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Development of Learner Activity Sheets Based on Guided Inquiry to Improve Student Learning Outcomes on Chemical Equilibrium Material

Surastri, Rudiana Agustini*

Chemistry Education Study Program, Universitas Negeri Surabaya, Surabaya, Indonesia
*e-mail: rudianaagustini@unesa.ac.id

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Abstract: Education plays an important role in improving the quality of human resources. In the context of implementing the Merdeka Curriculum, teachers are given the freedom to design adaptive and contextual learning processes. Based on preliminary research findings, 50% of students reported difficulties in understanding chemical equilibrium material, with the main obstacles being unfamiliar terminology, excessive memorization, and complex calculations. To address these issues, this study aims to develop guided inquiry-based Learner Activity Sheets on chemical equilibrium material to improve the learning outcomes of class XI high school students. Chemistry learning, especially on the topic of chemical equilibrium, sub-material factors that affect the direction of chemical equilibrium shifts, is often considered abstract and difficult for students to understand, so learning media is needed that can facilitate critical thinking processes and conceptual understanding. Guided inquiry was chosen as a learning approach because it provides a balance between teacher direction and independent exploration by students. The research method used is Research and Development (R&D) with reference to the 4-D development model (Define, Design, Develop, and Disseminate) and limited to the Develop stage only. The population in this study was class XI of IPIEMS Surabaya High School. The results of Learner Activity Sheets validation from the three validators obtained a mode score of 5, which means that Learner Activity Sheets is feasible with very valid categories. The percentage of students' responses obtained was 96% which was declared practical. The learning outcomes of students are declared complete if they reach a score of ≥ 80. Based on the posttest results, the percentage of completeness is 88.5%. This percentage shows that classical completeness has been achieved, so it can be concluded that guided inquiry-based learning is effective in improving student learning outcomes.

Keywords: Chemical Equilibrium; Guided Inquiry; LAPD; Learning Outcomes; Student Response.

Introduction

Education is a key element in the process of improving the quality of human resources. Government Regulation No. 57 of 2021 on National Education Standards is used as a reference for curriculum development and education implementation to realize national education goals. Based on these national standards, learning is carried out by inspiring, motivating learner activeness, challenging, interactive, and fun. Currently, learning in schools uses the independent curriculum. The independent curriculum is a curriculum used to replace the previous curriculum, namely the 2013 Curriculum. In the independent curriculum, teachers are given flexibility in creating quality learning that suits the needs and learning environment of students.

One of the challenging chemistry materials for students to learn is chemical equilibrium. Chemical equilibrium material includes material that often makes students experience difficulties because it is abstract and requires an in-depth understanding of concepts [1]. Difficult subject matter, such as changes in the equilibrium state at the sub-microscopic level, is difficult to observe macroscopically. This difficulty is caused by the abstract nature of the concept, difficulty understanding the terms because students only memorize without understanding, and difficulty in performing calculations [2]. As a result of not understanding chemical equilibrium material, students get less than optimal results on tests.

This is also reinforced by pre-research data conducted at IPIEMS Surabaya High School, which shows that as many as 50% of students consider chemical equilibrium material difficult to understand. This difficulty is caused by learning methods that do not actively involve students. As many as 95.5% of students stated that learning chemical equilibrium was only done through explanations from the teacher without other activities, so they quickly felt bored and did not understand the material deeply.

This fact is also reinforced by interviews with chemistry teachers at IPIEMS Surabaya High School, who revealed that chemistry learning is still dominated by the Teacher-Centered Learning (TCL) method, where students receive more explanations directly from the teacher, so that learning tends to be teacher-centered. In addition, learning activities still do not involve students actively, including the lack of implementation of experiments related to chemical equilibrium material. These conditions result in students being limited in expressing ideas and opinions, so that the scientific abilities of students do not develop. In addition, the results of interviews with chemistry teachers show that there are still students who are not complete in the learning outcomes of the cognitive ability of chemical equilibrium or do not meet the KKTP value, so that many students are remedial in the material. Learner Activity Sheets based on

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guided inquiry have never been used in chemistry learning at IPIEMS Surabaya High School.

The solution to overcoming the abstract concept of chemical equilibrium is the presence of videos in learning and given multilevel chemical representations. Multilevel chemical representations describe the course of chemical processes as well as entities such as atoms and molecules through the use of formulas, symbols, and structures [3]. The representation consists of three levels, namely macroscopic, submicroscopic, and symbolic. Abstract problems in chemical equilibrium materials can be explained effectively through representations at the submicroscopic level, given that understanding of molecules and atoms is very important in this context [4]. In addition, in overcoming the difficult and abstract concept of equilibrium, an effective learning approach is the application of guided inquiry models. This model was developed to facilitate students ' understanding of concepts and the relationship between concepts in more depth. By utilizing the search process through the scientific method, the guided inquiry model allows students to discover concepts independently, thereby increasing active and optimal involvement during the learning process [5].

In overcoming the abstract concept of chemical equilibrium, this is packaged in a Learner Activity Sheet which contains chemical equilibrium material whose content is represented at multiple levels, such as the macroscopic level, submicroscopic level and symbolic level, and uses a guided inquiry model. The existence of Learner Activity Sheets acts as a very effective media to implement the guided inquiry model in learning chemical equilibrium.

Learner Activity Sheets contain tasks that must be completed by students during the learning process, which are equipped with instructions or must be followed in order to achieve the indicators of achievement of predetermined learning outcomes. The benefit obtained by students from using Learner Activity Sheets is to support the ease of understanding the concept of the material being studied. Learner Activity Sheets act as a tool that encourages students to be more independent and active, so as to improve the quality of the learning process [6]. Based on the National Standards Agency, the development of Learner Activity Sheets must pay attention to several aspects, namely the feasibility of content, language, presentation, and graphics. An LAPD is considered feasible if it fulfils these four aspects [7].

Some research that has relevance to this study is research conducted by Mawan and Rusmini entitled “Development of Guided Inquiry-Oriented Student Worksheets to Train Science Process Skills on Chemical Equilibrium Material.” The results showed that students' responses to the worksheets developed were very positive, with a percentage reaching 97.15%. The worksheet is considered very feasible based on the assessment of various aspects, including content, language, presentation, graphics, application of guided inquiry, and science process skills. The relevance between previous research and this research lies in the development of Learner Activity Sheets which uses the guided inquiry learning model and focuses on the same material, namely chemical equilibrium. In addition, it also increases learning outcomes. The existence of previous research can be used as a reference for the development of Learner Activity Sheets [8]. Research conducted by Hidayati and Yonata with the title “Application of Guided Inquiry Learning Model to Train Students' Science Process Skills on Chemical Equilibrium Material Class XI Senior High School Ngoro Jombang” showed that the application of the guided inquiry learning model reached a percentage of implementation of 91.16%, which was classified as very good (≥ 61%). In addition, the classical completeness of learning outcomes in the cognitive domain after the posttest reached 94.12%. Based on the N-gain analysis, 27 students were in the high category, while 7 students were in the medium category. The relevance of this research lies in the development of Learner Activity Sheets designed to support the learning process using the guided inquiry model, where the model has been implemented and studied in previous studies. In addition, the material used is the same, namely chemical equilibrium, the existence of previous research on this application can be used as a reference for developing Learner Activity Sheets [9].

Based on this, the purpose of this research is to produce a valid guided inquiry-based Learner Activity Sheet.

Research Methods

This study applied a Research and Development (R&D) approach that refers to the 4D model developed by Thiagarajan et al., which includes four stages, namely Define, Design, Develop, and Disseminate [10]. However, this research only focused on the third stage, namely the development stage.

The define stage includes several types of analysis, namely front-end analysis, learner analysis, concept analysis, task analysis, and learning objectives analysis. Front-end analysis aims to identify the main problems that arise during the learning process. Learner analysis is conducted to understand the characteristics of learners that are relevant to the development design. Concept analysis aims to identify the main concepts taught in chemical equilibrium material. Meanwhile, task analysis focuses on introducing various tasks that must be carried out by students in using guided inquiry-based Learner Activity Sheets.

The design stage includes the preparation of reference tests, selection of Learner Activity Sheets formats, and making initial designs in the form of Draft I Learner Activity Sheets. At the development stage, the process includes review by supervisors, revision of Learner Activity Sheets based on input from supervisors, validation by two chemistry education lecturers and one chemistry teacher, and conducting limited trials. The limited trial aims to measure students' responses to the Learner Activity Sheets that have been developed (Draft II). The trial was conducted using a one-group Pretest-Posttest design, as follows:

$$O_1 \times O_2$$

Description:
X = Treatment in the form of learning activities on chemical equilibrium material, especially the submaterial of factors that affect the shift in the direction of equilibrium, which is carried out using guided inquiry-based Learner Activity Sheets
O1 = Pretest value (before using guided inquiry-based Learner Activity Sheets on reaction equilibrium material, sub-material factors that affect the shift in the direction of chemical equilibrium)

O2 = Posttest value (after using guided inquiry-based Learner Activity Sheets on reaction equilibrium material, sub-material factors that affect the shift in the direction of chemical equilibrium).

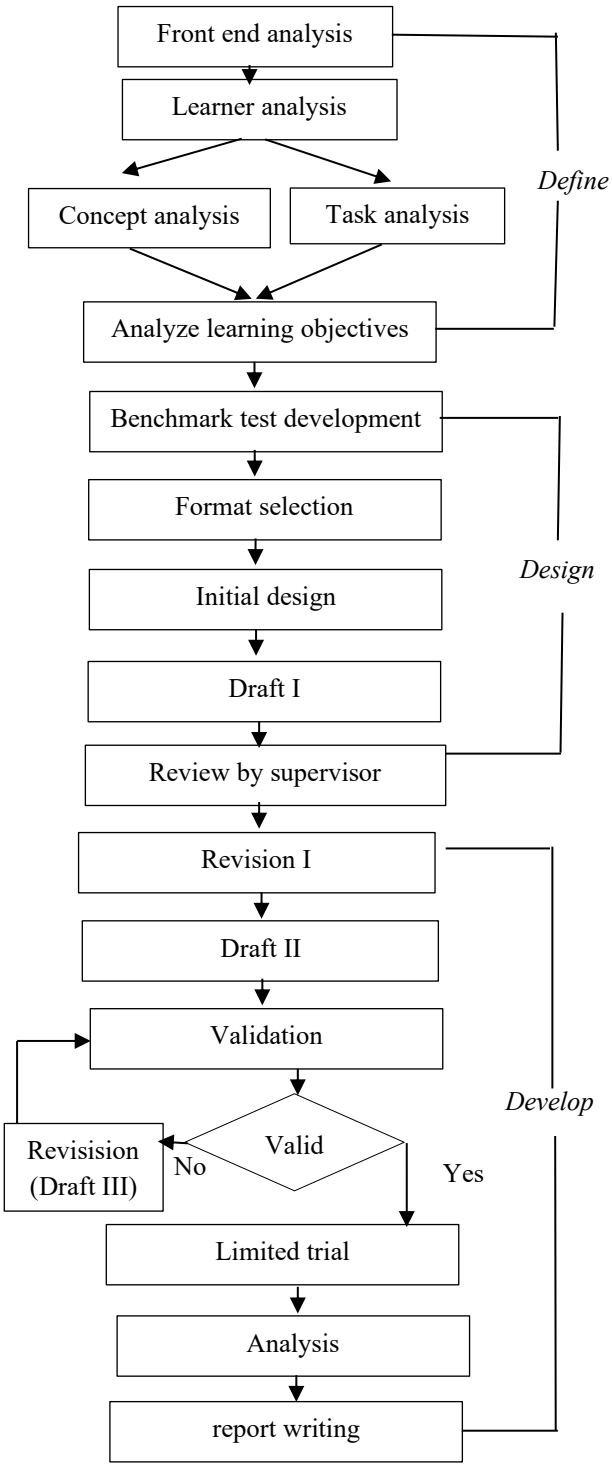

Figure 1. 4-D Development Model [11]

Validation in this study was conducted at the Department of Chemistry, Surabaya State University. The product trial was carried out at IPIEMS Surabaya High School. The research subjects consisted of three validators, consisting of two Chemistry lecturers from Surabaya State University and one chemistry teacher from IPIEMS Surabaya High School. Meanwhile, the product trial was aimed at 26 students of class XI-Merdeka 3 at IPIEMS Surabaya High School.

The data analysis techniques used in this study are as follows:

Validation Data Analysis

Validation was carried out by two chemistry lecturers and one chemistry teacher against Learner Activity Sheets using a Likert scale [12]. The validation results from the alidators were analyzed using quantitative descriptive ıethods.

Table 1. Data Validation Results Likert Scale Score

Assesment	Scale value
Not good	1
Not good enough	2
Fair	3
Good	4
Excellent	5

The data obtained is ordinal data, which cannot be added, multiplied or divided, so that it cannot be used for data analysis using the mode. The decision-making requirements are as follows:
1) If the mode ≥ 4, then the assessment is declared valid.
2) If the mode < 4, then the assessment is declared invalid [13].

Analysis of the Results of the Learner Response Questionnaire

Data from the student response questionnaire was obtained from the student response sheet to the use of LAPD using a Guttman scale.

Table 2. Guttman scale

No.	Question	Criteria	Score
1.	Positive	Agree	1
		Disagree	0
2.	Negative	Agree	0
		Disagree	1

Table 3. Guttman scale interpretation

Percentage (%)	Category
0 – 20	Not good
21 – 40	Not good enough
41- 60	Fair
61 – 80	Good
81 - 100	Excellent

Learner Activity Sheets based on guided inquiry are said to be practical as a learning media, if the results of the response questionnaire sheet have a percentage of ≥61% [12].

Analysis of Learner Activity Observation Results

The results of the learner activity observation sheet were used to support the practicality response questionnaire from the activities carried out by students during the trial, which were observed by the observer during the learning activities. Learner activities are said to be well implemented

and support the practicality of the developed Learner Activity Sheet if the percentage of relevant learner activities is greater than irrelevant learner activities.

Table 4. Percentage of Learner Activities

Percentage (%)	Category
0-20	Very less
21-40	Less
41-60	Enough
61-80	Good
81-100	Very good

The effectiveness of Learner Activity Sheets is analyzed through cognitive learning outcomes obtained from pretest and posttest scores. Analysis of the effectiveness of Learner Activity Sheets was carried out using several tests, namely the paired sample t-test, classical completeness test, and N-gain test. Before conducting the paired sample t-test, a normality test was first carried out using the Shapiro-Wilk test, because the amount of data was less than 30. If the test results show that the data is normally distributed (significance value> 0.05), then the analysis continues with the paired sample t-test. Conversely, if the data is not normally distributed (significance value <0.05), then the Wilcoxon non-parametric test is used.

Results and Discussion

Define

This stage is the initial stage, which consists of gathering information to determine the learning requirements. This information collection was carried out by conducting pre-research and interviews with chemistry teachers at IPIEMS Surabaya High School.

Based on the results of the front-end analysis, the curriculum used at IPIEMS Surabaya High School is an independent curriculum. Chemical equilibrium material is one of the materials included in the Learning Outcomes (CP) Phase F of the independent curriculum. At the end of phase F, it states that students have the ability to understand and explain the equilibrium of chemical reactions. Based on a pre-research questionnaire, which stated that 50% of students stated that chemical equilibrium material was difficult to understand because many terms were not understood. This is reinforced by research conducted by Ayunda, which states that chemical equilibrium material is often viewed as a complex topic in chemistry learning due to its abstract nature and the need for deep conceptual understanding, making it a challenge for many students [1].

In chemical equilibrium material, especially the sub-material of shifting the direction of chemical equilibrium, real observations are needed through practicum, so that students can observe changes in the color of the solution in the equilibrium system. This can help students understand and explain the causes of shifting chemical equilibrium. However, learning at IPIEMS Surabaya High School tends to involve listening to teacher explanations and rarely making direct observations or practicum. This is supported by a pre-research questionnaire, which shows that 45.5% of students stated that the media that teachers often use in learning chemistry is the blackboard, so that teachers can carry out the learning process.

In addressing this issue, it is proposed that a guided inquiry model be used, which emphasizes active discovery of concepts through experimentation. Based on Bruner's learning theory, students should learn by actively participating in the learning process, especially through direct engagement with the concepts and principles being studied. Learners are encouraged to gain direct experience and conduct experiments so that they can discover and understand these principles independently [14].Learning through concept discovery is believed to produce better transfer of learning effects than other learning methods. Overall, this approach can improve reasoning skills and encourage learners to think freely, critically, and systematically in understanding a topic. The Student Activity Sheet can be used to help students understand and apply the concept of equilibrium through practical work and can improve student learning outcomes [15].

The guided inquiry model consists of six main stages: focusing attention and explaining the inquiry process, presenting the problem or phenomenon to be studied, formulating a hypothesis as a temporary answer to the problem, collecting data to test the hypothesis, developing an explanation and drawing conclusions, and reflecting on the problem situation, the explanation obtained, and the thinking process undergone [16].

Design

This stage aims to develop the initial design of the Learner Activity Sheets, known as draft I. The steps taken at this stage are the preparation of reference tests, format selection, and initial design of Learner Activity Sheets (Draft I). There were 3 Learner Activity Sheets developed. Meeting 1 discussed concentration factors, meeting 2 discussed temperature factors, and meeting 3 discussed pressure and volume factors. The contents of the Learner Activity Sheets developed include cover, preface, table of contents, concept map, instructions for use and work, introduction, which includes subject matter, sub-material, class/phase, time allocation, learning outcomes, and learning objectives. Summary of material and learner activities.

Figure 2. Learner Activity Sheets Cover

Learner Activity Sheets contains a summary of material on factors that affect the shift in the direction of chemical equilibrium, student activities, namely experiments and video observations of concentration factor experiments, temperature factors, and pressure and volume factors.

Figure 3 shows an example of student activities in conducting concentration factor experiments. In Learner Activity Sheets 2, there are also activities involving temperature factor experiments, but in experiment 3, students only watch YouTube videos about pressure and volume factor experiments. The activities involve conducting experiments to prove the hypotheses that have been formulated. Additionally, Learner Activity Sheets provide question analyses that students must complete to assess their understanding after conducting the experiment. The Learner Activity Sheets developed are structured based on the syntax of the guided inquiry learning model.

Figure 3. Concentration factor experiment

Figure 4. Syntax of the guided inquiry model

Figure 4 shows an example of the guided inquiry model syntax. There are six steps or syntaxes in the guided inquiry learning model. The first stage is to focus attention and explain the inquiry process. In the second stage, students are expected to present inquiry problems or inconsistencies through a presented phenomenon. The third stage is to formulate a hypothesis from an existing phenomenon. Then, in the fourth stage, students are expected to collect data related to the existing phenomenon. In the fifth stage, students formulate an explanation by linking it to supporting theories. The final or sixth stage is to reflect on the inquiry process through conclusions. It is hoped that by applying these stages, students' learning outcomes will improve [16].

Develop

The development stage aims to produce Learner Activity Sheets products that have gone through the review stage by the supervisor, after which the review is revised, and draft II is produced. The results of draft II will go through the validation stage first by the three validations carried out by two chemistry lecturers and one chemistry teacher. If the results of the validation of draft II are not valid, revisions will be made to produce draft III. After the revision and the results are valid, it can be continued with the limited trial stage for students. This validation was carried out by three validators, namely two chemistry lecturers from Surabaya State University and one chemistry teacher from IPIEMS Surabaya High School. The Learner Activity Sheets validation results are presented in the following table.

The validation scores obtained from the three validators were analyzed using the mode score. Based on Table 5, the mode score obtained is 5, so that the content validity is declared very valid. In construct validity, a mode score of 4 was obtained, so that construct validity was declared valid. Overall validation obtained a mode score of 4 and 5, which indicates that the Learner Activity Sheets are valid for use in the trial stage.

Table 5. Learner Activity Sheets validation results

Eligibility criteria	Validator V1	V2	V3	Mode	Criteria
Content validity	5	5	5	5	Very valid
Construct validity					
Kegraphic	5	5	5	5	Very valid
Presentation	5	5	5	5	Very valid
Linguistics	4	5	4	4	valid

The next stage is the limited trial stage of the Learner Activity Sheets, which has previously been validated. The limited trial aims to determine the feasibility of Learner Activity Sheets in terms of practicality and effectiveness. The trial was conducted on 26 students in class XI of IPIEMS Surabaya High School. The instruments used to assess practicality include a learner response questionnaire and a learner activity observation sheet, both of which have gone through a previous validation process.

The results of students' responses obtained an average percentage of 96% with very practical criteria. Riduwan states that the results of the student response questionnaire are said to be practical or very practical if the results obtained have a percentage achievement of ≥ 61% [12]. The following are the results of the learner response questionnaire in Table 6.

Table 6. Result of the student response questionnaire

Statement	Response Positive (%)
Learner Activity Sheets are presented in a systematic way that is easy for you to understand.	100
The Learner Activity Sheets are presented in accordance with the indicators, and learning objectives are clearly presented.	100
Guided inquiry learning can lower your learning outcomes.	92
With guided inquiry learning, you can easily understand chemical equilibrium material.	92
The font size used in Learner Activity Sheets allows you to read clearly.	100
The Learner Activity Sheets presentation lacks pictures and illustrations.	96
The Learner Activity Sheets presentation makes you interested in working on it.	96
There is enough space for you to write your answers in the Learner Activity Sheets.	100

The Learner Activity Sheets has completeness such as: table of contents, concept map, instructions for use, introduction consisting of Learner Activity Sheets identity, learning outcomes, and learning objectives.	100
The activities presented in the Learner Activity Sheets arouse your curiosity.	92
The language used in Learner Activity Sheets is ambiguous or has multiple meanings.	92
The questions in the Learner Activity Sheets are clear and easy for you to understand.	96
The language used in the Learner Activity Sheets is PUEBI compliant.	92
The phenomena in the Learner Activity Sheets fail to lead you to conduct investigative activities.	100
There are basic explanations within the Learner Activity Sheets that make you explain further.	100
Learner Activity Sheets lead you to think logically.	96
Based on the phenomenon presented, it fails to train you to formulate a problem.	92
Based on the phenomenon presented, it fails to train you to formulate a hypothesis.	96
Based on the phenomenon presented, it can train you to identify variables.	88
The learning activities failed to train you to make inferences.	96
Average	96

In addition to the learner response questionnaire, practicality is also supported by the results of observations of learner activities. Based on observations made by three observers, the average percentage of relevant learner activities at the first, second, and third meetings was 90%, 91.11%, and 84.44% respectively. The percentage of relevant activities obtained is greater than irrelevant activities, which shows that the activities of students are well implemented according to the lesson plan. However, it can be seen that meeting 3 experienced a decrease in relevant activities, which was due to several factors. At the third meeting, a learning video was presented without students doing experiments, so that in answering questions, it did not take long enough. Presentation of experimental videos on Learner Activity Sheets, causing students' freedom in accessing cellphones to play instead of learning. This is reinforced by research conducted by Adelia et al., which states that there are students who misuse gadgets during class hours. Some of these students use gadgets (smartphones) to access social media applications during class time, even though the teacher instructing the class at that time had asked the students to use their gadgets (smartphones) to access the internet and search for additional materials related to the lesson being discussed at that time[17]. Table 7 shows the percentage of observations of students' activities.

The effectiveness of the Learner Activity Sheets developed is measured by the pretest and posttest results obtained by students who are analyzed using classical completeness testing, analysis using SPSS software, and N-gain calculations.

Table 7. Percentage of learner activity

Learner activity	Activity percentage (%)		
	P1	P2	P3
Relevant activities	90	91.11	84.44
Irrelevant activities	10	8.89	15.56

The classical completeness test on the pretest and posttest results was obtained as follows:

$$\% \text{ Classical learning completeness} = \frac{23}{26} \times 100\% = 88{,}5\%$$

The calculation results showed that the classical completeness of students reached a percentage of 88.5%. The percentage results show ≥ 85% which means that the classical completeness of students' cognitive learning outcomes is achieved [18]. This is supported by the increase in pretest and posttest results as follows:

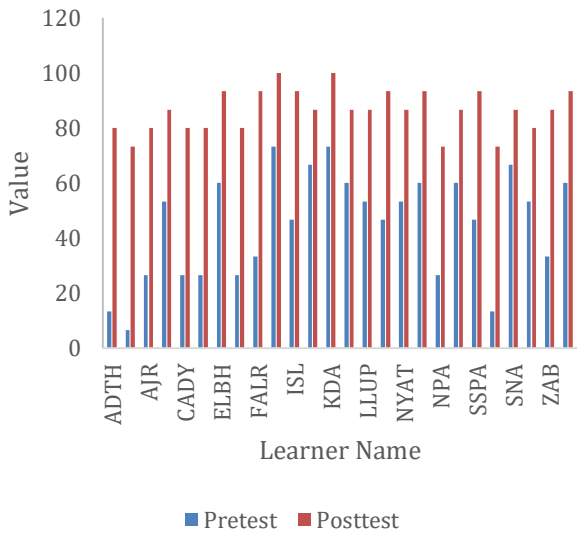

Figure 5. Graph of the increase in student learning outcomes

In addition, the pretest and posttest results were also analysed using statistical tests. Before conducting statistical tests, a normality test is first carried out to determine whether the data is normally distributed or not. The normality test used is Shapiro-Wilk, considering the number of samples used <30. Normality testing was performed using SPSS with the hypothesis that if the significance value was > 0.05, the data were normally distributed, and if the significance value was < 0.05, the data were not normally distributed. Normally distributed data was then tested using the T-test, and if the data was not normally distributed, it was tested using the Wilcoxon test [19].

Table 8. Normality Test

	Shapiro-Wilk		
	Statistics	df	Sig
Pretest	.931	26	.081
Posttest	.923	26	.052

Based on Table 8, about the Normality Test, the significance value is 0.081 for pretest data and 0.052 for posttest data. Because both values are greater than 0.05, the data can be categorized as normally distributed. Therefore, the analysis continued with parametric statistical tests using a paired sample t-test to test for significant differences between pretest and posttest scores. The following is the hypothesis used in the paired sample t-test. The following is the hypothesis of the paired sample t-test:

H0: There is no difference between pretest and posttest results after using guided inquiry-based Learner Activity Sheets.
H1: There is a difference between the pretest and posttest results after using guided inquiry-based Learner Activity Sheets.

Table 9. The paired sample t-test

Paired Samples Test									
		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Pretest-Posttest	-41.5462	14.4187	2.8277	-47.3700	-35.7223	-14.692	25	.000

Based on the results of the Paired Sample t-test in Table 9, the significance value (2-tailed) is less than 0.05. Thus, because the significance value is below 0.05, H0 is rejected and H1 is accepted. Therefore, it can be concluded that there is a significant difference between the pretest and posttest results after the application of guided inquiry-based Learner Activity Sheets.

In addition, the N-gain test was carried out by comparing the pretest and posttest scores of students. The pretest and posttest questions have the same level of difficulty. N-gain is the difference between pretest and posttest scores. Students are said to have improved learning outcomes if the N-gain shows a medium or high category [20]. The N-gain value obtained from 26 students is as high as 19 students get the N-gain value in the “high” category, while 7 students get the N-gain value in the “medium” category. The average N-gain value is 0.76 in the “high” category.

Conclusion

Based on the results of the research and discussion previously described, it can be concluded that the guided inquiry-based Learner Activity Sheet developed has the feasibility to be used as a learning media on the topic of chemical equilibrium. Feasibility is based on the results of validity, practicality, and effectiveness assessments. Content and construct validity are declared to meet valid criteria based on an assessment that shows the mode score is 5. The level of practicality of Learner Activity Sheets is obtained through the results of a student response questionnaire, which shows a percentage of 96%, which is included in the very practical category. In addition, observation data on learner activities showed a percentage of involvement in relevant activities of 90% at the first meeting, 91.11% at the second meeting, and 84.44% at the third meeting. This finding indicates that most students are involved in activities that are in accordance with the stages of guided inquiry-based learning, so that relevant activities are more dominant than irrelevant activities. The effectiveness of Learner Activity Sheets is measured based on the value of students' cognitive learning outcomes. The pretest and posttest scores showed a significance value of 0.000 in the paired sample t-test, which indicated an increase in learning outcomes. The results of the classical completeness test on the pretest and posttest showed a percentage of 88.5%, which indicated that classical completeness in the cognitive domain of students had been achieved. This finding is reinforced by the results of the N-gain analysis, which shows an increase in learning outcomes, where 19 students are in the high category and 7 students are in the medium category. The average N-gain value of 0.76 is included in the high category. Thus, it can be concluded that the development of guided inquiry-based Learner Activity Sheets on chemical equilibrium material is effective in improving student learning outcomes.

Author’s Contribution

Surastri: contributed to the conceptualization of the research, the design and development of the guided inquiry-based. Rudiana Agustini: validation of research instruments, as well as the final review of the manuscript.

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