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Enhancing students' science process skill and self-regulation through inquiry interactive demonstration in science materials

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Abstract

The research was conducted to obtain an overview of improving Science Process Skill and Self Regulation by using the Inquiry Interactive Demonstration learning model on science material at Junior High School Public No. 19 Bandar Lampung, this research uses a Quasy Experiment with a research design The Matching Only Pretest-Posttest Design. Collecting data using observation sheets and Science Process Skills test using multiple choice while for self regulation using a questionnaire. Data were analyzed using a multivariate test (Manova). This study concludes that the inquiry interactive demonstration model can improve science process skills and self-regulation. The researcher suggests applying the inquiry interactive demonstration model to improve science process skills and self regulation in other science learning materials so that they can help develop science skills and reduce learning difficulties in other learning materials.

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Introduction

Science is the knowledge that provides a positive impact on the growth of students, mainly to answer the development of the 21st century. According to Nuangchalerm & El Islami (2018), the nature of science consists of scientific processes and scientific attitudes. Science is related to all students finding natural phenomena systematically, so science is not only a collection of reliable knowledge in the form of facts, concepts, or principles but also includes the scientific method (Ritter et al., 2018). Science will generate high-quality learners with powerful values, attitudes, and critical thinking abilities, leading to a generation capable of problem-solving. Students' ability to acquire information and knowledge is determined by their active participation in the learning process. The material obtained does not have to be delivered by the teacher, but by students who actively participate in the teaching and learning process (Holden, 2015).

Science learning can help students to be interested in observing biological objects as real objects. Students will gain direct learning experience, with the observed things assisting them in understanding the subject (Romadhona & Suyanto, 2020). Learning Science prioritizes processing skills given that the principle of Science learning is the process, product, and attitude. The learning process of science tends to emphasize students to be given direct experience to develop competence and foster thinking ability.

Learning that prioritizes student experience through observation, questioning, reasoning, and observation-based learning to improve students' thinking skills so that the learning process is more optimal is central to the developmental demands of the 2013 Curriculum based on the learning process by prioritizing personal experience through observation, questioning, thinking, and observation-based learning to improve students' thinking skills so that the learning process is more optimal is central to the developmental needs of the 2013 Curriculum based on the learning process by prioritizing personal experience through observation, questioning, and thinking (Handini et al., 2023). Not only does it refer to the application of theories and concepts but it also the need for a process of skills in learning (Prasasti, 2017).

Science process skills are the tools needed in learning science and technology, such as problem-solving and students' development, and in society, such as mental skill, physical skill, and competency skills (Inayah et al., 2020). Science process skills are scientific abilities that must be owned by students so that they can use the scientific method in understanding problems, developing and discovering knowledge and these skills are very essential for students as a provision to use the scientific method in developing science and to be able to gain new understanding (Guswita et al., 2018).

In developing science process skills, students experience difficulties in learning science due to several factors, namely student attitudes, management in learning, and misconceptions. Misconceptions often occur in the learning process. Misconceptions can also be affected by emotional aspects such as Self-Regulation. Self-regulation is as important as the process of adaptation and maintenance of mental stability, the ability to self-regulate (Nazmi et al., 2019). Self-regulation can be measured when a person has been able to control and direct his actions well (Haka et al., 2021).

One alternative solution to handle the above problems is with the use of learning models that can empower the science process skill and ability to improve students' self-regulation. The learning model applied is the inquiry interactive demonstration learning model. The implemented learning model is an inquiry interactive demonstration model. This interactive inquiry demonstration learning model was developed by Wenning, which consists of five learning stages, namely the observation, manipulation, generalization, verification, and application stages.

Inquiry interactive demonstration learning can facilitate students to develop basic skills in the form of predicting, explaining, estimating, obtaining, and processing data, formulating and reviewing scientific explanations using logic and evidence, as well as recognizing and analyzing alternative explanations and models. Therefore students can understand science material because students are directly involved in the process of investigation and learning.

Based on the description above, the researchers conducted a study to (1) knowing the effect of the inquiry interactive demonstration model on the enhancement of science process Skill (2) knowing the effect of the inquiry interactive demonstration model on the enhancement of self-regulation.

Method

The research method used is the Quasy Experiment so that there are two classes. The two classes were given a pretest and posttest treatment of science process skills and self-regulation so that the research used the design of The Matching Only Pretest-Posttest Control Group. The pattern of The Matching Only Pretest-Posttest Control Group Design in Table 1.

Table 1. The matching only pretest-postest control group design

Class	Pretest	Treatment	Postest
Experiment	O_1	X	O_2
Control	O_1	C	O_2

(Sugiyono, 2015)

Note: O_1 = Pretest, O_2 = Postest, X = The Inquiry Interactive Demonstration model, C = Lecture and demonstration learning method

The population in this study were all eighth-grade students of Junior High School 19 in Bandar Lampung City, Lampung, Indonesia, in the academic year of 2020/2021. The sample in this study used a cluster random sampling technique to produce two selected classes, namely the experimental class, and the control class. Both of the sample classes are assumed homogenous. The number of students in this study that will be used as a research sample is 60 students who are divided into 2 classes (experimental class and control class), so that it consists of 30 students. The first class was chosen as an experimental class implementing an interactive inquiry demonstration learning model. The second class was chosen as a control class, implementing a conventional learning model.

The instrument for collecting the data was an test examining students' science process skills and a self-regulation questionnaire. The instrument of science process skill in this study adopted indicators from Tawil & Liliasari (2014) in Kurniawan et al., (2022), which consisted of twelve aspect, namely observing, classifying, interpreting, predicting, communicating, asking questions, hypotheses, planning experiment, using tools/materials, applying concepts, and conduct experiments. The instrument test of science process skill in this study used two instruments, namely multiple choice tests and observation sheets. The instrument test of science process skill consists of 20 questions about the material of the human digestive system, while on the instrument of observation sheet science process skills using the Guttman Scale which consisted of two intervals, namely Yes and No. Each question represents an indicators of science process skills. The indicators of the science process skills test are presented in Table 2.

Table 2. The indicators of the science process skills test

Question Number	Indicators	Sub Indicator Question
1, 2	Observing	Students can observe types of food nutrition from the activity of testing the content of food substances and organs of the digestive system of food
3, 4	Classifying	Students can classify the characteristics of foods containing glucose, protein, and carbohydrates
3, 5	Interpreting	Students can conclude from the results of the test for the content of foodstuffs containing carbohydrates, sugars, fats,

Question Number	Indicators	Sub Indicator Question
		and proteins from each type of food ingredients in daily life through the activity of testing the content of foodstuffs.
6	Predicting	Students can predict calorie needs to compose a balanced menu of body needs by using patterns or observations
7, 8	Communicating	Students can describe by reading tables or graphs or diagrams of nutritional needs and experimental results of food substance testing
9	Asking questions	Students can provide feedback by asking questions about the structure and use of each type of food nutrition
10, 11, 12	Hypotheses	Students can propose hypotheses to conduct experiments regarding the test of food substance content
13	Planning experiment	Students can plan experiments by determining tools, materials, and sources for conducting food testing
14, 15	Using tools/materials	Students can use tools and materials to determine the content of substances contained in food ingredients
16, 17, 18, 19	Applying concepts	Students can know the concept to explain the organs of the digestive system of food
20	Conduct experiments	Students can determine the working steps of an observation properly and correctly

The instrument of self-regulation in this study adopted indicators from Marzano (1994), which consisted of four indicators, namely self-awareness, structured planning, using clear sources, and sensitive to feedback. The instrument of self-regulation is in the form of a questionnaire consisting of 20 statements. Each statement consists of positive and negative statements. Self-regulation questionnaire using a Likert Scale consisting of four intervals, namely strongly agree, agree, disagree, and strongly disagree. Each statement represents an indicators of self-regulation. The indicators of the self-regulation questionnaires are presented in Table 3.

Table 3. The indicators of the self-regulation questionnaires

Indicators	Sub Indicator Statements	Question Number	
		Positive	Negative
Self-awareness	Students can efficiently control themselves in their own learning experiences in different ways	1,19	3, 4
Structured planning	Students can plan and organize an efficient learning system	2,6,9	12, 13, 16
Using clear sources	Students can determine and use resources effectively for learning	5, 15, 10	8, 7, 20
Sensitive to feedback	Students actively participate in every learning activity	11, 14	17, 18

The analysis of the science process skills and self-regulation was carried out in two ways, namely as follows: (1) descriptive statistical analysis was carried out by describing the data from the test results of science process skills and self-regulation. Furthermore, the analysis of science process skills and self-regulation was carried out using the Normalized Gain Score (N-Gain) test. The use of the N-Gain score test can describe the extent of the influence of the inquiry interactive demonstration model in improving students' science process skills and self-regulation. The N-gain value refers to the interpretation of the data which can be seen in Table 3; (2) inferential statistical analysis consists of prerequisite test and hypothesis testing. Analysis of science process skills and self-regulation through qualitative data converted to quantitative data.

Results and Discussion

Improvement of Science Process Skills

Measurement of science process skills is carried out in two ways, namely multiple choice tests and observation sheets. Regarding science process skills, students were treated by giving a pretest before starting the learning process and a posttest at the end of the material on the human digestive system. The results of the pretest and posttest obtained in the two classes are presented in Table 4.

Table 4. Recapitulation of the pretest and posttest scores of students science process skill in two class

Group	Component		
	Pretest	**Posttest**	**Total Students**
Experiment	49,03%	83,38%	31
Category	Enough	Very High	
Control	47,41%	66,93%	31
Category	Enough	High	

In the pretest, there was no significant difference in scores between the experimental class and the control class, so it can be interpreted that the students' initial ability in science process skills is still relatively low because it has not been prioritized. The low pretest in the experimental class and control class was caused by several factors, among others rarely doing practicum and doing questions on the types of science process skills. Another factor is caused by the model or learning method used at the time of learning has not facilitated students to develop science process skills. This is in accordance with the results of research conducted (Permanasari & Hamidah, 2013), states that one of the factors that cause the low science process skills of students is because in general teaching and learning activities are still using traditional (conventional) learning methods, so students are less able to develop and explore science process skills.

In addition to the pretest, a posttest was also handled to see the enhancement of science process skills after being treated in the form of an interactive inquiry demonstration model. The results of the post-test of science process skills in both research classes can be seen in table 4. In the posttest, there are differences between the experimental class and the control class, so it can be stated that the inquiry interactive demonstration model is better than the lecture and demonstration methods (conventional methods). This can be interpreted that the inquiry interactive demonstration learning conducted in the experimental class contributes to assisting students in mastering science process skills compared to the lecture and demonstration method (conventional) conducted in the control class. This is in accordance with the results of research conducted by (ghumdia, & adams, 2016), that the inquiry-based learning method is more effective in improving the achievement of students' science process skills compared to the lecture method.

In addition to conducting a pretest and posttest of science process skills, measurement of science process skills is carried out through practicum using an observation sheet. The practicum was carried out 4 times in the experimental class and the control class with different treatments, namely the experimental class conducted a practicum based on the inquiry interactive demonstration model and the control class conducted a practicum based on the lecture and demonstration method.

The results of the recapitulation of the combined value of the observation sheet for the experimental class and the control class are presented in Table 5. Based on table 5, the results show that the average value of the science process skill observation sheet in the experimental class is superior to the control class on all indicators. Overall in Table 5, the data obtained in the experimental class on the results of this observation sheet show the highest results on the classification indicator of 81.85% in the high category, and the lowest value on the communication indicator of 73.38% with the medium category.

Table 5. Results of the combined score recapitulation of science process skills observation sheets

Indicators	Control Class		Experiment Class	
	Score Average	Category	Score Average	Category
Observe	76,20%	High	81,44%	High
Classification	75,60%	Medium	81,85%	High
Interpretasion	75,40%	Medium	80,02%	High
Prediction	74,59%	Medium	79,22%	High
Communication	73,32%	Medium	73,38%	Medium
Question	73,38%	Medium	74,33%	Medium
Hypothesis	73,98%	Medium	74,99%	Medium
Planning an Experiment	75,60%	Medium	78,22%	High
Tools and Materials	75,40%	Medium	79,63%	High
Concept Application	78,62%	High	78,81%	High
Carry Out Experiment	76,07%	High	81,48%	High

In the classification indicator, the experimental class is higher than the control class. This is because in the experimental class on the syntax of observation and manipulation students are required to group and record each observation separately in the human digestive system practicum. In addition, the classification activities in the experimental class were more trained to students compared to the control class. Based on table 5, the combined results of the science process skill observation sheets obtained by the experimental class were higher than the control class. This is because students are emphasized to identify and make good observations through practical activities. persons will have skill if that person trains it through activities. Likewise, the science process skills in students will increase if they have the experience to perform or practice these skills (Kurniawan et al., 2022).

In addition, there are differences in N-Gain scores in the experimental class and the control class. The analysis of the N-Gain test in this study is useful for knowing the difference in the improvement of students' science process skills between the experimental class and the control class. The results of this N-Gain value can be seen in Table 6.

Table 6. The results of the n-gain score of science process skills in the experimental class and control class

Description	Control Class	Experimental Class
Amount Sample	31	31
N-Gain Average	0.34	0.66
Category	Medium	Medium

Based on Table 6, there is an increase in science process skills in both classes after learning is carried out. To find out the difference in the improvement of students' science process skills between the experimental class and the control class, an analysis was conducted using the N-gain test on science process skills. The N-gain value obtained by the experimental class is 0.66 in the high category while the control class is only obtained by 0.34 in the medium category. The higher average value of N-gain in the experimental class compared to the control class is in accordance with the research of (Rahmat & Suhandi, 2017), which states that the application of the inquiry interactive demonstration approach can improve students' science process skills.

1. Improvement of Self-Regulation

Self-regulation questionnaires were given to students at the beginning and end of learning to determine the increase in self-regulation. the results of the self-regulation indicator questionnaire can be seen in Table 7. Based on Table 7, the average value of the pretest in the experimental class and control class is in the high category indicating that there has been self-regulation in the class. Not significantly different from the pretest value between the experimental class and the control class. The pretest value in the experimental class is 69.83% in the high category and the control class is 70.76% in the high category.

Table 7. Results of the combined score recapitulation of self-regulation

Indicators	Control Class		Experiment Class	
	Pretest	Postest	Pretest	Postest
Awareness	68.14%	69.55%	67.33%	84.07%
Planning	72.98%	77.55%	54.83%	79.83%
Resources	71.50%	76.47%	71.50%	78.63%
Feedback	68.95%	76.47%	72.58%	80.24%
Score Average	**70.76%**	**75%**	**69.83%**	**79.31%**
Category	**High**	**High**	**High**	**High**

Based on Table 7, the average value of the pretest in the experimental class and control class is in the high category indicating that there has been self-regulation in the class. Not significantly different from the pretest value between the experimental class and the control class. The pretest value in the experimental class is 69.83% in the high category and the control class is 70.76% in the high category, this matter is stated that the experimental class and control class have self-regulation values that are not much different.

Based on Table 7, the results of the posttest mean scores have increased self-regulation in the experimental class and control class. In the experimental class, the average posttest score was higher than the control class. The experimental class obtained an average posttest score of 79.31% in the high category, while the control class obtained 69.83% in the high category. It can be stated that the experimental class by being treated with the inquiry interactive demonstration model can improve students' self-regulation compared to the conventional class.

The difference in the value of the self-regulation indicator in the experimental class and control class increased in the posttest. Overall, the self-regulation indicator The experimental class is superior to the control class in the posttest value section. The posttest mean score on the awareness indicator in the experimental class is higher than the control class. The posttest average value of the awareness indicator in the experimental class was higher than the control class. the experimental class in the awareness indicator got a score of 84.07% with a high category while the control class got a score of 69.55% with a category. In the experimental class using an interactive inquiry demonstration model, the teacher provides stimulus to students through the observation syntax first so that students can easily find out the problems that will be presented by the teacher. The application syntax gives students awareness that a problem can be solved and applied to everyday life. According to Haka et al., (2021), states that self-regulation can make students set learning strategies so that they can solve a problem independently by realizing their own thoughts.

Table 8. The results of the n-gain score of self-regulation in the experimental class and control class

Description	Control Class	Experimental Class
Amount Sample	31	31
N-Gain Average	0.31	0.11
Category	Medium	Medium

The results of the pretest and posttest are included in the N-gain calculation to see an increase in self-regulation ability. Table 8 shows that there is an increase in self-regulation in the experimental class and higher than the control class. The N-gain value in the experimental class was 0.31 in the medium category while the control class was 0.11 in the low category. This proves that the use of the inquiry interactive demonstration model can improve students' self-regulation abilities. Learning using an inquiry interactive demonstration learning model by conducting demonstrations in the form of learning videos and practical activities can improve student self-regulation. In the experimental class, students do practicums, discussions, and presentations students can realize their own thoughts to plan, set strategies, do homework, and prepare information related to learning materials can improve the quality of students' daily tests. This statement is supported by Dewi & Taufik, (2020), stating that self-regulation is the ability of individuals to regulate themselves in achieving the desired target so that this ability will affect the processes and results of the efforts carried out by individuals. If the individual can manage himself well, then he will get the results following the target. Conversely, if the individual cannot manage himself properly, then the desired target will not be achieved.

Description of Hypothesis Test Analysis of Multivariate (Manova Test)

The recapitulation of science process skills and self-regulation were analyzed using the analysis technique of Multivariate Test (Manova Test). Normality test using Kolmogorov-Smirnov test. If the data is normally distributed, it can proceed to the multivariate test stage. The results of the normality of science process skills and self-regulation are in Table 9. Based on Table 10, the results of the multivariate test and the test of the influence between subjects on science process skills and self-regulation follow the provisions of the proposed hypothesis as follows:

H0: accepted if the value is sig. ≥α (0.05), then H1 is declined.

H1: accepted if the value is sig. ≤α (0.05), then H0 is declined.

Table 9. The result of normality test

Test Type	Class Type	Asymp. Sig 2 Tailed	Table Significance Value Criteria (0,05)	Conclusion (Sig count > ½ (α) (0,025) = normal distribution)
Science Process Skills	Experiment	0,200	0,05	Normal Distribution
	Control	0,200	0,05	
Self Regulation	Experiment	0,188	0,05	Normal Distribution
	Control	0,078	0,05	

Based on Table 9, it can be seen that the normality test result for the n-Gain score of science process skills and self-regulation has a sig. value from Kolmogorov-Smirnov of > 0.05. Therefore, the research data obtained comes from the normally distributed population. Meanwhile, The results of the homogeneity of science process skills and self-regulation are in Table 10.

Tabel 10. The result of multivariate test (mannova) and between-subjects effect test

Test Type	Science Process Skill		Self-Regulation	
	Sig. (2-tailed)	Information	Sig. (2-tailed)	Information
Multivariate Test	0,000	Sig. (2-tailed) ≤ α (0,05)	0,000	Sig. (2-tailed) ≤ α (0,05)
Between-Subjects Effect Test	0,000	Sig. (2-tailed) ≤ α (0,05)	0,000	Sig. (2-tailed) ≤ α (0,05)

Based on Table 10, the results of the multivariate test and the between-subjects effect test on science process skills and self-regulation obtained sig. (2-tailed) 0.05, then H1 is accepted. Hypothesis testing using multivariate test and between-subject effect test showed that the use of the inquiry interactive demonstration model could improve students' science process skills and self-regulation. This can be interpreted that the treatment given to the experimental class in the form of inquiry interactive demonstration learning model affects the mastery of science process skills. According to Noviani (2019), the use of inquiry interactive demonstration learning model during the learning process takes place the teacher guides and trains students to develop and master science process skills.

Learning with the inquiry model provides opportunities for students to find and investigate concepts procedurally, systematically, and interrelated from one concept to another. at the level of junior high school, students need guidance in exploring a phenomenon to get a concept. This statement is supported by Harahap et al (2019). stating that the use of this model will foster intrinsic motives because students will feel satisfied with their own experiences in learning and inquiry learning is also very suitable for material that is cognitive, but requires a lot of time and if it is not directed and directed will not clear the material being studied. In general, this learning will develop science process skills and student learning outcomes to a certain level of expectation (Af'idayani et al., 2018).

In addition, inquiry interactive demonstration learning model can enhance self-regulation. During the learning process in the experimental class, students are motivated to learn actively, manage time well and collect relevant information for learning resources so that they can organize learning strategies well to solve problems because the advantages of the inquiry interactive demonstration learning model are to make students the center of learning and tend to solve the problem presented. Thus, students can regulate self-regulation well. This statement is supported by Marhayati et al (2021), which state that self-regulation is the ability to regulate behavior and implement such behavior as a strategy that affects one's performance in achieving learning goals. The results also found that there is a relationship between self-regulation and science process skills, indicating that self-regulation can help students improve learning outcomes in the form of science process skills. The higher the self-regulation possessed by students, the higher the learning outcomes obtained (Hapidoh, S., Bukhori, B., & Sessiani, 2019). In addition, according to Harizah et al (2020), the advantage of the inquiry interactive demonstration learning model is that it makes it easier for students to think scientifically.

Conclusion

Based on the results of research conducted on the effect of the interactive inquiry demonstration model on science process skills and student self-regulation, it can be concluded that there is an influence of the interactive inquiry demonstration model on science process skills and self-regulation. The achievement of science process skills and self-regulation of students in the experimental class was higher than in the control class. Because the use of interactive inquiry demonstration models can practice scientific skills, facilitate scientific activities, and help students for management in learning. The researcher suggests applying the interactive inquiry demonstration model to other science materials so that it can help students develop science skills and reducing difficulties in other science learning materials.

Credit Authorship Contribution Statement

Fauzan Kurniawan: Visualization, Formal analysis, Writing – original draft, Writing – review & editing, Supervision, Project administration, Resources. **Nukhbatul Bidayati Haka:** Conceptualization, Methodology, Software, Writing – original draft.

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