HYDROGEN
JURNAL KEPENDIDIKAN KIMIA
https://e-journal.undikma.ac.id/index.php/hydrogen/index

August 2024. 12(4)
e-ISSN: 2656-3061
p-ISSN: 2338-6487
pp. 834-843

Development of Student Worksheets based Assessment for Learning on Chemical Equilibrium to Improve Student Science Process Skills

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Article History
Received: 09-08-2024
Revised: 22-08-2024
Published: 31-08-2024

Keywords: student worksheet, assessment for learning, science process skills, chemical equilibrium

Abstract
This study focuses on creating Student Worksheets (LKPD) that incorporate Assessment for Learning principles to improve students' scientific process skills in chemical equilibrium. The research employs the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model of Research and Development (R&D). The study evaluates the LKPD's effectiveness, practicality, and validity. A one-sample t-test comparing pretest and posttest scores measures effectiveness. Practicality is determined through quantitative descriptive analysis of student feedback questionnaires and activity observation sheets. Validity assessment involves both qualitative and quantitative descriptive analysis using Likert scale validation forms. Results show that the developed LKPD achieved the highest possible validity score (mode of 5) across all aspects. It demonstrated 90.7% practicality and a statistically significant t-test result (p-value of 0.000). These outcomes suggest that the LKPD effectively enhances students' scientific process skills in chemical equilibrium studies. The Assessment for Learning approach and integrated feedback in the LKPD promote active student engagement and foster improved scientific process skills in this subject area.

How to Cite: Utami, D., & Agustini, R. (2024). Development of Student Worksheets based Assessment for Learning on Chemical Equilibrium to Improve Student Science Process Skills. Hydrogen: Jurnal Kependidikan Kimia, 12(4), 834-843. doi:https://doi.org/10.33394/hjkk.v12i4.12617

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INTRODUCTION

Education is crucial in enhancing the caliber of human resources, as articulated in the legislation known as Law Number 20 of 2003 regarding the national education framework. This law aims to produce high-quality graduates who are able to contribute to the country's progress (Sujana, 2019). In an effort to achieve this goal, Student Worksheets (LKPD) based on Assessment for Learning (AFL) appear as a promising alternative for improving the learning process and student competence, especially in complex subjects such as chemistry.

Prastowo (2015), defines LKPD as sheets that contain material, summaries and guides in the form of steps to complete tasks that must be done by students. Latukau (2022), highlights the notion that science process skills are honed predominantly through experimentation. Such activities naturally refine skills like classification and observational acumen. Apart from that, through LKPD students are trained to calculate, hypothesize and make temporary conclusions. Thus, AFL-based LKPD not only functions as a learning aid, but also as an effective instrument in developing various aspects of student competence in learning chemistry.

The efficacy of Assessment for Learning (AFL) has been demonstrated in enhancing student academic achievements in diverse academic disciplines. Yulaichah et al. (2024) Finding that providing regular feedback allows students to understand their progress and make improvements if necessary. Baas et al. (2015), have validated the necessity of incorporating AfL in education to oversee student progress. Furthermore, other studies suggest that the implementation of AfL in education leads to favorable adjustments that enhance the assessment procedure (DeLuca et al., 2015).

Nonetheless, there remains a deficiency in the creation of AFL-centered instructional resources tailored to enhance students' scientific process abilities within the realm of chemical equilibrium. Chemical equilibrium is considered a challenging topic for many students due to its abstract nature and the need to understand various representations (Fahyuni et al., 2019). The results of a pre-research conducted at SMAN 1 Kedamean on February 5, 2024, showed that students' science process skills were still relatively low. Tests given to 34 students of class XII IPA 3 revealed low scores in various aspects of science process skills. Additionally, 91% of students stated that practical activities in school were rarely conducted, while 74% of students expressed a desire to conduct practical work.

The development of AFL-based LKPD is highly necessary to address various gaps in current chemistry learning. Many students experience difficulties in understanding abstract chemical concepts, while existing assessment systems often do not provide effective and timely feedback. AFL-based LKPD can bridge this gap by providing continuous formative feedback, helping concept visualization, and encouraging student self-reflection. This approach not only improves conceptual understanding but also develops science process skills that are crucial in chemistry. In line with 21st-century curriculum demands and current educational standards, AFL-based LKPD also supports the development of competencies needed in the digital era. Numerous prior research works have demonstrated the efficacy of AFL in science education, suggesting substantial promise for crafting AFL-infused LKPD to enhance the overall standard of chemistry education.

Assessment for Learning (AfL) based LKPD was chosen as a teaching tool in this research because of several advantages supported by previous research. Relevant research related to improving learning outcomes as a result of implementing assessment for learning has been conducted by Ibnu & Marfuah (2020), which shows this demonstrates that integrating assessment for learning can influence the enhancement of students' academic achievements.. Additional research conducted by Oyinloye & Imenda (2019), illustrates that implementing assessment for learning enhances the efficacy of the teaching and learning process.

AFL-based LKPD also allows for better integration between theory and practice, especially in learning abstract chemical equilibrium concepts (Fahyuni et al., 2019). Afl-based LKPD also provides formative feedback that can improve student learning. Considering these factors, AFL-based LKPD is viewed as the most suitable teaching tool to improve students' science process skills in learning chemical equilibrium, offering a good balance between conceptual development, practical skills, and metacognitive abilities, while still considering the specific context and needs of chemistry learning in Indonesia.

Therefore, the development of AFL-based LKPD for the topic of chemical equilibrium becomes highly relevant and necessary to monitor student learning and provide periodic and continuous feedback. This method holds promise for enhancing the standard of chemistry education, fostering the growth of students' scientific process abilities, and ultimately aiding in the enhancement of science education quality in Indonesia. Properly designed AFL-based LKPD allows teachers to obtain useful information on how to improve student learning and enhance students' science process skills.

METHOD

This research took place in the academic year 2023/2024 over the second semester, spanning three sessions, utilizing a quantitative approach where data analysis led to conclusions using calculation formulas, measurement aspects, and numerical data. The research subjects were chosen based on needs analysis, specifically high school students in the eleventh grade who were studying chemical equilibrium and had not previously used AfL-based worksheets, employing the research and development (R&D) approach with the ADDIE model according to Sugiyono (2013). The research methodology adhered to the ADDIE model of research and development as outlined by Sugiyono (2016), encompassing five key phases: 1) analysis; 2) design; 3) development; 4) implementation; and 5) evaluation. The developmental model's progression is illustrated in the diagram below.

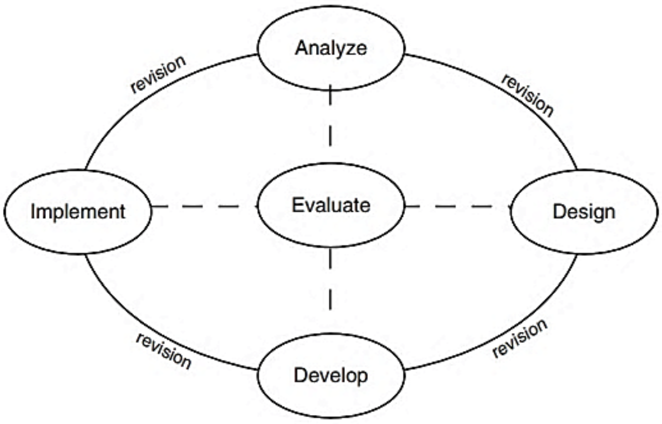

Figure 1. Development Model According to ADDIE according to Sugiyono, 2016

The tools employed in this study encompass (1) validation forms and instrument assessments; (2) observation sheets for student activities; and (3) questionnaires for student feedback. All data collection instruments utilized in this research have undergone validation by chemistry professors at Unesa and chemistry educators at SMAN 1 Kedamean.

The data gathering approach in this study includes observations, evaluations, and surveys. The observation method uses student activity observation sheets conducted by four observers. The evaluation technique comprises two stages: initially before and subsequently after the learning procedure (pretest and posttest). The objective is to delineate the enhancement in students' scientific process competencies pre- and post-learning. Observational assessments for scientific process skills are executed during student experimentations. The questionnaire approach in this research aims to gauge student reactions post-learning.

This study employs descriptive statistical methods for data collection. Descriptive analyses unveil learning achievements, advancements in scientific process abilities, the suitability of learning materials, and student feedback. The assessment technique utilizes N-Gain, which is employed to assess the enhancement in scientific process skill outcomes following the pretest and posttest phases. N-Gain is calculated by comparing the pretest and posttest scores.

The formula for calculating the N-Gain test is as follows.

$$\mathrm{N-gain\ value} = \frac{\mathrm{posttest\ score} - \mathrm{pretest\ score}}{100\% - \mathrm{pretest\ score}}$$

The n-gain values obtained are interpreted according to the following table:

Table 1. N-gain Level Criteria

Value	Criteria
(g) > 0,7	Tall
0 ≥ (g) > 0,3	Currently
(g) ≤ 0,3	Low

The research tools utilized comprise validation forms for evaluating the authenticity of AFL-centered worksheets, student feedback surveys to evaluate the usability of AFL-centered worksheets, and pretest-posttest questionnaires to evaluate the efficacy of the created AFL-centered worksheets.

The validity assessment involves analyzing validation data collected from three validators through the validation process using a Likert scale in accordance with Table 2.

Table 2. Likert Scale

Value	Indicator
5	Very Valid
4	Valid
3	Fairly Valid
2	Less Valid
1	Invalid

Adaptation of Riduwan, 2022)

The practicality analysis examines data from student response questionnaires concerning the implemented AFL-focused worksheets during the trial. The outcomes of the response surveys are assessed utilizing a specific formula:

$$\%Positive\ response\ to\ each\ item = \frac{\Sigma \text{ positive response to each item obtained}}{\Sigma\ total\ positive\ response\ to\ items} \times 100\%$$

Subsequently, the interpretation of the student response questionnaire results is conducted according to practical criteria outlined in Table 3.

Table 3. Practicality Score Criteria for Student Response Questionnaires

Percentage	Criteria
0 -20	Impractical
21 - 40	Less Practical
41 - 60	Quite Practical
61 - 80	Practical
81 - 100	Very Practical

(Adaptation of Riduwan, 2022)

The practicality is reinforced by observing student engagement throughout the learning phase. Student actions are evaluated utilizing the subsequent formula.

$$\%\text{practicality} = \frac{\Sigma \text{ activities carried out}}{\Sigma \text{ overall activity}} \times 100\%$$

The percentage outcomes acquired are subsequently transposed into the standards outlined in Table 4.

Table 4. Practicality Score Criteria for Student Observation Sheets

Percentage	Criteria
0 -20	Impractical
21 - 40	Less Practical
41 - 60	Quite Practical
61 - 80	Practical
81 - 100	Very Practical

(Adaptation of Riduwan, 2022)

Student engagement is deemed successful when the percentage of pertinent activities surpasses that of irrelevant activities (Riduwan, 2022).

Analyzing the effectiveness data entails examining the pretest-posttest scores through the t-test in conjunction with cognitive test outcomes. Before employing the t-test for data assessment, it is essential to conduct a normality check to ensure the data's distribution conforms to a normal curve. The Anderson-Darling statistical test, facilitated by Minitab 19, is utilized for this purpose. If the significance value (Sig) exceeds 0.05, the data is considered normally distributed based on the normality test.

Following the normality assessment, a one-sample t-test is conducted to ascertain both the normal distribution of the data and any noteworthy distinctions between the periods prior to and post the adoption of AFL-centered worksheets. If the significance (Sig) value obtained from the one-sample t-test exceeds 0.05, the null hypothesis (H_0) is retained, and the alternative hypothesis (H_a) is rejected. Conversely, if the significance value is below 0.05, the null hypothesis (H_0) is discarded, and the alternative hypothesis (H_a) is embraced.

RESULTS AND DISCUSSION

Validity

Validity pertains to the precision and completeness of a test in fulfilling its measurement role (Yusrizal, 2016). The assessment of data validity involves reviewing the content and construction validation outcomes provided by three validators. Content validity aims to assess the coherence and alignment between an AFL-based LKPD and the educational material. On the other hand, construction validity seeks to demonstrate how effectively the instrument can capture the theoretical attributes or constructs being evaluated. The validation findings are detailed in table 4.

Table 4. Data Validation Results

Validity Aspect	Mode		
	LKPD 1	LKPD 2	LKPD 3
Content Validity	5	5	5
Construct Validity	5	5	5
Validity of Construction According to KPS	5	5	5
Language Validity	5	5	5

Referring to the data in Table 4, AFL-based LKPDs 1, 2, and 3 achieve a mode of 5, indicating a high level of validity. With this mode 5 rating, the AFL-based LKPDs are deemed exceptionally valid in theory. Any areas falling short of the criteria should be rectified or modified and subsequently revalidated until they meet the stipulated standards (Lutfi, 2021).

Practicality

The practically of AFL-centered worksheets was assessed through student feedback questionnaires post-utilization of the AFL-based materials with a group of 24 students. These questionnaires comprised statements that students needed to respond to after engaging with the developed AFL-based worksheets. The outcomes from the student feedback questionnaires are depicted in Figure 2.

According to the data presented in Figure 2, students responded positively to the content at a rate of 94.45% and negatively at 5.55%. In terms of the construct aspect, the positive feedback received was 85.41%, with 14.59% expressing negative sentiments. Regarding the format, 96.66% of responses were positive, while 3.34% were negative. The overall average student response stood at 90.7%, indicating that the AFL-based worksheets are deemed practical, having surpassed the threshold of 61%.

The feasibility of AFL-centered worksheets is validated by the outcomes of student observational activities conducted throughout the learning process. The relevance of these activities is gauged based on the assessment of learning procedures, distinguishing between pertinent and irrelevant engagements. Rahman (2022), emphasized that student involvement is crucial for effective learning activities.

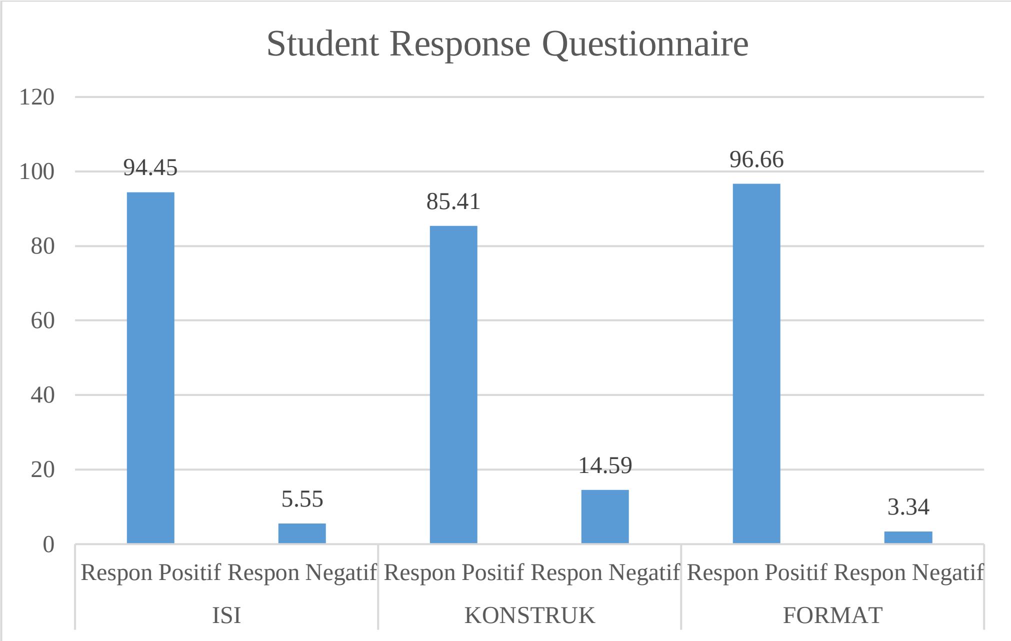

Figure 2. Results of Student Response Questionnaire

The results of student observations are presented in table 5.

Table 5. Results of student activity percentages

Observed Activity	Meeting 1	Meeting 2	Meeting 3
Relevant activities	80,21	88,19	93,40
Irrelevant activity	19,79	11,81	6,60

The table shows that the proportion of pertinent activities in each session exceeds that of irrelevant activities, demonstrating the efficacy of student participation during the learning sessions. By integrating the findings from student feedback surveys with the percentage of student engagements, it can be inferred that the AFL-based worksheets concentrating on chemical equilibrium materials function as practical assignments to enhance students' scientific process abilities.

Effectiveness

A cognitive evaluation was carried out both before and after to assess the efficacy of AFL-based worksheets, emphasizing learning assessment. The pretest and posttest were designed to ascertain the students' educational progress at the beginning and end stages before and after the integration of AFL-centered worksheets tailored for learning evaluation. The outcomes of these assessments are depicted in Figure 3.

Based on Figure 3, no student scored above the individual mastery score of 80 in the pretest, resulting in a 0% student mastery rate. The lack of student mastery is attributed to teaching methods still teacher-centered and assessment systems that do not involve students. This is because some students do not understand the concept of assessment in AFL-based worksheets as a learning tool. Some students struggle to comprehend the feedback provided by the teacher.

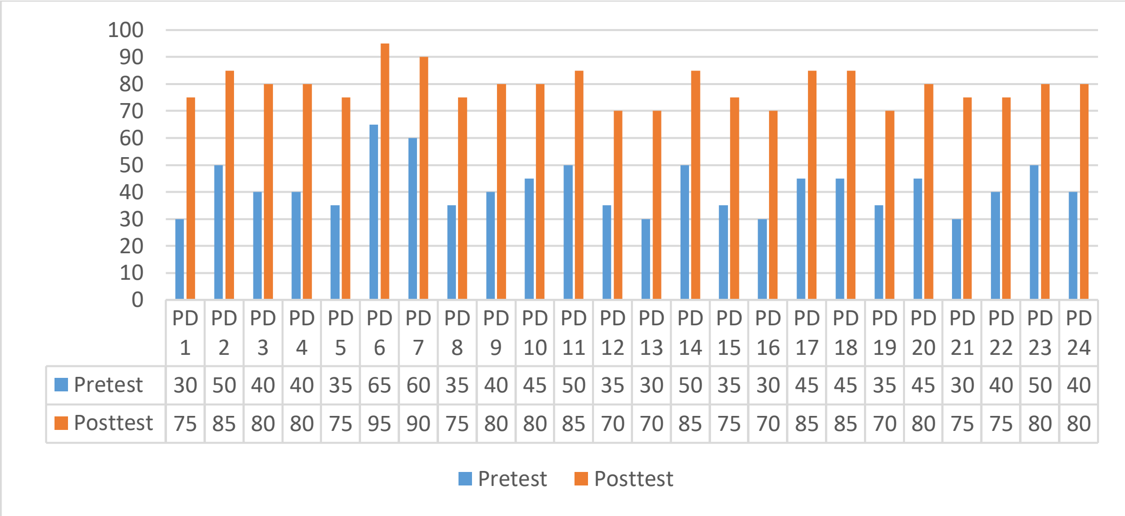

Figure 4. Pretest and Posttest Score Results

Students successfully achieved scores exceeding 80 in the posttest, resulting in a perfect classical mastery rate of 100%. This achievement can be attributed to the students' ability to absorb feedback from the instructor and the integrated learning assessment in AFL-based worksheets. This aligns with Budiyono (2015), finding results underscore the importance of assessment in education, highlighting that its core lies in the acquisition and application of information.. Amua-Sekyi (2016), add that the interaction between educators and learners generates knowledge or information that is then utilized by both parties to enhance the quality of participation in learning. Furthermore, Box et al. (2019), states that consistency in the learning process undertaken by students has the potential to enhance their learning outcomes in the material being studied.

One of the challenges faced in the implementation of AFL-based worksheets is the inconsistency in the number of students present compared to the initial plan. This can affect the dynamics of learning and interactions among students during the sessions using AFL-based worksheets. Additionally, difficulties arise in honing students' scientific process skills because answering questions in the worksheets is done in groups. As a result, some students may not be maximally engaged in discussions or the process of answering questions, which can ultimately affect the overall effectiveness of learning. Possible solutions that could be considered include adjustments in group arrangements or more inclusive collaborative strategies to ensure the participation of all students in learning activities.

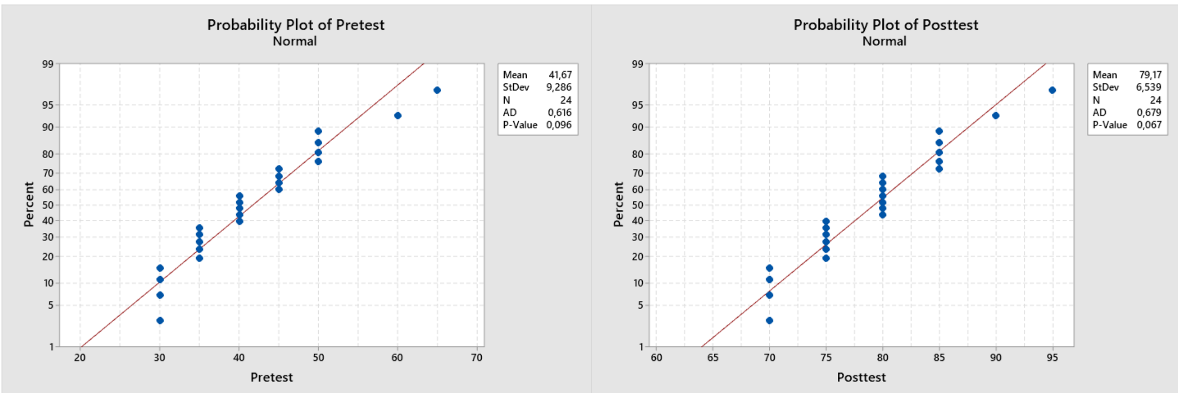

Figure 5. Pretest and Posttest Data Normality Test

The effectiveness data was assessed utilizing a t-test with the support of Minitab 19. Before proceeding with the t-test analysis, it is essential to conduct a normality check using the Anderson-Darling test. The outcomes of the normality assessment are presented in Figure 5.

Information from Figure 5 indicates that the P-Value for the pretest data stood at 0.096, and for the posttest data, it was 0.067. These results imply that both P-Values exceed 0.05, signifying that the data adheres to a normal distribution.

After evaluating normality, the pretest and posttest data underwent analysis using the one-sample t-test feature in Minitab 19. The results of this analysis are presented in Table 6.

Table 6. One Sample t-test Preset and Posttest Results

Null hypothesis		H_0: $\mu = 40$
Alternative hypothesis		H_1: $\mu > 40$
T-Value	**P-Value**	
29,35	0,000	

According to the t-test calculation results table, one party achieved a t-value of 29.35 with 23 degrees of freedom and a significance value of 0.000. Comparatively, the t-table result derived from data with 23 degrees of freedom and a significance value of 0.05 is 2.06. The conclusion drawn from the hypothesis is that the t-value (29.35) surpasses the t-table value (2.06), resulting in the null hypothesis (H_0) being refuted and the alternative hypothesis (H_a) being embraced, indicating that the posttest scores following the implementation of AFL-based worksheets surpass the pretest scores. The significant difference in mean pretest and posttest scores underscores the beneficial effect of employing AFL-based worksheets in improving students' academic performance in the subject of chemical equilibrium.

Learning assessment underscores the provision of feedback in student learning activities, enabling students to evaluate their proficiency in mastering the subject matter. Effective execution requires comprehensive readiness for assessments focused on learning (Jeyaraj, 2019). Teachers need to have the ability to manage educational processes, encompassing tasks such as planning, defining learning goals, and making informed choices based on assessment results to motivate students to improve their academic success (Wiliam, 2013). Incorporating assessment for learning proves to be extremely advantageous in enhancing students' academic results, demonstrating effectiveness in educational methodologies (Oyinloye & Imenda, 2019).

CONCLUSION

The validator deemed the LKPD-based AFL designed to enhance science process skills valid, assessing it based on content and construct validity with a mode score criterion of 5. The practicality of the LKPD-based AFL for enhancing science process skills was highly commended, supported by a student response questionnaire yielding a 90.7% approval rate and reinforced by relevant student engagement during meetings 1, 2, and 3 at 80.21%, 88.19%, and 93.40% respectively. The efficiency of using LKPD-based AFL to improve students' science process skills in the domain of chemical equilibrium was validated via a one sample t-test, yielding a significance value of 0.000 < 0.05. These results imply that the LKPD-based AFL is effective for improving students' science process skills in the realm of chemical equilibrium. Nonetheless, the assessment sheet generated in this study was tested with a restricted number of participants due to research limitations. It is hoped that in the future, this assessment sheet can be scaled up for commercial use and widespread distribution.

RECOMMENDATIONS

The development of Assessment for Learning-based LKPD on chemical equilibrium material was carried out with a limited number of research subjects, so it needs to be continued until testing with a larger number of research subjects.

ACKNOWLEDGEMENTS

Thank you to the Chemistry Education Lecturer at FMIPA State University of Surabaya, the Principal and Chemistry Teacher of SMAN 1 Kadamean and XI-1 Students as respondents in this research.

BIBLIOGRAPHY

Amua-Sekyi, E. T. (2016). Assessment, Student Learning and Classroom Practice: A Review. *Journal of Education and Practice*, *7*(21), 1–6.

Baas, D., Castelijns, J., Vermeulen, M., Martens, R., & Segers, M. (2015). The relation between Assessment for Learning and elementary students' cognitive and metacognitive strategy use. *British Journal of Educational Psychology*, *85*(1), 33–46.

Box, C., Box, & Vernikova. (2019). *Formative assessment in United States classrooms*. Springer.

Budiyono, B. (2015). *Pengantar penilaian hasil belajar*. UNS Press Surakarta.

DeLuca, C., Klinger, D., Pyper, J., & Woods, J. (2015). Instructional rounds as a professional learning model for systemic implementation of assessment for learning. *Assessment in Education: Principles, Policy & Practice*, *22*(1), 122–139.

Fahyuni, E. F., Arifin, M., & Nastiti, D. (2019). Development Textbook With Problem Posing Method To Improve Self Regulated Learning and Understanding Concept. *Jurnal Pendidikan Sains (Jps)*, *7*(1), 88–92.

Ibnu, S., & Marfuah, S. (2020). Students' Result of Learning at Chemistry Department through Assessment of, for, and as Learning Implementation. *International Journal of Instruction*, *13*(2), 165–178.

Jeyaraj, J. S. (2019). Effective learning and quality teaching. *University News: A Weekly Journal of Higher Education*, *57*(2–8), 30–35.

Latukau, M. (2022). Pembelajaran IPA Dengan Model Inkuiri Terbimbing Untuk Meningkatkan Pemahaman Konsep dan Keterampilan Proses Sains Siswa SD. *Jurnal Ilmiah Wahana Pendidikan*, *8*(23), 351–362.

Lutfi, A. (2021). Research and Development (R&D): Implikasi dalam pendidikan kimia. *Surabaya: Jurusan Kimia FMIPA Universitas Negeri Surabaya*.

Oyinloye, O. M., & Imenda, S. N. (2019). The Impact of Assessment for Learning on Learner Performance in Life Science. *EURASIA Journal of Mathematics, Science and Technology Education*, *15*(11).

Prastowo, A. (2015). *Panduan kreatif membuat bahan ajar inovatif (D. Wijaya*. Diva Press.

Rahman, R. (2022). Improving Student Participation in Learning Through Discovery Learning Methods in Social Studies Learning. *Jurnal Ilmiah Wahana Pendidikan*, *8*(4), 233–238.

Riduwan, M. B. A. (2022). *Skala pengukuran variabel-variabel penelitian*.

Sugiyono, D. (2013). *Metode penelitian pendidikan pendekatan kuantitatif, kualitatif dan R&D*.

Sugiyono, S. (2016). Metode penelitian kuantitatif, kualitatif, R&D. *Bandung: Alfabeta*, 1–11.

Sujana, I. W. C. (2019). Fungsi dan tujuan pendidikan Indonesia. *Adi Widya: Jurnal Pendidikan Dasar*, *4*(1), 29–39.

Wiliam, D. (2013). Assessment: The bridge between teaching and learning. *Voices from the Middle*, *21*(2), 15–20.

Yulaichah, S., Mariana, N., & Puspita, A. M. I. (2024). Implementasi Pembelajaran Berdiferensiasi dalam Membangun Budaya Kelas di Sekolah Anuban Khon Kaen, Thailand. *JIIP-Jurnal Ilmiah Ilmu Pendidikan*, *7*(3), 2319–2330.

Yusrizal, Y. (2016). *Tanya Jawab Seputar Pengukuran, Penilaian, dan Evaluasi Pendidikan*. Banda Aceh: Syiah Kuala University Press.