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Implementation of the Afl Guided Inquiry Model to Optimize Learning Outcomes in Acid-Base Titration Material

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Abstract: *Education in the era of globalization becomes a bridge that connects humans with the global environment in increasing the quality of human resources. This research describes the implementation, students' activities and responses, and the increase in learning outcomes before and after implementing an assessment for learning that is guided inquiry-oriented for Class XI Acid-Base Titration material. A quasi-experimental design with a nonequivalent control group design was used, while data collection instruments were questionnaires and tests. The scores of the guided inquiry model also obtained a score rating of 3-4, or very good, during the meetings. A comparison done through the right-hand t-test for the posttest 1 and posttest 2 analysis yielded a 0.000 p-value reflecting a significant enhancement statistically in the learning outcomes of students, at $p < 0.05$. Activities by the students were well conducted; the reception of the model was good, as shown by the average percentages, which ranged from 91.42% to 100%, falling within the "very good" range of acceptability.*

Keywords: *guided inquiry learning model; assessment for learning; learning outcomes*

INTRODUCTION

Education is an important aspect in the era of globalization (Kurnia & Risyda, 2021). Education in the era of globalization acts as a bridge that connects with the environment in the era of globalization and is able to improve the quality of human resources (Jahanger et al., 2022). Improving the quality of education can be done by renewing the system, namely the independent curriculum (Hadi, 2022). The 21st century is marked by increasingly rapid developments in science and technology (Rahayu et al., 2022). This is a challenge for the world of education.

21st century learning itself has characteristics and its own uniqueness, where learning carried out in educational institutions must focus on 21st century skills (Mahrunnisya, 2023). Learning must be designed in accordance with the 4C skills which include, 1) critical thinking skill, 2) creative and innovative thinking skill, 3) communication skill, and collaboration skill (Tambunan et al., 2024).

In 21st century learning, learning is centered on students, in this case the teacher is no longer the only source of learning but rather acts as a facilitator in the learning process (Yulita dan et al., 2020).

One of the subjects at school, especially at the SMA/MA level, is chemistry (Herawati & Muhtadi, 2018). Chemistry is one of the natural sciences in its learning, one of which is experiments that are developed based on theory (Emda, 2017). Chemistry learning places more emphasis on learning and innovation skills, students are expected to be able to solve problems, be creative and innovate (Asiah et al., 2017). Chemistry is considered difficult for students because apart from memorizing concepts, students also need to master the material thoroughly (Fajrin et al., 2020).

One chemical concept that is related is the concept of acid-base and acid-base titration. In the acid-base material, there is a sub-material on acid-base titration which is difficult to understand because it is included in abstract material (Tri Astuti & Marzuki, 2018) and has a high level of difficulty conceptually (Sari & Helsy, 2018).

In implementing the assessment for learning approach, it is necessary to have an appropriate learning model. The learning model that can be used is guided inquiry because in this learning model students can collect information in the form of facts and process these facts to draw conclusions and answer questions or problems raised by the teacher (Saragih & Dibyantini, 2024).

When implementing learning that uses an assessment for learning approach, there is also a need for Student Worksheets (LKPD). In the *assessment for learning* learning process, LKPD is needed for students with an *assessment for learning* orientation. The LKPD in question was previously developed by (Pratama & Muchlis, 2023).

The aim of this research is to describe the implementation of the learning model, student activities and responses as well as the increase in student learning outcomes after implementing guided inquiry oriented *assessment for learning* to improve student learning outcomes in Acid-Base Titration material for class XI SMA.

LITERATURE REVIEW

Assessment for learning

Assessment for learning in Indonesian is known as *assessment for learning*. Assessment for learning is an assessment process that is carried out continuously in interpreting evidence regarding student learning outcomes with the aim of knowing the achievement of their learning outcomes and conducting a review of the quality of student learning on the basis of assessment criteria (Rosana et al., 2020).

Fundamental Learning Theories

According to Piaget, it suggests that the majority's development depends on students' thinking and interaction with the environment (Siregar et al., 2024). Thinking skills and interaction with the environment can be characterized by stages of intelligence or cognitive abilities. Piaget divided cognitive development into four stages, namely: sensorimotor, pre-operational, concrete operational, and formal operational.

This model from Jerome Bruner is one of the influential models in the cognitive instructional model, which is often known as discovery learning. Bruner suggests that students should learn through active participation with concepts and principles so that they are encouraged to gain experience and carry out experiments that allow them to discover the principles themselves (Yanti & Simanjuntak, 2023).

According to Vygotsky, learning can occur if students are still working or carrying out tasks that have not yet been studied, but these tasks are still within their reach, which can be called the Zone Proximal Development (Daneobroto, 2017). Through this social interaction, students will be skilled at processing their cognitive devices and their cognitive abilities will increase.

Meaningful learning is a process in which new information is linked to relevant concepts contained in a person's cognitive structure. Meaningful learning can produce an increase in learning, from previously not

understanding to understanding and the results of this learning can enter long-term memory (Yanti & Simanjuntak, 2023). Factors that influence meaningful learning according to Ausubel are the existing cognitive structure, stability and clarity of knowledge in a particular field and at a particular time (Ramadhana & Sutiani, 2023).

Guided Inquiry Learning

According to Eggen (2012), in the guided inquiry learning model, the teacher provides examples of specific topics to students and guides them to understand the topic. This model effectively increases student engagement and motivation and helps students develop a deep understanding of well-defined topics.

Acids and Bases

The concentration of acid and base solutions can be determined using an experimental method called acid and base titration. Acid-base titration is determining the concentration of a base solution with an acid solution of known concentration, or conversely, determining the concentration of an acid solution with a known base solution is based on a neutralization reaction. Determination of the concentration of an acid solution with a known base solution, based on the neutralization reaction.

Learning outcomes

Learning outcomes are the basis used to determine the level of success of students in studying a lesson. Assessment of learning outcomes refers to learning outcomes as a program or object that is the target of research. Learning outcomes as a research object basically assess students' mastery of instructional objectives (Sudjana, 2017).

RESEARCH METHODS

The type of research used is quasi experimental research. The research design used in this research is nonequivalent control group design. The data collection techniques used were questionnaires and learning outcomes tests. The instruments used in this research were validation sheets, learning implementation observation sheets, student activity observation sheets, student learning outcome test question sheets (*pretest* and *posttest*), and response questionnaire sheets.

RESULTS AND DISCUSSION

Implementation of the Learning Model

Experimental Class

Each step of the guided inquiry learning model oriented towards *assessment for learning* has been implemented in its entirety, seen from the average implementation at meeting 1 and meeting 2 which received a minimum score of 3 from observers with good criteria. So that teachers in implementing the guided inquiry learning model are oriented towards *assessment for learning* to improve student learning outcomes well.

Students' activities in the experimental class during two meetings applying the guided inquiry model based on assessment for learning are highlighted in Table 1. In addition, other main activities observed during the teaching-learning process included setting learning targets, observing phenomena, hypothesis formulation, collecting data, analysis of results, and giving feedback.

Table 1. Percentage of experimental class student activities during guided inquiry learning based on assessment for learning at meetings 1 and 2

No	Observed Activity	Assessment for Learning Step	Guided Inquiry Phase	Meeting 1 (%)	Meeting 2 (%)
1	Students set learning targets	Clarifying learning objectives and success criteria	Focusing attention and explaining inquiry process	10.0	10.0
2	Students observe the acid-base titration phenomenon presented	Clarifying learning objectives	Focusing attention and explaining inquiry process	3.3	3.3
3	Students formulate investigative questions based on phenomenon	Designing effective class discussions and learning tasks	Presenting inquiry problems or phenomena	6.7	6.7
4	Students formulate hypotheses based on presented phenomenon	Designing effective class discussions and learning tasks	Assisting in formulating hypotheses	6.7	6.7
5	Students collect data to test their hypotheses	Designing effective class discussions and learning tasks	Gathering data to test hypotheses	13.3	13.3
6	Students write responses in worksheets and analyze data	Summarizing and concluding based on assessment	Concluding explanations and summarizing conclusions	6.7	6.7
7	Students present analysis results	Activating students as peer learning resources and providing feedback	Concluding explanations and summarizing conclusions	10.0	10.0
8	Students respond to peer analysis	Activating students as peer learning resources and providing feedback	Concluding explanations and summarizing conclusions	3.3	3.3
9	Peer discussions on exercises as mutual learning resources	Activating students as peer learning resources and providing feedback	Concluding explanations and summarizing conclusions	9.5	9.5
10	Students summarize findings	Concluding and reflecting on learning strategies	Reflecting on problems and thinking process	7.7	7.7
11	Students read their conclusions aloud	Reflecting on learning outcomes	Reflecting on problems and thinking process	3.3	3.3
12	Students reflect on learning approach, noting strengths and weaknesses	Ownership of learning and continuous feedback	Reflecting on problems and thinking process	3.3	3.3
13	Students write individual learning strategies	Ownership of learning and continuous feedback	Reflecting on problems and thinking process	6.7	9.5
14	Off-task activities (joking, using phones, etc.)	Irrelevant	-	9.5	6.7
Total Relevant Activities				90.5	93.3

In the first meeting, relevant activities reached 90.5%, and increased to 93.3% in the second meeting, indicating that this model is effective in maintaining student focus and reducing irrelevant activities, such as joking or using mobile phones. Overall, this table shows that guided inquiry based on assessment for learning has succeeded in increasing student involvement and strengthening self-reflection in learning.

Control Class

The control class had a similar model for inquiry but without a specific assessment-for-learning orientation. Table 1 indicates that whereas relevant activities also reached an average of around 89.6% to 90.5%, the absence of regular feedback resulted in increased off-task behaviors. Once more, the difference indicates (Safithri & Muchlis, 2022) result in how regular feedback in assessment-based models retains students' focus on and engagement in a lesson.

Student Activities

Experimental Class

In the experimental class, the assessment-oriented approach led to significant engagement. Table 1 highlights that students were notably engaged in discussion, hypothesis formation, and data analysis, indicating that the guided inquiry model fostered critical thinking and participation.

Table 2. Percentage of relevant and irrelevant activities of experimental class students at meetings 1 and 2

Meeting	Relevant Activity (%)	Irrelevant Activity (%)
1	90.5	9.5
2	93.3	6.7

This result concurs with findings (Dini & Muchlis, 2022), who observed that active participation in structured inquiry improved students' problem-solving skills and understanding of complex topics.

Control Class

The control class had more irrelevant activities, especially during the first meeting at 10.4%, which decreased to 9.5% in the second meeting.

Student Learning Outcomes

Experimental Class

Student learning outcomes are obtained from *pretest*, *posttest* 1 and *posttest* 2 scores. The *pretest* of learning outcomes is carried out before using assessment-oriented LKPD for learning. At the first meeting, LKPD 1 will be implemented with an *assessment for learning* orientation where students must complete all the tasks contained in the LKPD. After students work on LKPD 1, the teacher will provide feedback and students will reflect on their learning style, then students will work on *posttest* 1. The results obtained from *posttest* 1 will later be used as a reference for further learning continuity. After completing *posttest* 1, students will apply LKPD 2 during the learning process. The LKPD 2 that has been completed will later be given feedback by the teacher and students will reflect on the learning activities that have been carried out, after that students will take *posttest* 2 to measure their understanding.

It can be seen that implementing *assessment for learning* oriented LKPD can improve student learning outcomes in acid-base titration material. This is proven by the students' *posttest* 1 score being greater than the *pretest* score and the *posttest* 2 score also being greater than the *posttest* 1 score. There was an increase in student learning outcomes in the *pretest*, *posttest* 1, and *posttest* 2.

Control Class

Student learning outcomes are obtained from *pretest*, *posttest* 1 and *posttest* 2 scores. The *pretest* of learning outcomes is carried out before using the guided inquiry-oriented LKPD. At the first meeting, guided inquiry-oriented LKPD 1 will be implemented where students must complete all the tasks contained in the LKPD. After students work on the LKPD, students will work on *posttest* 1. The results obtained from *posttest* 1 will later be used as a reference for further learning continuity. After completing *posttest* 1,

students will apply LKPD 2 during the learning process. After completing LKPD 2, students will then do *posttest* 2 to measure their understanding.

The learning results obtained show that there is a tendency for LKPD to be oriented towards *assessment for learning* which can improve student learning outcomes as evidenced by the average score of the experimental class being higher than the average score of the control class. This is relevant to research conducted by (Safithri & Muchlis, 2022) that the application of *assessment for learning* in learning can support further learning activities and can improve learning outcomes significantly.

Student Response

Experimental Class

As many as 100% or 35 students stated that the learning model used made it easy for students to understand the material, and enabled students to write down the targets they wanted to achieve in the learning process. This is in line with the results of observations of the implementation of the guided inquiry learning model oriented towards *assessment for learning* at meetings one and two where it was implemented very well with the observer's implementation score being 4.

Control Class

As many as 100% of students stated that the guided inquiry learning model used made students easily understand the material.

This statement is in line with statement number 13, as many as 97.15% of students stated that the acid-base titration material presented was well understood, while 2.85% stated the opposite. This can be in accordance with statement number 7 where students who have understood the material well can relate the material to phenomena in everyday life, so it is proven by the positive response obtained from students at 91.42%, while it was 8.58% stated otherwise. This could be caused by the application of this guided inquiry model being implemented for the first time so that students are not able to follow the learning perfectly. Another obstacle is that there are still some students who lack focus and joke around during learning so they cannot understand the material presented by the teacher.

CONCLUSION

The result of the implementation of an assessment for learning-oriented inquiry learning model for acid-base titration material is excellent. The score gained in both the first and second meetings falls within 3-4; this means the teacher had been doing good in managing the teaching regarding acid-base titration material.

These are real indications that the student learning outcomes increased significantly, because the t-test analysis showed a p value of 0.000 on the posttest 1 and posttest 2 scores, since this value is less than 0.05. It can be stated that the increase in student learning outcomes is significant.

The activities of the students during learning with the assessment for learning-oriented guided inquiry model also proceeded smoothly. The total percentage of relevant student activities at the first meeting reached 90.01% and at the second meeting was 91.67%. It is mentioned that at each meeting, relevant activities get a higher percentage than irrelevant activities. Thus, students have carried out all learning activities that support the effectiveness of the guided inquiry model oriented towards assessment for learning.

On the other hand, the students' responses after participating in learning activities with the guided inquiry model oriented towards assessment for learning were very positive. The percentage of student response averaged between 91.42% and 100% in the very good category.

The results obtained from this study may be indicative that the application of an assessment-for-learning-oriented learning model through guided inquiry serves as an alternative to improving learning outcomes and student engagements effectively. Additionally, this may offer great benefits in terms of science and technology development within the education context.

REFERENCES

Dini, P. C., & Muchlis, M. (2022). Peningkatan Hasil Belajar Peserta Didik melalui Implementasi Pembelajaran Berbasis Assessment for Learning pada Materi Kesetimbangan Kimia. *PENDIPA Journal of Science Education*, *6*(2), 565–572. https://doi.org/10.33369/pendipa.6.2.565-572

Asiah, H. A., Susilaningsih, E., & Nuswowati, M. (2017). Inovasi Model Penilaian Proses pada Pembelajaran Kimia Untuk Mengukur Keterampilan Laboratorium dan Aktivitas Siswa. *Jurnal Inovasi Pendidikan Kimia*, *11(2)*.

Emda, A. (2017). Laboratorium sebagai sarana pembelajaran kimia dalam meningkatkan pengetahuan dan ketrampilan kerja ilmiah. *Lantanida journal, 5(1)*, 83-92.

Fajrin, S., Haetami, A., & Marhadi, Muh. A. (2020). Identifikasi Kesulitan Belajar Kimia Siswa Pada Materi Pokok Larutan Asam Dan Basa di Kelas Xi Ipa2 SMA Negeri 1 Wolowa Kabupaten Buton. *Jurnal Pendidikan Kimia FKIP Universitas Halu Oleo*, *5*(1), 27. https://doi.org/10.36709/jpkim.v5i1.13106

Hadi, M. Y. (2022). The Foundation of Curriculum Renewal (Reviewing from Philosophical, Juridic, Historical, Psychological, Social and Cultural Aspects). *Jurnal Pendidikan Indonesia: Teori, Penelitian, Dan Inovasi*, *2*(2). Https://Doi.Org/10.59818/Jpi.V2i2.202

Herawati, N. S., & Muhtadi, A. (2018). Pengembangan Modul Elektronik (E-Modul) Interaktif Pada Mata Pelajaran Kimia Kelas XI SMA. *Jurnal Inovasi Teknologi Pendidikan, 5(2)*, 180-191.

Jahanger, A., Usman, M., Murshed, M., Mahmood, H., & Balsalobre-Lorente, D. (2022). The Linkages Between Natural Resources, Human Capital, Globalization, Economic Growth, Financial Development, And Ecological Footprint: The Moderating Role of Technological Innovations. *Resources Policy*, *76*, 102569. Https://Doi.Org/10.1016/J.Resourpol.2022.102569

Kurnia, J. S., & Risyda, F. (2021). Rancang Bangun Penerapan Model Prototype Dalam Perancangan Sistem Informasi Pencatatan Persediaan Barang Berbasis Web. *Jsi (Jurnal Sistem Informasi) Universitas Suryadarma*, *8*(2), 223–230. Https://Doi.Org/10.35968/Jsi.V8i2.737

Mahrunnisya, D. (2023). Keterampilan Pembelajar Di Abad Ke-21. Jupenji: *Jurnal Pendidikan Jompa Indonesia, 2(1)*, 101-109.

Pratama, D., & Muchlis, M. (2023). Student Worksheet Oriented on Assessment for Learning to Improve Learning Outcome on Acid Base Titration. *Hydrogen: Jurnal Kependidikan Kimia*, *11*(4), 485–496. https://doi.org/10.33394/hjkk.v11i4.8154

Rahayu, R., Iskandar, S., & Abidin, Y. (2022). Inovasi pembelajaran abad 21 dan penerapannya di Indonesia. *Jurnal Basicedu, 6(2)*, 2099-2104.

Ramadhana, G. H., & Sutiani, A. (2023). Implementation of Problem Based Learning on Critical Thinking to Increase Learning Outcomes and Student Activities. *Jurnal Inovasi Pembelajaran Kimia (Journal of Innovation in Chemistry Education), 5(1)*, 37-43. https://jurnal.unimed.ac.id/2012/index.php/jipk

Rosana, D., Widodo, E., Setianingsih, W., & Didik Setyawarno, dan. (2020).

Pelatihan Implementasi Assessment of Learning, Assessment for Learning Dan Assessment As Learning Pada Pembelajaran IPA SMP di MGMP Kabupaten Magelang Assessment Of Learning, Assessment For Learning And As Learning Assessment Training In Smp Learning Learning In MGMP, Magelang District. *2020*(1), 71–78. http://journal.uny.ac.id/index.php/jpmmp

Safithri, D. L., & Muchlis, M. (2022). Implementasi Pembelajaran Berbasis Assessment for Learning untuk Meningkatkan Hasil Belajar Peserta Didik pada Materi Laju Reaksi. *PENDIPA Journal of Science Education*, *6*(2), 547–555. https://doi.org/10.33369/pendipa.6.2.547-555

Saragih, W. L., & Dibyantini, R. E. (2024). Implementation of an Integrated Problem Based Learning Model in Acid-Base Material. *Jurnal Inovasi Pembelajaran Kimia (Journal of Innovation in Chemistry Education)*, *6*(1), 8-19. https://doi.org/10.24114/jipk.v6i1.56437

Sari, C. W., & Helsy, I. (2018). Analisis Kemampuan Tiga Level Representasi Siswa Pada Konsep Asam-Basa Menggunakan Kerangka Dac (Definition, Algorithmic, Conceptual). *JTK (Jurnal Tadris Kimiya)*, *3*(2), 158–170. https://doi.org/10.15575/jtk.v3i2.3660

Tambunan, S. M., Purba, J., & Panggabean, F. T. M. (2024). The Influence of Problem Based Learning and Media to Increase Student Interest and Learning Outcomes. *Jurnal Inovasi Pembelajaran Kimia (Journal of Innovation in Chemistry Education)*, *6*(1), 120-129. https://doi.org/10.24114/jipk.v6i1.57337

Tri, A. R., & Marzuki, H. (2018). Analisis Kesulitan Pemahaman Konsep Pada Materi Titrasi Asam Basa Siswa Sma. *Orbital: Jurnal Pendidikan Kimia*, *1*(1), 22–27. https://doi.org/10.19109/ojpk.v1i1.1862

Yanti, F., & Simanjuntak, H. (2023). Effects of Implementing Innovative Character Integrated Chemical Bond Modules to Improve Learning Outcomes and Character. *Jurnal Inovasi Pembelajaran Kimia (Journal* Of *Innovation in Chemistry Education)*, *5*(1), 44-51. https://doi.org/10.24114/jipk.v5i1.33664

Yulita dan, R., Kunci, K., Terbimbing, I., Kritis, B., & Basa, A. (2020). Penerapan Model Inkuiri Terbimbing Untuk Melatihkan Keterampilan Berpikir Kritis Materi Asam Basa SMAN 3 Lamongan. In *UNESA Journal of Chemical Education* (Vol. 9, Issue 2).