



## THE IMPACT OF GUIDED INQUIRY LEARNING WITH DIGITAL SWING MODEL ON STUDENTS' GENERIC SCIENCE SKILL

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DOI: 10.15294/jpii.v9i4.26644

Accepted: October 14<sup>th</sup> 2020. Approved: December 28<sup>th</sup> 2020. Published: December 31<sup>st</sup> 2020

### ABSTRACT

The low condition of students' Generic Science Skills (GSS) becoming a concern since GSS is an essential provision for millennial living in the era of the industrial revolution 4.0. The study aimed to measure the impact of guided inquiry learning on generic science skills by using the digital swing model. This research used the experimental method which involved 360 students of 12<sup>th</sup> grade from senior high school. The primary data of students' GSS were obtained from observations during activities and reports of practicum activities, then the resulting data were analyzed by t-test. The average of students' GSS in the experimental class was 3.32, which is included in the very good category. Meanwhile in the control class was 3.17, which is included in the good category. Based on the results of the t-test analysis, the score was 0.044, which means that there were differences between the experimental class and the control class. Thus, it can be concluded that the use of digital swing has a positive impact on students' GGS. The use of digital swing could stimulate the students to do the practicum activities which leads to the improvement of student's GGS. However, this study is only focusing on the smaller angle; therefore, it is crucial for further research to set up the digital swing with the angle  $>15^\circ$  to identify the effect on it.

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Keywords: inquiry; digital swing; generic science skill

### INTRODUCTION

The results of the preliminary study found severe problems in the Generic Science Skills (GSS) of students in Semarang city, which had an average of 49.88% which included in the low category, and 50.12% which included a medium category (Siswanto et al., 2016). The finding above indicates that serious effort is needed to improve students' GSS, which is a crucial skill that is generally applicable in developing scientific work skills. GSS is needed in building high-level personalities and thinking patterns because it is the basis in the high-level thinking processes that include the ability to think creatively, critically, de-

cision-making, and solving problems in daily life (Wahyuni & Amdani, 2016; Brachem & Braun, 2018; Herranen & Aksela, 2019; Yu et al., 2019). GSS is a skill that can be used to learn various concepts and solve various scientific problems and can be useful to apply in continuing education and career success (Bogar, 2019; Ünlü & Dökme, 2020). Education is not specifically designed to develop GSS. However, due to the significant benefits of GSS in daily life, it is necessary to provide students with information about GSS from an early age through integration in the learning process.

The learning process of physics requires GGS because the students need the skills to apply the content in everyday life. GSS can be obtained through practicum activities to develop students'

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process skills, products, and attitudes. These skills can also solve problems faced by the community (Ghani et al., 2017; Sarkar et al., 2020).

The preliminary study found that the source of the problem in learning physics is due to the GSS is still low so that it impacts students having difficulty applying their content in everyday life. Improvements to the physics learning process can be pursued through activities using science equipment because scientific activities have a significant impact on students' generic science skills. Practicum activities using digital practicum tools train students' abilities to; (1) explore and formulate problems, (2) formulate hypotheses, (3) design and test hypotheses, (4) organize data, and (5) draw conclusions and communicate them (McDermott et al., 2000; Imastuti et al., 2016). Another relevant research result is the implementation of inquiry-based practicum, which states that learning designs can be used to improve the abilities needed (Adhim & Jatmiko, 2015; Rakhmawan et al., 2015; Annisa & Sudarmin, 2016; Nikmah et al., 2017).

Inquiry learning has space, opportunities, and drive to work (hands-on, minds-on, and socials-on) formally and systematically that is tested to obtain facts and concrete evidence such as what scientists do. Inquiry supports student learning processes to get active learning that encourages ability, provides opportunities for students to take the initiative in developing problem-solving skills, making decisions, doing research, and having real experience (Bunterm et al., 2014; Lotter et al., 2018; Fitriani & Fibriana, 2020). The inquiry will improve learning methods through memorization, repetition, and the practice of repeated questions so that they can become lifelong learning. The inquiry itself has several types, one of which is guided inquiry learning. Guided inquiry learning gets positive responses from students and can significantly improve students' generic science skills on the concept of refraction of light (Cheung, 2011).

Practical activity with the guided inquiry method is problem-based learning or investigation by searching for truth or knowledge that requires critical thinking, creative and using intuition (Chase et al., 2013; Kazempour, 2018; Turner et al., 2018). Inquiry learning is a learning pattern to help students formulate problems, test their own opinions, and have an awareness of their abilities. Learning begins with the submission of problems and questions. Students are required to

think logically, critically, and analogically in searching, investigating, and finding answers to the problem in question (Ural, 2016).

Digital swing, as a physics practicum tool, has a working system with a high-speed counter by processing information in the form of digital codes or numeric values (numbers). Before processing data, sensors are needed to convert real information into digital code. Digital code is sent by the sensor and will be processed by a computer (microprocessor). From the results of digital data processing, the information will be displayed on the screen (Kuehn, 2013; Trinter, 2016).

Before entering the digital era, physics practicum tools were mechanical technology, which prioritized mechanical or manual systems. Mechanical technology has not used a computer or microprocessor to regulate and operate because it already has a structured mechanical system. The weakness of this mechanical system is that its settings and accuracy are limited, and require a long time to process information. Practical migration from mechanical devices to digital is a need to adjust to the characteristics of alpha generation students (Kluge, 2014; Faber et al., 2017).

Considering the importance of GSS as a provision for the students' future and the characteristics of alpha generation students who always express activities quickly and accurately, the research to measure the impact of practicum activities with teaching aids that are following students' characteristics is essential. However, the previous research related to the GSS was implemented in the Chemistry subject (Nastiti et al., 2018). But there is no previous research which focuses on this area particularly in the Physics subject. Therefore, research on the impact of digital teaching aids on GSS is important to conduct so that students can analyze the form of application of Physics content. If it is done so that the material that has been studied becomes meaningful.

The teachers' low generic science skills have an impact on the students' low GSS (Maknun, 2015; Khabibah et al., 2017; Pujani et al., 2018; Saprudin & Sutarno, 2018; Sudarmin et al., 2018; Khoiri et al., 2020). Education is not specifically designed to develop students' generic science skills (Struyf et al., 2017). Because of the significant benefits of generic science skills in everyday life, it is necessary to equip students from an early age. The purpose of this study was to measure the impact of using digital swing props on students' generic science skills. Following

the indicator of GSS according to Brotosiswoyo (2000), it includes direct observation, indirect observation, scale awareness, symbolic language, logical framework, logical consistency, causal law, mathematical modeling, and concept building. Practicum tools to be used in the form of digital swings.

## METHODS

This study was an experimental study that aimed to find a causal relationship between the uses of digital swing tools with GSS through the method of providing treatments to obtain the desired results. The experimental research design was a quantitative research procedure that aimed to determine the effect of treatment on outcomes in research subjects (Creswell, 2013). In this study, the type of experimental research used was a quasi-experiment, because research activities provided treatment and measured the effects of the treatment but did not use random samples to infer changes caused by the treatment.

The population in this study was the senior high school students in Semarang city. Semarang city was chosen due to the large number of students who come from various social classes. It involves 360 students of the senior high school. The sampling technique used was a random cluster. The reason for sampling with this technique is the results of normality tests and homogeneity tests of the values obtained indicated that both were homogeneous.

The research activity began with a brief explanation of the swing tools along with the guidelines. The digital swing was used in the experimental class, and mechanical swing was used in the control class. After the explanation was given by the teacher, in this case, the researcher taught the students within an hour lesson then the students did practical activities. Student participation during the practicum activity was outstanding, judging from the dynamic behavior during the activity, the effectiveness of the time used, the data generated, and the activities of tidying up the props after use.

The instruments used in this study were observation sheets and assessment instruments for practicum results, which is developed by the researcher based on the indicators. The observation sheet revealed the GSS achievements in the affective aspects through deep observation. Meanwhile, the assessment of practicum reports was used to measure the cognitive achievement of students' GSS. Assessment of the affective types of GSS is the skills of direct ob-

servation, indirect observation, and awareness of the scale carried out using observation sheets (Brotosiswoyo, 2000). In contrast, the types of GSS that are cognitive include symbolic language, logical frameworks, logical consistency, causal laws, mathematical modelling, and concept building (Brotosiswoyo, 2000). Data collection was done through reports on the results of the practicum collected. The GSS assessment instrument used a scale (4: Very Good, 3: Good, 2: Poor, 1: Very Poor).

The results analysis of the study began by tabulating the data obtained. Tabulation was done by grouping indicators for each type of GSS. From the tabulations, scores were obtained from each GSS type indicator in the control class and experiment class. Scores on the assessment sheet were accumulated from the next scale. It is made in the form of a flat which is a picture of the students' achievement of GSS. Criteria for the achievement of students' GSS are shown in table 1.

**Table 1.** Criteria for GSS Assessment

Score Interval	Category
$3,25 \leq P < 4,00$	Very Good
$2,50 \leq P < 3,25$	Good
$1,75 \leq P < 2,50$	Poor
$1,00 \leq P < 1,75$	Very Poor

(Arikunto, 2016)

The next activity was conducting a t-test of the GSS score average from the experimental class and the control class. The t-test results will provide an overview of the impact of using digital swing tools on practical activities on students' GSS.

## RESULTS AND DISCUSSION

The results of this study were scored that illustrated the achievement of students' GGS after practicing using a swing based on the observation sheet's result which is collected through the peer-students and the practicum report. The experimental class used digital swing, while the control class used mechanical swing. Furthermore, the GSS scores for each group were made on average for one class. The results are shown in Figure 1.

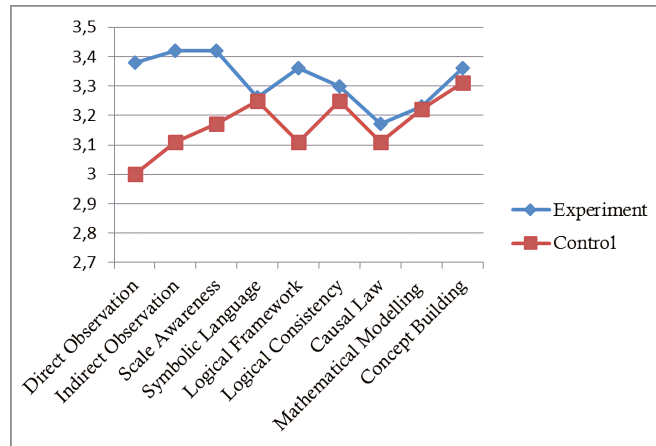


Figure 1. Students' GSS Score in Semarang

Figure 1 shows the average score of students' generic science skills in the experimental class was better than in the control class. Differences in students' GSS scores between the control and experimental classes occurred in all indicators. The average GSS of students in the experimental class was 3.32, in the very good category, while the control class was 3.17, in the good category. The next step is to do a statistical test of the students' GGS average. Testing is done to see the differences in GSS caused by actions in the experimental and control classes. A full test is carried out to test the normality and homogeneity tests. Testing is done to see the differences in GSS caused by actions in the experimental and control classes. The test begins with normality, then the homogeneity test. The normality test results are shown in Table 2.

Table 2. Results of Normaliy Test

Class	N	Mean	Significance
Experiment	36	76.3611	0.077
Control	36	73.0278	0.085

Based on the significant value in Table 2, the significance value of 0.077 was obtained, because  $0.077 > 0.05$ , the sample in the experimental class was from a normally distributed population. Based on the significant value in Table 2, the significance value of 0.085 was obtained, because  $0.085 > 0.05$ , the sample in the control class was from a normally distributed population.

Table 3. Results of Homogeneity Test

Class	N	Mean	Significance
Experiment	36	76.3611	0.284
Control	36	73.0278	

Based on the homogeneity test results from Table 4, the significance value of 0.284 was obtained, because the value of  $0.284 > 0.05$ , the variances of the population in the experimental class and the control class were the same (homogeneous). Then testing is done to see the differences between the experimental class and the control class, and the results are presented in Table 4.

Table 4. Results of T-test

Class	N	Mean	Significance (2- tailed)
Experiment	36	76.3611	0.044
Control	36	73.0278	

Based on the results of the t-test table, the significance value (2- tailed) was obtained at 0.044. Because of the value of  $0.044 < 0.05$ , there were differences between the experimental class and the control class.

The results showed that the average GSS of students in the experimental class was better than the control class. All nine indicators also showed that the GSS achievements of students in the experimental class were better than the control class. Although with different score differences, the average score has informed conclusively that the use of digital swing tools had a real impact on students' GSS. From the nine GSS indicators, the best achievements of students in the experimental class were direct observation, indirect observation, scale awareness, logic framework, and concept building. The better achievement of the experimental class GSS is strongly suspected due to the use of digital swings in practical activities. Good practice teaching aids have an impact on the motivation and fluency of practicum activities (Furberg, 2016; Susilawati et al., 2018; Walan, 2020). In this study, the use of digital swings makes practical activities simpler, and students are happy in implementing their learning, which means the impact of the use of digital swing props on students' GSS is real.



The activity of direct observation by students in digital swing practicum activities was to ensure that the sensor is in the right place, measuring the length of the rope and the magnitude of the initial deviation angle. Because the activity of direct observation on practicums with digital swings is effortless, it made the average score of students on this indicator very good (score 3.38). It is different from the control class, the students' activities on direct observation were measuring the length of the rope, observing the initial angle of deviation, counting the number of deviations, and observing the time on the stopwatch. Some students were still not right in starting and stopping the timer so that the GSS achievement of students in the control class was good (score 3.00).

The activity of indirect observation in digital swing practicum activities in the experimental class was observing the LCD screen connected to the sensor. This activity was recognized as an affective aspect since it could stimulate the students to do a practicum which is an impact on students' GGS. The screen display showed the time and number of swings. A clear display of data on the screen makes it easy for students to obtain complete information to formulate mathematical equations and construct concepts/conclusions of the practicum so that students' GSS achievements in the experimental class were very good (score 3.42). In the indirect observation of the control class in the form of information related to the number of swing periods was in a good category (score 3.11). The use of digital swings makes taking data/information about the number of swings and swing periods effortless, thus helping to change the mindset of students about practical activities that are difficult to do. It is very relevant to the research of Kluge (2014) that students' perceptions of teaching tools affect student motivation in carrying out practical activities.

The next GSS indicator is scale awareness, which is the students' knowledge mastery of a full scale. Scale reading in practical activities in the experimental class used digital swings, while the control class used mechanical swings, which almost the same. The difference is that with the digital swing, the data had been entirely presented on the LCD screen. For mechanical swings in the control class, students must first calculate the results of practicum data. The process of counting and communicating is in the results tables while practicum activities are obtained information on students' GSS achievements. The achievement of the scale awareness indicator in the experimental class was very good (score 3.42), whereas, for

the control class, the achievement of the same indicator was good (score 3.17). The allegation of why there are differences in performance on the scale awareness indicator is the result of the use of digital swings in the experimental class so that practicum activities can be carried out simply, quickly, and accurately. It has an impact on the students' focus that always awake. In contrast, the students in the control class have to do many things and seize the concentration to get the same information, and the students' focus on the scale is less. Practical tools that are simple and easy-to-use make student activities run effectively, and students do not get tired quickly in carrying out practical activities.

The next GSS indicator is symbolic language. Symbolic language that is intended is the mastery of students' knowledge about physical symbols related to the concept of simple swings. Symbolic language in practicum activities of experimental class that uses digital swing and in the control class that uses mechanical swing is the same. Achievements on the symbolic language indicators in the experimental class were in the very good category (score 3.26), while in the control class achievements on the same indicator also in the very good category (score 3.25). According to Struyf et al. (2017), to maximize the cognitive aspects of GSS, mechanical problems must be resolved. The conjecture why the achievements of the symbolic language indicators are equally very good categories with very little difference in score is because the symbolic language of physics on the simple swing concept is the same, so the impact of the digital swing on the GSS indicator of the symbolic language is very little on the achievement score but still in one very good category.

The next GSS indicators are cognitive ones, namely logic frameworks, logical consistency, causation, mathematical modelling, and concept building. For all the indicators, the data were taken from a brief report of the results of practicum activities by students. Student achievements for all the GSS indicators in the experimental class were better than the control class. This condition explains that the data generated when the lab used digital swings is very accurate data making it easy to analyze. The data displayed via the LCD screen also makes it easy for students to analyze without having to do the calculations manually. Accurate and consistent data makes it easy to build a consistent logic framework, mathematical modeling, and concept building. It is relevant to the results of research conducted by Struyf et al. (2017) that accurate results of practicum data will facilitate the development of cogni-

tive abilities of GSS elements of students through data analysis activities.

## CONCLUSION

Regarding the results and discussions, the use of digital swing between the experimental class and the control class has different results that obtaining the t-test scores of 0.44. It shows that the use of digital swing has a positive impact on students' GGS. Moreover, the digital swing could stimulate the students to do the practicum activities which leads to the improvement of student's GGS. However, this study is only focusing on the smaller angle; therefore, it is crucial for further research to set up the digital swing with the angle  $>15^\circ$  to identify the effect on it.

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