
Application of Process Portofolio Assessment Based on Guided Inquiry Model in Improving Critical Thinking Skills and Learning Outcomes of Science Education Students

Ummiy Fauziyah Laili*, Zakiyatus Soimah, Atika Anggraini, Sayyidah Auliayur Rohmah, Rahmawati Yanita Sari

Faculty of Tarbiyah, State Islamic Institute of Kediri, Kediri, Indonesia.

*Email: ummiyfauziyahlaili@iainkediri.ac.id

Article History:

Received date: April 9, 2023

Received in revised from: July 21, 2023

Accepted date: July 31, 2023

Available online: September 2, 2023

Citation:

Laili, U.F., Soimah, Z., Anggraini, A., Rohmah, S.A., & Sari, R.Y. 2023.

Application of process portofolio assessment based on guided inquiry model in improving critical thinking skills and learning outcomes of science education students. *JUPI (Jurnal IPA dan Pembelajaran IPA)*, 7(3):198-209.

Abstract. Critical thinking skills are one of the skills that must be possessed by human resources in the 21st century. In fact, the critical thinking skills of science education students have not been properly empowered. The design of this research is quasi-experimental research. The research population used was all Science Education students at IAIN Kediri. The sample used in this study were two classes of Batch 2022, namely class A and class B. Data collection was carried out using a pretest and posttest to measure critical thinking skills, process portfolio assessment, observation of student attitudes and skills learning outcomes. The results showed that there was a positive effect from the implementation of the process portfolio assessment on students' critical thinking skills and biology learning outcomes. The conclusion that can be drawn is that the application of process portfolio assessment in the guided inquiry model causes higher critical thinking skills and student biology learning outcomes.

Keywords: Process Portfolio Assessment, Guided Inquiry Model, Critical Thinking Skills, Biology Learning Outcomes.

Introduction

The curriculum was developed by the Indonesian government to answer the challenges of the 21st century education paradigm (Pratiwi, et al., 2019). Learning is needed to be oriented towards a science approach and improve student competence according to the needs of the 21st century. The "21st Century Partnership Learner Framework", currently mentions critical thinking skills as one of the abilities that must be possessed. Efforts to answer the challenges of 21st century education are by changing the learning process with a student center (Frydenberg & Andone, 2011; Abedi & Alrababah, 2017).

The designed learning approach is expected so that students apply scientific approach activities (Sokolowski, 2018). This activity allows students to build their own concepts. The scientific approach in learning emphasizes activeness and makes students more active so that they can build their own concepts or knowledge, and help students to formulate, deal with, and solve problems found. The results of the observations found that 1) the implementation of learning was carried out using the discussion method, but students were less active in the learning process, so students' thinking skills were still low, 2) efforts to empower students' critical thinking had not been carried out in a planned manner, this was evidenced from the level of questions given to students still low. The cognitive level has not empowered students to think critically, so that student answers are still in the form of short answers, 3) the assignments given do not have a task assessment format and rubric.

The results of interviews with the science education biology lecturer regarding the assessment given to students, it is known that in learning activities the lecturer only focuses on measuring student learning outcomes and has not been able to measure the ongoing learning process. Assessment of learning outcomes only measures student learning outcomes, not yet measuring attitudes and skills because in learning activities students rarely study in groups and communicate their learning outcomes.

Efforts to change Biology learning that can attract attention, activate the role of students is to change learning methods that contain inquiries about nature in a planned and sequential manner rather than just memorizing concepts and facts. therefore learning biology needs to be carried out learning activities into a process of discovery (Rahmawati, et al., 2022). Lecturers must provide more direct learning experiences so that students can be active in learning to build their own knowledge and the learning process becomes more meaningful.

The guided inquiry learning model can provide opportunities for students to gain experience in the learning process. The inquiry model used in learning is an innovative effort in order to answer the challenges of 21st century education (Harni, 2021). The guided inquiry model is with the help of lecturers guiding students during learning activities. The guided inquiry model allows students to ask questions, decide the best way to answer questions through investigations, conduct experiments, and draw conclusions based on the evidence obtained.

The guided inquiry learning model trains students to think critically to find their own concepts both in group and class discussions (Zulfikar, 2018). Students must practice critical thinking from learning to concluding the concepts they build themselves (Strickland, 2004; Susilowati, 2020). Inquiry learning is able to increase students' critical thinking level through problem solving activities, seeking information, finding ideas, analyzing their findings with existing knowledge. So, guided inquiry learning activities such as discussion activities in problem solving, evaluation of results, discovery of new knowledge, and development of new knowledge by individuals and groups are able to empower students' critical thinking skills, but deficiencies are also found in this learning model (Lismawati, et.al., 2021).

The weaknesses of the guided inquiry model are 1) it is difficult to understand, if you do not know the basis of the knowledge to be learned, 2) students who are active in learning can follow and be involved in learning, 3) it takes a long time to complete the steps of learning activities, 4) some students are still accustomed and understand more easily when using the lecture model, (5) only some material related to principles can use the guided inquiry model. Existing weaknesses can be corrected using appropriate assessment forms. The assessment used in guided inquiry learning is authentic assessment (Llewellyn, 2013).

One example of an authentic assessment is a portfolio assessment. Portfolio assessment is an authentic assessment involving lecturers and students as assessors which is carried out continuously, students are given the opportunity to analyze and criticize work (McMillan, 2007; Shair, 2014). Portfolio assessment is not only used as an authentic assessment, but in the portfolio development process it will affect student learning processes (Mareta, et.al., 2021) . This is because the preparation of portfolio assessment is carried out over a certain period of time in learning, besides that lecturers can also see how student learning progresses from time to time (Mhlauli & Kgosidialwa, 2016). The portfolio contains all of the students' work during the learning process. Students are required to be creative and given the opportunity to develop strategies to improve their way of learning from the reflections on the portfolios they have made (Heriyawati, 2020).

The portfolio has an important role in the learning process. Portfolio assessment has several advantages (Chang, et al., 2018). Nurani (2013) states that the advantages of applying portfolios to students can help cover the weaknesses of the guided inquiry model,

including 1) challenging students and increasing their enthusiasm for learning, 2) sources of references that can be studied increase students' insight and competence, 3) increase motivation students to understand the material being studied, 4) with learning opportunities and more knowledge, students will be confident. Several advantages of portfolio assessment are expected to improve critical thinking skills.

The application of portfolios in learning activities can develop student skills and student competence for problem solving so that meaningful learning can be obtained, so that this activity can improve students' critical thinking skills (Nurani, 2013; Lewis, 2017). The portfolio combines the principles of performance appraisal with student self-reflection, so that it can become a tool used to improve student learning outcomes (McMillan, 2007; Totter & Wyss, 2019). Application of portfolios can encourage students to become self-directed learners (SDL) and self-directed learners (Indriwati, 2017). The type of portfolio that is able to see the process of developing critical thinking skills and student learning outcomes is the process portfolio. The process portfolio contains all student activities from start to finish that reflect student learning development. Lecturers are able to assess the results and progress of students from the process portfolio, besides that the lecturer can also provide feedback so that students can learn even better. The aims of the research were to 1) find out the differences in critical thinking skills between science tadaris students who took part in guided inquiry learning using process portfolio assessment and those who did not apply process portfolio assessment. 2) Knowing the relationship between the process portfolio assessment and students' critical thinking skills. 3) Knowing the differences in learning outcomes between Science Education Biology who take part in guided inquiry learning using process portfolio assessment and those who do not apply process portfolio assessment. 4) Knowing the relationship between the portfolio assessment process and student learning outcomes.

Methods

This study used a quasi-experimental research design (quasi experiment). The research design used is nonequivalent control group design. The research design model for measuring critical thinking skills uses the pretest-posttest nonequivalent control group design research design presented in Table 1.

Table 1. Pretest-Posttest Nonequivalent Control Group Design

Group	Pretest	Treatment	Posttest
Control Class	O1	X1	O2
Treatment Class	O3	x2	O4

(Source: Leedy & Ormrod, 2005)

Information :

O1 and O3: Pretest scores for critical thinking skills and learning outcomes for attitudes and skills

O3 and O4: Posttest scores for critical thinking skills and learning outcomes for attitudes and skills

X 1 : Learning guided inquiry model without applying process portfolio assessment

X 2 : Guided inquiry learning model by applying process portfolio assessment

The research population used was all science education students at IAIN Kediri. The sample used in this study were two classes of Batch 2022, namely class A as an experimental class that used a process portfolio assessment in the guided inquiry learning model and class B as a control class that used the guided inquiry learning model without deep process portfolio assessment. The research sample was selected by purposive sampling, done deliberately based on the equality of (grade-point average) GPA scores.

The implementation of the applied learning model syntax can be seen through the learning implementation observation sheet. Observations were made at each meeting by one observer each. The percentage of the implementation of the guided inquiry learning model from the aspects of lecturers and students is calculated using the following formula, then the criteria for the implementation of the learning model are determined.

$$\% \text{ Execution} = \frac{\Sigma \text{ observer check mark}}{\Sigma \text{ max check}} \times 100\% \quad (1)$$

The level of students' critical thinking skills is determined based on the sum of the scores of students' critical thinking skill levels divided by the ideal maximum score of the level of critical thinking skills multiplied by 100%. The value obtained from this calculation is then classified according to the criteria for the percentage of critical thinking skills. The formula used to measure the level of students' critical thinking skills is as follows

$$NP = \frac{R}{SM} \times 100\% \quad (2)$$

Critical thinking skills data and learning outcomes are tested prerequisites with normality tests and homogeneity tests, then followed by hypothesis testing using covariance and regression analysis to test critical thinking skills, analysis of variance and regression to test learning outcomes attitudes, and Kruskal Wallis analysis and regression to measure student learning outcomes with a significance level of 5%.

Results and Discussion

Implementation of Guided Inquiry Learning

The percentage of student learning implementation in the experimental and control classes can be seen in Table 2.

Table 2. Percentage of Guided Inquiry Learning Implementation

Class	Average Score of Learning Implementation	Implementation Criteria
Experiment	99.18	Very well done
Control	99.31	Very well done

Learning that is applied to the experimental class and control class has been carried out by lecturers and students. The effect of process portfolio assessment on students' critical thinking skills in classes applying process portfolio assessment in the guided inquiry model and without process portfolio assessment. Students' critical thinking skills are obtained from pretest and posttest administration. The results of the Anakova test for students' critical thinking skills can be seen in Table 3.

Table 3. Summary of Anakova Test Results for Differences in the Effect of Learning Models on Students' Critical Thinking Skills

Class group	Mean Pretest	Mean Post test	Corrected mean posttest	KBK (%)	Sig.	Information	Conclusion
Control	49.24	71.18	71.42	71.42	0.00	Sig<0.05	Significantly different
Experiment	56.23	79.75	80.21	80.21			

Table 3 shows that the critical thinking skills of students in the control class have a sufficient level of critical thinking skills, while the critical thinking skills of students in the

experimental class have a good level of critical thinking skills. The results of the Anakova test show that there is a significant difference between the critical thinking skills of students in the experimental class who apply process portfolio assessment in guided inquiry learning and the critical thinking skills of students in the control class who do not apply process portfolio assessment, which means that there is an effect of process portfolio assessment on students' critical thinking skills, then the test is continued with a regression test. The results of the regression test can be seen in Table 4.

Table 4. Regression Summary of the Relationship between Process Portfolio Assessment and Student Critical Thinking Skills

	Model	B	Sig.	R.Square
1	(Constant)	41.126	0.019	0.243
	Aseesmen Portfolio	0.490		

Table 4 shows the regression equation for the relationship between process portfolio assessment and critical thinking skills, namely $Y = 41.126 + 0.490X_1$, which means that there is a positive effect of the process portfolio assessment on students' critical thinking skills, the higher the value of the portfolio assessment, the higher the students' critical thinking skills. There is a significant relationship between the process portfolio assessment and students' critical thinking skills. The process portfolio assessment contributed to students' critical thinking skills by 24.3% and the other 75.7% was influenced by other factors outside the process portfolio assessment.

The effect of process portfolio assessment on learning outcomes of student attitudes in classes applying process portfolio assessment in the guided inquiry model and without process portfolio assessment. Attitude learning outcomes were obtained from the posttest scores which were measured during the learning activities. The results of the ANOVA test of attitude learning outcomes can be seen in Table 5.

Table 5. Summary of Anava Test Results of Differences in the Effect of Learning Models on Attitude Learning Outcomes

Group	Mean	Sig.	Information	Conclusion
Control Class	82.69	0.000	Sig < 0.05	Significantly different
Experiment Class	86			

Table 5 shows that there is a significant difference between the learning outcomes of attitudes in the experimental class by applying the process portfolio assessment in guided inquiry learning and the control class without process portfolio assessment, which means that there is an effect of applying the process portfolio assessment on student attitude learning outcomes, thus test followed by regression test. The results of the regression test can be seen in Table 6.

Table 6. Regression Summary of Relationship between Process Portfolio Assessment and Student Attitude Learning Outcomes

	Model	B	Sig.	R. Square
1	(Constant)	52.476	0.000	0.721
	Aseesmen Portfolio	0.425		

Table 6 shows the regression equation for the relationship between the process portfolio assessment and the learning outcomes of experimental class students' attitudes, namely $Y = 52.476 + 0.425X_1$, which means that there is a positive influence from the process portfolio assessment on student attitude learning outcomes, the higher the value

of the student process portfolio assessment, the results learning attitude of students will be higher as well. There is a significant relationship between the process portfolio assessment and student attitude learning outcomes. The process portfolio assessment contributed 72.1% to the learning outcomes of student attitudes and the other 27.9% was influenced by other factors outside the process portfolio assessment.

The effect of process portfolio assessment on student skills learning outcomes in classes applying process portfolio assessment in the guided inquiry model and without process portfolio assessment. Skills learning outcomes are obtained from the posttest scores that are measured during the learning activities. The results of the Kruskal Wallis test for student skills learning outcomes can be seen in Table 7.

Table 7. Summary of Kruskal Wallis Test Results for Differences in the Effect of Learning Models

Group	Mean	Sig.	Information	Conclusion
Control Class	73.91	0.027	Sig < 0.05	Significantly different
Experiment Class	77.30			

Table 7 shows that there is a significant difference between the results of learning skills in the experimental class that applies the process portfolio assessment in guided inquiry learning and the control class without process portfolio assessment. The differences in the learning outcomes of these skills indicate that there is an effect of applying the process portfolio assessment to the learning outcomes of student skills, thus the test is continued with a regression test. The results of the regression test can be seen in Table 8.

Table 8. Regression Summary of the Relationship between Process Portfolio Assessment and Student Skills Learning Outcomes

Model	B	Sig.	R Square
1 (Constant)	20.040	0.000	0.586
Aseesmen Portfolio	0.724		

Table 8 shows the regression equation for the relationship between the process portfolio assessment and the learning outcomes of experimental class students' attitudes, namely $Y = 20.040 + 0.724X_1$, which means that there is a positive influence from the process portfolio assessment on student skills learning outcomes, the higher the value of the student process portfolio assessment, the results learning skills of students will be even higher. There is a significant relationship between the process portfolio assessment and student skills learning outcomes. The process portfolio assessment contributed 58.6% to student skills learning outcomes and the other 41.4% was influenced by other factors outside the process portfolio assessment.

The influence of process portfolio assessment on critical thinking skills among students in classes applying process portfolio assessment in the guided inquiry model and classes that do not apply process portfolio assessment. The critical thinking skills of students who apply the process portfolio assessment are higher and significantly different from students in classes who do not apply the process portfolio assessment. There is a significant relationship between the process portfolio assessment and students' critical thinking skills as seen from the posttest corrected critical thinking skills in guided inquiry learning using process portfolio assessment. Process portfolio assessment has a positive influence on students' critical thinking skills. If the value of the process portfolio assessment is high, then the value of students' critical thinking skills will also be higher. The process portfolio assessment has an effect of 24.3% on students' critical thinking skills.

Students' critical thinking skills that are empowered are the skills of making arguments, doing deduction, doing induction, evaluating, deciding and carrying out actions. Students' critical thinking skills are empowered through learning activities using the syntax of the guided inquiry learning model because students are conditioned to learn using the scientific method and study systematically. Apart from learning activities using the guided inquiry model, in the experimental class students' critical thinking skills were also empowered through the task of making a process portfolio containing resumes and self-reflection.

In the early learning activities, students in the experimental class were given the task of making a resume that would train students' critical thinking skills in deduction, induction, and evaluation. The resume contains lecture material that will be studied. Students read, collect information, analyze and evaluate information, carry out deductions by characterizing and deducing the ways of reproduction of plants and animals and conducting induction by grouping plants and animals according to their similarities in characteristics and ways of reproduction. Literature review activities from book and internet sources require students to remember, retrieve and relate previously possessed knowledge and analyze this information to build new concepts, thus a resume made by students will be able to empower students' deduction, induction and evaluation skills. Tung & Chang (2009) stated that making resume is one way for students to read more, because by reading students will develop critical thinking skills. Literature reading activities help improve analytical skills so that they can empower critical thinking.

In the final stages of learning activities, students in the experimental class reflect on the learning efforts that have been made during learning activities. This self-reflection activity is able to develop critical thinking skills in deciding and implementing an action that students will take to correct deficiencies in learning in subsequent learning. This is consistent with the results of Indriwati's research (2017) which shows that, through portfolio assessments carried out by students themselves, they are able to empower and make students self-directed learners so that students are able to organize and plan their own student learning activities, know what is needed and what is needed. must be done by students in order to carry out effective learning activities. The portfolio assessment process is carried out by the students themselves, colleagues and teachers. These three assessments will help teachers and students to determine new steps in improving their way of learning to improve students' critical thinking skills, thus students who apply process portfolio assessment in guided inquiry learning will have higher development of critical thinking skills than students who do not apply portfolio assessment. process. This statement is supported by the results of Hasanah's research (2016) which shows that learning inquiry with portfolios can improve critical thinking skills.

The effect of process portfolio assessment on learning outcomes of student attitudes in classes that implement process portfolio assessment in the guided inquiry model and classes that do not apply process portfolio assessment. The learning outcomes of student attitudes in the experimental class that applied the process portfolio assessment in the guided inquiry model were higher and significantly different from the attitude learning outcomes in the control class without implementing the process portfolio assessment. there is a significant relationship between the process portfolio assessment and the learning outcomes of student attitudes in guided inquiry learning using process portfolio assessment. The higher the value of the student process portfolio assessment, the higher the learning outcomes of student attitudes. The process portfolio assessment has an effect of 72.1% on the learning outcomes of student attitudes. The results of learning attitudes are changes in student behavior that occur during and after the learning process includes several indicators of honest, disciplined, and cooperative attitudes.

Student attitude learning outcomes are empowered through learning activities using the syntax of the guided inquiry learning model, besides that in the experimental class the

increase in student attitude learning outcomes is also obtained from their efforts to complete and collect process portfolios. Process portfolio documents that are capable of empowering attitude learning outcomes are making resumes independently and writing self-reflections. The task of making a resume provides an opportunity for students to better prepare themselves in learning, so that students have more 1) provision of knowledge, 2) are more prepared and be honest when facing exams, 3) practice discipline in studying, collect resumes and reflections, and 4) cooperate more when discussing and completing assignments.

The final stage of the process portfolio assessment was that students in the experimental class were given the task of making self-reflections that could encourage students to become self-directed learners. Self-reflection will provide opportunities for students to review the learning they have done, identify learning difficulties, show evidence of learning outcomes, evaluate learning progress, and explain the next plan in learning to improve student learning outcomes (Greenstein, 2012). Writing self-reflection will also train students' honesty, so that students are able to know their learning deficiencies and plan to improve their learning. This is in accordance with Hasanah's research (2016) which shows that inquiry learning with a portfolio can improve student learning outcomes.

Process portfolio assignments will foster students' positive attitudes towards subject matter. Students' positive attitudes towards subject matter will foster positive interest and enthusiasm for learning these subjects and foster motivation to learn, making it easier for students to absorb, understand and understand the lesson (Sholeh, 2011). The positive attitude of students towards the subject matter will affect the improvement of several attitude indicators such as honesty, discipline, and cooperation with students.

The effect of process portfolio assessment on student skills learning outcomes in classes applying process portfolio assessment in the guided inquiry model and classes that do not apply process portfolio assessment. The results of learning skills in the experimental class that applied the process portfolio assessment in guided inquiry learning were higher and significantly different from the skills learning outcomes in the control class that did not apply the process portfolio assessment. there is a significant relationship between the process portfolio assessment and student skills learning outcomes in guided inquiry learning using process portfolio assessment. The higher the value of the student process portfolio assessment, the higher the learning outcomes of student skills. The process portfolio assessment has an effect of 58.6% on student skills learning outcomes. Skills learning outcomes are an assessment of students' abilities when making practicum reports and communicating the work results obtained in presentation activities.

Student skills learning outcomes are empowered through learning activities that use the syntax of the guided inquiry learning model. Student skills learning outcomes in the experimental class were higher than the control class due to the application of a process portfolio assessment in the experimental class which contained resumes and self-reflection. Resumes in process portfolios provide more opportunities for students to read (Tung & Chang, 2009). Students who have more knowledge from their reading results will be able to empower their skills in communicating the knowledge they have acquired, both in writing in the form of lab reports and orally during presentations. Student skills in and be honest when facing exams, 3) practice discipline in studying, collect resumes and reflections, and 4) cooperate more when discussing and completing assignments.

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The task of making self-reflection made by students in the experimental class provides more opportunities to empower students' SDL (Indriwati, 2017). Students review the learning they have done, identify learning difficulties, show evidence of learning outcomes, evaluate learning progress, and explain the next plan in learning to improve student learning outcomes (Greenstein, 2012), so that by self-reflection, students are able to find out their learning deficiencies and can develop further study plans to improve student skills learning outcomes

Conclusion

The application of process portfolio assessment in the guided inquiry model led to higher critical thinking skills and student biology learning outcomes. Application of process portfolio assessment in the guided inquiry model it needs to be given to students for at least 1 semester to be able to know correctly how student learning progresses and become

a way to improve critical thinking skills and student biology learning outcomes. The value of the process portfolio should be taken from the results of the student's own assessment, colleagues and teachers with a score ratio of 1: 1: 2, because it is able to motivate students to compile a process portfolio seriously, disciplined and responsible so that it will affect critical thinking skills, results learning attitudes, and the results of learning skills.

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