Indonesian Journal of Science and Education
Volume 05, Nomor 02, 2020, pp: 68~79
ISSN: 2598-5213e-ISSN: 2598-5205, DOI: 10.31002/ijose.v5i2.4261
e-mail: ijose@untidar.ac.id, website: jurnal.untidar.ac.id/index.php/ijose

Implementation of ERP (*Engange, Research, Present)* Intructional Model Using Virtual Laboratory in Science Learning to Increase Student's Science Process Skills

Siswanto [1], Wartini[2a], Ahmad Muhlisin[3], Rina Rahayu[4], Fifit Firmadani[5]
[12345]Natural Science Education Departement, Tidar University
Jalan Kapten Suparman No. 39 Tuguran Potrobangsan North Magelang, Magelang City, Central Java, 56116, Indonesia
email: [a]wartiniblora15@gmail.com

Received: August, 17th 2021 *Revised: September, 10th 2021* *Accepted: October, 11th 2021*

ABSTRACT

Science process skills are important skills for students to solve problems. The results of the 2018 PISA survey show that the science competence of Indonesian students is ranked 71 out of 79 countries. Based on the problem, this study aims to analyze the differences in the improvement of science process skills between students whose learning process uses a virtual laboratory-based ERP instructional model compared to using discovery learning instructional models at SMP Negeri 2 Magelang. This study uses a quasi-experimental method , with a nonequivalent control group design. The result of this study is that there are differences in the improvement of science process skills between classes that apply the ERP instructional model (Engange, Research, Present) using a virtual laboratory compared to the discovery instructional model . The increase in science process skills (N-gain) in the class that applies the ERP model using a virtual laboratory is 0.50 with a medium improvement category. The increase in science process skills (N-gain) in the class that applies the discovery instructional model is 0.29 with a low improvement category. The suggestion put forward in this study is that teachers can use the ERP (Engange, Research, Present) instructional model using a virtual laboratory to train student's science process skills.

Keywords : ERP Instructional Model (Engange, Research, Present), Virtual Laboratory, Science Process Skills, Research Based Learning

INTRODUCTION

Natural Sciences is related to how to find out about nature systematically, so that science is not only mastery of a collection of knowledge in the form of facts, concepts, or principles but also a process of discovery (Wisudawati & Sulistyowati, 2014). The knowledge discovery process can be done by observation, experiment, practicum and investigation or investigation, so that science learning is closely related to science process skills.

Science process skills are a set of skills used by scientists in conducting scientific investigations or research (Hasanah & Utami, 2017). The importance of science process skills for students is to enable students to describe objects and events, ask questions, build knowledge, test theories and communicate ideas (Opara, 2011). Science process skills can train students to verify and construct concepts through a scientific approach (Maikristina, 2013). Science process skills enable students to solve problems (Abungu et al., 2014).

Science process skills are classified into two, namely basic process skills and integrated science process skills. Basic science process skills include observing, classifying, measuring, and inferring. Meanwhile, integrated science process skills include skills in formulating hypotheses, identifying and controlling variables, skills in conducting experiments, and interpreting data (Aydogdu, 2015).

The results of the 2018 Program for International Student Assessment (PISA) survey for science competence, Indonesia ranks 71 out of 79 countries with an average score of 396. Indonesian students' science competence is at level 1a. The average score of the Organization for Economic Cooperation and Development (OECD) science competence is 489, so the average score of Indonesian students in the field of scientific competence is below the OECD average score. One of the domains of scientific competence assessed by PISA is scientific literacy which includes context, knowledge and competence. Competence consists of explaining phenomena scientifically, investigating and designing investigations, and interpreting scientific evidence data (OECD, 2019). Therefore, science competence is related to science process skills.

Based on the results of interviews with science teachers at SMP Negeri 2 Magelang on January 30, 2021, researchers found information that students' science process skills were low. This is indicated by students having difficulty determining independent variables, control variables, and dependent variables in the experiment, so that they have difficulty controlling variables. Students have difficulty making temporary assumptions about a phenomenon or problem, so that it is not appropriate in formulating hypotheses. Students have difficulty designing experiments, so it is difficult to conduct experiments. Students have difficulty interpreting data and concluding learning activities. In online learning, students experience obstacles in conducting experiments, namely the limitations of the tools and materials used by students in conducting experiments. So far, the teacher uses the discovery instructional model in the science learning process.

Science process skills can be trained through learning activities using laboratories (Risanti and Setyarsih, 2015). One type of laboratory is a virtual laboratory. Virtual laboratory is a laboratory activity based on computer simulation (Wisudawati, 2014). Virtual laboratories provide a meaningful virtual experiment experience (Tatli & Ayas, 2013). Virtual laboratory can train students' science process skills (Luki, 2017; Hizbi, 2019; Cahyaningrum, 2020).

Science process skills can also be trained through scientific investigation activities (Ibrahim, 2010). One instructional model that integrates research activities or scientific investigations in the learning process is the ERP instructional model (Engange, Research, Present). The ERP instructional model provides opportunities for students to discover, explore, and develop knowledge and skills to solve problems they face by building connections between intellectual (thinking processes) and practical activities through integrated research activities in learning activities (Sukarno, et al., 2020).

The ERP instructional model consists of 3 phases, namely engange (involvement in the learning process), research (investigation activities), present (communication). The en gange phase consists of sub-phases of reading phenomena/problems, identifying important points in phenomena/problems, writing research questions, reviewing literature, making maps of the stages of investigation. The research phase consists of sub-phases of formulating hypotheses, conducting investigations, analyzing data and discussing, concluding, and making short reports. Phases present consists of sub-phases make mindmapping research, presented the results of studies using mindmapping (Sukarno, et al., 2020).

The virtual laboratory is integrated into the ERP instructional model in the research phase, precisely in the sub-phase of conducting an investigation. Virtual labs are used to facilitate research activities carried out by students. Based on this description, this study aims to analyze the differences in the improvement of process skills between students whose learning process uses a virtual laboratory-based ERP model compared to using the discovery instructional model at SMP Negeri 2 Magelang.

RESEARCH METHOD

This study uses a quasi-experimental method, with a nonequivalent control group design. This study used one experimental class and one control class. The experimental class was treated with an ERP instructional model using a virtual laboratory. The control class was treated with a discovery instructional model.

The research procedure consists of seven stages. The first stage is the preparation of learning tools consisting of learning designs, student worksheets, and teaching materials. The second stage is the preparation of research instruments consisting of science process skills test instruments and student activity observation sheets. The third stage is testing the validity and reliability of the test instrument. The fourth stage is to give a pretest to both classes. The fifth stage is to provide treatment for the ERP instructional model using a virtual laboratory in the experimental class and discovery instructional modeling in the control class. The sixth stage is to give posttest to both classes. The seventh stage is conducting data analysis.

The population in this study were students of SMP Negeri 2 Magelang in grade 8. The samples were taken as many as 2 of the class of 8 classes with purposive sampling technique . The instrument used in this research is a science process skill test instrument .

The test instrument was validated by experts and tested for validity using v aiken. The results of the vaiken analysis, the test instrument is valid. The test instrument was tested, then analyzed for construct validity, reliability, discriminatory power, level of difficulty. The test instrument is in the form of 14 multiple choice questions.

The increase in science process skills was analyzed using N-Gain with the following equation.

$$g = \frac{posttest\ score - pretest\ score}{maximal\ score - pretest\ score}$$

The results of the N-Gain calculation are then interpreted using the classification as shown in the following table.

Table 1. Criteria for N-Gain

The size of g	Interpretation
$g > 0{,}7$	Tall
$0{,}3 \leq g \leq 0{,}7$	Currently
$g < 0{,}3$	Low

(Hake, 1999)

Differences in the increase in scores in the experimental class and control class were analyzed using the SPSS statistical test.

RESULTS AND DISCUSSION

The results of the achievement of science process skills in the experimental class are shown in Table 2. The data on the average pretest score, the average posttest score, the N-Gain score can be seen in Table 2. The data on the achievement of science process skills were obtained from the pretest and posttest data.

Table 2 . Results of Experimental Class Science Process Skills Achievements

Test	Total students	Average Score	N-Gain	Category
Pretest	32	31.70	0.50	Currently
Posttest	32	65,40		

Table 1. shows that the average science process skills of students in the experimental class before the ERP instructional model was applied using a virtual laboratory was 31.70. The average of students' science process skills after applying the ERP instructional model using a virtual laboratory became 65.40. This shows that there is an increase in students' science process skills after applying the ERP instructional model using a virtual laboratory with an N-gain value of 0.50

which is categorized as moderate improvement.

The results of science process skills in the control class are shown in Table 3 . The data of the average pretest score, the posttest average score, the N-Gain score can be seen in Table 3. The data on the achievement of science process skills were obtained from pretest data and posttest data.

Table 3. Achievement Results of Control Class Science Process Skills

	Total students	Average Score	N-Gain	Category
Pretest	32	29.91	0.29	Low
Posttest	32	50.67		

Table 3. shows that the average science process skills of students in the control class before the discovery instructional model was applied was 29.91. The average of students' science process skills after the discovery instructional model was applied became 50.67. This shows that there is an increase in students' science process skills after the discovery learning instructional model is applied with an N-gain value of 0.29 which is categorized as low improvement.

Pretest and posttest were conducted in face-to-face learning. The learning process is carried out online through synchronous in the form of google meet and asynchronous in the form of whatsapp groups.

The normality test was carried out on the data group of increasing science process skills in the experimental class and control class. The results of the normality test with the Kolmogorov-Smirnov SPSS showed that the significance number in the experimental class was 0.200 and the control class was 0.200 . The significance in the experimental class and control class is greater than 0.05 (sig.> 0.05) so that the data distribution is normally distributed.

The homogeneity test was carried out on the data group of increasing science process skills in the experimental class and control class. The results of the homogeneity test with the Levene test SPSS showed that the significance number was 0.098 greater than 0.05 (sig.> 0.05) so it could be concluded that the increase in science process skills in the experimental class and homogeneous control class.

Based on the normality test and homogeneity test, the data were normally distributed and homogeneous, so that the hypothesis was tested using parametric statistical tests. The parametric statistical test used is the independent sample t test using SPSS. The results of the independent sample t test showed a significance value of 0.000 which was less than 0.005 . The significance value <0.05, H_0 is rejected and H_a accepted that "there is a difference between student skills improvement process that the learning process using the instructional model based ERP virtual laboratories compared by using model discovery learning in SMP Negeri 2 Magelang".

The increase in the score (N-Gain) of the experimental class and the control class is shown in Table 4.

Table 4. N-Gain of Experiment Class and Control Class

Class	N-Gain	Information
Experiment	0.50	Currently
Control	0.29	Low

Based on Table 4., the N-Gain in the experimental class was 0.50 with a moderate improvement category and 0.29 in the control class with a low improvement category. The data shows that there are differences in the improvement of science process skills in the experimental class and the control class. The improvement of students' science process skills in the class that applies the ERP instructional model using a virtual laboratory is greater than the class that applies the discovery instructional model.

According to the researcher's analysis, the increase in science process skills in the experimental class is higher than the control class because the stages of the ERP instructional model using a virtual laboratory can train science process skills. The sub-phase makes the investigation stage practice variable control skills. The sub-phase of formulating hypotheses trains the skills of making hypotheses. The investigation sub-phase which integrates the virtual laboratory trains the skills of conducting experiments. The sub-phase of data analysis and discussion trains data interpretation skills. The conclusion sub-phase trains the skills of drawing conclusions. The results of this study are in line with those expressed by Sukarno, et al. (2020) that the ERP instructional model is able to train students to have the skills needed to become a researcher. The control class applies a discovery learning instructional model whose learning stages consist of stimulation, problem identification, data collection, data processing, verification and generalization.

The improvement of science process skills in the experimental class in the medium improvement category. According to the researcher's analysis, the moderate increase was due to several factors. The first factor is the learning stage that is too long, so that one learning process is carried out in two meetings with the assignment model. Students are given three days to carry out research activities. The allocation of meetings in this study was four meetings, so that the ERP instructional model using a virtual laboratory was implemented in two learning processes. Less than three times the learning allocation of the learning process causes the ERP instructional model using a virtual laboratory has not resulted in a high improvement in this study. The reason for the limited allocation of meetings in this study is that the allocation of meetings must be adjusted to the semester program that has been prepared by the teacher at the school, so that it is not possible to add more meetings for each subject. The second factor is that not all students like the activity of making mind mapping, thus causing less motivation to learn.

The comparison of N-Gain for each aspect of science process skills in the experimental class and control class is shown in Figure 1.

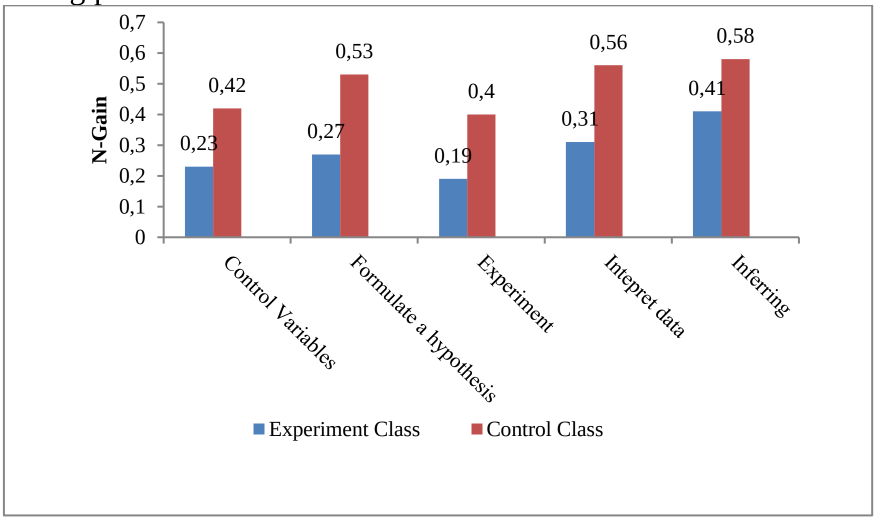

Figure 1. N-Gain of Science Process Skills in Experiment Class and Control Class

Based on Figure 1., it is known that there are five science process skills that are measured, namely controlling variables, formulating hypotheses, conducting experiments, interpreting data and drawing conclusions. The N-Gain aspect controls the variables in the experimental class by 0.42 and in the control class by 0.23. The N-Gain aspect of formulating hypotheses in the experimental class is 0.53 and in the control class is 0.27. The N-Gain aspect of experimenting in the experimental class is 0.40 and in the control class is 0.19. The N-Gain aspect of interpreting the data in the experimental class is 0.56 and in the control class is 0.31. The N-Gain aspect of drawing conclusions in the experimental class is 0.58 and in the control class is 0.41. Overall, the N-Gain of every aspect of science process skills is greater in the experimental class than the control class.

The lowest aspect of science process skills improvement in the experimental class and control class is the aspect of conducting experiments. The N-Gain aspect of conducting experiments in the experimental class is 0.40 and in the control class is 0.19. The increase in the aspect of conducting experiments was at the lowest increase because students had difficulty in designing experiments, so it was difficult to conduct experiments. The increase in aspects of conducting experiments was higher in the experimental class compared to the control class. The difference in this increase is caused by the stages of conducting an investigation on the ERP instructional model. At the stage of conducting an investigation, the activities carried out by students are conducting experiments using a virtual laboratory. In the control class, the data collection stage uses literature study. The results of this study are in line with the research of Martana, et al. (2017) which states that the activity of conducting experiments can practice the skills of conducting experiments. Virtual laboratories provide a meaningful virtual experiment experience (Tatli & Ayas, 2013). According to the researcher's analysis, the stages of data collection in the control class if designed using experiments, the increase in skills in conducting experiments is higher in the experimental class. In the ERP instructional model there is a sub-phase of making research stages that train students to design experiments, so that students are easier to carry out experiments.

The ERP instructional model consists of three phases, namely the engagement phase, the reaserch phase and the present phase. The engange phase is an activity aimed at preparing students to be actively involved in learning activities. The research phase is an investigation activity carried out by students. The present phase is the phase of communicating the results of the investigation. In the ERP learning process using a virtual laboratory, students are given student worksheets. Student worksheets contains the stages of learning that must be done by students. Student worksheets aims to train students' learning independence. The stages of ERP learning activities using a virtual laboratory in detail are shown in Table 5.

Table 5. Stages of ERP Instructional Model Using Virtual Laboratory

Phase	Sub Phase	Teacher Activities	Student Activities
Engage	Reading phenomena/problems	Show reading phenomena or problems related to the material	Reading phenomena or problems
	Identify important points in the phenomenon/problem	Guiding students to identify phenomena or problems	Identify the important points in the phenomenon or problem presented
	Writing research questions	Guiding students to make questions based on problems	Create research questions based on the problems presented
	Reviewing the literature	Guiding students to review literature	Reviewing literature from various reference sources (books, internet, etc.) to solve problems
	Making the investigation stage	Guiding students to arrange the stages of the investigation	Arrange the stages of the investigation based on the literature study conducted (designing experimental activities)
Research	Formulating a hypothesis	Guiding students to formulate research hypotheses	Formulate hypotheses based on the literature study conducted
	Doing research	Guiding students to carry out research activities	Conduct experiments using a virtual laboratory to answer problems and prove

Phase	Sub Phase	Teacher Activities	Student Activities
			the truth of the hypotheses that have been made, make videos of experimental activities using a virtual laboratory, and fill in the data on the results of experiments that have been carried out in the table
	Analyze data and discussion	Guiding students to analyze data and discussion	Perform data analysis, convert tabular data into graphs, interpret graphs, and analyze relationships between variables contained in graphs
	Conclude	Guiding students in making conclusions	Concluding experimental data based on the analysis carried out
	Make a short report	Guiding students in compiling short reports	Make a brief report of investigation activities consisting of problem identification, stages of investigation, hypotheses, experimental data, data analysis and discussion, conclusions
	Make a mind map of research activities	Guiding students to make mind maps	Make a mind map based on the results of research activities
Present	Presenting the results of the investigation using mind mapping	Facilitate students to present the results of mind mapping	Presenting the results of the investigation with a mind map that has been made through a virtual meeting

The engange phase is an activity aimed at preparing students to be actively involved in learning activities. The engange phase consists of five sub-phases, namely:

1) Reading phenomena/problems
   In this sub-phase, a contextual phenomenon/problem related to the material is presented. Contextual problems/phenomena that are integrated in learning can increase students' learning motivation. Activities carried out by students are reading phenomena/problems.
2) Identify important points in the phenomenon/problem
   In this sub-phase requires students to do critical thinking in identifying phenomena/problems appropriately, so that they can train students to think critically. Activities carried out by students are identifying phenomena/problems.
3) Writing research questions
   This sub-phase aims to focus and direct the investigation activities that must be carried out by students. Activities carried out by students are writing research questions based on phenomena/problems.
4) Reviewing the literature
   This sub-phase trains students to have the ability to collect and analyze concepts/theories related to research questions. This sub-phase aims to make it easier for students to map out all the possibilities that students can do in conducting an investigation. Activities carried out by students are conducting literature studies from various reference sources (books, internet, etc.).
5) Making the investigation stage
   In this sub-phase, students are required to make an investigation stage or design an investigation activity that will be carried out to solve the problem. The stages of

the investigation were made based on the results of the literature review. The activity carried out by students is to make the stages of investigation. The stages of the investigation made were the design of experimental activities using a virtual laboratory. The virtual laboratory used is www.physicsclassroom.com . In this sub-phase, students really need teacher guidance in designing experimental activities using virtual laboratories. Based on the activities carried out in this sub-phase, the sub-phase composes the investigation stage to practice variable control skills.

The research phase is an investigation activity carried out by students. The research phase consists of six sub-phases, namely:

1) Formulate a hypothesis

This sub-phase trains students to make tentative guesses to answer research questions. The hypothesis is made based on the literature review that has been carried out in the engange phase , making it easier for students to formulate hypotheses. In formulating hypotheses, critical thinking is needed so that the formulated hypothesis is right. Activities carried out by students are formulating hypotheses based on literature studies carried out to answer research questions that have been made. Based on the activities carried out in this sub-phase, the sub-phase of formulating hypotheses trains students to have the skills to make hypotheses.

2) Doing an investigation

At this stage, students collect information to prove the hypothesis made. Investigation activities are carried out with experimental activities using a virtual laboratory. Virtual laboratories can facilitate students in conducting investigations. Activities carried out by students are conducting experiments using a virtual laboratory, making videos of research activities and filling in data on the results of experiments carried out in tables. Based on the activities carried out in this sub-phase, the sub-phase of conducting an investigation using a virtual laboratory can practice experimenting skills.

3) Analyze data and discussion

In this sub-phase, students analyze data and discuss data obtained from investigation activities. Activities carried out by students are analyzing and discussing data, changing investigation data from tabular form into graph form, interpreting graphs made, and analyzing relationships between variables on graphs. Based on the activities carried out in this sub-phase, the sub-phase analyzes the data and the discussion trains students to interpret the data.

4) Conclude

In this sub-phase, students evaluate the hypothesis made whether it is in accordance with the results of the investigation or not. Activities carried out by students are making conclusions based on data analysis and discussion. Based on the activities carried out in this sub-phase, this sub-phase trains students to draw conclusions.

5) Make a short report

In this sub-phase, students make a brief report on the investigation activities that have been carried out. Activities carried out by students are making short reports that identify problems, research questions, stages of investigation, hypotheses, investigation data, data analysis and discussion, and conclusions.

The present phase is the phase of communicating the results of the investigation. The present phase consists of two sub-phases, namely:

1) Make a mind map of research activities

In this sub-phase, students make a mind map that contains the course of students' thoughts in carrying out activities carried out in the engange phase and the research phase . Students are required to use communicative, effective and efficient language in making mind maps . Mind mapping is made using an attractive display. The activities carried out by the students were making a mind mapping of the investigation activities based on the short report made.

2) Presenting research results using mind mapping

The activities carried out by students in this sub-phase are presenting the mind mapping made at the virtual meeting .

During the learning process using a virtual laboratory-based ERP instructional model, the researcher got several findings. 1) Students need teacher guidance in carrying out the stages of the learning process. 2) Students are enthusiastic in the learning process which is indicated by students carrying out each stage of the learning process. 3) Students are interested in conducting research/investigation activities using a virtual laboratory indicated by students asking questions when conducting an investigation. Students' questions indicate that students are curious about research/investigation activities using virtual laboratories.

The ERP instructional model is a research-based instructional model (investigation) designed to train research activities in the context of acquiring knowledge (Sukarno, et al., 2020). The results showed that the ERP instructional model using a virtual laboratory was effective in improving science process skills. The results of this study are also in accordance with the findings of previous research which states that the application of the inquiry instructional model (investigation-based learning) combined with a virtual laboratory can improve science process skills (Adha & Wahyuni, 2020 and Cahyaningrum, 2020).

The ERP Instructional model uses a student center learning approach . The ERP instructional model emphasizes the activeness and independence of students, the teacher acts as a facilitator and does not dominate the learning process. The ERP instructional model provides opportunities for students to find, explore, and develop knowledge and skills to solve the problems they face (Sukarno, et al., 2020).

Virtual laboratories allow students to do real experiments as well as when experimenting using real laboratories (Ariani & Hariyanto, 2010; Hafsyah, et al., 2012). The use of virtual laboratories in learning provides a meaningful virtual experiment experience (Tatli & Ayas, 2013). The virtual laboratory also provides a fun experimenting experience (Nurrokhmah & Sunarto, 2013). Based on these findings, it can be concluded that the use of virtual laboratories in the learning process can facilitate students in conducting meaningful experiments.

In the control class apply the instructional model of discovery learning . The instructional model discovery learning is a discovery-based instructional model (discovery) in the process of acquiring knowledge. The discovery instructional model consists of five stages, namely stimulation, problem identification, data collection, verification and generalization. In the discovery learning process , students are given student worksheets. Student worksheets contains the stages of learning that must be done by students. Student worksheets aims to train students' learning independence. The stages of the discovery instructional model in detail are shown in Table 6.

Table 6. Stages of the Discovery Instructional model

Stages	Teacher Activities	Student Activities
Stimulation	Provide stimulation to students in the form of questions related to the material	Understand the questions given by the teacher
Identification of problems	Guiding students to identify problems	Identifying problems based on the given stimulus
Data collection	Guiding students to collect data to answer questions	Collect data by conducting literacy studies with references (books, internet, etc.) to answer questions
Data processing	Guiding students to process discovery data	Process discovery data to answer questions
Verification	Guiding students to prove whether the data findings are true or not by making presentations at virtual meetings and discussions	Proving whether or not the data findings are true by making presentations at virtual meetings and discussions
Generalization	Guiding students to conclude discovery activities	Concluding discovery activities

The discovery instructional model consists of five stages, namely:

1. Stimulation
   At this stage, the teacher provides stimulation in the form of questions related to the material. Activities carried out by students understand the teacher's questions.
2. Identification of problems
   Activities carried out by students at this stage are identifying problems based on the stimulus given by the teacher.
3. Data collection
   Activities carried out by students collect data to answer the formulation of the problem and prove the hypothesis made. Data collection activities are carried out by studying literacy using references (books, internet, etc.).
4. Data processing
   The activities carried out by students at this stage are processing the data found by providing explanations. This stage trains the skills of interpreting data.
5. Verification
   Activities carried out by students at this stage are conducting examinations to prove whether or not the discovery data is true by presenting them through virtual meetings and discussions.
6. Generalization
   The activities carried out by students at this stage are making conclusions based on the findings. This stage trains the skills of drawing conclusions .

CONCLUSION

The conclusion of this research is that there are differences in the improvement of science process skills between classes that apply the ERP instructional model (Engange, Research, Present) using a virtual laboratory compared to the discovery instructional model . The increase in science process skills (N-gain) in the class that applies the ERP model using a virtual laboratory is 0.50 with a medium improvement category. The increase in science process skills (N-gain) in the class that applies the discovery instructional model is 0.29 with a low improvement category.

Suggestions put forward by researchers are 1) Teachers can use the ERP instructional model (Engange, Research, Present) using a virtual laboratory to train students' science process skills, 2) Further research needs to be carried out which is designed with a longer time allocation in order to provide high improvement.

ACKNOWLEDGMENTS

Thank you to SMP Negeri 2 Magelang for collaborating in this research.

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