students to learn directly. In addition, students have the opportunity to practice developing process skills, thinking skills, and being scientific. The inquiry learning model provides space for students to learn, think and work on their own initiative. The inquiry learning model is more centered on students, the teacher's role is only as a facilitator and guide. This inquiry learning model is one of the suitable learning models applied by teachers in the knowledge century. According to Hasan (2003), the learning approach used in the century of knowledge is a mixed approach, namely a combination of learning approaches from teachers, learning from other students, and learning on their own. Learning practices in the century of knowledge are teachers as facilitators, mentors, and consultants. Learning practices depend on modern knowledge tools, namely computers and telecommunications, but most of the characteristics of the Century of Knowledge can be achieved without utilizing modern tools.

Method

This research was conducted in the odd semester of the 2022/2023 school year in class XII IPA SMA Negeri 1 Tapa. The type of research used is quantitative research using the quasi-experiment method. The design in this study is *Nonequivalent Control Group Design* design that uses two classes that compare the independent variable (bound) between before and after treatment.

Table 1. Nonequivalent Control Group Design

Group	*Pretest*	*Treatment*	*Posttest*
experimental class (E)	O_1	X_1	O_2
control class (K)	O_3	X_2	O_4

Bulus, (2021).
Description:
E= Experimental group (Using inquiry learning model)
K= Control group (Using the discovery learning model)
X = Treatment (application of inquiry learning model)
O_1 = Experimental class pretest
O_2 = Posttest of experimental class
O_3 = Pretest of control class
O_4 = Posttest of control class

The population in this study were all XII science classes of SMA Negeri 1 Tapa. Adapaun sample in this study students of class XII IPA 1 as an experimental class and XII IPA 2 as a control class. Samples were selected by purposive sampling. The data collection techniques used were science process skills test, observation sheet of students' science process skills and teacher activity sheet.

Analysis of Science Process Skills Learning Outcome Test

The tests were conducted in the form of an initial test (pretest) and a final test (posttest). The initial test (pretest) was given before treatment while the final test (posttest) was given after treatment. Learning outcomes data were analyzed using the individual learning completeness presentation formula, namely:

$$\text{Student grades} = \frac{\text{the score obtained by the student}}{\text{maximum score}} \, x\ 100\% \qquad (1)$$

Analysis of the achievement of student learning outcomes in general is seen from the average value of student learning outcomes in the class. To see the class average value, you can use the following formula:

$$\bar{x} = \frac{X1 + X2 + \cdots + Xn}{n} \qquad (2)$$

Description:
$\bar{x}$ = Class average score
$X1 + X2 + \ldots + X_n$ = Total number of students
N= Total number of students

Normality Test

After the research data is obtained, data normality testing is carried out, this aims to determine whether the data obtained from the research results are normally distributed or not. This data normality test uses the chi squared X2 formula as follows:

$$x^2\text{Count} = \sum \frac{(f0 - fh)}{fh} \qquad (3)$$

Homogeneity Test

Variance homogeneity testing aims to test the average similarity of several variances. Because in this study using two classes, the formula used is the equality of two variances. It will be tested regarding the two-party test for the null hypothesis pair H_0 and its counterpoint H_1:

$$H_o : \sigma_1^2 = \sigma_2^2 \qquad (4)$$
$$H_1 : \sigma_1^2 \neq \sigma_2^2$$

N-Gain Test

Gain is the difference between pretest scores and posttest scores. Gain reflects the increase in the ability or mastery of the concept of students after learning. to avoid the results of the author's normal conclusions, because the pretest scores of the two research groups are already different, the gain test can be calculated using the hake equation.

$$N\text{-}gain = \frac{Posttest\ score - Pretest\ score}{Maximum\ Score - Pretest\ Score} \qquad (5)$$

Table 2. N-gain Interpretation

Large N-Gain	Interpretation
$<g> \geq 0.7$	High
$0.7 > <g> \geq 0.3$	Medium
$<g> < 0.3$	Low

Riduwan, (2015)

Hypothesis Test

This hypothesis testing aims to determine the difference in science process skills in experimental and control classes. Hypothesis testing in this study uses parametric statistical tests with t test statistics through the following formula:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \qquad (6)$$

Result and Discussion

Based on the research that has been conducted, the following results are obtained: Description of Experimental Class Pretest and Posttest Results.

Table 3. Description of PreTest and PostTest Results

Average Description	Science Process Skills Score			
	Experiment		Control	
	Pretest	Posttest	Pretest	Posttest
Mean	41.64	85.93	40.46	81.14
Number of Samples	28	28	28	28
Standard Deviation	78.57	8.21	8.09	8.13
Maximum Value	53	100	53	93
Minimum Value	27	73	27	67

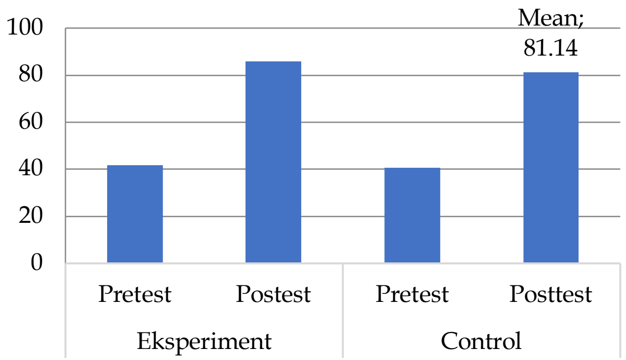

Figure 1. Average of Preset and Posttest

Table 3 and Figure 1 shows the average value of students' science process skills in each class. It can be seen that the ability of science process skills (pretest) of students in experimental and control classes has almost the same average, namely in the experimental class 41.64 and control class 40.46. In the final science process skills (posttest) for the experimental class to get a higher average value than the control class, namely in the experimental class 85.93 and the control class 81.14. Thus, it can be seen that the treatment given to the experimental class with the inquiry learning model has a higher level of science process skills than the control class. According to Siahaan et al. (2021) that the inquiry learning process provides opportunities for students to have real and active learning experiences so that students are trained in solving problems as well as making decisions. Science learning with inquiry has a real influence on students' science process skills. Inquiry learning is more effective in helping students to acquire science process skills because students are directly involved such as asking questions in an informal setting, testing hypotheses, and constructing explanations. The activities that take place during inquiry learning not only contribute to scientific inquiry skills but also students' understanding of science concepts. According to Gasila et al. (2019) that process skills need to be developed through direct experiences as learning experiences. Because through direct experience, one can better appreciate the process or activity that is being carried out.

According to Sulistiyono (2020) the inquiry learning model can improve students' intellectual KPS. This is because guided inquiry provides broader thinking about the subject matter, makes it easier to collect data from observations, students find it easier to find solutions to problems and train students' creativity in expressing ideas without limits but still within the scope of the material being studied, making it easier to remember the material. This is in line with the opinion of Taib et al. (2020) that the inquiry model can train students to solve problems using steps in the science process and students are trained to always think critically to familiarize students in solving a problem on their own. By practicing science process skills, students are also expected to master the concepts that have been obtained through the inquiry learning model that has been applied in class. Meanwhile, according to Asy'ari et al. (2019) that Inquiry learning model may improve students' critical thinking, logical reasoning, and problem solving in creative manner.

The following is the difference in data on the results of science process skills of experimental and control class students when given a pretest and posttest for each indicator of science process skills.

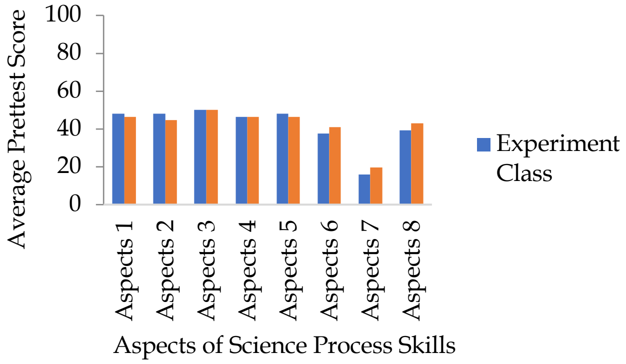

Figure 2. Average Pretest Score on Each Aspect of Science Process Skills Indicator.

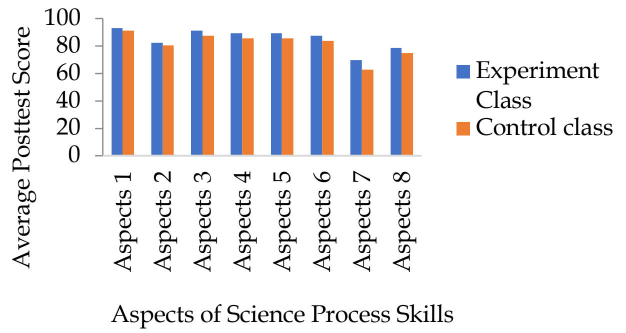

Figure 3. Average Posttest Score on Each Aspect of Science Process Skills Indicator.

The average pretest score on each aspect of the science process skills indicator addressed by Figure 2 that the highest average score obtained by the experimental class and control class is in the type of interpreting skills while the aspect that shows the lowest score is in hypothesizing skills. While the average posttest score on each aspect of the science process skills indicator addressed by Figure 3 that the average highest score obtained by the experimental class and control class is in the skill of observing and interpreting. This is because after experiencing the learning process, observing and interpreting skills become skills that are easy for students to do where students are directly involved with real objects so that when given a test in the form of a picture, students easily understand the contents of the problem and are able to explain and observe what is in the picture. The importance of science process skills for observing aspects in the teaching and learning process is that students will be easily active, in this aspect students will use all their five senses. According to Nurhasannah (2016) that the indicator of observing is a fundamental scientific skill and observing students must be able to use all five senses including seeing, hearing, feeling, tasting and smelling. In learning activities, students are required to interact directly with real objects or events, so that students more easily understand or observe an object.

The skill that has the lowest score is hypothesizing skills in both the experimental and control classes. Because students are not used to formulating hypotheses, so this is still a difficult part or job for students and not all students are able to carry it out. The hypothesizing aspect is included in the ability to think abstractly. Abstract thinking ability is inseparable from concept knowledge, because thinking requires the ability to imagine or describe objects and events that are not always physically present. This is in line with what is meant by Sari (2016) that the ability to think abstractly is the ability to find solutions to problems without the real object of the problem being present, in the sense that students carry out symbolic or imaginative thinking activities on the object of the problem. However, the low level of this aspect does not affect the level of achievement of students' science process skills, because students' science process skills are still in the high category and almost all aspects of science process skills used in the study have increased.

However, this low aspect does not affect the level of achievement of students' science process skills, because students' science process skills are still in the high category and almost all aspects of science process skills used in the study have increased. According to Maison et al. (2021) that Inquiry learning requires students to work collaboratively to ask questions, make temporary hypotheses, design an investigation, develop results and findings following obtained, and build communication. According to Yunianti et al. (2019) that one of learning model can make student active and develop science process skill optimally is by using guided inquiry model.

The aspect of classifying has increased in both experimental and control classes. This is because students are able to classify factors that affect germination in seeds and are able to classify several functions of hormones in plants. According to Solpa et al. (2022) Classifying skills are the basic skills of observing skills. The best parameters used to classify are unambiguous, clear, and based on observations, not conclusions. In accordance with this, to train the skill of classifying it is necessary to observe or observe the object or a phenomenon of the illustration being classified.

The aspect of interpreting the experimental class obtained a high score. This is due to the application of the inquiry learning model, namely making conclusions where students are required to dare to conclude the results of the experiments they do themselves. In contrast to the control class, the aspect of interpreting/interpretation did not experience too high an increase in the medium category. This is because the method used is only a lecture method so that students are not too brave to convey the conclusions they get from the learning process. According to Leni et al. (2019) that the ability to interpret or interpret data is one of the important science process skills, which generally must be mastered by scientists or in this case students. Then in the experimental class students were more focused in doing all the procedures that had been given because the inquiry learning model made students actively involved in all learning activities. This is supported by the statement of Anggereini et al. (2019) that guided inquiry involves students to be active in learning, especially Science Process Skills. According to Rusmini et al. (2021), data interpretation is carried out by linking results with relevant theories, expanding the results of the analysis by asking questions about relationships, differences between analysis results, causes, implications of previous analysis results.

The aspect of predicting has increased, this is that students are able to guess the possible results that will be obtained from practicum and students will predict a certain situation that has never been observed directly based on the knowledge that has been obtained. Thus students' science process skills in the aspect of predicting can be mastered well. According to Fitriani (2019) predicting is suggesting what might happen in a situation that has not been observed.

The aspect of planning an experiment has increased because students are able to determine what will be carried out in the form of work steps. The aspect of planning experiments is important to be applied to question instruments so that students understand what will be done when conducting experiments. According to Purnamasari et al. (2021) the skill of planning experiments asks students to recall the work steps that have been made before doing the practicum, students must also determine the steps of the experiment to be carried out, therefore before doing the practicum students make work steps first so that the experiments to be carried out are planned and directed.

The communication aspect has increased because students are able to provide or describe empirical data from experiments or observations with graphs or tables or diagrams. According to Andayani et al. (2018) the science process skills of the communication aspect have several indicators, namely describing empirical data from experimental results with tables/graphics/ diagrams, submitting systematic reports, explaining experimental results, reading graphs, and discussing the results of activities. This is in line with the opinion of

Sideri & Skoumios (2021) that the communication aspect is an aspect that uses words or graphic symbols to describe an action, object, or event.

According to Siahaan et al. (2021) that students' difficulties in inquiry learning include formulating problems and hypotheses. One of the reasons is that students have not understood the demonstration presented by the teacher because it is still not multi-representative. Multi-representative presentations can make it easier for students to develop their multi-representational abilities which are key in solving mathematical problems. According to Fatwa et al. (2018) one of the distinctive characteristics of inquiry activities in the field of science is providing opportunities for students to practice formulating problems and hypotheses, designing experiments, interpreting data and practicing communicating the results of their learning activities.

Description of Normality Test

Based on Table 4, it can be seen that the Sig. value of the experimental class, both on the pretest and posttest has a Sig. value greater than 0.05, which is 0.056 and 0.067. Then from the control class both on the Pretest and Posttest, the Sig. value is more than 0.05, which is 0.093 and 0.054. So that this research data can be said to be normally distributed.

Table 4. Normality Test Results

Statistics	Experiment		Control	
	Pretest	Posttest	Pretest	Posttest
Sig.	0.056	0.067	0.093	0.054
conclusion	Normal	Normal	Normal	Normal

Source: Data Processed, (2023)

Description of Homogeneity Test

Based on Table 5, it can be seen that the science process skills of students are homogeneity with a significance value of 0.943. From the homogeneity analysis data, it is said to be homogeneous because it has a significance greater than 0.05 which can be said that the experimental class and control class have the same variance.

Table 5. Homogeneity Test of Science Process Skills

Data	Level Statistic	Sig.
Based on mean	0.005	0.943

Source: Data Processed, (2023)

Description of N-Gain Test Data

Based on Table 6. above, it can be seen that the difference in the achievement of the average value of science process skills can be analyzed using SPSS 25, the average results of the science process skills of the two classes both increased, for the experimental class 0.76 and the control class 0.69. From the N-Gain test using SPSS 25, it can be seen that the increase in science process skills of experimental class students is higher than the control class. This is in accordance with the results of research by Alhudaya et al. (2018) that inquiry activities are very effective for involving students in learning, because learning using inquiry develops science process skills in students in its syntax. The difference in the results of students' science process skills between the experimental class and the control class is because in learning with the guided inquiry model, students are more active in learning activities than in the conventional approach so as to improve basic science process skills. Inquiry activities provide a brilliant opportunity to build knowledge through investigation so that students can find their own concepts in a structured way so that what they get will be more familiar and meaningful. The results of the data above are also supported by research conducted by Nugraha & Nurita (2021), which states that students' science process skills can be improved by applying an inquiry learning model. According to Suryanti et al. (2020) that Science process skills should be utilized by teachers to teach the facts of science effectively. This is because science is not just of knowledge but it is a way to systematically understand the environment. This is in line with the opinion of Beichumila (2022) that science process skills allow students to investigate the environment and construct their own meaning during the learning process.

Table 6. N-Gain Test Results

Class				Value	Criteria
	N-Gain	N	Min	Max	
Eksperiment	0.76	28	0.5	1	High
Control	0.69	28	0.45	0.90	Medium

Source: Data Processed, (2023)

Description of Homogeneity Test

Table 7. Homogeneity Test Results

Data Type	Sig. (2-tailed)	Decision	Description
Posttest	0.033	Ha Retrieved	Significantly Different

Source: Data Processed, 2023

Based on Table 7. above, the sig. (2-tailed) value of 0.033 <0.05 can be obtained, then according to the basis for decision making in the independent sample t-test test, it can be concluded that H0 is rejected and Ha is accepted, which means that there are differences in the science process skills of students between classes that use inquiry learning models and classes that do not use inquiry learning models. This value shows that there is a difference in results between students who follow inquiry learning and students who do not follow inquiry learning on science process skills. This means that the inquiry learning model affects the science process skills of XII science class students of SMA Negeri 1 Tapa.

Conclusion

Based on the results of research and discussion that has been done, it can be concluded that the application of inquiry learning models on the material of growth and development in plants can improve the science process skills of students. This is according to the SPSS 25 test obtained sig value. 0,033. These results are smaller than the value of α = 0.05 then Ha is accepted and H0 is rejected. This means that the application of the inquiry learning model on the material of growth and development in plants can improve the science process skills of students. As well as the results of the N-Gain of the experimental and control classes of 0.76 (high category) and 0.69 (low category), this means that the science process skills of students in the experimental class have increased.

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Regarding this study, the author declares that there is no conflict of interest.

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