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The application of modified free inquiry for the science process skills

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ABSTRACT

This study aimed to improve students' science process skills by applying modified free inquiry, which is a modification of two approaches: guided inquiry and free inquiry. The research method used is true-experimental design. The instruments used are test questions with indicators of science process skills and observation sheets on implementing the modified free inquiry learning model. The data collection technique was descriptive and quantitative with hypothesis testing using a nonparametric test Two Independent Sample Test, the Mann-Whitney test, and the gain score pretest and posttest. The results showed an increase in science process skills with an N-Gain value in the experimental class of 0.87 and the control class of 0.19. The results of hypothesis testing using the Mann-Whitney test obtained a significance value of 0.000 < 0.005, and the observation sheet on the modified free inquiry learning model was obtained 100% well implemented. Based on data analysis, it can be concluded that modified free inquiry can be used as a learning model that can be applied to biology learning and improve science process skills.

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Keywords
Digestive Concept, Guided Inquiry, Free Inquiry, Modified Free Inquiry, Science Process Skills

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INTRODUCTION

The biology learning process emphasizes providing direct experience to develop competencies in order to explore and scientifically understand the natural surrounding. It is carried out scientifically (scientific inquiry) to foster the ability to think, work and behave scientifically and communicate it as an essential aspect of life skills. The same thing was stated by Sugiartini et al. (2013), that science learning can be a vehicle for oneself and the natural surroundings, so that the learning process emphasizes providing direct experience to develop competence and scientifically understand the natural surroundings. In order to realize the objectives of learning biology, it is necessary to cultivate science process skills because learning biology directly observes nature and its components. Science process skills are essential skills that facilitate science learning, ensure students are more active, and increase responsibility in learning.

Process skills involve cognitive, manual, and social skills. There are several involved in skills: cognitive skills trigger students to use their minds and manual skills involve students using tools and materials. Furthermore, they can improve measuring and arranging tools in social skills. The

students' cognitive levels became the reference for the researcher to determine the appropriate level of inquiry for the sample of the experiment, by applying the modified free inquiry model (Hadi et al., 2018). In comparison, social skills stimulate students to interact with each other in carrying out teaching and learning activities (Rustaman, 2011). For students, science process skills are helpful as an introduction to scientific thinking from an early age so that their thinking processes can be neat and coherent. Meanwhile, Science curricula worldwide emphasize the philosophy of inquiry in science teaching (Ongowo & Indoshi, 2013). In addition, students can acquire and develop knowledge independently through science process skills.

Through inquiry, students can develop science process skills to find new knowledge independently. However, students still need guidance and direction from the teacher so that there is no misunderstanding of the concepts being studied. According to Mahlianurrahman & Syamsu (2019), students need teacher assistance to develop their ability to find new knowledge. One of the learnings through the inquiry process is the modified free inquiry learning model, a collaboration or modification of two inquiry approaches the guided inquiry approach and the free inquiry approach (Shofiyah, 2017). In modified free inquiry learning, students accept problems from the teacher to be solved and still get guidance, but the teacher limits the guidance so that students try to be independent and find their solutions. Thus, through modified free inquiry learning, it will be able to improve students' science process skills on the material of the digestive system.

One of class XI biological materials is the human digestive system (Kemdikbud, 2013). These materials are closely related to everyday life. Narut (2018), stated that the digestive system is one of the biological materials following the characteristics of science process skills. This material requires students to carry out scientific processes such as observing the digestive organs, comparing the digestive organs in humans, classifying types of food, testing the content of food substances, and testing the presence of digestive enzymes. Characteristics of the digestive system material are abstract, which means they cannot be seen directly by students. This system requires a learning model that will help students to make it easier to find their concepts in an active, creative, and fun way. The material of the digestive system is identical to the invention; students are required to be able to find their concepts in determining the types of substances contained in a food ingredient, explaining the difference between mechanical and chemical digestion and digestive apparatus through experiments. Based on this view, the modified free inquiry is a suitable learning model to convey material on the digestive system. Thus, through modified free inquiry learning, it will be able to improve students' scientific process skills on the material of the digestive system.

The results of previous research by Amalia et al. (2020), revealed an increase in science process skills that applied the modified free inquiry learning model compared to classes that applied the guided inquiry learning model. Another research result by Marta et al. (2018), is that the modified free inquiry-based practicum method can improve science process skills. The phases of modified free inquiry learning are; formulating problems, designing hypotheses, designing experiments, conducting experiments, collecting, analyzing data, reviewing the work and communicating them, and making conclusions (Marta et al., 2018).

By using questions that lead to the discovery of problem-solving, modified free inquiry

learning emphasises the need for students to actively think about, investigate, and discover their mental conceptions. This discovery is made in order to meet learning objectives. Based on the description above, this research was conducted to determine the effect of the modified free inquiry learning model on students' science process skills.

METHOD

This research method uses a true-experimental design, which is to investigate the possibility of a causal relationship between the design of the experimental group and the control group and compare the results of the treatment closely. The research was conducted at MA PUI Maja. The sampling technique used a nonprobability sampling method with a purposive sampling technique. A sample of 17 students in class XI MIPA A was assigned as the experimental class and 21 in class XI MIPA B as the control class. The research design used was a pretest-posttest control group design. Pretest and posttest were analyzed by calculating the gain value.

The data collection instrument is in the form of test questions that use indicators of students' science process skills in observation, classifying, predicting, measuring, communicating, and concluding. The observer team assessed the observation sheet instrument to determine the implementation of this learning model. The analysis technique was descriptive and quantitative with a non-parametric test used to assess the hypotheses. Because the pretest and post-test data generated from the control and experimental classes were normally distributed but not homogeneous, the gain score was determined from the pretest and post-test results. Two independent sample tests, specifically the Mann-Whitney test, were used. The hypothesis test was used to determine the effectiveness of the application of the modified free inquiry learning model on science process skills in the digestive system. It was observed on the organs of the human digestive tract, designing and conducting experiments on food substances tested with chemical reagents and on the digestive process in the mouth to determine the work of saliva.

RESULTS AND DISCUSSION

The data obtained include the results of the science process skill test on six indicators (observation, classifying, predicting, hypothesizing, designing experiments and communicating) and the results implementing of the syntax of the modified free inquiry learning model. The results of students' science process skills on digestion material were different from the experimental class and the control class. Here are the results of the pretest in Figure 1.

Based on the Figure 1, there are differences in the results of the pretest on each indicator of science process skills between the experimental class and control classes. For the highest indicator value seen in the experimental and control classes, there are indicators designing experiments, namely 75% in the experimental and 60% in control classes. The results of the posttest can be seen in Figure 2.

There was a significant increase based on the graph of the experimental class posttest results after being given treatment with the modified free inquiry learning model. They Obtained post-test scores on indicators of observation, classifying, predicting, hypotheses, designing experiments,

communicating, and concluding shows an increase. In the control class that uses the conventional method, there is only an increase in the observation, classifying, predicting, and hypotheses indicators. At the same time, there is no improvement in designing experiments and communicating indicators. This indicator proves the modified free inquiry learning model can improve students' science process skills.

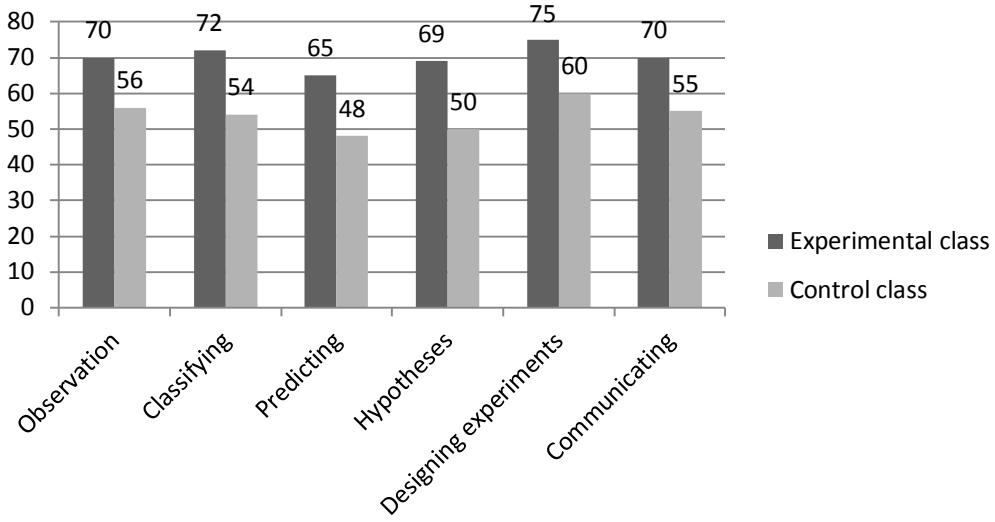


Figure 1. Graph of the pretest results for each science process skill indicator in the experimental and control classes

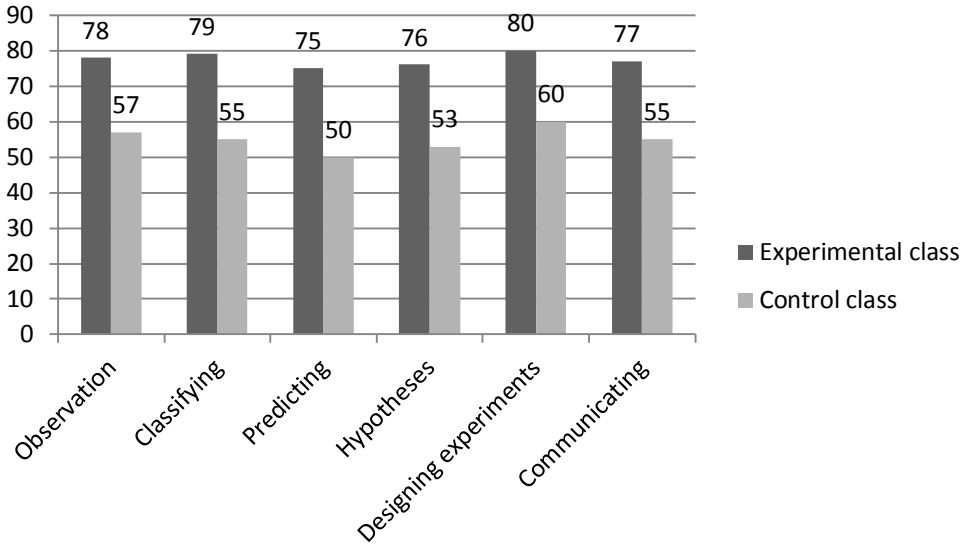


Figure 2. Graph of posttest results for each indicator of the experimental and control classes

The pretest and posttest rsult show that the modified free inquiry learning model improve students in the digestive system material through observing the digestive organs and conducting food substance testing experiments with chemical reagents and experimenting with the digestive process in the mouth to find out how saliva works. Through this learning model, students learn to accept the problems given to the digestive system material to be solved and still receive guidance. However, the guidance provided is limited so, students try to work independently and can find their solutions. However, when students cannot solve the problem, guidance can be given indirectly by

providing examples relevant to the problems at hand, or through discussions with students in other groups. Rahmi et al. (2020), suggest that learning with modified free inquiry is learning that provides opportunities for students to learn by doing science process skills. Biology lessons seek to equip students with various abilities to know and to do things that can help students understand the natural surroundings in depth. Therefore, Science process skills are skills commonly practised by scientists to gain experience (Yulianti et al., 2018). The results of increasing science process skills based on N-gain can be seen in Table 1.

Table 1. The result of improving science process skills

No.	Class	Pre-test	Post-test	N-Gain
1.	Experiment	60.14	77.5	0.87
2.	Control	53.83	55	0.19

The test data shows that the experimental class's pretest value has an average value of 60.14% and, an increase in the post-test value to 77.5 with the N-Gain result of 0.87 (high criteria). While the results of the pretest control class obtained an average value of 53.83 and the post-test results were 55 with an N-Gain result of 0.19 (low criteria). These results concluded that the experimental class and control classes both experienced an increase, but seen from the results of the N-Gain, the experimental class was included in the high criteria and, the control class was included in the low criteria.

The results of the N-Gain obtained in the experimental class are higher than in the control class. This result shows that the modified free inquiry learning model can develop intellectually but all the potential that exists in students, including emotional and skills that involve mental and physical to solve problems in digestive system material. Putri et al., (2017), stated that modified free inquiry has the characteristic that the teacher limits giving guidance to students, so that students are more able to work independently and find solutions to problems.

After calculating the gain score, the prerequisite tests are carried out, namely normality and homogeneity tests and further tests. The prerequisite test is to obtain test data for normality and homogeneity of science process skills values in the experimental and control classes. The following prerequisite test data are presented in Table 2.

Table 2. The results of science process skill test in the experimental and control classes

Data	Test	Type of test	Result	Conslusion
Experimental class	Normalitas	Komogorov-Smirnov	Sig *pretest* = 0.944 Sig *Postest* = 0.626	Normalized Normalized
	Homogenitas	Levene Statistic	Sig = 0.025	Not Homogenity
Control Class	Normalitas	Komogorov-Smirnov	Sig *pretest* = 0.902 Sig *Postest* = 0.902	Normalized Normalized
	Homogenitas	Levene Statistic	Sig = 0.018	Not Homogenity

The post-test normality test data for the experimental class showed that the experimental class obtained a significant result of 0.626 > 0.05. this result indicates that it was normally distributed, and the results of the pretest normality test for science process skills in the

experimental class obtained a normal distribution because the significance of the pretest was 0.944 > 0.005. The results of the homogeneity test using the Levene Statistical test in the experimental class obtained a pretest significance of 0.025 < 0.05 and concluded that the data on the value of science process skills in the experimental class was not homogeneous.

The results of the pretest normality test of science process skills in the control class obtained a significance of 0.902> 0.05. It was concluded that the data were normally distributed. For the posttest normality test, the control class obtained a significance of 0.902 < 0.05, meaning that the control class posttest data were normally distributed. The results of the homogeneity test in the control class obtained a significance of 0.018 < 0.05, so it can be concluded that the data on the value of science process skills in the control class is not homogeneous.

Based on the results of the normality and homogeneity test of the pretest and posttest data in the experimental and control classes, data for both classes were expected but not homogeneous. The further test was determined by using nonparametric statistics, the Mann-Whitney Test at the significance level (sig 2-tailed) = 0.05. The Mann-Whitney test data are presented in Table 3.

Table 3. Mann Whitney KPS test results in experiment and control classes

Data	Test of Type	Result	Conclusion
Experimental class	Mann-Whitney	$-t_{count}$ = -2.477 P = 0.000	Result are not the same (there is a difference)
Control class	Mann-Whitney	$-t_{count}$ = -5.246 P= 0.000	Result are not the same (there is a difference)

Based on the results of the Mann-Whitney test in the experimental class, the t_{count} value is -2.477 with a probability (p) of 0.000 (p < 0.005). These results indicate differences in the value of the science process skills of experimental class students before and after being given the modified free inquiry learning model. The results of the Mann-Whitney test in the control class also concluded that there were differences in science process skills before and after learning using conventional methods. However, the results were not as significant as in the experimental class.

Based on the results of the significant difference in the improvement of science process skills between the experimental class and the control class on the material of the digestive system, it is proven that the modified free inquiry learning model can improve students' science process skills because the modified free inquiry learning model is limited in guiding students. So that students try to work independently first, with the hope that students can find the solution themselves (Putri, 2013). This proves that inquiry uses more student-centered learning methods as proposed by Navy et al. (2021), from the results of their research that teachers use inquiry-based learning to improve process skills compared to problem-based learning methods, this is because Inquiry-based learning is a method that can create student-centered learning. The same opinion according to Golding (2013), shows the results of his research that teachers who apply inquiry-based learning are able to help students to conduct independent investigations and learn on their own so that they learn to ask questions and participate in an investigation that is guided but not controlled by the teacher so as to create effective learning. Learning. The results of another study conducted by Joshi & Lau (2021), show that inquiry-based learning can develop student performance on tasks given by the

teacher through inquiry processes.

The hypothesis test results indicate that the modified free inquiry learning model has a crucial role in learning activities. Students will play an essential and active role in exercising courage, communicating and trying to gain their knowledge by generating various ideas and through an investigation to solve problems given by the teacher. Philip & Taber (2016), stated the results of their research that learning by conducting inquiry processes can help students to talk more about relevant ideas and concepts related to the knowledge they are studying. This potential can support learning from practical work on biological material. Fatmawati (2021), argues that students need an effort to conduct the modified free inquiry learning model that emphasizes problem-solving. So that students actively think and explore all information to determine the concept by following teacher instructions and teacher guidance in the form of questions that lead to problem-solving so that learning objectives will be achieved properly. Jauhar (2013), suggests that in the modified free inquiry learning model, the problems that are used as topics for students to investigate in the learning process are given by the teacher using the existing curriculum reference guidelines. The student will get opportunities when The free inquiry learning model is modified. They will develop biological principles and values to grow reasoning power and logical, systematic, critical, open, and curious thinking. The modified free inquiry learning model will provide opportunities for students to experience the science process (Rahayu, 2011). Another opinion according to Von-Renesse & Ecke (2015) inquiry-based learning builds students' strengths in the humanities, where students have high creativity skills, oral communication skills, and critical thinking.

Based on some of the views above, the modified free inquiry learning model can improve science process skills. Through a series of learning activities that involve all students' abilities to search for, investigate and solve problems systematically, critically, and logically so that students can find their knowledge, attitudes, and science process skills that involve intellectual, manual and social skills.

Another instrument used in this research is the observation sheet on implementing the modified free inquiry learning model in the experimental class. The observation sheet was assessed by a team of observers who observed teacher activities in the implementation of the modified free inquiry learning model, which consisted of initial, core and closing activities.

The application of the modified free inquiry learning model is carried out in core activities consisting of 6 phases, namely presenting problems, designing hypotheses, designing experiments, conducting experiments, collecting or analyzing data, and making conclusions. The following is the syntax of the modified free inquiry learning model, which can be seen in Table 4.

The results of the observation sheet on implementing the modified free inquiry learning model are 100% implemented in each phase. In the presenting phase, the problem is less than optimal because students have not been maximal in studying the problem of classifying food ingredients containing carbohydrates, protein, fat and protein before conducting a food substance test. This condition is due to the habit of learning students who previously tended to be less active in learning because they learned by memorizing techniques recorded from the teacher's

explanations and books. This situation causes student activities to be less than optimal, so students have difficulty processing knowledge, skills and values that do not develop entirely in students. Thus there are still difficulties in formulating the problem and need teacher guidance. Students are less than optimal in formulating the problem. This is also because the modified free inquiry learning model has the following advantages and disadvantages: (a) Helping the development of students' thinking, especially in conclusion, (b) Students discover concepts directly, so it is hard to forget, (c) Students are encouraged to think and work on their initiative, (d) Students can take advantage of other learning resources, and (e) Learning is student-centered. Some of the shortcomings include: (a) Less effective when used in a class with many students, (b) Students are prone to frustration and failure to find solutions to problems, and (c) It takes much time, effort, and expense.

Table 4. Learning syntax modified free inquiry

Stage	Activity
Formulating Problems	The teacher explains the learning objectives then gives problems to be discussed with the group
Designing a Hypothesis	Students in active groups discuss to solve problems by exploring several sources, studying theories, principles and laws
Doing Research	Students make observations, take and record data and discuss conveying the results of observations
Reviewing the work and communicating it	ach group presents the results of the investigation and conveys the results of the group discussion
Draw Conclusions	Each group draws conclusions from the material studied

From some of the advantages and disadvantages above, modified free inquiry learning emphasizes problem-solving efforts so that students must actively think and explore various information in order to find their mental concepts by following the teacher's instructions. Eristya (2019), suggests that through modified free inquiry students, connect theory with existing problems, generate new ideas for problem-solving, make observations to develop many ideas, and conduct experiments to find solutions.

CONCLUSION

The research found that the modified free inquiry learning model has a major role in improving the science process skills of class XI students on the digestive system material with a significant value of 0.000, which is less than 0.05. The results of the observation sheet on implementation of the modified free inquiry learning model can be carried out well even though the phase of presenting the problem is not optimal.

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