Inquiry-Flipped Classroom E-worksheet to Train Critical Thinking Skills on Chemical Equilibrium Learning

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Abstrak: This study aims to obtain a feasible e-worksheet to train students' critical thinking skills. This type of research includes research and development. The development model used refers to the 4-D model but is only limited to the define, design, and develop stages. The pilot test was conducted in one randomly selected class. The feasibility of the developed e-worksheet is guided by validity, practicality, and effectiveness. Validation was conducted by expert validators with scores determined based on mode values. The validation results obtained a score of 5 with a very valid category on the three e-worksheets. Practicality analysis results are seen from the results of the learner response questionnaire and learner activity observations. The percentage of practicality based on the students' response questionnaire was obtained at 98.08% with a very practical category. As for the results of the observation of students' activities, relevant activities were obtained at meeting 1 of 94.23%, meeting 2 of 93.34%, and meeting 3 of 93.78%. Of the three activity percentages, the percentage of relevant activities of students is 93.78% so that it can be said that the e-worksheet developed is very practical. The results of the e-worksheet effectiveness analysis were measured based on the score value of cognitive learning outcomes analyzed using the Wilcoxon test and classical completeness test and the value of critical thinking skills results analyzed using the t test and classical completeness test. The Wilcoxon test results on cognitive learning outcome scores obtained a significance value of 0.000 and a percentage of classical completeness test of 93.75%. The result of critical thinking skills value from t-test obtained a significance value of 0.000 and the percentage of classical completeness test was 96.88%. From both analysis results, the developed e-worksheet can be said to be effective. Based on the results of the analysis of validity, practicality, and effectiveness, it is found that the inquiry-flipped classroom e-worksheet to train critical thinking skills developed is suitable for use.

Keywords: Chemical Equilibrium; Critical Thinking Skills ; E-Worksheet; Inquiry-Flipped Classroom.

Introduction

Education in Indonesia is one of the factors affected by the covid-19 pandemic. The learning crisis is exacerbated by the covid-19 pandemic with the loss of learning and the increasing learning gap [1]. This learning gap can be overcome by the existence of technology-based learning media and several Ministry of Education and Research programs. Kemendikbudristek has published the latest curriculum after the Covid-19 pandemic. At the beginning of 2022 the Ministry of Education, Culture and Research authorized the existence of a new curriculum, namely the independent curriculum. The independent curriculum comes into effect in the 2022/2023 school year [2].

The independent curriculum is the latest breakthrough in helping teachers to connect, collaborate, and inspire each other in realizing the Pancasila learner profile for the advancement of education and achieving quality education for all Indonesian people. The focus of the independent curriculum is not the breadth of material but the depth of concepts that will be received by students. The independent curriculum provides flexibility for teachers to use various teaching tools according to the needs and characteristics of students [1]. Teachers are not only bound by book learning media or learning tools from the government or educational institutions, but are allowed to use other learning tools, one of which is by utilizing digital technology.

The freedom of teachers in choosing and using teaching tools in learning activities goes hand in hand with the advancement of digital technology. This must be balanced with various educational innovations so that education in Indonesia is not left behind and continues to develop. E-learning-based education is a new strategy in the teaching and learning process. Indonesian people are forced to move quickly, adjust to the challenges of the times, maximize technology and creativity [3].

Independent learning can be interpreted as the application of the curriculum in the learning process must be fun, coupled with the development of innovative thinking by teachers [4]. To support the implementation of an independent curriculum in Indonesia where students can receive learning with fun and understand the concepts taught, of course, it must be supported by learning media with appropriate learning models and approaches. E-worksheet can be an alternative learning media that is more effective and efficient in times of technological development like now. In the teaching module of the independent curriculum at the final stage, several components are mentioned which include student worksheets, enrichment and remedial, teacher and student reading materials, glossary, and bibliography [5]. There is no interactive e-worksheet that is suitable for face-

to-face or non-face learning using the independent curriculum [6].

The inquiry learning model is a learning model that provides opportunities for students to find their own solutions to problems based on their thoughts and observations [7]. The inquiry learning model can be combined with the flipped classroom because the syntax can be put together with each other to support learning to be more effective [8]. Flipped classroom is an approach that combines learning technology and active learning by utilizing technology in order to obtain knowledge and information sources that can be accessed easily by learners in online form. In addition, the flipped classroom provides time for asynchronous learning so that learners find and learn the material to be learned in advance [9]. Using the flipped classroom approach will help achieve the objectives of the independent curriculum, which is to focus on the depth of concepts rather than the width of the material that students will receive.

Understanding chemical concepts is very important for students because chemical concepts are related to one another so that learning them must be coherent and continuous. One of the Learning Outcomes (CP) that students must master in the independent curriculum chemistry subject in phase F is understanding and explaining the equilibrium of chemical reactions. Learning on chemical equilibrium material is one of the materials that requires students to be able to use the critical thinking skills that students have. This is reflected in the learning competencies of chemical equilibrium which require students to analyze, design, conduct, conclude, and present the results of experiments [10]. The characteristics of chemical equilibrium material are interrelated with the syntax of the inquiry learning model. The inquiry learning model can be used for learning chemistry on chemical equilibrium material [11]. Supported by one study which states that there is still a lack of learning media that is easily understood by students on the subject matter of chemical equilibrium [12].

The weak learning process that requires students to think critically is one of the problems of education in Indonesia today. Whereas in dealing with a problem in the learning process, students are required to always think at a high level. However, in reality, students only absorb information passively and then remember it when taking tests [13]. This is in line with the desire of the Ministry of Education and Research in independent learning so that educational output produces better quality and no longer produces students who are only adept at memorizing, but also have sharp analytical skills, reasoning and comprehensive understanding in learning to develop themselves.

The inquiry-flipped classroom learning model uses steps that intersect directly with the elements of critical thinking skills. The steps of the inquiry model are the foundation for critical thinking and can be used as a mind map. The process of reasoning systematically, logically, and deeply accompanied by scientific arguments along with evidence in the form of accurate data/information so as to obtain conclusions that can be used to train critical thinking [14]. Learning using the flipped classroom approach includes observing, questioning, gathering information, associating and analyzing, and communicating [15].

Critical thinking skills consist of several indicators, namely interpretation, analysis, evaluation, inference, explanation, and self-regulation [16]. In the independent curriculum, critical thinking skills are seen as important to prepare students to be able to become critical, analytical, and problem-solving citizens [17]. In this study, the indicators of critical thinking skills used refer to Facione, namely interpretation, analysis, evaluation, and inference. The other two indicators, namely explanation and self-regulation, are not used because the four indicators already fulfill critical thinking skills, while the indicators of explanation and self-regulation are only owned by strong critical thinkers [16].

In the e-worksheet that will be developed, there are various experimental activities, namely experiments using virtual laboratories and direct experiments carried out in the laboratory. Virtual laboratories make it easier for students to understand the concept of learning material so that it can optimize learning outcomes. While practicum activities in the laboratory directly become one of the learning activities for students to develop the ability to think, analyze, solve problems, prove and draw conclusions of an object from the material studied [18].

In learning chemistry in the independent curriculum is required to train critical thinking skills including in chemical equilibrium material. In chemical equilibrium material, the implementation of learning to train critical thinking skills requires appropriate learning media, namely in the form of e-worksheet which is interactive, can guide students to find concepts independently, presents worksheets consisting of two activities, namely synchronous and asynchronous learning which will help students to understand chemical equilibrium material more deeply, contains direct experimental activities or uses virtual laboratories, there are teaching materials as learning support, and is based on the independent curriculum as the latest curriculum in Indonesia. Based on the literature review that has been carried out, the e-worksheet does not yet exist and is very much needed, it is necessary to develop an inquiry-flipped classroom e-worksheet on chemical equilibrium material to train students' critical thinking skills that are feasible to use as learning media based on validity, practicality, and effectiveness.

Research Methods

This study used the research and development (R&D) method. The development model used is 4-D developed by S. Thiagarajan (1974), consisting of 4 main stages namely define, design, develop, and disseminate. The feasibility of e-worksheet is obtained from the results of validity, practicality, and effectiveness. This research was only limited to the define, design, and develop stages. The pilot test was conducted in one randomly selected class. The define stage consists of five steps, namely front end analysis, learner analysis, task analysis, concept analysis, and specification of learning objectives. At the design stage, media selection, format selection, and initial design are carried out. The develop stage consists of three steps, namely review, validation, and trial.

The trial was conducted to determine the practicality and effectiveness of the developed e-worksheet. The instruments used to assess practicality and effectiveness have previously been validated by expert validators so that the

instruments used have been declared valid to be tested on students. The instruments used to measure practicality are the learner response questionnaire sheet and the learner activity observation sheet. Meanwhile, the instruments to measure effectiveness are pretest and posttest sheets of cognitive learning outcomes and critical thinking skills of students.

Validation of learning devices was carried out by three expert validators by filling out a validation sheet. The percentage of validation sheet results was analyzed based on Likert scale criteria [19]. The data from the assessment results by the validator is determined based on the mode value of each indicator by making a decision declared valid if the score is at least 4. If the score is less than 4 then improvements are made.

Table 1. Likert Scale Scores

Score	Statement
1	Invalid
2	Less Valid
3	Fairly Valid
4	Valid
5	Very Valid

Practicality data is obtained from the students' response questionnaire and the results of observations of students' activities on e-worksheet. The measurement scale of the results of the learner response questionnaire uses a Guttman scale [19].

Table 2. Guttman Scale Scores

Response	Assessment	Score
Positive	Yes	1
	No	0
Negative	Yes	0
	No	1

The data obtained from the students' response questionnaire were analyzed using the percentage formula as follows.

$$\text{Practicality Percentage (\%)} = \frac{\Sigma \text{ Score each assessment}}{\Sigma \text{ Respondents}} \times 100\%$$

Data on the practicality of e-worksheet was also obtained from the results of observation of students' activities with an interval of 2 minutes. The data from the observation of students' activities were analyzed using the percentage formula as follows.

$$\text{Activity Percentage (\%)} = \frac{\Sigma \text{ Relevant Activities}}{\Sigma \text{ Overall Activity}} \times 100\%$$

The percentage results of the learner response questionnaire and learner activity observations are interpreted as in the following table [20].

Table 3. Practicality Assessment Scores Conversion

Percentage (%)	Criteria
0-20	Not practical
21-40	Less practical
41-60	Practical enough
61-80	Practical
81-100	Very practical

E-worksheet is declared practical if the percentage of student activity observation results ≥ 61% with practical or very practical criteria.

The effectiveness of the e-worksheet was analyzed based on the value of cognitive learning outcomes and critical thinking skills obtained based on pretest and posttest scores. The effectiveness of the developed e-worksheet was analyzed using paired sample t-test and classical completeness test used to determine whether or not there was an increase and difference in the average value of pretest and posttest results of cognitive learning outcomes and critical thinking skills. The normality test was conducted before the analysis using the paired sample t-test test to determine whether the data obtained was normally distributed. The normality test used is the Shapiro-Wilk test using SPSS. Data is declared normally distributed if the significance value is >0.05 and the data is declared not normally distributed if the significance value is <0.05. If the data obtained is normally distributed, the t test is used to analyze the data. However, if the data is not normally distributed, the Wilcoxon test is used.

Results and Discussion

Define

This stage is the initial stage in the form of providing an overview of learning. Information collection was carried out by reviewing literature and conducting pre-research with 30 students and interviewing chemistry teachers of MBI Amanatul Ummah Pacet Mojokerto Regency.

Based on the results of the front end analysis, it is known that the curriculum applied in class XI MBI Amanatul Ummah Pacet Mojokerto Regency is an independent curriculum. Chemical equilibrium material is material that is taught in grade XI at the equivalent high school level. One of the Learning Outcomes (CP) that students must master in the independent curriculum chemistry subject in phase F is understanding and explaining the equilibrium of chemical reactions. Chemical equilibrium learning competencies require students to analyze, design, conduct, conclude, and present experimental results [10]. In Permendikbudristek Number 16 of 2022 it is explained about Process Standards in Early Childhood Education, Basic Education, and Secondary Education which states that the assessment by the students concerned of the implementation of the learning carried out aims to train students to be able to think critically. In addition, in the independent curriculum, the Pancasila learner profile is a form of translation of national education goals. In the Pancasila learner profile, there are six dimensions including faith in God Almighty and noble character, independence, mutual cooperation, global diversity, critical reasoning, and creativity. Critical thinking skills are analysis and evaluation activities to increase understanding, broaden appreciation, and improve work [20]. But in reality, the critical thinking skills of students are still relatively lacking. This is supported by the results of the critical thinking skills test of MBI Amanatul Ummah Pacet Mojokerto Regency students who are in the sufficient category and need to be improved. One of the more effective and efficient learning media in times of technological development and can train students' critical thinking skills is e-worksheet. E-worksheet is an electronic-based learner

worksheet that contains work procedures and tasks that must be completed. The results of the questionnaire of MBI Amanatul Ummah Pacet Mojokerto Regency students found that students only use textbooks as a medium of learning support. E-worksheet using the right model and approach can train students' critical thinking skills.

The inquiry learning model can be used to improve aspects of critical thinking skills both in terms of cognitive and affective dispositions [14]. The inquiry learning model is a learning model that provides opportunities for students to find their own solutions to problems based on their thoughts and observations [7]. In learning by using the flipped classroom approach includes observing, questioning, gathering information, associating and analyzing, and communicating. It is proven to improve learning outcomes and improve students' critical thinking skills [15].

Design

At the design stage, it is carried out to design an inquiry-flipped classroom e-worksheet on chemical equilibrium material to train critical thinking skills which will become draft I. The steps taken at the design stage include media selection, format selection, and making initial designs. There are three e-worksheets developed for three meetings. Meeting 1 discussed the concentration factor, meeting 2 the temperature factor, and meeting 3 the pressure and volume factors. The e-worksheet developed can be accessed through the Liveworksheet web which is one of the webs that can convert hardcopy worksheet into digital forms that can be done directly and interactively [22]. The contents of the developed e-worksheet include a cover, preface, table of contents, instructions for use, an introduction that includes CP, TP, and ATP, menu sheets, learning materials, learner activities that include critical thinking skills, and a bibliography.
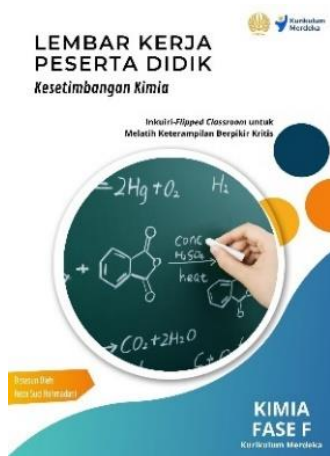

Figure 1. E-Worksheet Cover Design

The e-worksheet contains teaching materials that can be accessed by students to assist asynchronous learning. In addition, in each e-worksheet there are experimental activities using virtual laboratories or direct experiments.

The teaching materials contained in the e-worksheet contain chemical equilibrium material that can be used by students to support asynchronous learning and as a source of material for preparing experimental hypotheses.

Figure 2. Cover of Teaching Material Concentration Factor

Figure 3. Virtual Laboratory in e-worksheet

In the e-worksheet there is a virtual laboratory as a student activity to prove the hypothesis that has been compiled. The virtual laboratory can be accessed directly through the e-worksheet. The e-worksheet has been equipped with experimental instructions to make it easier for students to conduct experiments. The virtual laboratory contained in the e-worksheet facilitates students to gain learning from the case study approach, interact with laboratory equipment digitally, carry out experiments, review results, and evaluate the entire learning process.

In the e-worksheet developed, students' activities are arranged based on the syntax of the inquiry learning model which is associated with indicators of critical thinking skills. In phases 1 and 2 the critical thinking skills indicator that is trained is interpretation. In phase 3 train the inference indicator. Phase 4 is designed to train the analysis indicator. In phase 5 aims to train the inference indicator, while in phase 6 to train the evaluation indicator.

Figure 4. Linkage of Inquiry Phase and Critical Thinking Skills Indicators in E-worksheet

Develop

The third stage is the development stage which consists of three steps, namely review, validation, and testing. The review was conducted by one chemistry lecturer at Surabaya State University which was useful for getting comments or suggestions from experts on the developed e-worksheet which was used as the basis for revision material if there were errors in the initial design. After the revision, a draft II was compiled which will be carried out in the

validation stage. Validation aims to get an expert assessment which is used as the basis for revision material if there are errors in draft II so as to produce valid e-worksheet to be tested on students. Validation was carried out by 3 validators, namely 2 chemistry lecturers from Surabaya State University and 1 chemistry teacher from MBI Amanatul Ummah Pacet, Mojokerto Regency. The results of e-worksheet validation are presented in the following table.

Table 4. E-worksheet Validation Result

Assessed Aspect	E-WORKSHEET Mode			Criteria
	1	2	3	
Contents	5	5	5	Very valid
Construct	5	5	5	Very valid
Validity Mode	5	5	5	Very valid

The scores of e-worksheet validations results 1, 2, and 3 were analyzed by determining the mode given by the three validators on each assessment indicator. Based on Table 4, it can be seen that the content validity of the three e-worksheets obtained a mode of 5 so that the validity of the e-worksheet content can be declared very valid. In construct validity, the mode obtained based on the assessment of three validators is 5, so it can be stated that the construct validity of the three e-worksheets is very valid. The overall mode obtained is 5 which indicates that e-worksheet 1, 2, and 3 can be declared valid for use at the trial stage. This is in line with previous research which obtained the results of validation of guided inquiry-based student worksheets to train critical thinking skills on chemical equilibrium material developed was classified as very high [23].

The next stage is the e-worksheet trial which has previously been validated. The trial was conducted to determine the feasibility of e-worksheet in the flipped classroom, especially in the aspects of practicality and effectiveness. The trial was conducted on 32 students of class XI MBI Amanatul Ummah Pacet Mojokerto. The instruments used to measure the practicality of e-worksheet are student response questionnaires and student activity observation sheets which have previously been validated by expert validators and declared valid for use. The results of the learner response questionnaire are presented in Table 5.

The results of the percentage of student response questionnaires amounted to 98.08% so that the e-worksheet developed can be declared very practical. in line with previous research where the guided inquiry-based e-worksheet developed is classified as very practical to train students' critical thinking skills [24].

In the learner activity observation sheet instrument in the instrument of the student activity observation sheet, the results in Table 6 show the percentage of relevant activities at meeting 1 of 94.23%, meeting 2 of 93.34%, and meeting 3 of 93.78%. From the three meetings, the overall percentage was 93.78% so that the e-worksheet could be said to be very practical.

The effectiveness of the developed e-worksheet media was measured from the pretest and posttest results of cognitive learning outcomes and critical thinking skills of students analyzed using the t test and classical completeness test. The pretest and posttest results of cognitive learning outcomes were tested for normality first to determine whether the data were normally distributed.

Table 5. Recapitulation of the Results of the Learner Response Questionnaire

Aspects	Percentage (%)
The e-worksheet media makes me excited to follow the learning.	100.00
The e-worksheet display is boring.	100.00
The e-worksheet media makes it easier for me to understand chemical equilibrium material.	96.88
The experiments presented in the e-worksheet help in understanding the material.	100.00
The phenomenon presented in the e-worksheet is interesting so that it increases my interest in learning.	100.00
I feel that the information presented in the e-worksheet is complete and easy to understand.	93.75
I feel that the information presented in the e-worksheet is complete and easy to understand.	100.00
I can understand the learning instructions in the e-worksheet clearly, so I can easily use it.	100.00
I experienced difficulties in using the e-worksheet	93.75
I feel that the practice questions in the e-worksheet are in accordance with the material presented	93.75
It is easier for me to understand the material because the pictures on the e-worksheet are in accordance with the content of the material.	96.88
Chemistry learning on chemical equilibrium material becomes more practical with e-worksheet media.	100.00

Aspects	Percentage (%)
The language used in the e-worksheet is very communicative and interactive.	100.00
% Practicality	98.08

Table 6. Recapitulation of Observation Results of Student Activities

Student Activity	Aktivity Percentage (%)		
	P1	P2	P3
Relevant Activities	94.23	93.34	93.78
Irrelevant Activities	1.33	2.22	1.78
Percentage Total	95.56	95.56	95.56

Table 7. Normality Test of Cognitive Learning Outcomes

	Shapiro-Wilk		
	Statistic	df	Sig.
Cognitive Pretest Score	.918	32	.019
Cognitive Posttest Score	.872	32	.001

Based on Table 7, the normality test results of cognitive learning outcomes obtained a significance value of 0.019 for pretest scores and 0.001 for posttest scores. These results indicate that the data are not normally distributed because the significance value is <0.05 so that the t test cannot be done. As an alternative form, the Wilcoxon test was conducted to determine the difference in the average pretest and posttest scores of cognitive learning outcomes.

Table 8. Wilcoxon Test of Cognitive Learning Outcomes

Test Statistics[a]

	Cognitive Posttest Score – Cognitive Pretest Score
Z	-5.045[b]
Asymp. Sig. (2-tailed)	.000

a. Wilcoxon Signed Ranks Test
b. Based on negative ranks.

Based on Table 8, the significance value in the Wilcoxon test was obtained at 0.000, indicating a difference in the mean value of the pretest and posttest cognitive learning outcomes. The significance result obtained is <0.05 which means that e-worksheet can be said to be effective.

Classical completeness test on pretest and posttest results of cognitive learning outcomes obtained the following results.

$$\text{Percentage of Classical Completion} = \frac{\Sigma \text{ students complete}}{\Sigma \text{ students}} \times 100\%$$

$$= \frac{30}{32} \times 100\% = 93.75\%$$

Based on the above calculations, it can be seen that the classical completeness of students gets a percentage of 93.75%. The percentage result is $\geq 85\%$ which means that the classical completeness of students' cognitive learning outcomes is achieved [25]. Based on the results obtained, it can be interpreted that the e-worksheet media is said to be effective for improving students' cognitive learning outcomes. In line with previous research that learning with the help of guided inquiry e-LKPD has an effect on students' cognitive learning outcomes [26].

On the results of the pretest and posttest values of critical thinking skills, a normality test was carried out to determine whether the data was normally distributed.

Table 9. Normality Test of Critical Thinking Skills Test

	Shapiro-Wilk		
	Statistic	df	Sig.
CTS Pretest Score	.944	32	.097
CTS Posttest Score	.954	32	.189

Based on Table 9, the normality test results for critical thinking skills obtained a significance value of 0.097 for pretest scores and 0.189 for posttest scores. These results indicate that the data is normally distributed because the significance value is <0.05 so that it can be continued with the t test analysis.

Table 10. Critical Thinking Skills Test T-test

		Paired Samples Test							
		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Pretest Score - Posttest Score	-43.125	7.272	1.286	-45.747	-40.503	-33.545	31	.000

Based on Table 10, the significance value in the t test is obtained at 0.000, which shows that there is a difference in the average value of the pretest and posttest of critical thinking skills. The significance result obtained is <0.05 which means that e-worksheet can be said to be effective.

The classical completeness test on the pretest and posttest results of critical thinking skills obtained the following results.

$$\text{Percentage of Classical Completion} = \frac{\Sigma \text{ students complete}}{\Sigma \text{ students}} \times 100\%$$

$$= \frac{31}{32} \times 100\% = 96.88\%$$

Based on the above calculation, it can be seen that the classical completeness of students gets a percentage of 96.88%. The percentage result is $\geq 85\%$ which means that the classical completeness of students' critical thinking skills is achieved [25]. Based on the results obtained, it can be interpreted that the e-worksheet media is said to be effective for training students' critical thinking skills.

Based on the pretest and posttest scores of students' critical thinking skills on each indicator, the percentage results are obtained as shown in the following table.

Table 11. Percentage Value of Critical Thinking Skills Indicators

Indicators	Percentage Value (%)	
	Pretest	Posttest
Interpretation	50.19	88.83
Analysis	47.19	87.77
Evaluation	35.98	83.52
Inference	40.63	85.80

Based on the percentage of pretest and posttest scores, it can be seen that the interpretation indicator gets the highest score compared to other indicators. Indicators with the highest to lowest scores in a row are interpretation, analysis, inference, and evaluation indicators. The order is proven to be the same between the percentage of pretest and posttest scores. The high percentage of interpretation indicators is because in this indicator students simply explain and formulate the meaning of a concept. This statement is supported by research which explains that in the interpretation indicator students only know the problems provided by writing what is understood or asked correctly [27]. While the small percentage of evaluation indicator scores is due to students not being able to provide an explanation of the relationship between the conclusions that have been obtained and the phenomena presented. In line with the statement, which states that inadequate skills in students come from the inability of students to write the final results, provide explanations and logical reasons for the conclusions drawn, so that it has an impact on students' critical thinking skills [28].

From the results of the validity, practicality, and effectiveness tests, the developed e-worksheet can be used as one of the learning media on chemical equilibrium material to train students' critical thinking skills. The e-worksheet has been equipped with learning activities in accordance with the steps of the inquiry learning model which are continuous with indicators of critical thinking skills. Through the activities contained in the e-worksheet can train students' critical thinking skills. The inquiry learning model is one of the learning models used in science learning and can be used to improve critical thinking skills [14].

Conclusion

Based on the results of the research and discussion previously described, it can be concluded that the developed inquiry-flipped classroom e-worksheet is feasible to use as learning media on chemical equilibrium material. Feasibility is based on the results of validity, practicality, and effectiveness assessments. Validity obtained a mode value of 5 in terms of content and construct validity with very valid criteria. The practicality of e-worksheet based on the students' response questionnaire obtained a percentage value of 98.08% with a very practical category and the results of student activity observations obtained a percentage at meeting 1 of 94.23%, meeting 2 of 93.34%, and meeting 3 of 93.78%. From the three activity percentages, the percentage of students' relevant activities was 93.78% with a very practical category. The effectiveness of e-worksheet is

based on the value of cognitive learning outcomes and critical thinking skills of students. The results of the pretest and posttest scores of students' cognitive learning outcomes get a sig value. 0.000 from the Wilcoxon test which shows there is an increase in student learning outcomes. In addition, the results of the pretest and posttest values of critical thinking skills get a sig value. 0.000 from the paired sample t-test which shows there is an increase in students' critical thinking skills. Meanwhile, the classical completeness test on the pretest and posttest scores of cognitive learning outcomes and critical thinking skills of students respectively obtained a percentage value of 93.75% and 96.88% which met the classical completeness standard. This research is only limited to the develop stage, so it is recommended for further researchers to continue to the disseminate stage. For teachers, the developed e-worksheet can be used as learning media on chemical equilibrium material to train students' critical thinking skills.

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