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Science Process Skills Oriented E-LKPD Assisted by Liveworksheets on The Subject of Shifting Factors in Chemical Equilibrium

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Abstract
This development research aims to describe the feasibility of electronic-based Learner Worksheets to train science process skills assisted by liveworksheets on the sub-matter of shifting factors in the direction of chemical equilibrium. E-LKPD feasibility in terms of validity, practicality, and effectiveness. This study used research and development (R&D) methods using the Borg & Gall model. This research is limited to limited trials. A limited trial was conducted at SMA Negeri 20 Surabaya on 27 students in class XI MIPA 6 who had previously received material on chemical equilibrium. E-LKPD, oriented to science process skills assisted by live worksheets, is declared feasible. When reviewed based on content and construct validity, Mode 5 is a very valid category. Based on student responses to the content, presentation, language, visuals, and science process skills criteria, the percentages for practicality were 93.1%, 83.72%, 95.07%, 95.07%, and 90.29%, respectively. Which is included in the very practical category, and is supported by the results of observations of relevant student activities that are more dominant than irrelevant activities. When viewed from the aspect of effectiveness, the results obtained based on the paired sample t-test values of pretest and posttest in the realm of science process skills show that t_{count} is 21.458, t_{table} is 1.706, and Sig. 0.000, This suggests that there are differences in the results of the pretest and posttest and is supported by the classical mastery of learning outcomes in the realm of knowledge of 92.59%.

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INTRODUCTION

Chemistry is a scientific discipline that is part of science and cannot be separated from the nature of science, namely products, processes, and attitudes. Facts, ideas, principles, rules, and hypotheses all exist in the field of chemistry as scientific products. Science process skills can be thought of as a representation of chemistry as a process. Chemistry as a form of attitude shows the ability to develop cooperation and scientific attitudes. Chemistry is an activity of direct research and observation. (Fienda Ayuningtiyas, 2019).

The teacher's involvement is unquestionably necessary for the learning process in the forms of subject mastery, investigation, and scientific observation. Teachers cannot be the only ones who convey facts and theories, so it is necessary to apply science process skills in the learning process (Dimyati, 2009). Science Process Skill (SPS) is very important in the world of education because, with the development of SPS, basic competencies will develop, namely the scientific attitude of students and skills in solving problems, so that creative, competitive, innovative, and critically open students can be formed in competition in the global world in society (Mahmudah, 2017).

Science process skills have not been trained and developed optimally (Chiappetta dan Koballa, 2010). Applying the guided inquiry learning is one strategy for enhancing students' scientific process skills (SPS) (Budiyono & Hartini, 2016). The guided inquiry learning approach encourages each student to actively participate in learning activities because it views students as the topic of learning (Amijaya et al., 2018). According to the findings of earlier research by Jariyah and Ainung (2016) on class XI high school students, SPS of chemical equilibrium material may enhance by implementing the guided inquiry learning model, getting 81% of students' completion.

The Learner Worksheet (LKPD) is one of the teaching resources needed to use the guided inquiry learning model. Teachers can utilize the learning tool known as LKPD to get more students involved in the learning process (Noprinda & Soleh, 2019). According to Firdaus and Wilujeng (2018), LKPD is an activity sheet that is used in the learning process to discover ideas through theory, demonstration, and research. It has clear instructions and work processes to develop science process skills in performing activities in accordance with the learning indicators to be attained (Utami, 2020). LKPD often includes practicum instructions, experiments that may be completed at home, discussion materials, practice questions, and different sorts of instructions that encourage students to actively engage in the learning process (Noprinda & Soleh, 2019).

Various E-LKPD (Electronic Learner Worksheets) have been developed along with today's technological advances, one of which is with the help of Liveworksheets (Zahara et al., 2021). Liveworksheets have advantages for both teachers and learners. For teachers, the benefits are saving paper and time. For students, it motivates them to learn (Andriyani et al., 2020). However, online teaching materials such as E-LKPD are still rarely used (Hidayah et al., 2020).

Chemical equilibrium material, namely the sub-material factors that affect the shift in the direction of chemical equilibrium, is one of the chemical materials that is considered difficult. Based on the results of research conducted by Seliwati (2017), it was found that the order of difficulty based on indicators was: (1) the effect of concentration factors on shifting the direction of chemical equilibrium by 62.82%; (2) the effect of temperature factors on shifting the direction of chemical equilibrium by 55.28%; (3) the effect of volume factors on shifting the direction of chemical equilibrium by 61.96%; and (4) the effect of pressure factors on shifting the direction of chemical equilibrium by 53.56%.

Based on a pre-research questionnaire conducted at SMAN 20 Surabaya on 27 students, 75% of students do not understand the chemical equilibrium material subchapter of factors that affect the shift in the direction of chemical equilibrium. The LKPD that has been used can train students in formulating problems as much as 55.6%, formulating hypotheses as much as 38.9%, identifying experimental variables as much as 22.2%, planning problem-solving strategies as much as 36.1%, collecting experimental data and making observation tables as much as 52.8%, analyzing experimental data as much as 38.9%, and making conclusions of experimental results as much as 88.9%. This is also supported by the results of interviews with chemistry teachers, who expressed that science process skills have been introduced to students in general but not maximally trained.

Based on the description above, the researcher wants to develop an electronic-based student worksheet that is suitable for use in the learning process to improve students' science process skills. The science process skills that will be trained include formulating problems, creating conceptual frameworks, making hypotheses, identifying variables, designing investigations, collecting data, analyzing data, and making conclusions.

METHOD

This research uses the Research and Development (R&D) method and the Borg & Gall model up to the limited trial stage only. The research procedure scheme is as follows:

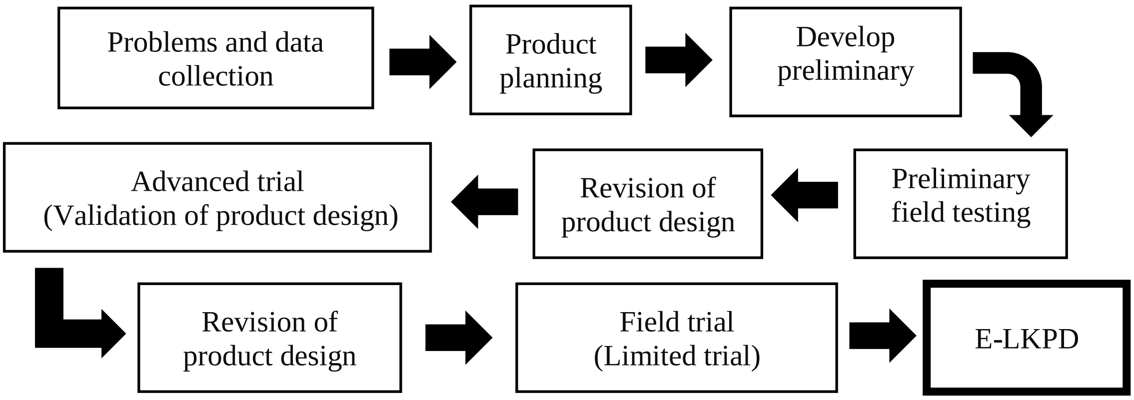


Figure 1. Steps to Use the Borg & Gall Model

The target of this research is E-LKPD. Students of class XI MIPA 6 SMA Negeri 20 Surabaya and observers are data sources during the limited trial to get the results of practicality and effectiveness tests. While chemistry lecturers are data sources to obtain valid test results. The limited trial was conducted with a one-group pretest-posttest design. The research design can be represented mathematically:

$$O_1 \ X \ O_2.$$

While, O_1: before applying the produced E-LKPD, students' knowledge and science process abilities were pretested; X: learning using the developed E-LKPD; O_2: results of a post-test on students' knowledge and science process abilities after utilizing the created E-LKPD.

Data collection techniques included surveys, observation, and testing. A review sheet, validation sheet, answer questionnaire, student activity observation sheet, and a science process skills and knowledge exam sheet are all obviously necessary tools.

Validity Test

Three chemistry professors validated the E-LKPD to ascertain whether the created E-LKPD was feasible, which includes content validity and construct validity. The validation sheet is analyzed descriptively quantitatively, namely, the validator will provide an assessment with a score of 1–5 regarding the E-LKPD according to the assessment indicators adapted from the Likert scale as shown on Table 1.

Table 1. Likert Scale Range

Scale	Category
1	Invalid
2	Less Valid
3	Fairly Valid
4	Valid
5	Very Valid

(Sugiyono, 2021)

The validation result data is said to be valid if it gets a minimum mode of 4 (Luthfi, 2021).

Practicality Test

In the limited trial, the findings of the student response survey given following instruction using E-LKPD are utilized as data to assess the practicality of E-LKPD. This questionnaire asks students to provide responses based on the answer options "yes" or "no", which are then analyzed by applying the Guttman scale as follows (Table 2).

Table 2. Guttman Scale Score

Answer	Score for positive statement	Score for negative statement
Yes	1	0
No	0	1

(Riduwan, 2016)

Furthermore, the formula used to calculate data from the Guttman scale is

$$P\ (\%) = \frac{F}{N} x\ 100\%$$

Description:
P = percentage of students' answers
F = the total number of scores
N = total score

The percentage results obtained are interpreted according to the following criteria (Table 3).

Table 3. Interpretation of the Learner Response Questionnaire Score

Percentage (%)	Rating Category
81 - 100	Very practical
61 – 80	Practical
41 - 60	Less practical
21 - 40	Not practical
0 – 20	Very impractical

The developed E-LKPD is declared practical if it produces a percentage ≥ 61% (Riduwan, 2016).

Data from observations of student activity during the learning process is used to support the practicality test, obtained with the help of observers in each group. The following formula is used to analyze data on student activity observation results:

$$\text{Activities (\%)} = \frac{\Sigma frequency\ of\ activity\ occurring}{\Sigma frequency\ of\ overall\ activity}\, x\ 100\%$$

If the percentage of relevant student activities is greater than the percentage of irrelevant student activities, then student activities can be said to support the practicality of the E-LKPD (Riduwan, 2016).

Effectiveness Test

The scientific process skills domain learning outcomes are used for the effectiveness test. and is supported by the knowledge domain learning outcomes. First of all, a normality test analysis was conducted using the Shapiro Wilk test. The data are considered normally distributed if the Sig. > 0.05, and are not normally distributed if the Sig. < 0.05 (Suardi, 2019).

The paired sample t-test is utilized with normally distributed data. This study's hypotheses include the following:

- H_0: Both the pretest and the posttest show the same results.
- H_1: There is a difference between the results of the pretest and posttest.

Making conclusions on the t-test can be reviewed from the t_{count}, t_{table}, and Sig value, namely:

- If $t_{count} > t_{table}$ and Sig. < 0,05, then H_0 is refused and H_1 is allowed.

- If $t_{count} < t_{table}$ and Sig. > 0,05, then H_0 is allowed and H_1 is refused (Payadnya & Jayantika, 2018).

E-LKPD is said to be effective if $t_{count} > t_{table}$ and Sig. < 0,05. The Wilcoxon Signed Rank Test is used if the data gathered are not normally distributed. The basis for making the Wilcoxon Signed Rank Test decision is as follows:

- If sig. < (0,05), then H_0 is refused
- If sig. > (0,05), then H_0 is allowed (Lontoh et al., 2013).

This study's hypotheses include the following:

- H_0: Both the pretest and the posttest show the same results.
- H_1: There is a difference between the results of the pretest and posttest.

E-LKPD is said to be effective if sig. <0,05. Data on learning outcomes in the knowledge domain are also used as supporting data for the effectiveness of the developed E-LKPD. Students' knowledge domain pretest and posttest scores were assessed using the following formula:

$$\text{Score} = \frac{score\ obtained\ by\ students}{maximum\ score} x100$$

Learners are considered complete in their knowledgeability if they get a score of ≥75. Data on learning outcomes in the knowledge domain can support the effectiveness of the developed E-LKPD if classical completeness ≥75% of students get a score ≥75 (Riduwan, 2016).

RESULT AND DISCUSSION

This research uses the Research and Development (R&D) method and the Borg & Gall model. The research conducted was limited to a limited trial. The research stage carried out is divided into eight stages further.

Problems and Data Collection

In this first stage, a literature study is carried out in the form of searching for journal and book references related to science process skills, guided inquiry learning models, development of LKPD and E-LKPD, as well as the sub-material of shifting factors in the direction of chemical equilibrium. Journal references that have been obtained are then analyzed starting from the introduction, the study methodologies, the research findings and analysis, and the conclusions.

Relevant previous research journal references include: (1) Masruhah et al (2022) regarding the development of E-LKPD based on the guided inquiry learning model to improve the science process skills of junior high school students in science subjects shows that the E-LKPD developed is valid, very practical, and quite effective in improving students' science process skills; (2) Nadiroh (2017) regarding guided inquiry-based Learner Activity Sheets (LKPD) to train science process skills in one of the high school class X chemistry materials, namely redox material developed was declared theoretically and empirically feasible; (3) Mawan & Rusmini (2017) regarding guided inquiry-oriented Learner Worksheets to train science process skills developed on chemical equilibrium material obtained very feasible theoretical and empirical validation results.

Reference books that are by the research are about: (1) according to Joyce et al (2009), there are 5 stages in the guided inquiry learning model: presenting phenomena or problems, collecting verification data, collecting experimental data, organizing, formulating, explaining, and analyzing the inquiry process; (2) the guidelines used in developing E-LKPD are by Depdiknas (2008), namely curriculum analysis, compiling the E-LKPD needs a map, determining the E-LKPD title, and writing E-LKPD; (3) Learning theories that support this research include cognitive theory, information processing theory, meaningful learning theory, and J. Bruner's discovery learning theory. The next stage is a field study for pre-research data collection at SMA Negeri 20 Surabaya in the form of giving questionnaires to students and interviews with chemistry teachers at SMA Negeri 20 Surabaya. This stage is carried out to know the conditions of students or teachers, learning strategies carried out by teachers in the process of learning and student’s science process skills.

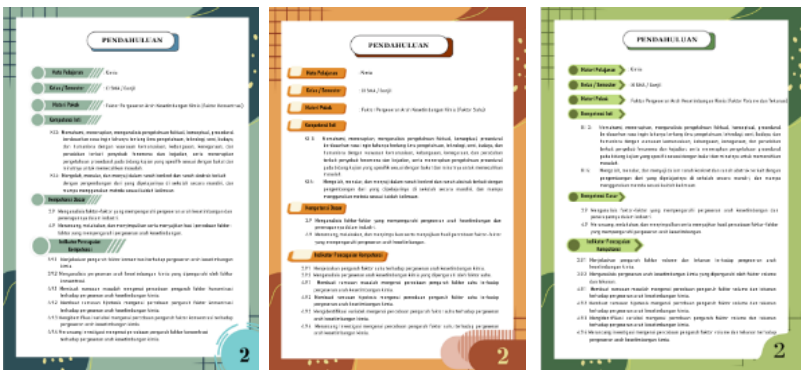
Product Planning

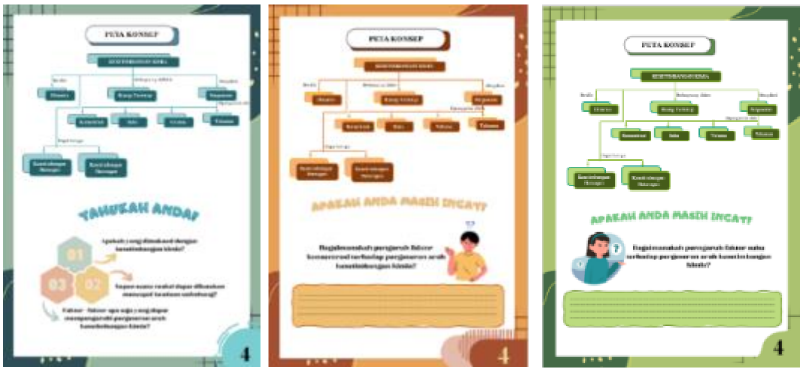
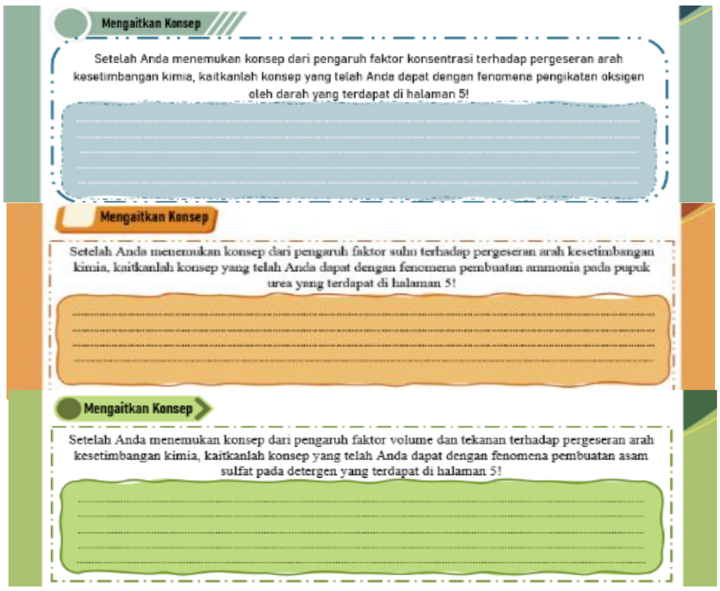
In this planning stage, the activities carried out start with the preparation of materials, media selection, and the format for preparing student worksheets that can support the achievement of the objectives of the E-LKPD and train students' science process skills. The step of material preparation entails identifying the core and fundamental competencies that must be attained, outlining the learning indicators and learning objectives, and locating the learning resources, phenomena, or activities that will be assigned to the students. The title, learning objectives, competences to be met, supporting data, tasks, and bibliography are all LKS components. (Kemendikbud, 2013).

Develop Preliminary

The student worksheets that will be used are online-based or commonly referred to as electronic student worksheets. The E-LKPD that will be created is made up of 3 E-LKPDs. The first E-LKPD is E-LKPD regarding the effect of concentration factors on shifting the direction of chemical equilibrium, the second E-LKPD is E-LKPD regarding the effect of temperature factors on shifting the direction of chemical equilibrium, and the last is E-LKPD regarding the effect of volume and pressure factors on shifting the direction of chemical equilibrium. The design of science process skills-oriented E-LKPD can be seen more clearly in Table 4.

Table 4. E-LKPD Design

No	Design	Description
1		The front cover of E-LKPD which has a title, a place to write the identity of students, and class.
2		The introduction section contains the identity of E-LKPD, namely subject, class, semester, subject matter, core competencies, basic competencies, indicators of competency achievement, and learning objectives.

3		Concept maps regarding learning materials on E-LKPD as well as apperception questions.
4		The phenomena presented in E-LKPD. The phenomenon of E-LKPD 1 regarding the concentration factor, the phenomenon of E-LKPD 2 regarding the temperature factor, and E-LKPD 3 regarding the volume and pressure factors.
5		In E-LKPD 1, 2, and 3 there are questions about the components of science process skills which consist of formulating problems, formulating hypotheses, identifying variables, designing investigations, collecting data, analyzing data, and making conclusions.
6		There is a command to relate concepts, namely after students have found the concept, students are asked to relate the concept to the phenomenon that has been presented.

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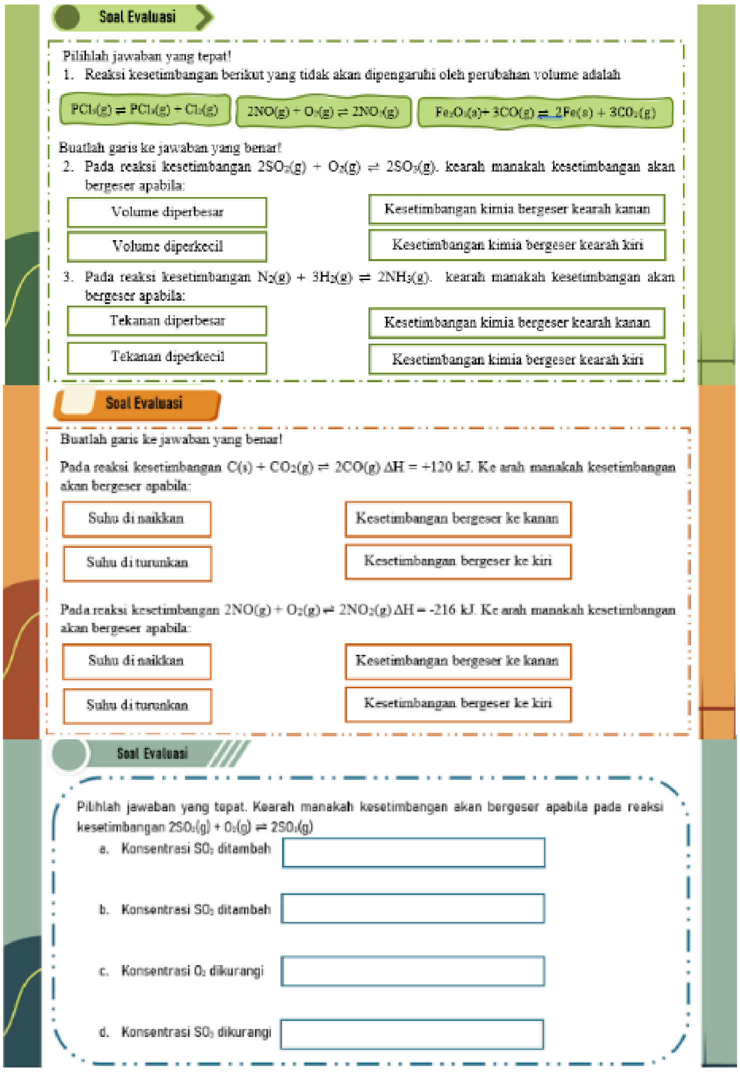

There are several questions to evaluate students' understanding of the learning material

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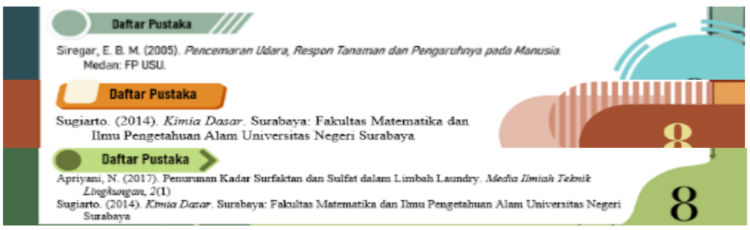


Bibliography related to information contained in E-LKPD.

Preliminary Field Testing

The initial trial is the review stage. The review was conducted by one chemistry lecturer at Surabaya State University by providing criticism and suggestions related to the content and construct criteria, which were then used as a guide to improve the E-LKPD. The following suggestions were given during the review of the developed E-LKPD:

- In E-LKPD 1, 2, and 3 added Competency Achievement Indicators regarding the creation of a conceptual framework.
- E-LKPD 1, 2, and 3 added questions related to making a conceptual framework.
- The phenomena presented in E-LKPD 1, E-LKPD 2, and E-LKPD 3 should ask about the manipulated variables and response variables.
- E-LKPD 1, 2, and 3 add directions to the data analysis component so that students understand what to do.

Based on the suggestions that have been given, there are several things related to the content and construct criteria that are not appropriate, so revisions are needed.

Revision of Product Design

Based on the suggestions related to E-LKPD that have been given by the reviewers at the product review stage, further revisions of E-LKPD are made related to the content and construct criteria that are not yet appropriate.

In the content criteria, the first aspect that is not suitable is that the achievement indicators (IPK) contained in E-LKPD do not match the IPK in the lesson plan where the IPK in the lesson plan mentions that students are able to create a conceptual framework after formulating the problem, but the IPK in E-LKPD does not exist so that IPK is added regarding making a conceptual framework in E-LKPD. IPK in E-LKPD 1, 2, and 3 before being revised are listed in Figure 2.

4.9.1 Membuat rumusan masalah mengenai percobaan pengaruh faktor konsentrasi terhadap pergeseran arah kesetimbangan kimia.
4.9.2 Membuat rumusan hipotesis mengenai percobaan pengaruh faktor konsentrasi terhadap pergeseran arah kesetimbangan kimia.

4.9.1 Membuat rumusan masalah mengenai percobaan pengaruh faktor suhu terhadap pergeseran arah kesetimbangan kimia.
4.9.2 Membuat rumusan hipotesis mengenai percobaan pengaruh faktor suhu terhadap pergeseran arah kesetimbangan kimia.

4.9.1 Membuat rumusan masalah mengenai percobaan pengaruh faktor volume dan tekanan terhadap pergeseran arah kesetimbangan kimia.
4.9.2 Membuat rumusan hipotesis mengenai percobaan pengaruh faktor volume dan tekanan terhadap pergeseran arah kesetimbangan kimia.

Figure 2. The Achievement Indicators Before Revision

Subsequently, a revision was made by adding IPK on creating a conceptual framework to IPK 4.9.2, as shown in Figure 3.

4.9.1 Membuat rumusan masalah mengenai percobaan pengaruh faktor konsentrasi terhadap pergeseran arah kesetimbangan kimia.
4.9.2 Membuat kerangka konseptual mengenai percobaan pengaruh faktor konsentrasi terhadap pergeseran arah kesetimbangan kimia.

4.9.1 Membuat rumusan masalah mengenai percobaan pengaruh faktor suhu terhadap pergeseran arah kesetimbangan kimia.
4.9.2 Membuat kerangka konseptual mengenai percobaan pengaruh faktor suhu terhadap pergeseran arah kesetimbangan kimia.

4.9.1 Membuat rumusan masalah mengenai percobaan pengaruh faktor volume dan tekanan terhadap pergeseran arah kesetimbangan kimia.
4.9.2 Membuat kerangka konseptual mengenai percobaan pengaruh faktor volume dan tekanan terhadap pergeseran arah kesetimbangan kimia.

Figure 3. The Achievement Indicators After Revision

The second aspect that is not appropriate is the learning objectives. Because in the GPA there are additions regarding the creation of a conceptual framework, so the learning objectives also need to add something similar, namely learning objectives regarding the creation of a conceptual framework. The learning objectives on E-LKPD 1, 2, and 3 before revision are listed in Figure 4.

4.9.1.1 Peserta didik mampu membuat rumusan masalah mengenai percobaan pengaruh faktor konsentrasi terhadap pergeseran arah kesetimbangan kimia berdasarkan permasalahan yang telah disediakan dengan tepat.
4.9.2.1 Peserta didik mampu membuat rumusan hipotesis mengenai percobaan pengaruh faktor konsentrasi terhadap pergeseran arah kesetimbangan kimia berdasarkan permasalahan yang telah disediakan dengan tepat.

4.9.1.1 Peserta didik mampu membuat rumusan masalah mengenai percobaan pengaruh faktor suhu terhadap pergeseran arah kesetimbangan kimia berdasarkan permasalahan yang telah disediakan dengan tepat.
4.9.2.1 Peserta didik mampu membuat rumusan hipotesis mengenai percobaan pengaruh faktor suhu terhadap pergeseran arah kesetimbangan kimia berdasarkan permasalahan yang

4.9.1.1 Peserta didik mampu membuat rumusan masalah mengenai percobaan pengaruh faktor volume dan tekanan terhadap pergeseran arah kesetimbangan kimia berdasarkan pengamatan video percobaan yang telah disediakan dengan tepat.
4.9.2.1 Peserta didik mampu membuat rumusan hipotesis mengenai percobaan pengaruh faktor volume dan tekanan terhadap pergeseran arah kesetimbangan kimia berdasarkan pengamatan video percobaan yang telah disediakan dengan tepat.

Figure 4. Learning Objectives Before Revision

Furthermore, a revision was made by adding learning objectives regarding the creation of a conceptual framework to learning objective 4.9.2.1, as shown in Figure 5.

4.9.1.1 Peserta didik mampu membuat rumusan masalah mengenai percobaan pengaruh faktor konsentrasi terhadap pergeseran arah kesetimbangan kimia berdasarkan permasalahan yang telah disediakan dengan tepat.
4.9.2.1 Peserta didik mampu membuat kerangka konseptual mengenai percobaan pengaruh faktor konsentrasi terhadap pergeseran arah kesetimbangan kimia berdasarkan permasalahan yang telah disediakan dengan tepat.

4.9.1.1 Peserta didik mampu membuat rumusan masalah mengenai percobaan pengaruh faktor suhu terhadap pergeseran arah kesetimbangan kimia berdasarkan permasalahan yang telah disediakan dengan tepat.
4.9.2.1 Peserta didik mampu membuat kerangka konseptual mengenai percobaan pengaruh faktor suhu terhadap pergeseran arah kesetimbangan kimia berdasarkan permasalahan yang telah disediakan dengan tepat.

4.9.1.1 Peserta didik mampu membuat rumusan masalah mengenai percobaan pengaruh faktor volume dan tekanan terhadap pergeseran arah kesetimbangan kimia berdasarkan pengamatan video percobaan yang telah disediakan dengan tepat.
4.9.2.1 Peserta didik mampu membuat kerangka konseptual mengenai percobaan pengaruh faktor volume dan tekanan terhadap pergeseran arah kesetimbangan kimia berdasarkan pengamatan video percobaan yang telah disediakan dengan tepat.

Figure 5. Learning Objectives After Revision

The third aspect that is less appropriate is in the questions or questions regarding the components of science process skills, there is no component of making a conceptual framework so that questions or questions need to be added to train students in making the conceptual framework after students formulate the problem.

Buatlah rumusan masalah terkait percobaan yang telah Anda amati!

Berdasarkan rumusan masalah yang telah Anda buat, tuliskah hipotesis yang sesuai dengan rumusan masalah tersebut!

Buatlah rumusan masalah terkait kegiatan *virtual lab* yang telah Anda lakukan!

Berdasarkan rumusan masalah yang telah dibuat, tulislah hipotesis yang sesuai dengan rumusan masalah!

Berdasarkan fenomena di atas, tuliskan rumusan masalah yang sesuai!

Berdasarkan rumusan masalah yang telah Anda buat, tulislah hipotesis yang sesuai dengan rumusan masalah tersebut!

Figure 6. Questions Before Revision

Questions on E-LKPD 1, 2, and 3 before being revised are listed in Figure 6, then revisions are made by adding questions or questions about making a conceptual framework after formulating the problem, as shown in Figure 7.


Berdasarkan rumusan masalah yang telah dibuat, tulislah kerangka konseptual yang sesuai dengan rumusan masalah guna merumuskan hipotesis!

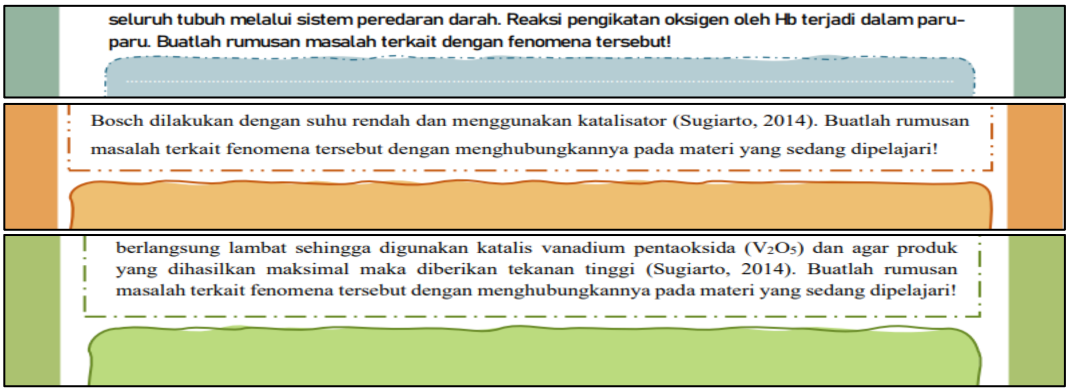
Berdasarkan rumusan masalah yang telah dibuat, tulislah kerangka konseptual yang sesuai dengan rumusan masalah guna merumuskan hipotesis!

Berdasarkan rumusan masalah yang telah dibuat, tulislah kerangka konseptual yang sesuai dengan rumusan masalah guna merumuskan hipotesis!

5

Figure 7. Questions After Revision

The fourth aspect that is less appropriate is the command in the phenomenon section. Where in the phenomenon section should not contain an order for students to make a problem formula but the teacher asks the manipulated variables and response variables regarding the phenomenon so that students are able to connect the two variables to the problem formulation. The phenomenon section commands on E-LKPD 1, 2, and 3 before revision are shown in Figure 8.

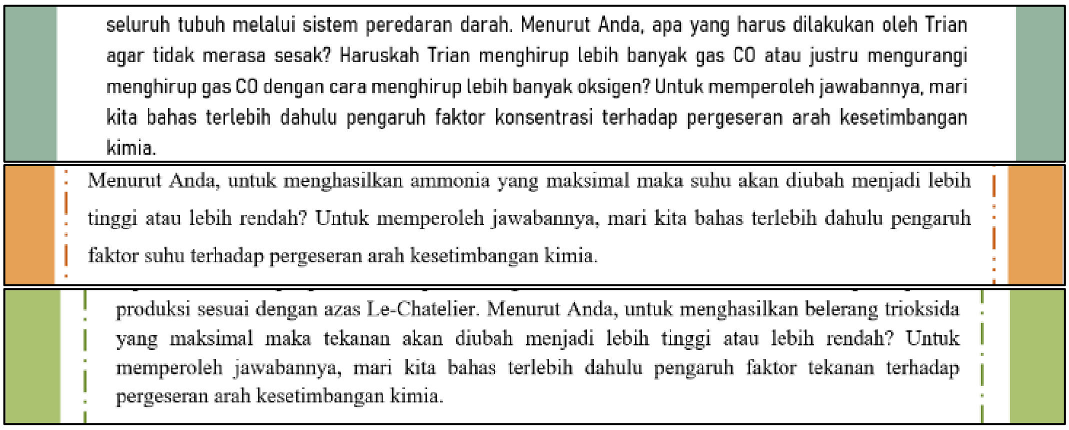

seluruh tubuh melalui sistem peredaran darah. Reaksi pengikatan oksigen oleh Hb terjadi dalam paru-paru. Buatlah rumusan masalah terkait dengan fenomena tersebut!

Bosch dilakukan dengan suhu rendah dan menggunakan katalisator (Sugiarto, 2014). Buatlah rumusan masalah terkait fenomena tersebut dengan menghubungkannya pada materi yang sedang dipelajari!

berlangsung lambat sehingga digunakan katalis vanadium pentaoksida (V_2O_5) dan agar produk yang dihasilkan maksimal maka diberikan tekanan tinggi (Sugiarto, 2014). Buatlah rumusan masalah terkait fenomena tersebut dengan menghubungkannya pada materi yang sedang dipelajari!

Figure 8. Commands on Phenomena Before Revision

Further revisions were made by adding questions that connect the manipulation and response variables, as shown in Figure 9.

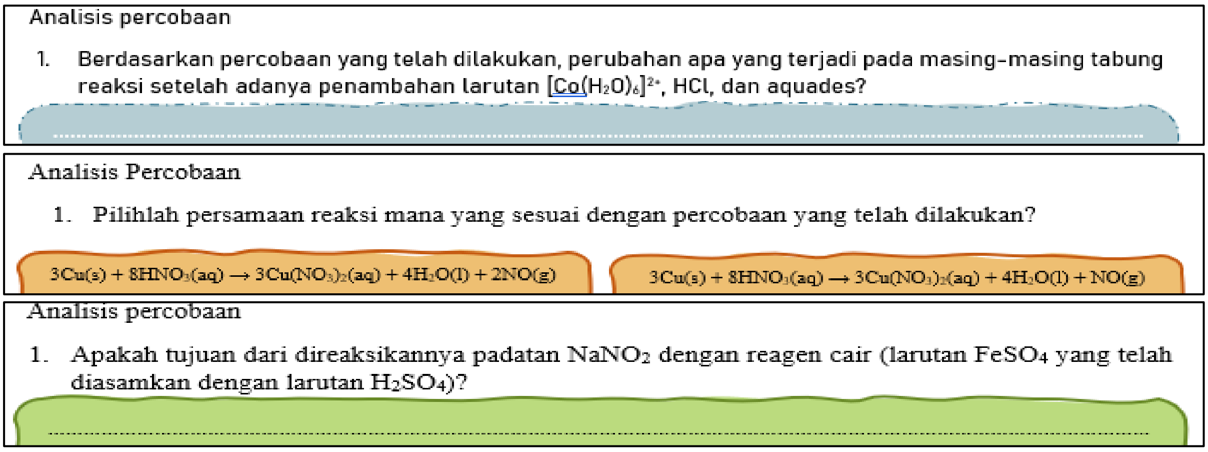

seluruh tubuh melalui sistem peredaran darah. Menurut Anda, apa yang harus dilakukan oleh Trian agar tidak merasa sesak? Haruskah Trian menghirup lebih banyak gas CO atau justru mengurangi menghirup gas CO dengan cara menghirup lebih banyak oksigen? Untuk memperoleh jawabannya, mari kita bahas terlebih dahulu pengaruh faktor konsentrasi terhadap pergeseran arah kesetimbangan kimia.

Menurut Anda, untuk menghasilkan ammonia yang maksimal maka suhu akan diubah menjadi lebih tinggi atau lebih rendah? Untuk memperoleh jawabannya, mari kita bahas terlebih dahulu pengaruh faktor suhu terhadap pergeseran arah kesetimbangan kimia.

produksi sesuai dengan azas Le-Chatelier. Menurut Anda, untuk menghasilkan belerang trioksida yang maksimal maka tekanan akan diubah menjadi lebih tinggi atau lebih rendah? Untuk memperoleh jawabannya, mari kita bahas terlebih dahulu pengaruh faktor tekanan terhadap pergeseran arah kesetimbangan kimia.

Figure 9. Commands on Phenomena After Revision

The first aspect of the construct criteria that is not suitable is in the questions or questions about analyzing data, there are no clear instructions or directions so that it feels confusing for students who want to work. Questions on E-LKPD 1, 2, and 3 before revision are listed in Figure 10.


Analisis percobaan

1. Berdasarkan percobaan yang telah dilakukan, perubahan apa yang terjadi pada masing-masing tabung reaksi setelah adanya penambahan larutan $[Co(H_2O)_6]^{2+}$, HCl, dan aquades?

Analisis Percobaan

1. Pilihlah persamaan reaksi mana yang sesuai dengan percobaan yang telah dilakukan?

$3Cu(s) + 8HNO_3(aq) \rightarrow 3Cu(NO_3)_2(aq) + 4H_2O(l) + 2NO(g)$

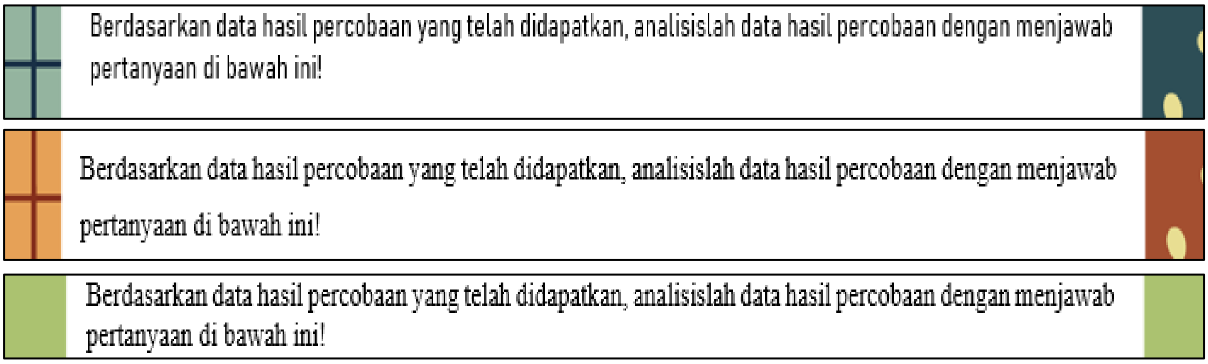
$3Cu(s) + 8HNO_3(aq) \rightarrow 3Cu(NO_3)_2(aq) + 4H_2O(l) + NO(g)$

Analisis percobaan

1. Apakah tujuan dari direaksikannya padatan $NaNO_2$ dengan reagen cair (larutan $FeSO_4$ yang telah diasamkan dengan larutan H_2SO_4)?

Figure 10. Directions on Analyzing Data Before Revision

Furthermore, revisions were made by adding directions for students to work on questions to train one of the components of science process skills, namely analyzing data, as shown in Figure 11.


Berdasarkan data hasil percobaan yang telah didapatkan, analisislah data hasil percobaan dengan menjawab pertanyaan di bawah ini!

Berdasarkan data hasil percobaan yang telah didapatkan, analisislah data hasil percobaan dengan menjawab pertanyaan di bawah ini!

Berdasarkan data hasil percobaan yang telah didapatkan, analisislah data hasil percobaan dengan menjawab pertanyaan di bawah ini!

Figure 11. Directions on Analyzing Data After Revision

The results of the revisions that have been made to the E-LKPD based on the suggestions of the reviewers then produce a draft II E-LKPD. The second draft of E-LKPD will then be validated.

Advanced Trial (Validation of Product Design)

The revised results after the review then carried out further trials in the form of a validation stage conducted by 3 chemistry lecturers at Surabaya State University. The validated criteria consist of content and construct criteria. The validation results on each criterion can be seen in Table 5.

Table 5. Criteria Validation Results

No	Aspect	Mode	Category
1	Content Criteria	5	Very Valid
2	Construct Criteria	5	Very Valid

Content Criteria

Aspects regarding the suitability of the phenomena presented with the subject matter, the correctness of facts, concepts, and images/illustrations in E-LKPD, and the suitability of the criteria for making conclusions to train science process skills are aspects that obtain a mode value of 4 with a valid category. The subject matter of each E-LKPD developed is different, so the phenomena presented vary according to the subject matter.

While the aspects that obtained a mode value of 5 with a very valid category were the suitability between indicators of competency achievement (IPK) with basic competencies (KD), the suitability of learning objectives with IPK, practicum activities carried out in E-LKPD, the suitability of criteria for creating questions, hypotheses, identifying variables, planning experiments, gathering data, and doing analyses. The Basic Competencies (KD) to be achieved in the E-LKPD developed are KD 3.9 and 4.9 in chemistry class XI SMA. KD 3.9 reads "Analyzing the factors that affect the shift in the direction of equilibrium and its application in the industry". While KD 4.9 reads "Design, conduct, conclude, and present the results of experiments on factors that affect the shift in the direction of equilibrium". Furthermore, the indicators of competency achievement (IPK) are arranged following the KD. Likewise, the learning objectives that are compiled are following the IPK with the correct writing, namely containing ABCD components (Audience, Behavior, Conditions, and degree). the audience, which means the students themselves; behavior is the behavior that must be carried out by students as a result of learning; the condition is the situation when students work on the problem; and degree is the result to be achieved in the learning (Febri, 2023)

Construct Criteria

Completeness of components and directions in making conclusions presented in E-LKPD are aspects that get mode 4 with the valid category. While aspects that get mode 5 with a very valid category are about directions for students in formulating problems, creating hypotheses, identifying variables, planning investigations, assembling data, interpreting data, and drawing findings, these directions are clear, It makes it simpler for pupils to comprehend and work on E-LKPD.

Based on Table 5, it can be seen that the mode based on the criteria (content and construct criteria) is getting a mode of 5, which is classified as a very valid category. Therefore, it meets the requirements to be said to be valid, namely, if the mode is at least 4. This means that the E-LKPD oriented science process skills, aided by liveworksheets on the sub-material of shifting factors in the direction of chemical equilibrium, are validly feasible to be used in the learning process.

Revision of Product Design

Based on the suggestions related to the E-LKPD that have been given by the validators, the E-LKPD is then revised regarding the content and construct criteria that are not yet appropriate.

Field Trial (Limited Trial)

The field trial was a limited trial at SMA Negeri 20 Surabaya on students of class XI MIPA 6, which amounted to 27 students. The data obtained from the limited trial was used to determine the practicality and effectiveness of the E-LKPD. The practicality test is measured through a learner response questionnaire and supported by learner activities, While the findings of the pretest-posttest for the science process skills domain are used to assess the effectiveness test, the knowledge domain results are also used to support this measurement.

Practicality Test

When conducting a limited trial at SMAN 20 Surabaya, the results were obtained to test the practicality of the developed E-LKPD. The practicality test was obtained through the results of the students' response questionnaire and supported by the student's activities during the learning process by applying the E-LKPD, namely as many as three meetings. Questionnaire The learner response is based on the aspects of helpfulness and convenience (Edi & Rosnawati, 2021)

The response questionnaire was given to students after learning using E-LKPD to find out their responses. In the learner response questionnaire, there are several criteria, including:

1. The content criteria of the developed E-LKPD can be said to be practical, which can be reviewed based on the overall percentage of the average content criteria of 93.1%.
2. The presentation criteria of the developed E-LKPD can be said to be practical, which can be reviewed based on the overall average percentage of presentation criteria, namely 83.72%.
3. The language criteria of the developed E-LKPD can be said to be practical, which can be reviewed based on the overall average percentage of language criteria, namely 95.07%.
4. Graphic criteria of the developed E-LKPD can be said to be practical, which can be reviewed based on the overall percentage average of the graphic criteria, namely 95.07%.
5. The science process skills criteria of the developed E-LKPD can be said to be practical, which can be reviewed based on the overall average percentage of science process skills criteria, namely 90.29%.

The percentage of aspects in the criteria for content, presentation, language, graphics, and science process skills successively obtained from the results of students' responses is 93.10%, 83.72%, 95.07%, 95.07%, and 90.29%. This means that the percentage in each aspect is ≥61%. The highest percentage is in the criteria of language and graphics because it has used language that is following the EYD of Indonesian so that students can clearly and easily learn it, E-LKPD developed can be read and seen clearly, and the color combination contained in E-LKPD does not disturb students, it increases students' interest in learning it.

The outcomes of observing students' actions are the data used to support the practicality of E-LKPD. Based on observations of student’s activities carried out by observers, relevant activities are more often carried out by students than irrelevant activities, with a percentage of 91.22% relevant activities and 8.78% irrelevant activities. If relevant student activities have a greater percentage than irrelevant student activities, then student activities can be said to support the practicality of the E-LKPD developed (Riduwan, 2016). So, it can be assumed that the activities of students can support the practicality of the E-LKPD.

Effectiveness Test

The effectiveness test is based on the learning outcomes of the science process skills domain, the science process skills domain test is carried out before and after learning using the developed E-LKPD. The level of effectiveness of the use of learning tools can be known by assessing students who use learning tools (Idrus, 2019), namely after the use of E-LKPD through pre-test and post-test instruments. pretest and posttest instruments.

At the time of the pretest, it was known that 100% or all students had not reached the standard of completeness, namely with a score of ≥75. The lowest pretest score was 9.38, obtained by 1 student, while the highest pretest score was 50, which was also obtained by only 1 student. But after learning by applying the developed E-LKPD, the learning outcomes of students experienced an overall increase at the time of the posttest, namely, 3 students obtained a perfect score of 100, while the lowest score was 75 obtained by 2 students.

According to the outcomes of the posttest, all pupils, or 100% of students, are considered complete in working on posttest questions because the scores of all students are ≥75. Figure 12 below shows that there has been an increase in each of the science process skills components in addition to the rise in learning outcomes in the skills domain between the pretest and posttest.

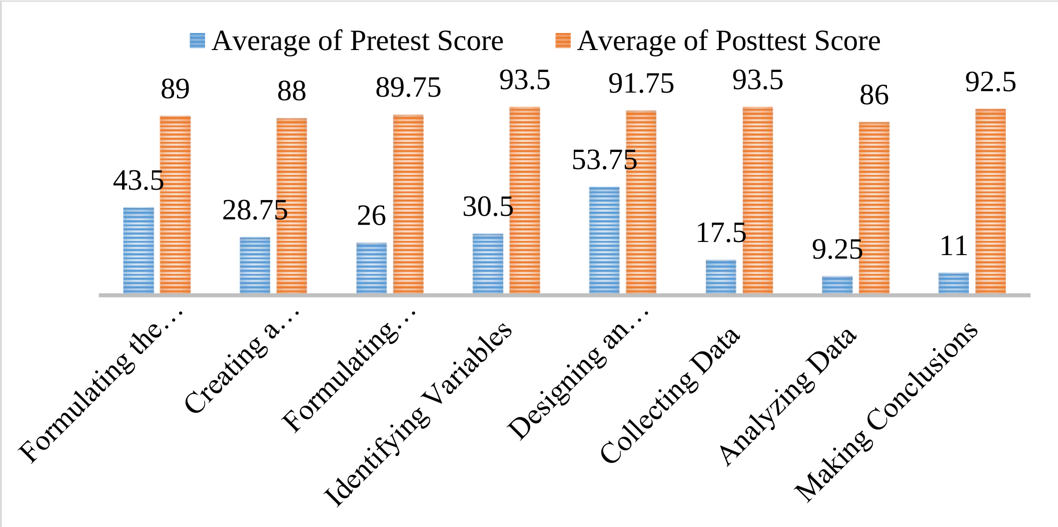


Figure 12. Graph of the Increase in the Value of Each SPS Component

A normality test is conducted using the Shapiro-Wilk test based on the learning outcomes that were acquired from the pretest and posttest. The Shapiro-Wilk test's findings show that the pretest data's sig value is 0.433, which means Sig. > 0,05. Likewise, the sig value on the posttest result data is 0.070, which means Sig. > 0.05. The data from the SPS domain's pretest and posttest results may thus be stated to follow a normal distribution (Suardi, 2019).

After the data from the SPS pretest and posttest results have been proven to be normally distributed, a further test is carried out, namely the paired sample t-test. The paired sample t-test has the characteristic that, at the time of the study, two samples of data were obtained from the same individual (Montolalu & Langi, 2018). The paired sample t-test test aims to review any significant differences between pretest and posttest values (Lontoh et al., 2013). When conducting the paired sample t-test, two types of data are obtained: paired sample statistics and paired sample tests. It is evident from the paired sample statistics data that the average value has increased. During the pretest, the average value obtained was 27.55, while during the posttest, the average value increased to 90.51.

Based on the results of the paired sample test, when viewed based on the t_{count} and t_{table}, the t_{count} result is 21.458. With a significant value of 0.05, the t_{table} on a one-party test is 1.706. So, the conclusion obtained is $t_{count} > t_{table}$. When reviewed based on the Sig value, the results obtained are Sig 0.000, so that Sig. < 0,05. Following the basis for decision-making that has been described, the results obtained show that H_0 is refused and H_1 is allowed. Therefore, it may be said that there is a difference between the results of the pretest and posttest. This means that E-LKPD oriented science process skills aided by liveworksheets can be said to be effective.

The data used to support the effectiveness test are the learning outcomes of the knowledge domain obtained through the knowledge domain test before and after using the developed E-LKPD. During the pretest, it was known that 100% or all students had not reached the standard of completeness, namely with a score of ≥75. There was only one participant who achieved a pretest score of 70, which was also the highest score. However, the learning outcomes of students experienced an overall increase during the posttest. At the time of the posttest, the highest value was a perfect score of 100 obtained by two students. However, two learners scored 65 and 70, meaning that the two learners were not complete. However, for these two students, there is still improvement in learning outcomes in the knowledge domain, as seen by an improvement from the pretest to the posttest value. If calculated in percentage, the classical completeness of posttest questions is 92.59%. Consequently, it can be said that the knowledge domain's learning outcomes support the E-LKPD's efficacy.

CONCLUSION

Electronic-based learner worksheets have been produced to train science process skills assisted by liveworksheets on the subject of shifting factors in the direction of chemical equilibrium in class XI SMA which are feasible for use in the chemistry learning process. The feasibility of E-LKPD is described as follows

1. Based on validity (content, and construct validation) on three E-LKPD, each of which includes E-LKPD on the impact of concentration, temperature, volume, and pressure variables that influence the shift in the direction of equilibrium, is given mode 5, which is categorized as a highly valid category. This demonstrates that the validity requirements for the E-LKPD are met.
2. Based on practicality, the results of the questionnaire of students' responses to science process skills-oriented E-LKPD supported by liveworksheets on the criteria of content, presentation, language, graphics, and science process skills get a percentage of 93.1%; 83.72%; 95.07%; 95.07%; and 90.29%, which are included in the very practical category. The results of observations of student's activities also support practicality, with a percentage of relevant activities of 91.22% and irrelevant activities of 8.78%, meaning that relevant activities are more dominant than irrelevant activities. This shows that the developed E-LKPD meets the criteria of practicality.
3. Based on effectiveness, there is an increase in the mean pretest and posttest scores in the realm of science process skills. The results of the analysis using the paired sample t-test on the results of the pretest and posttest scores in the realm of science process skills show a t_{count} value of 21.458 with a significant value of α of 0.05, and the t_{table} on the one-party test is 1.706, so that the conclusion obtained is $t_{count} > t_{table}$. When reviewed based on the Sig value, the results obtained are Sig 0.000, so that Sig. < 0,05. So, the results that have been obtained show that H_0 is refused and H_1 is allowed. Thus, there is a difference between the results of the pretest and posttest. Also supported by the learning outcomes of the knowledge domain based on the classical completeness that has been obtained, 92.59% of students are complete, namely getting a score ≥75. This shows that the developed E-LKPD meets the effectiveness criteria.

RECOMMENDATION

Based on the results obtained in the study, suggestions can be given to further researchers. The suggestions are as follows

1. The application of the developed E-LKPD needs to pay attention to the time allocation, because the activities in the E-LKPD start from formulating problems to making conclusions so that it requires the right time estimate in managing the learning process using the guided inquiry learning model.
2. It is better to conduct trials on a wider scale so that the research results can be more accurate.

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