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DEVELOPMENT OF GUIDED INQUIRY-ORIENTED E-WORKSHEETS TO IMPROVE STUDENTS' SCIENCE PROCESS SKILLS IN ACID-BASE MATERIAL

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Abstract: This study aims to describe the feasibility of guided inquiry-oriented E-worksheets to improve students' science process skills on acid-base material. The research method is Research and Development (R&D), using the 4D development model, which is limited to the development stage and limited trials on 38 eleventh grades at Al-Islam Krian senior high school. The results showed the feasibility of E-worksheets as follows : (1) The validity of E-worksheets based on the criteria of content, presentation, language, and graphics, obtained the mode in E-worksheets 1 and E-worksheets 2, respectively: content criteria 5 and 5; presentation criteria 4.5 and 4.5; language criteria 4 and 4; graphic criteria 5 and 5 with valid and very valid categories, so that the developed E-worksheets are feasible based on the validity criteria. (2) The practicality of the E-worksheets is reviewed from the responses and activities of students. Learner responses based on content, presentation, language, and graphic criteria obtained a percentage of 96.42%; 96.70%; 99.12%; and 100% with a very practical category. Relevant learner activities at meeting 1 and meeting 2 received a percentage of 95.02% and 96.56% in the very practical category. (3) E-worksheets' effectiveness is based on improving science process skills. A normality test showed a significant score on the pretest and posttest of 0.004 and 0.000, respectively, so the significance < 0.05 showed that its data was not distributed normally. Furthermore, pretest and posttest data are analyzed using the Wilcoxon signed rank test, with a significance score of 0.000 < 0.05, showing a significant difference in pretest and posttest results. Data pretest and posttest then also analyze using N-gain with a score from 0.70 to 1.00 with a high category, so students' science process skills are said to increase. E-worksheets effectively improve science process skills.

Keywords: *E-worksheets, Guided Inquiry, Science Process Skills, Acid-Base*

INTRODUCTION

The characteristic of the 2013 curriculum is to develop balanced teaching and learning between spiritual and social behavior, knowledge, and skills. It expects learning to be student-centered so students are more proactive during learning. The 2013 curriculum requires strengthening multimedia-oriented learning [1].

The scope of school subjects in high school is the natural sciences, consisting of physics, chemistry, and biology. Chemistry is the science that studies the properties, structure, composition, changes, and energy of a material [2]. Acid-base material is a chemistry lesson intended for students in senior high school grade 11. The characteristics of acid-base materials are very complex when viewed from three chemical representations: macroscopic, microscopic, and symbolic [3].

Acid-base basic competencies are 3.10, explaining the concept of acid-base and their strength and ionization equilibrium in solutions, and 4.10, conducting experiments to test the trajectory of the change in pH of some indicators derived by natural ingredients [4]. Based on the basic competency of acid-base, it emphasizes the mastery of concepts and theories and requires proof through practicum. Therefore students need science process skills, namely the skills necessary for scientists, to obtain and develop scientific knowledge through practicum [5].

Science process skills can be defined as skills that facilitate science teaching and learning, where students can develop, acquire, and apply knowledge through experiments [6]. Science process skills involve formulating problems, developing hypotheses, identifying variables, designing experiments, collecting data, analyzing data, and drawing conclusions [7].

Based on pre-research questionnaire results that were conducted on 39 twelfth-grade students at Al-Islam Krian senior high school on September 21, 2022, it states that science process skills are still relatively low, with only 11.54% of students able to formulate problems; 10.26% developing hypotheses; 11.54% identify variables; 35.89% design experiments; 78.20% collect data; 34.61% analyze data; and 16.67% draw conclusions correctly. Pre-research results prove that students' science process skills are categorized as relatively low, so they need to be trained.

Guided inquiry can practice science process skills involving science process skills or basic scientific working abilities [8]. The syntax of the guided inquiry is as follows: phase 1 centers students' concerns and describes the inquiry or investigation step; Phase 2 shows the inquiry question or phenomenon; Phase 3 assists students in developing hypotheses to describe problems or phenomena; Phase 4 pushes students to gather data for hypothesis testing; phase 5 formulates a conclusion; and phase 6 reflects on the problem and the learning process [9]. In the guided inquiry's syntax, science process skill components appear in phase 2, namely formulating the

problem; phase 3, namely formulating hypotheses; phase 4, namely identifying variables, designing experiments, and collecting data; phase 5, namely analyzing data and drawing conclusions.

Factors that support successful learning are teachers, students, and educational tools [10], so suitable teaching materials are also necessary besides needing the appropriate learning model. Student worksheets are teaching materials that can simplify the teacher's lesson presentation. A good student worksheet contains laboratory activities, simple experiments, group learning activities, portfolio tasks, and exercises to become proactive during learning[11].

E-worksheets are a teaching material that can support the learning process because, in E-worksheets, teachers can also add audio, video, animation, links, and exercises that can be accessed using electronic tools such as handphones, laptops, and computers [12]. The platform that provides services for the development of E-worksheets is liveworksheets.

The advantages of liveworksheets are: (a) making it easier for teachers to develop electronic E-LKPD so that teachers can add interesting animated images, videos, and links; (b) making it easier for students to use E-LKPD because students do not need to download the application and do not need to log in to be able to access E-LKPD; (c) students' answers can be written directly in the E-LKPD column that has been provided; (d) students' answers can be sent directly to the teacher, making it easier for the teacher to assess students' work.

Previous research indicated that guided inquiry-oriented worksheets could increase students' science process skills, as evidenced by the developed worksheets being feasible based on their validity, practicality, and effectiveness [13]. Previous research still used printed worksheets. Thus E-worksheets are needed that can take advantage of technological developments in the world of education; besides that, in previous studies, the improvement of science process skills only measured the completeness by classical learning outcomes, so it did not measure the improvement of science process skills and the difference in pretest and posttest significantly.

Based on previous research, researchers are interested in developing guided inquiry-oriented E-worksheets for improving science process skills by measuring the improvement of science process skills and the difference in pretest and posttest significantly.

RESEARCH METHOD

This study was conducted using the Research and Development (R&D) method, using a 4D development model limited to the development stage. This study aims to determine the feasibility of guided inquiry-oriented E-worksheets to improve students' science process skills on acid-base materials. The feasibility of E-worksheets was reviewed based on aspects of validity, practicality, and effectiveness. E-worksheets were tested limited to 38 eleventh-grade students at Al-Islam Krian senior high school, held on April 12 and 14, 2023.

In this study, the instruments used were the validation sheet, student response questionnaire, student activity sheet, and science process skill test. The methods of data gathering used were questionnaires, tests, and observations.

Feasibility in the aspect of validity was considered according to the criteria of content, presentation, language, and graphics. E-worksheets validation was conducted by 2 chemistry lecturers and 1 chemistry teacher. E-worksheets validation was analyzed descriptively quantitatively with percentage calculations on a Likert scale below.

Table 1. The Likert of scale

Score	Information
5	Excellent
4	Good
3	Enough
2	Kess
1	Very less

[14]

The data obtained then sought the mode score of each content, presentation, language, and graphics criterion. The score that often appears or becomes the mode is the validity value of the E-worksheets. The model is then interpreted according to the validity criteria interpretation table in the following table.

Table 2. Interpretation of Validity Mode

Mode	Category
$1 \leq M < 2$	Invalid
$2 \leq M < 3$	Less valid
$3 \leq M < 4$	Quite valid
$4 \leq M < 5$	Valid
$M = 5$	Very valid

Adapted [15]

Guided inquiry-oriented E-worksheets are valid if they get the mode of ≥ 3 [16].

The feasibility aspect of practicality is based on students' responses and activities. Students filled in the students' response questionnaire after learning using E-worksheets, then analyzed descriptively quantitatively. The assessment of the learner response questionnaire can be calculated using the table below.

Table 3. Guttman Scale

Answer	Value
Yes	1
No	0

The data obtained can be counted as a percent by utilizing the following equation:

$$P = \frac{F}{N} \times 100\%$$

P is the percent average for respondents' answers (%), F is the total number of respondents' answers, and N is the number of respondents [14]. Collected data were interpreted according to the criteria presented in the table below.

Table 4. The Interpretation of Practicality Score

Percentage	Category
0-20	Not practical
21-40	Less practical
41-60	Practical enough
61-80	Practical
81-100	Very practical

[14]

Students' response to the guided inquiry-oriented E-worksheets developed is said to get a positive response with a percentage of ≥ 61%, so the E-worksheets are declared practical.

Student activity observations were analyzed to identify student activities during learning experiences using E-worksheets. Learner activity data is obtained from observing learner activities carried out by three observers, observing learner activities every 3 minutes. Activity data is analyzed using quantitative descriptive analysis based on the average observation results from three observers, which can be calculated using the equation:

$$\text{Percentage (\%)} = \frac{\text{the number of student activities that appear}}{\text{as a total number of activities}} \times 100\%$$

The resulting percentages were applied to the categories presented in the following table:

Table 5. Interpretation of Practicality Score

Percentage	Category
0-20	Not practical
21-40	Less practical
41-60	Practical enough
61-80	Practical
81-100	Very practical

[14]

Student activities are considered well implemented and support the practicality of the developed E-worksheets if the relevant percentage of student activity ≥ 61%.

The feasibility of the effectiveness aspect was reviewed from the science process skills test results. This test data was collected through pretest and posttest, which was analyzed descriptively quantitatively. The students' science process skills score was calculated using the equation:

$$\text{KPS score} = \frac{\text{score obtained}}{\text{maximum score}} \times 100$$

The pretest and posttest data were then checked to see whether the data was normally distributed. The normality test used is the Kolmogorov-Smirnov normality test. Then the data was processed into a non-parametric test using Wilcoxon's signed rank test.

Wilcoxon is utilized to establish significant differences in pretest and posttest. Wilcoxon's signed rank test is conducted using SPSS with the following hypothesis and basis for decision-making [17]:

Hypothesis proposed:

- H_0 = no significant differences in students' mean scores of science process skills for the pretest and posttest.
- H_1 = There is a significant difference in students' mean scores of science process skills for the pretest and posttest.

Decision-making basis:

- if the significant score < 0.05, so H_0 being rejected.
- if the significant score > 0,05, so H_0 being accepted.

The improvement of science process skills was obtained using the comparative pretest and posttest scores, which were analyzed by N-gain calculation with the equation as follows:

$$< g > = \frac{\text{posttest score} - \text{pretest score}}{\text{maximum score} - \text{pretest score}}$$

The N-gain score was interpreted in the criteria shown below.

Table 6. N-gain Score Criteria

Interval	Criteria
$<g> \geq 0.7$	High
$0.3 \leq <g> < 0.7$	Medium
$g < 0.3$	Low

[18]

Science process skills are said to increase after learning using E-worksheets oriented guided inquiry if the n-gain value reaches ≥ 0.7 with high criteria or $0.3 \leq <g> < 0.7$ with medium criteria so that E-worksheets are declared effective for improving students' science process skills.

RESULT AND DISCUSSION

The study's purpose is to describe how the feasibility of guided inquiry-oriented E-worksheets to improve students' science process skills in acid and base materials. Validation, practicality, and effectiveness data are the results of this study.

Validity of E-Worksheets

E-worksheet validity is derived based on the results of E-worksheet validation by 2 chemistry lecturers and 1 chemistry teacher, which is reviewed by criteria such as content, presentation, language, and

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graphics. The instrument used is a validation sheet. Data from E-worksheets validation results were analyzed descriptively quantitatively, as presented in the table below.

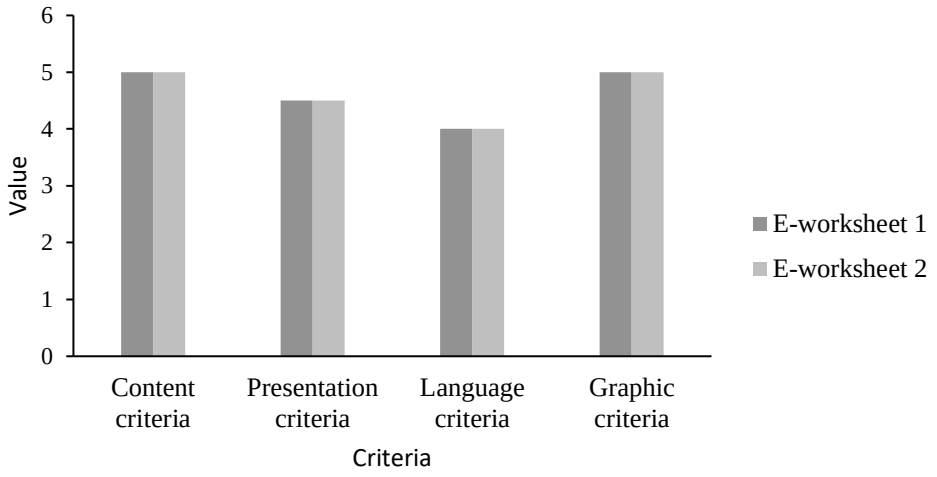

Figure 1. Mode of Each Validity Criterion

The content validity criteria include the conformity of the material with the 2013 curriculum, the conformity between material and basic competencies, the conformity between competency achievement indicators and basic competencies, the conformity of learning objectives with competency achievement indicators, the conformity of the phenomenon with the material, the conformity of the guided inquiry learning, and conformity of the science process skills component.

The development of teaching material needs to match the curriculum used [19], and the preparation of teaching materials must also be adjusted with basic competencies, indicators of competency achievement, and the learning goals that want to get reached [20]. Competency achievement indicators are compiled based on the basic competencies of acid-base material; then, learning objectives are compiled based on competency achievement indicators. How to develop learning objectives must follow ABCD (Audience, Behavior, Condition, Degree) rules [21].

In the content criteria, E-worksheets 1 and 2 get modes 5 and 5 with a very valid category, meaning that E-worksheets are valid based on content criteria. Relevant to previous research if the worksheet on the content criteria by getting mode 3 with the valid category, meaning that the developed worksheets are valid based on the content criteria [22].

Presentation criteria include the cover presenting the contents of the E-worksheets, phenomena, and images that can motivate students, and presentation in electronic form can motivate and make students more active during lessons. The development of teaching materials based on presentation criteria, namely, the cover, must present the content of the teaching materials developed [23]. The phenomena presented must contain chemical concepts and their application in everyday life so that they can make learning more meaningful and can motivate students [24]. The presentation of images must motivate learning and using teaching materials [25]. The presentation of teaching materials in electronic form can motivate and facilitate understanding of the material [26].

In the presentation criteria, E-worksheets 1 and 2 get modes 4.5 and 4.5 with a very valid category, meaning that E-worksheets are valid based on presentation criteria. Relevant to previous research if the worksheet on presentation criteria gets a mode of 3.5 with a valid category, meaning that the worksheet developed is valid based on presentation criteria [22].

Language criteria include the proper and correct use of the Indonesian language, the use of precise and understandable terms, and using simplified sentences. The development of teaching materials based on language criteria must use the right and understandable language [27], the information provided must be clear and understandable to students[20], and the sentences used must use simple words[28].

In the language criteria, E-worksheets 1 and 2 get mode 4 and 4 with a very valid category, meaning that E-worksheets is valid based on language criteria. Relevant to previous research, if the worksheet on linguistic criteria gets mode 4 with a very valid category, It simply refers to the worksheet being valid based on language criteria [29].

Graphic criteria include the choice of fonts (type and size) that can simplify the reading process, attractive covers, background suitability with writing color, layout, images, and tables in harmony. The development of teaching materials based on graphic criteria, namely the use of fonts (type and size) must be easily read by students, meaning that it is not too big or too small [28], the cover design is made as attractive as possible with bright colors, easy-to-read font sizes, and attractive images, and pay attention to the harmony between the location of text, pictures, and

tables, which can make students understand what the teaching material is about [23]. In the graphic criteria, E-worksheets 1 and 2 get modes 5 and 5 with a very valid category, meaning that E-worksheets are valid based on graphic criteria.

Practicality of E-Worksheets

1. Students' Response

The practicality of the E-worksheets was reviewed based on students' responses and activities. The students' response questionnaire is provided to determine the students' responses after learning using E-worksheets so that the E-worksheets practicality data can be obtained. Data on students' responses to E-worksheets are presented in the following table.

Table 7. Percentage of Student' Response

Aspects	Percentage (%)	Category
Content criteria	98.42	Very practical
Presentation criteria	96.70	Very practical
Language criteria	99.12	Very practical
Graphic criteria	100	Very practical

The students' responses to the E-worksheets developed received a positive response with a percentage on the content criteria of 98.42%; presentation criteria 96.70%; language criteria 99.12%; and 100% graphic criteria in the very practical category, so E-worksheets are feasible based on practicality criteria. Relevant to previous research, which states if the developed inquiry E-worksheets get a positive response on content criteria 94%, presentation criteria 88%, language criteria 94%, and also 100% graphic criteria, E-worksheets are declared feasible on practicality criteria [30], The results of other studies state that if the students' responses are positive and support the practicality of the worksheets if they get a percentage of 90.80% in the very practical category [31].

On graphic criteria, students' responses get a percentage of 100%, meaning that fonts (type and size) can make students comfortable reading, and the selection of background and writing color is appropriate. The font used in teaching materials must adjust to the comfort of the reader [23]; the E-worksheet background design is made simple so that the focus of students is not disturbed but still attractive.

2. Students' Activities

Students' activities were obtained from the observation sheet of students' activities, which contained students' activities during learning using E-worksheets oriented guided inquiry observed by three observers, with each observer observing 1-3 groups. Data from the observation of students' activities are shown in the table below.

Table 8. Students' Activities Observation Data

Students' Activities	Percentage of student activity (%)	
	Meeting 1	Meeting 2
Relevant activities:		
1. Observing the phenomenon of E-worksheets	8.81	8..42
2. Expressing an opinion	14.17	21.83
3. Listening to the explanation of the teacher	18.39	12.26
4. Formulating a problem	4.21	3.83
5. Formulate a hypothesis	4.59	4.59
6. Identifying variables	4.21	4.59
7. Designing an experiment	6.13	4.59
8. Collecting data	18.00	18.00
9. Analyzing data	9.19	11.49
10. Making conclusions	7.27	6.89
Percentage of total relevant activities (%)	95.02	96.56
Performing irrelevant activities (other than activities 1-10)	4.98	3.44
Total percentage	100%	100%

Based on the percentage of relevant learner activities at meetings 1 and meeting 2, 95.02% and 96.56%, respectively, with a very practical category. Learner activities can be declared well implemented and support E-worksheets' practicality so that guided inquiry-oriented E-worksheets are declared practical to use. Relevant to previous research if the activities observed during the worksheets trial at meetings 1 and 2 get an average percentage of 84% and 73% so that relevant activities are greater than irrelevant activities, meaning that learner activities support the worksheets practicality data [32].

Irrelevant learner activities received a percentage at meeting 1 of 4.98% and meeting 2 of 3.44%. Irrelevant learner activities are activities carried out while learning other than relevant

activities, namely playing on cell phones, joking with friends, and not paying attention to the teacher.

The most dominant activity in meeting 1 is listening to the teacher's explanation, with a percentage of 18.39%. During the first meeting, listening to the teacher's explanation was dominant because the teacher introduced, trained, and guided students to solve problems based on the components of science process skills. Learners at the first meeting still found it difficult to answer science process skills questions, so the teacher acts as a facilitator to explain briefly, then discuss with teacher guidance. However, at the second meeting, listening to the teacher's explanation dropped to 12.26% because students had begun to understand and could work on problems that were prepared based on science process skills.

The most dominant activity at meeting 2 was expressing opinions, with a percentage of 21.83%; this activity increased rapidly compared to previously at meeting 1, only 14.17%. The characteristics of the guided inquiry model are that the teacher, as a facilitator, provides opportunities and encourages students to find their answers to the problems given, thus helping students become more confident in expressing their opinions [33]. It means that students at the second meeting have begun to understand and can answer questions about science process skills and have more confidence to express their opinions. Hence, the activity of expressing opinions is most dominant at meeting 2.

The dominant activity at meetings 1 and 2 was collecting data, with a percentage of 18.00% at meeting 1 and 18.00% at meeting 2. Learners carry out data collection activities to take tools and materials, conduct experiments, record experimental results, wash tools, and return tools, which takes a long time. The dominant activity is conducting experiments because students get direct contact experience using laboratory materials and tools to prove a problem [34]. Relevant to previous research, this proves that the activity of conducting experiments is the dominant activity at each meeting, with a percentage of 35%; this is because conducting experiments takes quite a long time [35].

Effectiveness of E-Worksheets

E-worksheet effectiveness is measured by improving students' science process skills, which is measured by the pretest given before treatment and the posttest after treatment. The meant treatment is learning using the E-worksheets that have been developed. The pretest and posttest sheets contain 14 essay questions that are adapted from the components of science process skills. The gathered data were analyzed descriptively and quantitatively.

Kolmogorov-Sminrnov normally tests data for pretest and posttest to determine whether the data is normally distributed. The data obtained based on the Kolmogorov-Smirnov normality test is shown below.

Table 9. Kolmogorov-Smirnov Normality Test

One-Sample Kolmogorov-Smirnov Test			
		Pretest	Posttest
N		38	38
Normal Parameters[a,b]	Mean	19.7363	92.5458
	Std. Deviation	13.60376	4.29427
Most Extreme Differences	Absolute	.178	.208
	Positive	.178	.132
	Negative	-.109	-.208
Test Statistic		.178	.208
Asymp. Sig. (2-tailed)		.004[c]	.000[c]

The test for normality indicated that the significant scores for the pretest and posttest were 0.004 and 0.000, respectively. Hence, the sig value < 0.05 showed that the pretest and posttest were not normally distributed. Relevant to previous research, it has been proven that if the normality test data is analyzed using SPSS assistance, it means that the pretest and posttest data are not normally distributed because the significant value was less than 0.05 [35]. Therefore, the data were tested non-parametrically with Wilcoxon's signed rank test.

Table 10. Wilcoxon Signed Rank Test

	Posttest-Pretest
Z	-5.378[b]
Asymp. Sig. (2-tailed)	.000

According to the Wilcoxon signed rank test, a significant score (2-tailed) on both the pretest and posttest of 0.000 < 0.05, meaning that there was a significant difference in mean scores of students' science process skills on the pretest and posttest. It means that guided inquiry-oriented worksheets are effectively used to improve science process skills. Relevant to previous research, this proves that the Wilcoxon signed rank test gets the value of significance (2-tailed) 0.000 < 0.05, which indicates that there is a significant difference between the pretest and posttest data [36]. Improvement in each component of science process skills, according to Wilcoxon analysis, is shown in the following table.

Table 11. Wilcoxon Signed Rank Test for Each Component of Science Process Skills

	PosttestA - PretestA	PosttestB - PretestB	PosttestC - PretestC	PosttestD - PretestD	PosttestE- PretestE	PosttestF - PretestF	PosttestG - PretestG
Z	-5.335[b]	-5.402[b]	-5.427[b]	-5.434[b]	-5.124[b]	-5.406[b]	-5.487[b]
Asymp. Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000

The data from the Wilcoxon signed rank test for each component of science process skills, such as formulating problems, developing hypotheses, identifying variables, designing experiments, collecting data, analyzing data, and drawing conclusions, obtained a significant score (2-tailed) 0.000 < 0.05, so there is a significant difference from the pretest and posttest for each component, which means that each component of students' science process skills is said to increase. E-worksheets are effective for improving science process skills.

The following data were analyzed with N-gain. Students' pretest and posttest get N-gain scores ranging from 0.70-1.00 with a high category. Data from the pretest and posttest increased by N-gain scores ≥ 0.7 with a high category, so E-worksheets effectively improve students' science process skills. Relevant to previous research when obtained N-gain values between 0.68 to 0.91 in the medium and high categories, meaning that the teaching materials developed effectively improved science process skills [37]; also relevant to previous research E-worksheet was declared effective if it had achieved a score of N-gain 0.4-0.5 that indicated the skills trained were increasing [38]. The table below shows the improvement of each science process skill component.

Table 12. Pretest and Posttest N-gain Score

KPS	Pretest	Posttest	N-gain score	Category
Formulating problems	19.30	82.45	0.78	High
Developing hypotheses	23.25	90.78	0.88	High
Identifying variables	6.58	85.96	0.85	High
Designing experiments	20.18	100	1.00	High
Collecting data	31.58	97.36	0.96	High
Analyzing data	23.68	96.49	0.95	High
Drawing conclusions	13.60	94.73	0.94	High

Based on the N-gain data for each component of science process skills, such as formulating problems, developing hypotheses, identifying variables, designing experiments, collecting data, analyzing data, and drawing conclusions, the N-gain values are sequentially 0.78; 0.88; 0.85; 1.00; 0.96; 0.95; and 0.94 with high categories, which means that each component can be considered as improving and E-worksheets is effective to improve science process skills. Relevant to previous research, the science process skills of each component received an N-gain value between 0.48-1.00 with moderate and high categories, meaning that there was an increase from the pretest to the posttest [39].

The improvement in designing experiments skills received a perfect N-gain score of 1.00, which means that all students increased in designing experiments, this is because students have previously been taught to design experiments, but usually, there are still wrong and incoherent steps, so when learning using E-worksheets students are guided to design the correct experiment so that they can design experiments coherently and correctly. Learners can master the skills of designing experiments if trained repeatedly and consistently so that students become accustomed to and can apply them [40].

The increase in formulating problems skills in this study was not too high; this is because previously, students had been taught to formulate problems but did not contain two experimental variables (manipulation and response), so when learning using E-worksheets students were a little confused, after being guided and discussing with the group, students began to understand and could formulate the correct problem. Relevant to previous research conducted if the increase in skills to formulate problems is not so significant because students have previously been taught to formulate problems that do not contain manipulation and response variables [37].

The increase in developing hypotheses skills received a not-too-high N-gain increase after formulating problem skills because the basis for formulating hypotheses is based on formulating the problem. In developing hypotheses, the activity of formulating the problem must be well organized [41]. The hypothesis is a temporary solution to the formulation of problems that still need to be proven correct [42].

The increase in the skill of identifying variables gets an N-gain score of 0.85 because students were previously rarely taught to identify control, manipulation, and response variables. Students are then trained to identify variables through learning using E-worksheets oriented guided inquiry to improve science process skills so that students with little difficulty could become more understanding in identifying variables. It is relevant to previous research if students have been taught to identify variables, but they still experience some difficulty differentiating among control, manipulation, and response variables [37].

CONCLUSION

This research can be concluded from the results and discussion is e-worksheets are declared valid according to the criteria such as content, presentation, language, and graphics, obtaining the following modes in E-worksheet 1 and E-worksheet 2,

respectively: (a) content criteria 5 and 5; (b) presentation criteria 4.5 and 4.5; (c) language criteria 4 and 4; (d) grammar criteria 5 and 5 with valid and very valid categories, so that the E-worksheets developed is feasible based on validity criteria. E-worksheets are declared practical based on students' responses and activities. Learner responses based on content, presentation, language, and graphic criteria sequentially get a percentage of 98.42%; 96.70%; 99.12%; and 100% with a very practical category. Relevant learner activities at meeting 1 and meeting 2 received a percentage of 95.02% and 96.56% in the very practical category. E-worksheets are declared effective based on the improvement of science process skills. A normality test showed a significant score on the pretest and posttest of 0.004 and 0.000, respectively, so the significance was <0.05, showing that its data was not distributed normally. Furthermore, pretest and posttest data are analyzed using the Wilcoxon signed rank test, with a significance score of 0.000 < 0.05, showing a significant difference in pretest and posttest results. Data pretest and posttest then also analyze using N-gain with a score from 0.70 to 1.00 with a high category, so students' science process skills are said to increase, and E-worksheets effectively improve science process skills.

REFERENCES

[1] Kemendikbud. (2018). *Permendikbud RI No.36 Tahun 2018 Tentang Perubahan Atas Peraturan Menteri Pendidikan Dan Kebudayaan Nomor 59 Tahun 2014 Tentang Kurikulum 2013 Sekolah Menengah Atas/Madrasah Aliyah.* Jakarta: Kemendikbud.

[2] Djarwo, C. F. (2019). Analisis Miskonsepsi Mahasiswa Pendidikan Kimia pada Materi Hidrokarbon. *Jurnal Ilmiah IKIP Mataram*, 6(2), 2355-6358.

[3] Adriani, M., Muhali, & Dewi, C. A. (2019). Pengembangan Modul Kimia Berbasis Kontekstual Untuk Membangun Pemahaman Konsep Siswa Pada Materi Asam Basa. *Jurnal Kependidikan Kimia*, 7(1), 25-34.

[4] Kemendikbud. (2018). *Permendikbud RI Nomor 37 Tahun 2018 tentang Perubahan Atas Permendikbud Nomor 24 Tahun 2016 tentang Kompetensi Inti dan Kompetensi Dasar Pelajaran pada Kurikulum 2013 pada Pendidikan Dasar dan Pendidikan Menengah.* Jakarta: Kemendikbud.

[5] Fitriana, Kurniawati, Y., & Utami, L. (2019). Analisis Keterampilan Proses Sains Peserta Didik pada Materi Laju Reaksi melalui Model Pembelajaran Bounded Inquiry Laboratory. *Jurnal Tadris Kimiya*, 4(2), 226-236.

[6] Gasila, Y., Fadillah, S., & Wahyudi. (2019). Analisis Keterampilan Proses Sains Siswa dalam Menyelesaikan Soal IPA di SMP Negeri Kota Pontianak. *Jurnal Inovasi dan Pembelajaran Fisika*, 6(1), 14-22.

[7] Hidayati, N., & Yonata, B. (2019). Penerapan Model Pembelajaran Inkuiri Terbimbing untuk Melatihkan Keterampilan Proses Sains Peserta Didik pada Materi Kesetimbangan Kimia Kelas XI SMAN Ngoro Jombang. *Unesa Jurnal of Chemical Education*, 8(2), 148-155.

[8] Haerullah, A., & Hasan, S. (2017). *Model dan pendekatan Inovatif (Teori dan Aplikasi).* Yogyakarta: Lintas Nalar.

[9] Arends, R. (2012). *Learning to Teach 9 th Edition.* New York: McGraw-Hill.

[10] Wibowo, S. H., & Hidayah, R. (2016). Pengembangan Lembar Kegiatan Siswa Berorientasi Inkuiri Terbimbing untuk Melatihkan Keterampilan Proses Sains Siswa pada Materi Asam Basa. *Unesa Journal of Chemical Education*, Volume 5 Nomor 2.

[11] Hamidah, N., Haryani, S., & Wardani, S. (2018). Efektivitas Lembar Kerja Peserta Didik Berbasis Inkuiri Terbimbing untuk Meningkatkan Hasil Belajar Peserta Didik. *Jurnal Inovasi Pendidikan Kimia*, 12(2), 2212-2223.

[12] Lathifah, M. F., Hidayati, B. N., & Zulandri. (2021). Efektifitas LKPD Elektronik sebagai Media Pembelajaran pada Masa Pandemi Covid-19 untuk Guru di YPI Bidayatul Hidayah Ampenan. *Jurnal Pengabdian Magister Pendidikan IPA*, 4(2), 25-30.

[13] Rochmani, N. L., Agustini, R., & Mitarlis. (2018). Development of Student Worksheet Based On Guided Inquiry Model On Electrolyte And Non Electrolyte Solution Matter To Train the Science Process Skills in X Grade Senior High School. *UNESA Journal of Chemical Education*, 7(1), 46-51.

[14] Riduwan. (2015). *Skala Pengukuran Variabel-Variabel Penelitian.* Bandung: Alfabeta.

[15] Ratumanan, G., & Laurents, T. (2013). *Evaluasi Hasil Belajar pada Tingkat Satuan Pendidikan.* Surabaya: UNESA PRESS.

[16] Lutfi, A. (2021). *Research and Development (R&D) : Implikasi dalam Pendidikan Kimia.* Surabaya: Jurusan Kimia FMIPA UNESA.

[17] Rudianto, D., Putri, N. N., Said, M., Anjani, J. M., Erliyani, F., & Muliawati, T. (2020). Pengaruh Hubungan E-Learning dalam mata Kuliah MAFIKI di Institut Teknologi Sumatera Menggunakan Metode Wilcoxon. *Indonesian Journal of Applied Mathematics*, 1(2), 1-5.

[18] Hake, R. (1999). *Analyzing Change/Gain Score.* Americans Educational Research Association's Division Measurement and Research Methodology.

[19] Novita, H., Lutfi, Ardi, & Selaras, G. H. (2023). Validitas Lembar Kerja Peserta Didik (LKPD) Berbasis Inkuiri Terbimbing. *Journal on Teacher Education*, 4(3), 251-263.

[20] Depdiknas. (2008). *Panduan Pengembangan Bahan Ajar.* Jakarta: Departemen Pendidikan Nasional.

[21] Evitasari, A. D., Musyadad, F., & Sholihah, F. (2021). Kesesuaian RPP Tematik Integratif dengan Surat Edaran Nomor 14 Tahun 2019. *Jurnal Ilmiah Pendidikan Dasar*, 8(1), 18-34.

[22] Masriyah. (2022). Pengembangan Lembar Kegiatan Peserta Didik untuk Melatih Keterampilan Berpikir Kritis Siswa Kelas X SMA pada Materi tingkat Organisasi Kehidupan. *BioEdu*, 11(2), 294-301.

[23] Afridayanti, R., & Azizah, U. (2020). Validitas Lembar Kerja Peserta Didik (LKPD) dengan Model Pembelajaran Learning Cycle 7E untuk Melatihkan Keterampilan Berpikir Kritis pada Materi Asam Basa di SMA Kelas XI. *Unesa Journal of Chemical Education*, 9(1), 53-58.

[24] Pertiwi, W. J., Solfarina, & Langitasari, I. (2021). Pengembangan Lembar Kerja Pesert Didik (LKPD) berbasis Etnosains pada Konsep Larutan Elektrolit dan Nonelektrolit. *Jurnal Inovasi Pendidikan Kimia*, 15(1), 2717-2730.

[25] Is' ad, N., & Sukarmin, S. (2022). Implementation of problem-solving learning model assisted by student worksheets to improve critical thinking skills in the context of reaction rate. *Jurnal Pijar Mipa*, *17*(2), 199-208.

[26] Shofawati, A., Widodo, W., & Sari, D. A. P. (2023). The use of multimedia interactive to improve students science literacy in the new normal era. *Jurnal Pijar Mipa*, *18*(1), 65-71.

[27] Husnadi, S. I., Ilhamdi, M. L., & Khair, B. N. (2021). Pengembangan Multimedia Interaktif Berbasis Macromedia Flash Professional 8 Pada Tema Daerah Tempat Tinggalku (Kearifan Lokal Lombok) untuk Siswa Sekolah Dasar. *Jurnal Pijar Mipa*, *16*(2), 191-197.

[28] Nareswari, S. R., Suarjana, I., & Sumantri. (2021). Belajar Matematika dengan LKPD Berbasis Kontekstual. *Jurnal Mimbar Ilmu* , 26(2), 204-213.

[29] Sanchia, A. I., & Faizah, U. (2019). Pengembangan LKPD Berbasis Search, Solve, Create and Share (SSCS) untuk Melatih Keterampilan Proses Sains pada Materi Arthropoda Kelas X SMA. *Jurnal Riset Biologi dan Aplikasinya*, 1(1), 9-17.

[30] Isnaini, M., & Yonata, B. (2021). Pengembangan LKPD Inkuiri Berpendekatan Nested untuk Melatihkan Keterampilan Proses Sains pada Materi Laju Reaksi. *Chemistry Education Practice*, 4(2), 153-159.

[31] Ramadianti, A. A. (2021). Development of LKPD Based on Project Based Learning Model to Improve Mathematical Creative Thinking Ability of Grade V Elementary School Student. *SENSEI International Journal of Education and Linguistics*, 1(3), 719-731.

[32] Sari, A. P., & Nasrudin, H. (2022). Guided Inquiry-Based Worksheet Development to Improve Critical Thinking. *Jurnal Pendidikan dan Pembelajaran Kimia*, 11(1), 23-31.

[33] Sanjaya, W. (2014). *Strategi Pembelajaran : Berorientasi Standar Proses Pendidikan.* Jakarta: Kencana Prenada Media.

[34] Irham, S. M., Mawardi, & Oktavia, B. (2017). The Development of Guided Inquiry-based Worksheet on Colligative Properties of Solution for Chemistry Learning. *Advances in Social Science, Education and Humanities Research (ASSEHR)*, Volume 57, 38-42.

[35] Nisa, F. A., & Nasrudin, H. (2022). Development of Student Worksheet with Guided Inquiry to Train High Order Thinking Skills on the Reaction Rate Materials. *Prisma Sains: Jurnal Pengkajian Ilmu dan Pembelajaran Matematika dan IPA IKIP Mataram*, 10(1), 69-83.

[36] Pryanti, W., & Nasrudin, H. (2022). Penerapan Model Pembelajaran Kooperatif Tipe STAD untuk Meningkatkan Literasi Sains Peserta Didik Melalui Metode Blended Learning pada Materi Laju Reaksi. *PENDIPA Journal of Science Education*, 6(2), 508-515.

[37] Rahmawati, A., & Yonata, B. (2019). Pengembangan LKPD Berbasis Contextual Teaching and Learning (CTL) untuk Melatihkan Keterampilan Proses Sains pada Materi Kesetimbangan Kimia. *UNESA Journal of Chemical Education*, 8(2), 15-22.

[38] Zulfa, E. E., & Syamsurizal. (2021). The Effectiveness of Guided Inquiry-Based LKPD to Improve the Student's Critical and Creative Thinking Skills. *IJSSHR International Journal of Social Science And Human Research*, 4(7), 1768-1775.

[39] Sholihah, Z., & Azizah, U. (2019). Penerapan Model Pembelajaran Inkuiri Terbimbing untuk Meningkatkan Keterampilan Proses Sains pada Materi Laju Reaksi. *Unesa Journal of Chemical Education*, 8(2), 106-112.

[40] Ningtyas, R. A., & Purnomo, T. (2018). Penerapan Pendekatan Saintifik pada Materi Pencemaran Lingkungan dan Dampaknya untuk Meningkatkan Keterampilan Proses Sains. *Pensa-ejournal*, 81(8), 482-486.

[41] Amique, I. N., Jumaeri, Sumarni, W., & Susilaningsih, E. (2020). Pengembangan Lembar Kerja Praktikum Inovatif pada Pembelajaran Berbasis Proyek untuk Mengukur Keterampilan Proses Sains. *Journal of Chemistry In Education*, 9(2), 2252-6609.

[42] Sudibyo, E., Nurita, T., & Fauziyah, A. (2018). Penggunaan Lembar Kerja Berorientasi Pendekatan Keterampilan Proses untuk Melatihkan Keterampilan Proses Sains Siswa SMP. *JPPIPA*, 3(1), 21-26.