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The Effect of Assessment for Learning in Chemistry Learning on Students' Learning Outcomes

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Abstract: This research aims to describe the effect of the implementation of assessment for learning (AfL) in chemistry learning on student learning outcomes. This type of research is pre-experiment. The design used in this research is One Group Pretest Posttest Design, with the same treatment in class XI, that is pretest - meeting 1 - posttest 1 - meeting 2 - posttest 2. Meetings 1 and 2 respectively are the implementation of AfL on the material of acidic buffer solutions and basic buffer solutions. The subjects of this research were students of class A and B SMAN 2 Bangkalan. Students' chemistry learning outcomes were obtained from the results of pretest, posttest 1, and posttest 2. Data analysis techniques using normality test followed by hypothesis testing and N-Gain test. The results showed that there was a significant difference between the pretest and posttest 1 and between posttest 1 and posttest 2 in classes A and B. Students' learning outcomes also improved based on the results of the N-Gain test. Based on the results of the research, it can be concluded that the implementation of AfL in learning chemistry has an effect on learning outcomes and is able to improve student learning outcomes.

Keywords: Assessment for learning; Chemistry; Learning outcomes

Introduction

Chemistry is one of the parts of science (Natural Sciences) found in phases E and F of the Merdeka curriculum which studies the nature, composition of matter, material structure, changes and energy that accompany material changes (Langitasari et al., 2021; Sari et al., 2020). Buffer solution is included in chemistry lessons and is considered one of the difficult materials (Ayuningsih & Muna, 2023; Safitri et al., 2022). Buffer solution material requires an understanding of concepts and a broad scope of material and students are required to understand every difference and characteristic of the compounds involved in the formation of buffer solutions (Musdalifa et al., 2020). The characteristics of buffer solution material are complex because of the relationship with the material that has been studied and is a prerequisite, especially acid-base and equilibrium material. These characteristics trigger students' assumptions that buffer solution material is difficult to understand (Agusti et al., 2021).

In addition, the average chemistry learning outcomes of students are still low, the low learning outcomes are influenced by several factors such as, students consider that chemistry is a scary, difficult to understand, and less interesting lesson (Fitriarieswa et al., 2023; Sariati et al., 2020). Difficulties usually occur in understanding concepts and understanding various chemical formulas. Difficulties in understanding concepts arise because most students only memorize but do not properly understand the meaning of the concept. The ability of students to understand the concept of learning can affect learning outcomes. Learning activities that can attract the attention of students and vary will have a positive impact on the process of understanding the concepts of students. Students whose understanding of concepts is well embedded will have an impact on learning outcomes (Khumairah et al., 2020).

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In addition, students often have difficulty with chemical materials that are calculated and the activeness of students in learning chemistry is also low (Amni et al., 2021; Yetmi et al., 2023). The learning process that does not involve students can affect student learning outcomes (Ana et al., 2019). At this time learning is developed to be student-centered which involves the activeness of students and directs students to explore the potential that exists in themselves. However, the implementation of science learning including chemistry in senior high school still does not pay attention to the achievement of understanding and student activity (Sabang et al., 2023). Teachers have a very important role in learning activities with students. The achievement of learning objectives in schools is highly dependent on the teacher's ability to understand the learning process.

Learning outcomes are very important in the world of education because they are an indicator of the achievement of planned targets. Learning outcomes are the abilities possessed by students after receiving learning experiences (Nasution, 2000). Students' learning outcomes can give information to teachers about students' progress in achieving their learning goals through learning activities (Laknasa et al., 2021). Based on the results of interviews with one of the chemistry teachers at SMAN Bangkalan, it was found that the learning outcomes in one class on buffer solution material were 60% of students said to have not reached the passing grade. Low chemistry learning outcomes indicate that students still have difficulty understanding chemistry material, especially buffer solution material (Amni et al., 2021; Sariati et al., 2020).

Improving the quality of learning can be done by improving the quality of assessment (Noor, 2020). Assessment is the process of giving value based on measurement results according to criteria with certain quality values (Azizah et al., 2024). Assessment has an important role in education and in the learning and teaching process (Hikmawati et al., 2021). Assessments can provide clues to teachers about how students understand and perform certain tasks and also provides feedback to students about what they have achieved (Hidayat & Qudsiyah, 2018).

In general, assessment can be divided into two, which are formative assessment and summative assessment (Rati et al., 2019). Summative assessment is an assessment carried out when learning has ended and is considered complete. While formative assessment is an assessment carried out during the learning process to get feedback and improve the learning process (Sari et al., 2019).

The results of an interview with one of the teachers of SMAN Bangkalan stated that the assessment used was still related to summative assessment, namely in the form of a test after the buffer solution material had been completed or called assessment of learning (AfL). Through the assessment conducted by the teacher, students have not received feedback after the test. Based on this, it can be seen that assessment for learning (AfL) in chemistry learning has not been accepted by students. Therefore, learning is needed that focuses on providing feedback to students during the learning process, namely through AfL-oriented learning.

Assessment for learning (AfL) is part of formative assessment (Witoko & Wardono, 2019). AfL is a process of continuous assessment as evidence about student learning is collected and interpreted to determine how far learning has been achieved, where to continue, and how best to achieve it (Rosana et al., 2020). The main principle in the implementation of AfL is a comprehensive evaluation from planning, process to the end of learning (Hidayah et al., 2024). AfL requires clarity of learning objectives and success criteria in learning using effective questions, self-assessment, and feedback for students (Fukuda et al., 2022). Assessment for learning (AfL) focuses on the use of feedback in learning that is reflected by students to find out how far their ability to understand learning materials (Basuki & Hariyanto, 2014). The steps of implementing AfL in a learning process are 1) clarifying learning intentions and criteria for success, 2) engineering effective classroom discussions and other learning tasks that provide evidence of student understanding, 3) providing feedback that moves learners forward, 4) activating students as a instructional for one another, and 5) activating students as owners of their own learning (Black & Wiliam, 2018).

The implementation of AfL in this research refers to the steps of AfL according to Black et al. (2018). However, for easier implementation, steps 3 and 4 are combined into one so that the implementation of AfL includes the steps of 1) clarifying learning objectives and learning success criteria, 2) engineering effective class discussions and other learning tasks that provide evidence of student understanding, 3) activating students as learning resources for each other and providing feedback that moves students in a better direction, and 4) activating students as owners of their own learning. These steps have been tested and shown their impact on improving student learning outcomes (Pratama & Muchlis, 2023; Sudarsono & Muchlis, 2023).

Through the implementation of assessment for learning in the learning process, it will improve students' learning outcomes (Hidayat & Qudsiyah, 2018; Muchlis et al., 2019). Learning with AfL can improve the learning process, and can motivate students. AfL is sustainable, and helps teachers to identify needs in learning activities and to inform students about progress in achieving the goals desired during the learning process (Oyinloye & Imenda, 2019). Based on previous

research, AfL-based learning is effective in improving student learning outcomes, especially on the subject matter of reaction rates (Safithri & Muchlis, 2022). Learning outcomes in AfL-based learning on chemical equilibrium material have increased with N-Gain of 97.22% in the high criteria, and 2.78% in the medium criteria (Dini & Muchlis, 2022). The difference between this research and previous research lies in the chemical learning material and learning outcomes in this research obtained from pretests and two posttests, which are posttest 1 and posttest 2.

Based on the description above, the purpose of this study is to describe the effect of assessment for learning (AfL) in learning chemistry on student learning outcomes. This research is important to improve and maximize students' chemistry learning outcomes on buffer solution material with improvements regarding learning assessment, one of which is the implementation of AfL.

Method

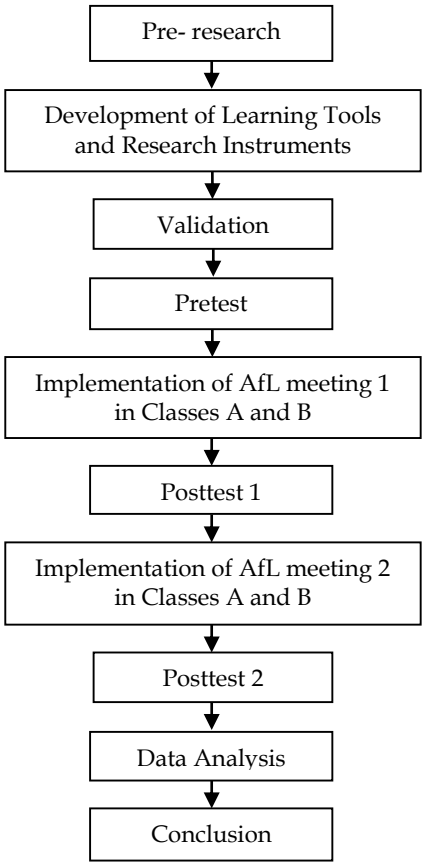

Figure 1. Research procedure

The type of research used is pre-experiment research. In this research using two classes, the first class acts as an experimental class and the second class as a reinforcement class. Both classes will be given the same treatment, that is the implementation of AfL on buffer solution material. The design used in this research is One Group Pretest Posttest Design. The research was conducted by identifying the initial condition or before being given the implementation of AfL with a pretest. Then an AfL implementation was carried out. At the end of the implementation of AfL at each meeting, a posttest will be given to determine the final condition. The results of this posttest 1 will show whether the targets made by students have been achieved or not. Students will also get individualized feedback from the results of posttest 1. Each student will get feedback from the teacher regarding the understanding of the material and how to learn from students. The feedback given can be a direction for students to improve their learning methods and learning outcomes at the second meeting The same thing is also done at meeting 2 and posttest 2. The pretest and posttest given were essay questions totaling 6 questions. essay assessment can affect students' competency achievement in science learning (Amanda et al., 2023).

This research was conducted in the even semester of the 2023/2024 school year when entering the buffer solution material at SMAN 2 Bangkalan. This research focuses on the sub-material of acid and base buffer solution. The subjects of this study were students of class XI-3 and XI-5, then class XI-3 is called class A and class XI-5 is called class B. Each class consisted of 35 students. Each class consists of 35 students. Before the implementation of AfL, learning devices and research instruments have been validated. Validation of learning devices and research instruments was carried out by 2 lecturers of Chemistry Education at Surabaya State University and 1 chemistry teacher. The validation results obtained valid categories for all types of research instruments and learning devices.

Data analysis techniques used are prerequisite tests and hypothesis tests. Normality test was conducted as a prerequisite test to ensure that the data used was normally distributed if the significance value > 0.05. Hypothesis testing is done by looking at the results of the normality test, if the data is normally distributed then a parametric hypothesis test will be carried out with a paired sample t-test (t test), whereas if the data is not normally distributed then a non-parametric test will be carried out, namely the Wilcoxon test. Hypothesis testing is carried out to see if there is a significant difference in the learning outcomes of students before and after the implementation of AfL, students will be given a pretest before posttest 1 and posttest 1 will be the pretest for the second meeting so that the improvement can be seen. Students' learning outcomes are said to have a significant difference if the sig value (Asymp. Sig) <0.05.

After conducting the hypothesis test, the N-Gain test was then conducted to determine the improvement

of students' learning outcomes. The results of the N-Gain calculation were then interpreted using the criteria shown in Table 1. The learning outcomes of students after the implementation of AfL are said to have increased if the percentage of the the total student who gets N-Gain in the medium and high criteria is ≥ 85%.

Table 1. Data Criteria for N-Gain Value for Learning Outcomes

N-Gain Value	Criteria
0.70 - 1	High
0.31 – 0.69	Medium
0 – 0.30	Low

Result and Discussion

Result

The learning outcomes of students on buffer solution material are obtained from the learning outcomes in the pretest, posttest 1, and posttest 2 that have been carried out by students in classes A and B. To find out whether the data is normally distributed or not, a normality test is carried out with the hypothesis. To find out whether the data is normally distributed or not, a normality test is carried out with the following hypothesis.

H_0 : The research data is normally distributed.

H_1 : The research data is not normally distributed.

If the sig value > 0.05 then H_0 is accepted and if the sig value < 0.05 then H_0 is rejected The results of the normality test are presented in Table 2.

Table 2. Normality Test of Learning Outcomes

Class	Test Type	Sig. Kolmogorov-Smirnov
Class A	Pretest	0.003
	Posttest 1	0.000
	Posttest 2	0.043
Class B	Pretest	0.057
	Posttest 1	0.000
	Posttest 2	0.049

Based on the normality test in Table 2, the pretest and posttest 1 and 2 data in class A have a significance < 0.05, while in class B the pretest data has a significance > 0.05 and posttest 1 and 2 have a significance < 0.05. The normality test results show that there are 5 values with significance < 0.05, meaning that the data is not normally distributed. The hypothesis test used is a non-parametric hypothesis test because the data is not normally distributed. The non-parametric test used is the Wilcoxon test.

The Wilcoxon test is used to see if there is a significant difference between the learning outcomes of students before and after the implementation of AfL in chemistry learning with the following hypothesis.

H_0 :There was no significant difference in students' learning outcomes after the implementation of AfL in chemistry learning.

H_1 :There was a significant difference in students' learning outcomes after the implementation of AfL in chemistry learning.

If the sig value > 0.05 then H_0 is accepted, and if the sig value < 0.05 then H_0 is rejected. Wilcoxon test results are presented in Table 3.

Table 3. Wilcoxon Hypothesis Test

Class	Test Type	Z	Asymp Sig. (2-tailed)
Class A	Posttest 1 - Pretest	-5.188	0.000
	Posttest 2 - Posttest 1	-5.164	0.000
Class B	Posttest 1 - Pretest	-5.198	0.000
	Posttest 2 - Posttest 1	-5.164	0.000

Based on Table 3, which is a hypothesis test on student learning outcomes in classes A and B, it is known that the negative Z value on posttest 1 for classes A and B is smaller than the value on posttest 2. The Wilcoxon test results for classes A and B show that the significance value for pretest, posttest 1, and posttest 2 data is 0.000, which means that the value is < 0.05. Furthermore, based on the test results, because the sig. (2-tailed) < 0.05, then H_0 is rejected and H_1 is accepted. So it can be concluded that there is a significant difference after the implementation of AfL in chemistry learning on student learning outcomes between pretest and posttest 1 and between posttest 1 and posttest 2 in classes A and B.

Furthermore, after knowing that there is a significant difference in the learning outcomes of students after the implementation of AfL in classes A and B, an N-Gain analysis is carried out to determine the improvement of students' learning outcomes. The results of the N-Gain test analysis are presented in Table 4.

Table 4. N-Gain Test Results of Student Learning Outcomes

Class		% N-Gain Value	Criteria
Class A	N-Gain 1	0	Low
		97.14	Medium
		2.86	High
	N-Gain 2	0	Low
		2.86	Medium
		97.14	High
Class B	N-Gain 1	0	Low
		97.14	Medium
		2.86	High
	N-Gain 2	0	Low
		8.57	Medium
		91.43	High

Based on Table 4, it can be seen that the N-Gain of learning outcomes of class A and B students at posttest 1 and 2 is in the medium and high criteria. In posttest 2, the learning outcomes of students in classes A and B have improved with the percentage of N-Gain 2 values in high criteria greater than the percentage of N-Gain 1 values in posttest 1. The percentage of the total students who get N-gain in the medium and high categories in classes A and B > 85% is 100%. These results are relevant to previous research which shows that the implementation of AfL can improve student learning outcomes with N-Gain criteria in medium and high criteria (Dini & Muchlis, 2022; Safithri & Muchlis, 2022).

Discussion

The implementation of assessment for learning (AfL) can affect students' chemistry learning outcomes on buffer solution material. This is shown from the results of the Wilcoxon analysis test, it is found that H_0 is rejected, which means that H_1 is accepted or there is a significant difference with a Sig value. (2-tailed) <0.05, so the implementation of AfL in chemistry learning can affect students' chemistry learning outcomes. The learning outcomes measured in this research are in the cognitive domain of students. The implementation of AfL also pays attention to AfL steps so that the learning and teaching process becomes more structured and directed (Black & Wiliam, 2018). This research was conducted by adjusting the learning schedule of buffer solution material at school.

Assessment that is carried out during the learning process and is AfL aims to improve the quality of learning and the quality of students' learning. The quality of good learning can be seen from the quality of the assessment, and the quality of the assessment can show how the quality of learning (Astuti et al., 2024; Noor, 2020). AfL is a continuous assessment process of collecting and interpreting evidence about students' learning outcomes with a view to determining the extent of their learning achievement, where they need to continue and how best to get there (Muchlis et al., 2019; Rosana et al., 2020).

The learning outcomes of chemistry students on buffer solution material are said to have improved if the results of posttest 1 and posttest 2 have experienced completeness and the results of posttest 2 are better than the results of posttest 1. In posttest 1 students will work on test questions with acidic buffer solution sub-materials, while in posttest 2 related to basic buffer solution sub-materials.

Before the implementation of AfL, the teacher will give a pretest to students in both classes A and B. Posttest 1 was conducted after the first meeting of AfL implementation. At the first meeting, AfL-oriented learning will be implemented using LKPD 1 where students must fill in the LKPD. LKPD 1 from each student will be given feedback from the teacher and students will reflect on the learning activities that have been carried out then students will take posttest 1. The results of posttest 1 will be used by students as a reference for further learning continuity. After students reflect on the learning outcomes in posttest 1, then LKPD 2 is implemented. LKPD 2 from each student will be given feedback from the teacher and students will reflect on the learning activities that have been carried out then students will take posttest 2. The feedback given by the teacher during meetings 1 and 2 is expected to be an evaluation for students before taking the posttest so that they get good results.

Every posttest that has been done by students will get feedback from the teacher. Students' learning outcomes depend on feedback quality and detail (Sudirman et al., 2023). The teacher will provide feedback on each answer to the questions that students do. Each student gets different feedback from the teacher depending on the student's level of understanding in doing the test. Students can find out where their mistakes and abilities are in doing the test through the feedback given by the teacher so that students can repair and improve their learning outcomes. In addition, teachers also provide feedback on how students learn so that students can improve their learning methods to improve learning outcomes in the next lesson.

Based on the findings in the field, the answers from posttest 1 of class A and B students still have some mistakes. However, in posttest 2 students' answers improved so that the learning outcomes obtained also improved. This is evidenced by the learning outcomes of class A and B students as evidenced by the percentage of N-Gain in high criteria which has improved in posttest 2. The improvement in learning outcomes experienced by students is because students pay attention to the feedback provided by the teacher so that their learning outcomes can improve and help students assess their abilities (Armiyati & Agung, 2023; Muchlis et al., 2020; Puteri et al., 2023). Based on the learning outcomes of students, it is known that teachers have a very important role in improving student learning outcomes through the learning process carried out and the feedback provided (Hindriana et al., 2023).

Student learning outcomes are also influenced by internal and external factors (Indah & Farida, 2021). One of the factors that affect learning outcomes is how students learn. AfL can involve students in self-assessment through reflection activities. Students will be directed to write down learning targets to be achieved and reflect on their targets at the end of learning. Through recording student targets, the learning process will run more effectively because students clearly understand the goals they want to achieve (Magdalena

et al., 2024). The targets that students write down will be given feedback from the teacher. The feedback given can be reflected by students to become the basis for further learning (Basuki & Hariyanto, 2014; Warsita, 2016).

In addition, AfL provides opportunities for students to evaluate themselves, and adjust teaching strategies with assessment information through reflection activities (Rasyid & Mansyur, 2011). Evaluation is very important to do with the aim of knowing the extent to which the learning has been implemented (Haqiqi et al., 2018). Reflection activities in the implementation of AfL are in the form of questions related to the weaknesses and strengths of students' learning and lesson planning. The implementation of the right learning plan will affect the learning outcomes that will be achieved (Dhamayanti, 2022). This activity will be written by students on LKPD and will get feedback from the teacher. The feedback provided by the teacher will provide an overview of student progress, provide motivation to make students become more active, recognize their weaknesses and abilities to improve themselves and ensure all learners achieve learning objectives (Djoue et al., 2023; Yusron & Sudiyatno, 2021).

Based on the answer of one of the students in class A and B at the first meeting who wrote related to how to study, that is by studying harder. The teacher provides feedback so that students can write their learning plans in more detail and are associated with students' learning styles. The teacher also gives examples of learning styles and suitable learning strategies to give students an idea of how to write a suitable learning plan. This was implemented by students in the second meeting who had written good learning plans and adapted to their learning styles. This causes student learning outcomes to also improve in posttest 2 apart from paying attention to feedback, students also implement learning plans or ways of learning that are in accordance with the characteristics of each individual so that the learning outcomes obtained can increase.

This shows that the implementation of AfL in chemistry learning can help students in increasing motivation by providing feedback, knowing how students learn, and can guide students in determining the weaknesses and strengths that exist in themselves (Oyinloye & Imenda, 2019; Sudarsono & Muchlis, 2023).

Conclusion

Based on the results of research and discussion, it can be concluded that the implementation of AfL in learning chemistry has an effect on learning outcomes and is able to improve student learning outcomes.

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The authors declare no conflict of interest.

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