



# Application of STEM-Integrated Guided Inquiry Model to Improve Science Process Skills of Junior High School Learners on Human Respiratory System Material

Alvyn Karina Lestari<sup>1\*</sup>, Any Fitriani<sup>2</sup>, Kusnadi<sup>2</sup>

<sup>1</sup> Master of Science Education Study Program, Faculty of Mathematics and Natural Education, Indonesia University of Education, Bandung, Indonesia.

<sup>2</sup> Department of Biology Education, Faculty of Mathematics and Natural Education, Indonesia University of Education, Bandung, Indonesia.

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Corresponding Author:

Alvyn Karina Lestari

[karinaalvyn@gmail.com](mailto:karinaalvyn@gmail.com)

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**Abstract:** This study was conducted with the aim of knowing the improvement of science process skills of students whose learning process uses a STEM-integrated guided inquiry learning model on human respiratory system material. The research method used was quasi experimental. The population in this study were all VIII science classes of State Junior High School totaling 175 students. The samples used were two classes taken with cluster random sampling technique. The normality value in the experimental class is  $0.424 > 0.05$  which is in the normal category, while the control class normality value is  $0.120 > 0.05$  which is in the normal category, The average N-Gain value in the experimental class is 0.60 and the average N-Gain value in the control class is 0.52, both N-Gain values are included in the medium category, the results of the independent t test  $0.003 < 0.05$  ( $\alpha=0.05$ ) which means that there is a significant difference between the science process skills of students in the experimental class and the control class. Based on the results of this study after applying the STEM-integrated guided inquiry model there is an increase in the science process skills of students in the experimental class on the human respiratory system.

**Keywords:** Human respiratory system; Science process skills; STEM-integrated guided inquiry model

## Introduction

Indonesia is still experiencing various challenges regarding science education for the achievement of education by looking at aspects of mastery of material and skills. Knowledge-based skills to achieve success in the learning process that students can be expected to achieve.

Science learning is expected to be a forum for students to study the surrounding nature that applies knowledge in everyday life. Therefore through the learning experience of science, students should have a variety of activities such as cognitive, psychomotor and attitudinal activities. Skills that involve in science process skills (Rustaman et al., 2005). If someone has been trained with science process skills, they will have

skills in solving a problem, analyzing, seeing and making plans (Ambarsari & Santosa, 2013).

Based on interviews with science teachers that in a concept or way to solve problems in accordance with what is in the science textbook used. In discussion activities also only in groups and only a few students can complete the discussion, other members are only passive by following what is being done without any curiosity. Therefore, the researcher provides an alternative solution by providing learning that can improve the science process skills of students by applying the STEM integrated guided inquiry learning models (Erlinawati, 2021).

The guided inquiry learning models it self is a learning model that is student centered or in other words centered on students, this model puts students in a

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situation where they are required to experiment independently in order to see for themselves the phenomena that occur (Wulaningsih et al., 2012). According to Rizal (2014) the guided inquiry learning approach can improve science process skills because in the learning stages it will provide more opportunities for students to seek and find their own facts with direct experience which results in a more optimal learning process.

The guided inquiry model can also involve students for active participation in science learning in the classroom, so that it can integrate with STEM according to the 2013 curriculum that STEM is one of the learning that emphasizes the learning process so that students can use a scientific approach to understand various materials (Afrianti et al., 2022). STEM (Science, Technology, Engineering and Mathematics) is an integrated learning approach that connects real-world realities with classroom learning related to natural knowledge, technology, engineering and mathematics (Permanasari, 2016). Learning in STEM-based learning can improve students' science process skills to apply knowledge when making designs as a form of problem solving related to the environment and technology (Afrianti et al., 2022).

STEM integration in the guided inquiry learning model is found in the learning steps with 7 stages, namely problem orientation included in STEM-Science, formulating problems included in STEM-Science and Engineering, collecting data included in STEM-Engineering, making hypotheses included in STEM-Science and Engineering, conducting experiments included in STEM-Science, Technology and Engineering, analyzing data included in STEM-Engineering and Mathematics, and drawing conclusions included in STEM-Science and Engineering (Kahar et al., 2022). the STEM integration in learning can enhance the dominance role of students in the learning process (Zhai, 2019). Therefore, teacher has a important role in giving real support in order students can build the knowledge and interdisciplines skills (Nathan & Pearson, 2014).

The laboratory in the school facilities to be examined has tools and materials that are slightly incomplete, so that in science subjects, especially the material of the human respiratory system, sometimes practicum is not given and only given questions without knowing how the human respiratory system is in humans. So that students do not know science subjects with human respiratory system material to the fullest and only know from existing theories. Based on these problems, researchers have an alternative solution to be able to see how to find out the science process skills of students by applying the STEM-integrated guided

inquiry learning model on human respiratory system material in class VIII Junior High School.

## Method

This research uses the quasi experiment method. There is an experimental group and a control group but participants are not randomly grouped into the two groups (Fraenkel, 2012). The research design used pretest-posttest control group design, which is research conducted with two groups randomly selected then given a pretest or initial test then carried out treatment in both classes respectively which is then ended with a test (posttest) (Fraenkel, 2012).

This study was conducted in one of the Class VIII junior high schools in Cirebon Regency, West Java Province. The sample used with 2 classes taken using side random sampling technique. Sampling from a random population is homogeneous and has the same level of ability. Based on the sampling, VIII B class was obtained as the experimental class and VIII D as the control class.

The instruments used in this study were pretest and posttest questions related to human respiratory system material. This instrument has gone through the stages of empirical validation and thorough testing before being given in the study. The purpose of validity is to measure the accuracy of the instrument that can measure what should be measured, while reliability aims to measure the consistency of the instrument (Fraenkel, 2012). In the first stage of the research carried out by measuring the initial ability of students by using pretest questions about the human respiratory system. Statistical tests were carried out to see the N-Gain of the experimental class and control class, in addition to calculating the N-Gain of each indicator. After that, learning activities were carried out using the STEM-integrated guided inquiry model. After the learning stage is complete, students are given a posttest.

Based on this research method, the data will be analyzed using normalized gain to determine the effectiveness of the learning carried out on students.

## Result and Discussion

This study aims to see the improvement of students' science process skills by using a STEM-integrated guided inquiry learning model. Based on the recapitulation of the results of pretest, posttest and N-gain data on students' science process skills in experimental and control classes as in table 1.

Based on Table 1, it can be seen that there are differences in the science process skills of students between the experimental class and the control class,

namely in the initial ability value (pretest) in the experimental class and control class at the maximum value seen in Table 1 pretest at the maximum value in the experimental class is 38.46 while the control class at the maximum pretest value is 28.21. Then on the final ability value (posttest) of science process skills listed in Table 1 that the maximum value of the experimental class is 87.18 while the control class is 76.92. The average value of science process skills after learning was 72.12

for the experimental class and 63.22 for the control class. The standard deviation value of science process skills of science process skills after learning for the experimental class is 8.18 and for the control class is 7.53. Learning integrated with science, technology, engineering and mathematics and connected with science, skills and attitude shows higher score in posttest than pretest (Sandall, 2018).

**Table 1.** Recapitulation of the Mean Value of Pretest, Posttest, and N-Gain of Science Process Skills of Experimental Class and Control Class Students

Value	Experimental class n=32			Control class n=32		
	Pre-test	Post-test	N-gain	Pre-test	Post-test	N-gain
Maximum	38.46	87.18	0.83	28.21	76.92	0.74
Minimum	15.38	5.97	0.42	10.26	51.28	0.37
Average	29.33	72.12	0.60	22.04	63.22	0.52
Standard Deviation	6.35	8.18	0.11	6.00	7.53	0.09

The maximum value of improvement (N-Gain) of science process skills as stated in Table 1 in the experimental class is 0.83 in the high category and in the control class is 0.74 in the high category. The minimum N-Gain value of the experimental class is 0.42 in the medium category and the minimum N-Gain value of the control class is 0.37 in the medium category. The average N-Gain value of the experimental class science process skills is 0.60 with a standard deviation of the experimental class N-Gain of 0.11, while the average N-Gain value of the control class science process skills is 0.52 with a standard deviation of the control class N-Gain of 0.09. The criteria for improving the science process skills of experimental and control classes both show moderate criteria (Hake, 2014).

Based on Table 1, the science process skills of students at the beginning of learning before treatment (pretest) is given to the experimental class and the control class shows a difference in value even though the two classes have the same ability and before treatment. However, in observations and looking at the daily tests of the two classes, it appears that the experimental class is more active than the control class in learning the previous material.

After being given a pretest, treatment is carried out with learning devices starting from the learning process plan with the steps of the STEM integrated guided inquiry model and student worksheets to train students' process skills with human respiratory system material. Experimental classes using STEM-integrated guided inquiry model lesson plans and student worksheets that direct the science process skills of students with human respiratory system material and conduct practicum, so that they can activate designing experiments that are included in the science process skills. When students experience difficulties in working on the student

worksheets, the teacher helps and guides the students directly (Udin et al., 2013). The role of STEM in science learning is integrated into learning plans and instruments for achieving scientific literacy in line with research conducted by (Afriana et al., 2016). In line with the statement (Afrianti et al., 2022) learning activities carried out using STEM-based students worksheets through guided inquiry are developed to require students to carry out scientific activities through observation, making hypotheses, and doing practice and connecting the concepts obtained with everyday life.

The practicum of the human respiratory system using experimental design is on the discussion of the causes of respiratory disorders caused by someone who smokes. Learners design using mineral bottles, cigarettes and cotton that function as human lungs, after the practicum, the results of observations are written in the student worksheet, this also trains students in the ability to communicate which is included in the science process skills (Nuriyawan et al., 2016).

The treatment was conducted in 3 meetings, then given a posttest with the same questions as the pretest. The results of the posttest from the experimental class and control class are listed in Table 1 and show the results that the experimental class has higher results than the control class. This is because the learning process in the experimental class has been trained in science process skills through lesson plans and student worksheets while in the control class in learning using a conventional model with lectures and discussions and student worksheets does not direct in science process skills (Zahroh et al., 2017).

Based on the results of the N-Gain analysis, the improvement of students' science process skills is obtained as in table 2. Table 2 explains that there are differences in science process skills in students in

experimental and control classes. The difference in the improvement of science process skills is inseparable from the learning process experienced by each group of students. In the experimental class, learning is carried out by applying a guided inquiry model that is integrated with STEM can facilitate students to be more actively involved during learning activities, so that they can develop and practice the abilities they have including science process skills (Rohmatul et al., 2022).

This is due to the characteristics of inquiry as a process of finding and investigating problems, formulating hypotheses, planning experiments, collecting data, and drawing conclusions (Andrini, 2016). Supported by research Sutoyo et al. (2019) which explains that STEM-based learning can increase students' motivational abilities, creativity and understanding of science concepts.

**Table 2.** Recapitulation of N-Gain Statistical Test Results of Science Process Skills of Experimental and Control Classes

Classes	Normality <sup>1)</sup> $\alpha = 0.05$		Homogeneity <sup>2)</sup> $\alpha = 0.05$		T-test <sup>3)</sup> $\alpha = 0.05$	
	Sig.	Criterion	Sig.	Criterion	Sig.	Criteria
Experiment	0.42	Normal	0.153	Homogeneous	0.003	There is a significant difference
Control	0.12	Normal				

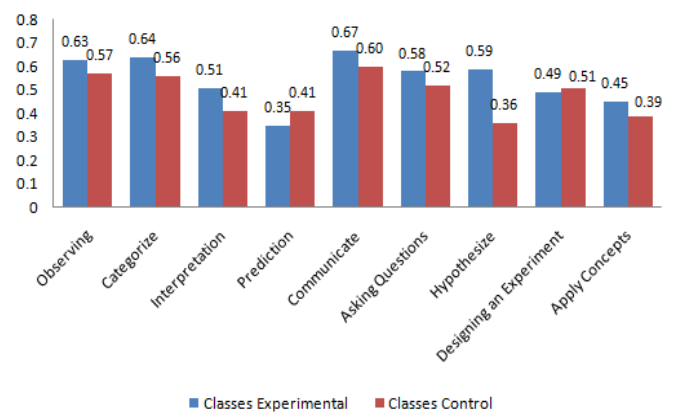
Description: 1) Shapiro-Wilk test; 2) Levene's test; 3) T-test for equality for means

According to Rizal (2014) the guided inquiry learning model can improve students' science process skills because it follows the guided inquiry learning steps. Through scientific activities that provide more opportunities for students to find their own facts, concepts, and principles through direct experience so that the learning process becomes optimal. In line with research (Lestari & Rahmawati, 2020) explains that the STEM-based guided inquiry model makes students focus more on learning material related to daily life so that students can easily utilize technology to be able to prove the hypotheses that have been set. Learning carried out with STEM integration can improve and develop students' scientific work skills (Fitriansyah et al., 2021).

Table 2 states that data of N-gain of science process skills of experimental class and control class are normally distributed and have homogeneous variance. The results of the t-test for equality for means obtained showed that there was a significant difference in the improvement of science process skills between the experimental and control classes. This shows that the STEM integrated guided inquiry model can improve science process skills.

Description of the improvement in each indicator of students' science process skills represented by the N-Gain value of each indicator for the experimental and control classes as shown in Figure 1. Figure 1 all N-Gain values per indicator of science process skills are included in the moderate category. The highest indicator in the communication indicator is in the experimental class, while the lowest indicator in the experimental class is the prediction indicator. This is also in line with research Nensy (2019) which explains that science process skills in the communication indicator are indicators with a high percentage in the very good category, the

influencing factor is social practice during group practicum (Davidi et al., 2021). Then the highest indicator in the control class is the indicator of carrying out communication, while the lowest indicator in the control class is the indicator of carrying out hypotheses. In line with research (Ramdan) which explains that prediction activities are still weak for students to carry out in the learning process. Also agrees with research (Hijriyah et al., 2020) which explains that the results of the prediction indicators between the experimental class were higher compared to the results of the control class.



**Figure 1.** N-gain increase in each indicator of science process skills of experimental and control class students

This the science process skills of each learner for each indicator have increased which is included in the moderate category. This is because students are not accustomed to applying science process skills because learning in the previous school has not been practiced. As Zahroh et al. (2017) states that science process skills will be mastered by students if practiced repeatedly and continuously so that students will get used to it. Also

supported by research Sudibyo et al. (2018) which explains that at the age of 11 years of logical development, they are still less able to abstract knowledge and concepts.

Guided inquiry model learning is learning that has the aim of forming students to solve a problem by linking the concepts learned in class. Guided inquiry model learning is learning that makes students direct objects in solving a problem so that in implementing learning the teacher acts only as a guide (Zulhadi, 2019). This is in line with research Astuti et al. (2013) which states that inquiry learning that is suitable for Middle School (SMP) students is guided inquiry-based learning. Based on the results of the study, it can improve the science process skills of students who use the STEM-integrated guided inquiry learning model in contrast to the control class which uses a conventional learning model without any stimulus regarding science process skills so that the ability of students' science process skills does not develop.

The results of this study are also supported by research conducted by Kurniawan et al. (2017) which states that the implementation of the STEM-based guided inquiry model can be implemented very well which in the science process skills of students has increased after applying the STEM-based guided inquiry model. In line with research Afrianti et al. (2022) which states that the science process skills of students can increase with the application of STEM-based LKPD in the guided inquiry model.

Previous research also discussed guided inquiry conducted by Amatullah et al. (2019) which states that there is an effect of the guided inquiry learning model on learning outcomes as indicated by the results of significant differences in N-gain between the experimental class and the control class, which is seen from  $t_{count} > t_{table}$ , namely with a value of  $5.485 > 2.069$  so that the confidence level is 95. In addition, similar research has also been conducted by Alhudaya et al. (2018) which states that there are differences in the science process skills of experimental and control class students where the experimental class science process skills are higher than the control class science process skills.

Based on the results of the independent t test obtained in this study that learning STEM integrated guided inquiry learning model produces significant differences with science process skills using conventional models. This can be seen from the average science process skills of the experimental class with the average skills of the control class which resulted in differences in experimental and control classes influenced by the treatment given. In line with research Kahar et al. (2022) explains that the t test results have

increased which shows that the STEM integrated guided inquiry learning model can improve science skills. Supported by research Stohlmann et al. (2012) explains that STEM integrated education can motivate students for student success.

## Conclusion

Based on the research results, it can be concluded that the application of the STEM integrated guided inquiry model can improve students' science process skills in learning the human respiratory system with problems that exist in students' daily lives, this makes students actively participate and experience new things during learning

## Author Contributions

The authors in this research are divided into executor and advisor.

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## Conflicts of Interest

The author declares no conflict of interest in this research.

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