

PROMOTING SCIENCE PROCESS SKILLS AND LEARNING OUTCOMES THROUGH CYBERGOGY APPROACHES WITH PhET MEDIA FOR JUNIOR HIGH SCHOOL STUDENTS

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Abstract: This study aims to describe the implementation of the cybergogy approach in improving Science Process Skills and learning outcomes. The research design used is One Group Pretest Posttest Design with a quantitative approach. The data collection method used is test and observation. The subjects of this study were 16 students of class VIII-A of Junior High School 2 Papar, Indonesia. Observers in this study were two science teachers and one student majoring in science. The instruments used in this study include learning implementation sheets, Science Process Skills observation sheets, pretest and posttest sheets of cognitive learning outcomes. The data analysis technique used quantitative analysis. Implementing learning through the cybergogy approach is carried out well, and a high learning success rate affects the improvement of science process skills and learning outcomes. The pretest of 80% and posttest of 94,4% showed increased cognitive and affective learning outcomes. The average N-Gain result obtained is 0.7 with high criteria. Science process skills as psychomotor and affective aspects experienced a significant increase. The use of PhET media also increased science process skills and learning outcomes. This study concludes that implementing the cybergogy approach to learning using PhET as a V-Lab media can improve science process skills and student learning outcomes.

Keywords: Cybergogy, Learning Outcomes, Science Process Skills, PhET

INTRODUCTION

The rapid development of scientific knowledge, especially science and technology, provides many benefits for humans, but often learning has not fully utilized existing technology [1]. The most important thing in learning is accuracy in choosing learning strategies. The achievement of learning depends on a structured strategy and professionalism in teaching. One type of learning strategy that can be implemented is cybergogy. Cybergogy is a cyber-based educational service system & digital learning that can build a conducive learning ecosystem by utilizing information technology. A key element in cybergogy is to combine pedagogy concepts with andragogy that has been practiced over the years into a teaching and learning process with a new learning approach [2]. Cybergogy learning strategies can train students through social, cognitive, and emotive factors [3]. Cybergogy strategy has a role for a teacher in using technology and digital in the learning carried out. The cybergogy approach supports social constructivists built through student internalization. Implementing this strategy is expected to improve science process skills and student learning outcomes in the digitalization era [4].

Science process skills are a skill that mobilizes all the abilities of students to acquire knowledge [5]. These skills include observing, calculating, grouping, asking questions, making hypotheses, making plans, and conducting experiments [6]. The role of a teacher who emphasizes learning in the process is as a guide. At

the same time, students are the drivers of the process. A similar expression states that science process skills in learning are basic skills that students must possess. Therefore, this skill cannot be negotiable [7]. In addition, the existence of science process skills is also expected to affect learning outcomes. Learning outcomes are a form of change experienced by students after being given a lesson [8]. It is obtained from an effort through the learning process and can be measured using tests to determine progress or improvement in student learning [9].

The urgency of doing this research after observing at Junior High School 2 Papar in Kediri that teaching methods in science learning are still teacher-centered and have not fully utilized the progress of digitalization in learning, so learning is still passive to books and power points. Based on the problems above, it causes student learning outcomes to be not optimal in every lesson. Therefore a learning model is needed to require students to be active and other media not only rely on books and PowerPoint. In addition, interactive media can also develop students' science process skills.

The updated solution based on the problems in the learning above is to use the concept of cybergogy learning and a new interactive media, namely PhET. Cybergogy is an update in learning by utilizing technological advances in information and communication with several important factors: social, emotional, and cognitive. Learning methods can be applied in the era of globalization by utilizing technology that is not limited by space and time [10]. The Sadjim

opinion reinforces that the concept of cybergogy learning can spur students to use information technology to obtain information and learning references. The use of appropriate media in this study is PhET Simulation [11].

Physics Education and Technology (PhET) is an interactive simulation media that can help teachers learn [12] and students visually understand science concepts. Previous research stated that the PhET media could clearly describe difficult material to explain through lectures, PhET can reduce misconceptions that occur to students [13]. Previous research showed that PhET media reduced students' misconceptions more than other media. The decrease was due to PhET being able to present an abstract and microscopic phenomenon, and previous research also stated that cybergogy learning strategies could increase students' interest in learning and science process skills [14].

The current research focuses on implementing the PhET-Media Cybergogy Approach to Improve Science Process Skills and Learning Outcomes in Junior High School Students.

RESEARCH METHODS

This research was carried out in the academic year 2021/2022 for even semesters for two meetings, using a quantitative approach where the data analysis to the conclusion uses formula calculations, aspects of measurement, and numerical data [15]. This study's subjects were randomly or randomly selected from one class and used the One Group Pretest Posttest Design [16]. The pretest was given at the first meeting before being given treatment to measure the student's initial abilities, and the posttest was given at the end of learning at the second meeting after being given treatment to find out the changes that occurred after being given treatment [17-18]. A simple research design can be presented as follows:

$$O_1 \text{ X } O_2$$

Description : O_1 = Pretest; X= Giving cybergogy model treatment with PhET media; O_2 = Posttest

The subjects of this study were 16 grade 8A students of Junior High School 2 Papar in Kediri Regency, which consisted of 10 male students and six female students. Class selection using random sampling, in which a randomly selected class will be used as the subject of the study. The sampling method is a technique that is often used in research, and the method is carried out by taking one sample from a population to be studied [19].

Research instruments are all tools used to retrieve data from a study [20]. The instruments used in this study include (1) learning implementation sheets; (2) posttest and pretest; (3) LKPD; (4) science process skills observation sheet; (5) Student response questionnaire sheet. All instruments used to collect data in this study have

been validated by supervisors, tutors, and other science teachers.

This study's data collection methods use observation, tests, and questionnaires. The observation method used a learning implementation sheet carried out by three observers: one science student and two science teachers from Junior High School 2 Papar. The test method was carried out twice before and after the learning process (pretest) and after learning (posttest). The aim was to describe the increase in student learning outcomes before and after learning. The science process skill observation sheet was carried out when students experimented using PhET. At the same time, the questionnaire method in this study aims to determine student responses after learning.

This study uses descriptive statistical data collection techniques. The descriptive analysis technique reveals learning outcomes, improvement of science process skills, implementation of learning, and student responses. The test method uses the N-Gain. The N-Gain was used to determine the increase in learning outcomes after being given a pretest and posttest. The N-Gain was obtained based on the difference pretest and posttest.

The calculation formula of the N-Gain Test is stated as follows.

$$N\text{-Gain} = \frac{S_{\text{posttest}} - S_{\text{pretest}}}{S_{\text{max}} - S_{\text{pretest}}}$$

The criteria for the N-Gain results obtained by the students were analyzed based on the N-Gain criteria in Table 1.

Table 1 Criteria for N-Gain

Gain Indeks	Gain Criteria
$0.7 \leq < g >$	High
$0.3 \leq < g > < 0.7$	Medium
$< g > < 0.3$	Low

[21]

Students' science process skills were conducted using a non-test method using the science process skills observation sheet. Observations were made when students conducted experiments using PhET. The science process skills assessment uses quantitative descriptive analysis with a Likert scale of 1 to 4. The Likert scale determines a person's opinion or perception [22]. The science process skills assessment is depicted in table 2.

The calculation formula uses a Likert scale as follows.

$$\text{Persentase} = \frac{\text{Score total}}{\text{maximum score}} \times 100\%$$

After calculating, the results obtained are then categorized in the following table 3.

Table 2 Science Process Skills Assessment

Criteria Assessment	Assessment Score
Meets 4 assessment criteria	4
Meets only 3 assessment criteria	3
Meets only 2 assessment criteria	2
Meets only 1 assessment criteria	1

[23]

Table 3 Science Process Skills Assessment Categories

Score	Criteria
≥85	Very good
70-85	Good
55-70	Fair
40-55	Not good
≥40	Very poor

Table 4. Criteria for implementing learning

Percentage	Criteria
81-100%	Very good
61-80%	Good
41-60%	Enough
21-40%	Less
0-20%	Very poor

The implementation of learning in this study was calculated using the following formula.

$$\% \text{ Implementation} = \frac{\text{Score total}}{\text{maximum score}} \times 100\%$$

Based on the implementation percentage formula, it can be perceived in the following table 4.

Questionnaires were given to determine student responses after this research was conducted. Student response questionnaires used an assessment with the following alternative answers: SS (Strongly Agree), S (Agree), TS (Disagree), and STS (Strongly Disagree). This questionnaire uses a Likert scale with the following scoring categories. Student response questionnaires in this study were calculated using the following formula.

$$\text{Indeks (\%)} = \frac{\text{score total}}{\text{maximum score}} \times 100\%$$

Based on the percentage formula for the response questionnaire can be seen in Table 5.

Table 5. Questionnaire percentage criteria

Indeks (%)	Criteria
0 – 19.99	Strongly disagree
20 – 39.99	Disagree
40 – 59.99	Don't agree
60 – 79.99	Agree
80-100	Strongly agree

RESULT AND DISCUSSION

Implementation of Learning

Learning in this study was carried out for two meetings. Implementation of guided inquiry learning model learning by applying the concept of cybergogy PhET media at Junior High School 2 Papar resulted in an average of 92.9 at meeting one and 92.3 at meeting 2. The percentage of learning implementation in detail can be seen in Table 6 and Table 7 below.

Table 6. Implementation First Meeting Learning

No.	Activity	Percentage of Implementation (%)			Average (%)
		O1	O2	O3	
1	Introduction	98.0	96.2	94.2	96.1
2	Core	86.0	95.0	92.5	91.2
3	Closing	83.0	100	91.6	91.5
Average					92.9

Table 7. Implementation Second Meeting Learning

No.	Activity	Percentage of Implementation (%)			Average (%)
		O1	O2	O3	
1	Introduction	95.0	95.8	83.3	91.4
2	Core	86.6	96.6	92.2	91.8
3	Closing	87.5	100	93.7	93.7
Average					92.3

Description:

- O1 = Observer 1 (Unesa Science Student)
- O2 = Observer 2 (Public Teacher of Junior High School 2 Papar)
- O3 = Observer 3 (Science teacher at Junior High School 2 Papar)

Based on Table 4, the implementation of learning at the first meeting in the preliminary activities obtained an average percentage of implementation of 96.1%, with an excellent category. The core activities obtained an average percentage of implementation of 91.2% in the excellent category. Then in the closing stage, the average percentage of implementation was 91.5% in the excellent category. Then at the first meeting, the total average obtained was 92.9%. Referring to Table 5, the implementation of the second meeting learning in the preliminary activities obtained an average percentage of implementation of 91.4%, with an excellent category. The core activities obtained an average implementation percentage of 91.8% with an excellent category, then an average implementation percentage of 93.7% with an excellent category index at the closing stage.

Furthermore, the total average obtained at the second meeting was 92.3%. The implementation of learning at the first meeting had a higher average percentage than in the second meeting. It was because learning at the first meeting was more conducive to using a computer lab, but the average percentage was not much different. Implementation of the guided inquiry learning model with the cybergogy overall at the first and second meetings went well. This learning model emphasizes student activity [24] so that the influencing factors in the cybergogy can be implemented. These factors include: cognitive, social, and emotional [25].

Science Process Skills

Based on the study results, learning with a cybergogy using the PhET media increased science process skills. Science process skills are a student's ability to understand and develop a framework of thinking in the science field [26]. In this study, science process skills observations were carried out when students conducted experiments on vibration and wave materials using a virtual lab, namely PhET. Science process skills observations using PhET can be used as benchmarks in the psychomotor realm, and implementing cybergogy using PhET media can increase student learning activity [27]. The psychomotor aspect is an aspect that relates to an action carried out by nerves and muscles, the competence that occurs in this realm can take action in the form of skills [28]. The science process skills in this study are divided into 5, namely formulating problems, making hypotheses, carrying out experiments, interpreting data, and concluding. A brief definition of the science process skills aspect is as follows: formulating a problem is a skill in compiling questions in short and clear sentences based on a phenomenon. Creating a hypothesis is a skill in making guesswork answers based on the problem formulation previously referred to as the basic theory. Experimenting is a skill in experimenting to prove an existing theory. Interpreting data involves connecting the analysis results with the theory to find the meaning of the data obtained to solve the problem formulation. The conclusion is a skill in analyzing a whole between the data obtained and the theory. The data from the science process skills observations when students conduct experiments using virtual labs or PhET are presented in Table 8 below:

Table 8 Average Science Process Skills

Science Process Skills Aspects	Average Science Skills Meeting 1	Average Science Skills Meeting 2	N-Gain
Formulating Problem	71.8%	79.6%	0.28
Making hypotheses	76.5%	84.4%	0.33
Carry out the experiment	67.1%	79.9%	0.38
Interpret data	65.6%	71.9%	0.18
Conclude	71.8%	85.9%	0.6
Mean	71.4%	80.3%	0.44

Some of the science process skills aspects in Table 7 show that the average science process skills in formulating problems at the first meeting obtained an average of 71.8% in the excellent category. The second meeting obtained an average of 79.6% in the excellent category. There was an increase in problem formulation skills by 7.8%. Making a hypothesis at the first meeting obtained an average of 76.5% in the excellent category and the second meeting obtained an average of 84.4% in the excellent category. There was an increase in

hypothesis-making skills of 7.9%. Experimenting with the first meeting obtained an average of 67.1% in the excellent category and the second meeting obtained an average of 79.9% in the excellent category. There was an increase in carrying out experiments by 12.8%. Interpreting the data at the first meeting obtained an average of 65.6% in the excellent category, and at the second meeting, an average of 71.9% was obtained. There was an increase in data interpreting skills by 6.3%.

At the first meeting, the average was 71.8% in the excellent category, and at the second meeting, the average was 85.9% in the excellent category. There is an increase in the concluding aspect of 14.1%. Based on all aspects of science process skills, the total average at the first meeting was 71.4% with good criteria, and the total average at the second meeting was 80.3%, so there was an increase of 8.9%. Experimenting in the laboratory could improve students' science process skills [29]. Experiments in the laboratory can improve science process skills in determining problem formulations and hypotheses, conducting experiments, analyzing data, and even making conclusions. Two factors affect students' science process skills, both those that inhibit or increase science process skills, namely internal from the students themselves and external from friends, environment, and family [30]. The factors influencing students' science process skills are the teaching media used, the level of material difficulty, and the learning support infrastructure.

Learning Outcomes

Based on previous research, the approach using cybergogy can attract students' interest in learning. A study says interest in learning and learning outcomes is directly proportional. If interest in learning is high, learning outcomes are also the same [31]. The cognitive factor is one of the crucial factors in cybergogy. Previous Astuti research [32] stated that learning outcomes in the cognitive domain were less attractive because learning was only teacher-centered, so students were less active. This statement is reinforced in research conducted by Wibowo [33] that the cause of low learning outcomes is the lack of teacher skills, so students are only used as listeners. Based on the test results, learning by applying the cybergogy PhET media can influence students' cognitive aspects or learning outcomes.

The following is an overall increase in learning outcomes for 16 students at Junior High School 2 Papar in Figure 1.

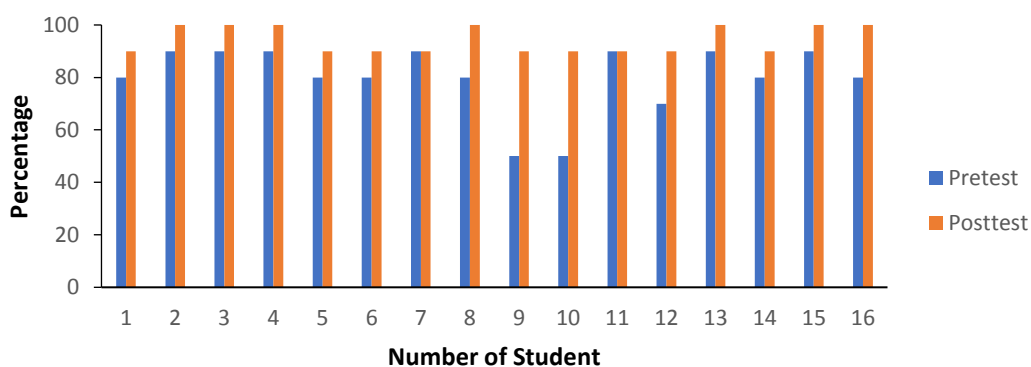


Figure 1 Diagram of pretest & posttest

Based on Figure 1, it can be seen that most students experienced a significant increase, but two students got scores that did not change, that affect student grades that differ from one another are the different academic abilities of each student and the comprehension of the material presented, so this can affect different cognitive learning outcomes.

Based on the pretest and posttest results, students cognitive learning outcomes are briefly presented in Figure 2.

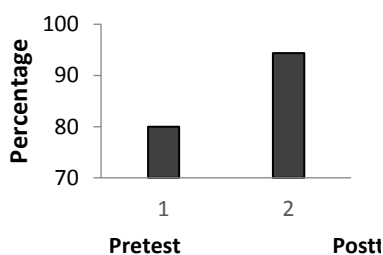


Figure 2. Diagram of the average pretest and posttest

Based on the diagram in Figure 2, there is a change between the mean pretest and posttest. The average pretest obtained was 80, and the posttest was 94.4. This indicates an increase in learning outcomes. Learning outcomes cover psychomotor, affective and cognitive domains. The cognitive domain is oriented to the ability to think, the affective domain is oriented to feelings and emotions, and the psychomotor domain is oriented to behaviour or action. Learning with a cybergogy using PhET media covers all aspects that affect learning outcomes. Strategies in cybergogy can spur students through emotional, social and cognitive. While the use of PhET media in learning can improve affective and psychomotor aspects [34], all areas needed to improve learning outcomes have been fulfilled by cybergogy and the use of PhET media, as evidenced by an increase in N-Gain. The average value of N-Gain is 0.7 with high criteria. Percentage diagram N-Gain showed in Figure 3.

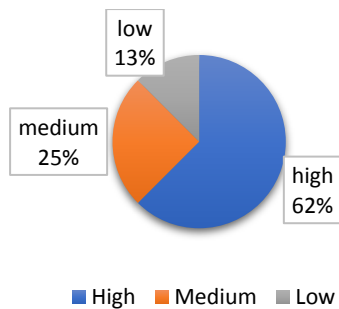


Figure 3. percentage N-Gain students

Ten students obtained an increase in N-Gain with high criteria of 62%. Four students obtained as much as 25% on medium criteria, while two obtained the low criteria of 13%. There are

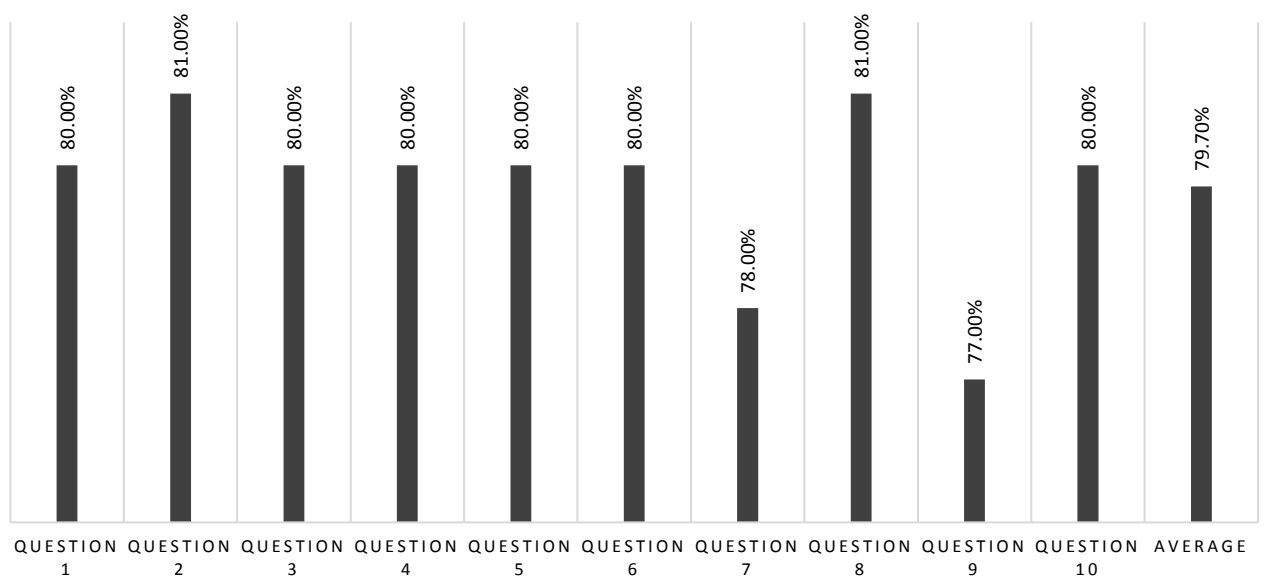


Figure 4. Diagram of the percentage of student response questionnaires

Figure 4 shows that the application of learning using the cybergogy using the PhET Simulation got a good response from students. It is indicated by the average score of 79.7% in the excellent category. The student response questionnaire in this study contained ten questions. Eight questions received a response with an average score of 80% in the category of strongly agree, and two questions with an average score of > 80% in the agree with category. Exciting learning can make students happier and make understanding the knowledge conveyed during learning easier. Based on the results of the response questionnaires, most students agreed with learning with the cybergogy using the help of PhET media [36].

CONCLUSION

This research succeeded in producing criteria for the cybergogy approach in learning. It can be concluded that the implementation of learning using the cybergogy at the first meeting

different criteria for each student. Internal factors can affect student learning outcomes that come from the students themselves, for example, psychological, physical, and external factors such as the student's social environment [35].

Student Response

Response questionnaires were given to students at the end of the meeting after the implementation of learning using the cybergogy. Students are given a questionnaire using a Likert scale which contains ten questions about students' opinions after attending the lesson. The results of student responses are presented in Figure 4.

was 92.9% and at the second meeting was 92.3%, with excellent criteria. Approach cybergogy using PhET as a virtual lab can improve students' science process skills as a psychomotor aspect. The average at the first meeting is 71.4% and at the second meeting is 80.3%, so there is an increase of 8.9%. In addition, the pretest and posttest of 94,4% showed increased cognitive and affective learning outcomes. The average N-Gain result obtained is 0.7 with high criteria. The response questionnaire given at the end of the meeting received a positive response from students, indicated by the average percentage of 79.7% belonging to the agreement on category.

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