JURNAL PIJAR MIPA
https://jurnalfkip.unram.ac.id/index.php/JPM

ISSN 1907-1744 (Print)
ISSN 2460-1500 (Online)

Development of E-Worksheet Inquiry-Flipped Classroom on Chemical Equilibrium Material To Improve Students' Analytical Thinking Skills

Lailatul Maulidiya, Dian Novita*

Chemistry Education Study Program, Faculty of Mathematics and Natural Sciences, Surabaya State University, Suraya, Indonesia
*Email: diannovita@unesa.ac.id

Received: May 29, 2024. Accepted: July 8, 2024. Published: July 30, 2024

Abstract: One of the skills that students must have in the 21st century is analytical thinking skills. Learning media that can support this is needed to facilitate learning and practice analytical thinking skills. One learning media that can be used is an electronic student activity sheet (e-worksheet). This research aims to produce a product in the form of an e-worksheet suitable for use to improve students' analytical thinking skills on chemical equilibrium material. The feasibility of the e-worksheet is reviewed on its validity, effectiveness, and practicality. The method used is the research and development of 4D models consisting of definition, design, development, and deployment. This research was limited to the development stage by conducting a limited trial on students in grades XI-8 of SMAN 7 Surabaya who had studied chemical equilibrium material. The data collection technique of this research uses questionnaire, observation, and test methods. The research instruments used in this study include study sheets, validation sheets, student response questionnaire sheets, observation sheets, and test sheets. This study was analyzed using the N-gain test and the Wilcoxon test. The results of the validation of the e-worksheet from the aspects of content validity and construct validity obtained a mode of 4 so that it can be declared very valid for use. The results of the student response questionnaire reached an average of 98% positive responses in the very practical category. The results of the analysis of pretest and post-test data were obtained to improve analytical thinking skills, which was shown by 80% of students receiving an N-gain score of ≥ 0.7 with a high category and based on the Wilcoxon test, a P-Value value of 0.000 (< 0.05) was obtained which stated that there was a significant difference between the pretest and posttest scores Learners. From the results of the N-Gain analysis and the Wilcoxon Test, the e-worksheet was declared effective. It was concluded that the flipped classroom inquiry e-worksheet on chemical equilibrium material is suitable for training students' analytical thinking skills.

Keywords: Analytical Thinking Skills; Chemical Equilibrium; Inquiry.

Introduction

The 21st century is marked by the rapid development of knowledge and technology, including in education. In this era, education is a primary need so that students can innovate, master technology, and access information to survive with their life skills [1]. Students need to have the skills to analyze and use the information to solve problems in the real world [2]. One of the skills that students must have is analytical thinking skills reflected in graduate competency standards that emphasize the ability to analyze complex problems and ideas and convey indispensable arguments [3].

Chemical equilibrium is a science that requires a deeper understanding of the concept [4]. One of the learning objectives that students in chemical equilibrium subjects must master is to design, conduct experiments, and make scientific reports on factors that affect the shift in the direction of equilibrium collaboratively [5]. To achieve these learning goals, high analytical thinking skills are needed so that students can understand and analyze chemical equilibrium material, not only memorize the theories so that they do not trigger misconceptions.

It must be balanced by applying a learning model syntactically related to analytical thinking skills to improve analytical thinking skills in chemical equilibrium materials. One of them is the inquiry learning model. The inquiry model is a learning activity that emphasizes the process of critical thinking and analysis to find answers to a problem [6]. Concept discovery can help students understand the material more easily, actively participate in learning activities, and improve their analytical skills [7]. The inquiry learning model can be combined with the flipped classroom strategy.

The flipped classroom strategy can be used as a solution to overcoming the problem of limited time during learning in the classroom and the learning style gap experienced by students. Independent learning outside the classroom can provide more responsibility to students to understand the subject matter outside the classroom [8]. Implementing the flipped classroom strategy at the lowest level of the cognitive realm according to taxonomy, namely memorization and comprehension activities practised by themselves outside of class hours. Meanwhile, in the classroom, students are more focused on learning at a deeper cognitive level, namely analyzing [9].

How to Cite:
Maulidiya, L., & Novita, D. (2024). Development of E-Worksheet Inquiry-Flipped Classroom on Chemical Equilibrium Material To Improve Students' Analytical Thinking Skills. *Jurnal Pijar Mipa*, *19*(4), 649–656. https://doi.org/10.29303/jpm.v19i4.6939

In implementing a learning model, learning media that can contain the syntax of the learning model is needed. One learning media that can be used is an electronic student activity sheet (e-worksheet). E-worksheets can be created using the live worksheet website [10]. E-worksheets are used as a solution in this study because they can simplify and narrow the space and time so that learning becomes more effective and can increase students' enthusiasm for carrying out learning activities [11]. In addition, e-worksheets can contain the syntax of the inquiry learning model used and can include learning videos and virtual labs.

Based on the description of the problems that have been described above, the development of learning media is needed as an effort to improve analytical thinking skills in the learning process, one of which is chemical equilibrium material. Therefore it is necessary to conduct research with the title "Development of E- Worksheet Inquiry-Flipped Classroom on Chemical Equilibrium Materials to Improve Analytical Thinking Skills of Grade XI High School Students".

Research Methods

This research was conducted at SMAN 7 Surabaya in grades XI-8 in the even semester of the 2023/2024 school year. This type of research is research and development (R&D), as proposed by Thiagaragan. The development model, namely 4-D, consists of 4 main stages: define, design, development, and disseminate [12]. However, this study is only limited to the development stage by conducting limited trials.

The preliminary stage is an analysis stage that is carried out to obtain initial information about the characteristics of students in participating in learning activities and students' understanding of the concept of chemical equilibrium material. From this stage, researchers can formulate learning objectives for chemical equilibrium material. The design stage is preparing a draft of electronic student activity sheet media (e-worksheet). The development stage is a review, validation and limited testing stage using a one-group pretest-posttest design [14].

The data sources used in this study are primary data obtained from research instruments in the form of study sheets, validation sheets, observation sheets, questionnaire sheets, and student test sheets. Meanwhile, secondary data comes from sources in the literature that support this research**.** The data collection methods used are observation, questionnaire (analysis questionnaires, validation, responses), and test methods.

The validation questionnaire analysis uses the mode values of three validators. If the validation score is obtained ≥ 3, then the media developed is declared valid [15].

Table 1. Guttman Scale Score

Valuation	Response	Score
Yes	Positive	1
Not		0
Yes	Negative	0
Not		1

The data used to determine the product's practicality was obtained by filling out a questionnaire of student responses (quantitative data). The measurement scale used for practicality is the Guttman scale, as shown in Table 1[16].

Data from filling out student response questionnaires were analyzed using percentage analysis as follows :

$$\text{Practicallity percentage}(\%) = \frac{\sum \text{score obtained}}{\sum \text{maximum score}} \text{x } 100\%$$

The results of the response questionnaire are then used to determine the percentage of practicality interpreted in the practicality criteria table as follows [16].

Table 2. Percentage of Practicality Criteria

Percentage	Criterion
0.00%-20%	Impractical
20.1%-40%	Less Practical
40.1%-60%	Quite Practical
60.1%-80%	Practical
80.1%-100%	Very Practical

The e-worksheet learning media is said to be practical if it obtains a percentage of ≥ 61%. The e-worksheet learning media is said to be practical, but it obtained a percentage of ≥ 61%.

The data from student observations was analyzed to support the data from the student response questionnaire in analyzing the practicality of the e-worksheet. The scoring is based on the Guttman scale criteria, as shown in Table 1. The percentage of each student's activity is calculated using the following formula.

$$\text{Practicallity percentage}(\%) = \frac{\sum \text{score obtained}}{\sum \text{maximum score}} \text{x } 100\%$$

The results of the observation scores of student activities obtained were analyzed quantitatively using the interpretation of the scores shown in Table 2. The e-worksheet learning media is said to be practical, but it gets a percentage of ≥ 61%.

The analysis of test results in this study uses two types of analysis: the N-gain Test and the Wilcoxon Test. These two tests were conducted to see if there was a significant difference in students' analytical thinking skills after and before treatment. The test result data was obtained from the pretest (before treatment) and posttest (after treatment). The following formula can calculate the N-gain test:

$$\text{N} - \text{gain Score} = \frac{\text{posttest score} - \text{pretest score}}{\text{maximum score} - \text{pretest score}}$$

Furthermore, the n-gain obtained was interpreted using the n-gain score table to determine the improvement of learners' analytical thinking skills [17].

Table 3. N-gain Interpretation Criteria

Interval	Criterion
N-gain ≥ 0.7	High
0.3 ≤N-gain< 0.7	Medium
N-gain< 0.3	Low

In addition to the N-gain test, the Wilcoxon test was also carried out. The Wilcoxon test is a non-parametric test used to test hypotheses about an increase in students' analytical thinking skills if the data is not normally distributed [18]. The Wilcoxon test is performed using the Minitab program. The decision-making criteria on the Wilcoxon Test is that if the P-value value < 0.05, it can be concluded that there is a significant difference in the pretest and post-test data.

Results and Discussion

Define

This stage aims to define and collect various information related to the media to be developed to train students' analytical thinking skills [12]. In the preliminary stage, several types of activities are carried out, including initial analysis, student analysis, task analysis, concept analysis, and specification of learning objectives. The preliminary analysis aims to identify the main problems that students face in chemistry learning, which researchers will use to develop relevant learning media. The analysis was conducted based on related journals and interviews with chemistry teachers at SMAN 7 Surabaya. The interviews show that chemistry learning at the school is still teacher-centered, with teachers dominating the classroom and lacking time for students to learn effectively. A learning model that encourages active student participation is needed to overcome this, such as an inquiry model combined with a flipped classroom. The inquiry model allows students to find solutions to problems through thinking and observation. At the same time, the flipped classroom reverses the conventional classroom by asking students to understand the material outside of class hours, thus creating a more flexible and personalized learning environment [19].

Student analysis aims to understand the characteristics of students in learning. The results of the study of students at SMAN 7 Surabaya by providing a questionnaire showed that 70% of students considered chemical equilibrium material to require a deep understanding of concepts. To understand the material, students need analytical thinking skills, but the test results show that students' analytical skills are relatively low, namely elemental analysis 22.9%, relationship analysis 53.3%, and organizational principles analysis 17.1%. Students feel that the learning media used only contains material and practice questions, which makes them bored and less interested. The teacher also confirmed that the learning media used has not been effective in practicing analytical thinking skills. To overcome this problem, it is necessary to develop learning media that is more interactive and can increase students' enthusiasm and analytical thinking skills in learning chemical equilibrium material.

Concept analysis aims to find out the main concepts to be taught and systematically compile concepts from one another to form a concept map in the subject matter of chemical equilibrium. Therefore, a concept map of chemical equilibrium material is obtained, which can be seen in Figure 1.

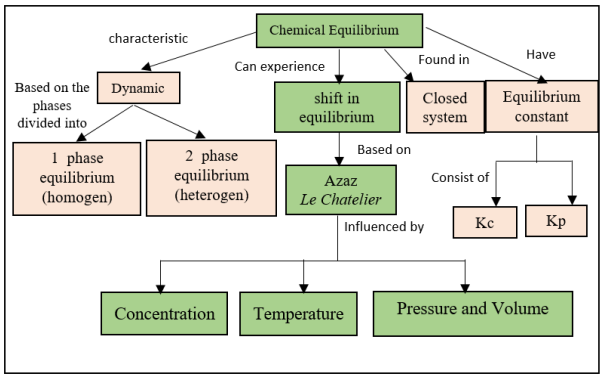

Figure 1. Chemical Equilibrium Concept Map

Task analysis aims to determine the content of the e-worksheet to be developed. E-worksheet will be adjusted to learning outcomes (CP) and learning objectives (TP) according to the independent curriculum at SMAN 7 Surabaya. The learning objectives to be achieved in this study are designing, conducting experiments, and making scientific reports on factors that affect equilibrium shifts collaboratively. Activities in the e-worksheet include reading phenomena, observing videos, formulating problems, determining hypotheses, conducting experiments, collecting and interpreting data, making inferences, and communicating results.

Design

At the design stage, researchers prepare an inquiry-flipped classroom e-worksheet tailored to the components of analytical thinking skills that will be trained in students. This stage begins with preparing tests to test students' analytical thinking skills and knowledge of chemical equilibrium material. The preparation for the test is divided into two parts, namely the initial test (pretest) and the final test (posttest). After that, it continued with the selection of media to be developed in this study, namely electronic student activity sheets (e-worksheets). The platform used to support e-worksheets is the liveworksheet website. Here's what the e-worksheet developed looks like.

Figure 2. E-worksheet Cover Display

The e-worksheet developed is also equipped with instructions to make it easier for students to use the features in the e-worksheet. Here's what the e-worksheet user instructions look like.

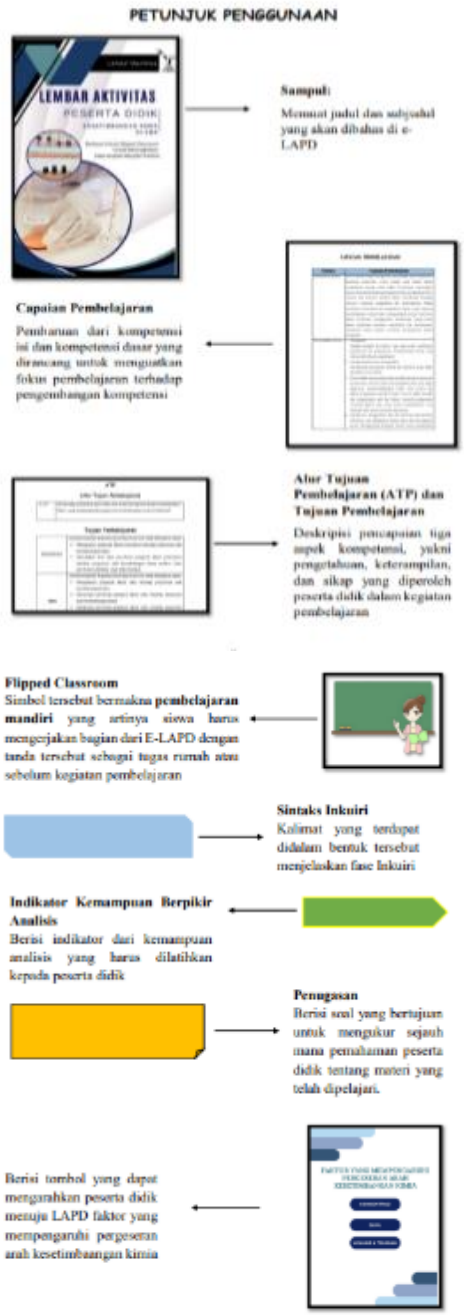

Figure 3. E-worksheet Instructions for Use

In e-worksheets, researchers use several media that can facilitate students' understanding of the material, encourage them to participate in learning, and improve analytical thinking skills actively. Some media used are Google Classroom, experimental videos, and laboratory activities directly or indirectly using virtual labs. Google Classroom is a platform used to support the flipped classroom strategy in this study. Before doing face-to-face learning, teachers share prerequisite understanding through Google Classroom, and students can learn the material before participating in face-to-face learning. In addition, Google Classroom is used to share assignments. Here's what looks Google Classroom.

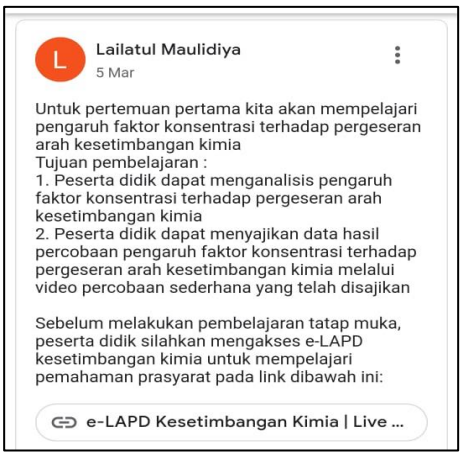

Figure 4. Google Clasroom Display

The e-worksheet developed by researchers is equipped with learning videos as learning media. This video contains experiments on the effect of concentration on shifts in the direction of chemical equilibrium carried out by researchers. Here's the test video.

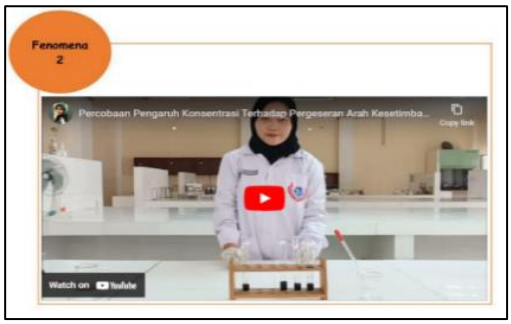

Figure 5. Ekperiment Video Display

Researchers also added laboratory activities carried out in person and virtually. In virtual laboratory activities, researchers use virtual labs. Here's what the virtual lab [20].

Figure 6. Virtual lab

Development

The development stage aims to determine the feasibility of the developed device. The eligibility criteria referred to in this study include validity, practicality, and effectiveness [12]. The validity aspect of this study was obtained from the validation sheets carried out by three validators. Before entering the validation stage, the e-worksheet is first reviewed by a chemistry lecturer. The study results are suggestions and comments on improving the e-worksheet before the validation stage.

The review of the e-worksheet to get suggestions and comments on the first cover of the e-worksheet must be accompanied by images that represent the material contained in the e-worksheet. In addition, the e-worksheet for the concentration factor phase 2 section is added with a learning video in the form of a concentration factor experiment on the shift in chemical equilibrium carried out by the researcher himself. After the e-worksheet was reviewed and improved, it was validated by three validators: two chemistry lecturers and one chemistry teacher. The validation assessed includes the validity of the content and the construct validity. The following is a recapitulation of the three validators.

Table 4. Recapitulation of an e-worksheet Validation Results

Validation Aspect	Valuation			Modus	Criterion
	V1	V2	V3		
Content Validity	3	4	4	4	Very valid
Construct Validity	3	4	4	4	Very valid

Based on Table 4, each mode obtained on the validity of content and construct is 4, so in this hall, the e-worksheet inquiry-flipped classroom media to train students' analytical thinking skills there is chemical equilibrium material can be said to be valid.

After going through the validation stage, to determine the practicality and effectiveness of the e-worksheet, a limited trial was carried out on 35 students of SMAN 7 Surabaya who had received chemical equilibrium material with heterogeneous abilities. The research was conducted on March 1-18, 2024, by conducting three meetings. The practicality of e-worksheets can be assessed through data from student response questionnaires and observations of student activities during learning activities.

Response questionnaires were distributed after students participated in learning activities using the inquiry-flipped classroom e-worksheet as a learning medium. The student response questionnaire contains statements about the appearance of the e-worksheet, the ease of features on the e-worksheet, and the completeness of information related to chemical equilibrium materials. The following are the results of the analysis of student response questionnaires.

Table 5. Result of Response Questionnaire Analysis

No.	Statement	Response (%)	Category
1.	The information presented in the e-worksheet is complete and easy to understand	100	
2.	The study instructions in the e-worksheet are less clear, making it difficult to use them	95	
3.	Inquiry-based e-worksheet makes chemical equilibrium materials more accessible to understand	85	
4.	The e-worksheet used can train me to analyze a phenomenon related to chemical equilibrium	100	
5.	Practice questions in an e-worksheet according to the material presented	100	Very Practical
6.	The experimental activities contained in the e-worksheet made it easier for me to understand the concept of chemical equilibrium	100	
7.	Images, videos, and virtual-labs on the e-worksheet do not match the content of the material	100	
8.	The language used is uncommunicative and unclear	100	
9.	I think the type and size of the letters used are appropriate and accessible to read	100	
10.	With e-worksheet media it adds practicality to learning about chemical equilibrium material	100	
	Average	98	Very Practical

From the response questionnaire analysis results, 98% of students agreed with positive statements and did not agree with negative statements contained in the response questionnaire. The results of observations of student activities support the results of the analysis of student response questionnaires. Five observers made observations, with 12 statements observed according to the inquiry phase, analytical thinking components, and students' effectiveness in following learning for three meetings. The following are the results of the analysis of observations of student activities.

Data from the analysis of student activity shows that during learning with three face-to-face meetings, student activities in the inquiry phase and the component of analytical thinking skills were carried out with a percentage range of 75%-100% at the first meeting, 75%-100% at the second meeting, and 90%-100% at the third meeting. The results obtained from the analysis of observations of student activities are in line with the results of the study of student response questionnaires. Following the practical criteria in Table 3, the flipped classroom inquiry e-worksheet is declared practical to be used as a learning medium for chemical equilibrium material to improve students' analytical thinking skills.

Furthermore, the feasibility of the effectiveness of the e-worksheet in this study was determined using the N-gain test and Wilcoxon test. The data used in this analysis was obtained from students' pretest and posttest results. The N-gain test is performed to determine whether or not there is a difference before and after treatment. The following are the results of the N-gain test analysis of learners.

Table 6. Result of Observation of Student Activities

No	Statement	Percentage (%)			Category
		P1	P2	P3	
1.	Students occupy their respective seats	80	85	90	
2.	Students read prayers before learning	100	100	100	
3.	Students listen well to the instructions for using the e-worksheet	85	75	90	
4.	Students listen to the teacher's explanation throughout the learning process	75	80	90	
5.	Students learn prerequisite knowledge and then work on the questions contained in phase 1 of the e-worksheet	80	90	95	
6.	Learners observe and understand phenomena related to factors that influence shifts in the direction of chemical equilibrium contained in the e-worksheet	90	90	95	
7.	Learners create hypotheses to explain phenomena	100	100	100	Very Practical
8.	Students observe experimental videos and experiments directly or indirectly using the virtual lab contained in the e-worksheet, then record the results of observations and experiments	100	100	100	
9.	Students work on the analytical questions contained in the e-worksheet and draw conclusions	100	100	100	
10.	Students associate hypotheses that have been made based on Phenomenon 1 with the conclusions obtained	100	100	100	
11.	e-worksheet makes students more enthusiastic during learning activities	85	100	90	
12.	Students upload the e-worksheet that has been done	100	100	100	

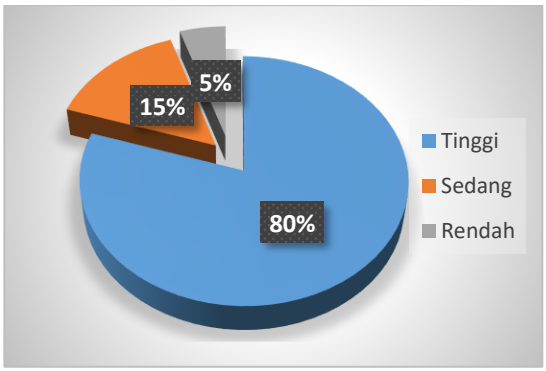

Figure 7. Analytical Thinking Skills N-gain score chart

The overall percentage of n-gain score data is presented as a diagram stating that students' analytical thinking skills have improved. As many as 80% of students get an n-gain score with high criteria, 15% get n-gain scores with medium criteria, and 5% get n-gain scores with low criteria. Analytical thinking skills are broken down based on their components: element analysis, relationship analysis, and organizational principle analysis [6]. The results of data analysis of analytical thinking skills tests based on their components are presented in the following table.

Table 7. Analytical Thinking Skills N-gain Analysis Result

No.	KBA Components	Value (%)		N-Gain Score	Category
		Pre	Pos		
1.	Elemental analysis	35.1	85.3	0.77	High
2.	Relationship analysis	36.2	78.5	0.66	Medium
3.	Analysis of organizational principles	31.8	80.5	0.71	High
		Average		0.71	High

Based on Table 7, an analysis of the analytical thinking skills test data revealed that n-gain score results were obtained with a range of 0.6 to 0.7 in the medium to high category. The components of analytical thinking skills, namely elemental analysis and analysis of organizational principles, get an n-gain value of 0.7 in the high category. However, one component of analytical thinking skills receives a lower n-gain value than the other components, namely relationship analysis, with an n-gain score of 0.6, which is in the medium category. Students are still weak in analyzing the relationship between equilibrium influencing factors and the phenomenon in question. Apart from that, some students still do not completely participate in learning activities, so the understanding of the concepts obtained is not optimal.

After carrying out the N-gain test, the Wilcoxon test was carried out to test the hypothesis about increased students' analytical thinking skills before and after treatment. The Wilcoxon test was carried out because the post-test data in this study were not normally distributed.

In Figure 8, a graph states that the pretest scores are normally distributed with a P-value of 0.100 (>0.05). Meanwhile, in Figure 9, a graph states that posttest students got a P-value of 0.010 (<0.05), so it can be concluded that the data is not normally distributed. Because the assumption of normality was not met, a non-parametric test was carried out, namely the Wilcoxon test. The Wilcoxon test in this study was explained using Minitab. The decision-making criteria for the Wilcoxon Test is if the P-Value is <0.05, then it can be concluded that there is a significant difference in the pretest and post-test data. Meanwhile, if the P-value value is > 0.05, it can be concluded that there is no significant difference in the pretest and posttest data. The following results were obtained via the Wilcoxon Test via the Minitab application.

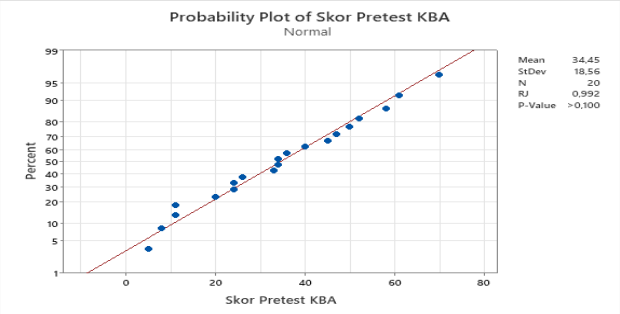

Figure 8. Analytical Thinking Skills Pretest Normality

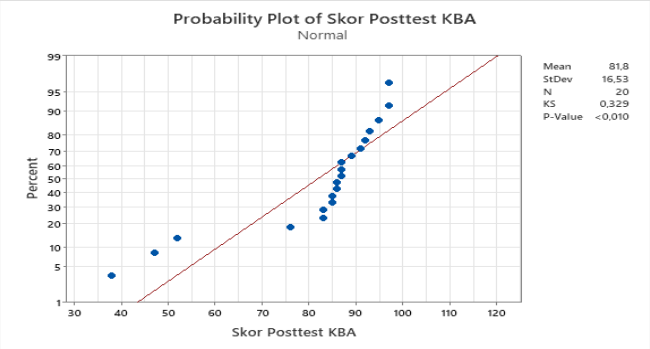

Figure 9. Analytical Thinking Skills Posttest Normality Test

Table 8. Wilcoxon analysis result

Descriptive Statistics

Sample	N	Median
DATA WILCOXON	20	-48

Test

Null hypothesis	H_0: $\eta = 0$
Alternative hypothesis	H_1: $\eta \neq 0$

Sample	N for Test	Wilcoxon Statistic	P-Value
DATA WILCOXON	20	0.00	0.000

Based on the results of the data analysis above, it can be seen that the P-value value obtained is 0.000 (< 0.05), so it can be concluded that there is a significant difference in the pretest and posttest data. So that the results Ha are accepted and Ho are rejected, it can be concluded that there is a substantial difference in students' scores before and after using the inquiry-flipped classroom e-worksheet to improve students' analytical thinking skills on chemical equilibrium material. The results of this research are also supported by Setiani, which stated that the development of e-LKPD using the inquiry learning model was effectively used to improve analytical thinking skills as indicated by an average score of pretest and posttest results of 90 [21].

Conclusion

E-worksheet inquiry-flipped classroom on chemical equilibrium material to improve analytical thinking skills of grade XI high school students is declared suitable for use as a learning medium. This is based on the results of media validity that obtained mode 4 with very valid criteria in terms of content and construct validity. In addition, from the practicality aspect, 98% of students gave positive responses, and the percentage of student activity during three meetings was in the range of 75%-90% with a very practical category, as well as effectiveness results based on pretest and posttest scores of analytical thinking skills as many as 80% of students had a gain score of ≥ 0.7 with a high category and based on the Wilcoxon test which had a P-Value value of 0.000 (< 0.05) it was stated that there was a difference significantly on pretest and posttest data.

Acknowledgements

The researcher would like to thank SMA Negeri 7 Surabaya for supporting and assisting in providing data and information as a goal in implementing this research.

References

[1] Wijaya, E. Y., Sudjimat, D. A., & Malang, U. N. (2016). Transformasi Pendidikan Abad 21 Sebagai Tuntutan Pengembangan Sumber Daya Manusia Di Era Gloal. *Prosiding Seminar Nasional Pendidikan Matematika* (pp. 263-278). Malang: Prosiding Seminar Nasional Pendidikan Matematika.

[2] O'Sullivan, M. K., & Dallas, K. B. (2010). Pendekatan Kolaboratif untuk Menerapkan Kererampilan Abad 21 di Kelas Penelitian Senior Sekolah Menengah Atas. *Perpustakaan Pendidikan*, 3-9.

[3] Kemenikbud. (2016). *Permendikbud No.24 tentang Standart Kompetensi Inti dan Kompetensi Dasar Pelajaran pada Kurikulum 2013*. Jakarta: Kementerian Pendidikan dan Kebudayaan.

[4] Chang, R. (2005). *Kimia Dasar Konsep-Konsep Inti*. Jakarta: Erlangga.

[5] Kemendikbudristek. (2022). *Keputusan Menteri Pendidikan, Kebudayaan, Riset, dan Teknologi Republik Indonesia Nomor 56/M/2022*.. Jakarta: Kementrian Pendidikan, Kebudayaan. Riset, dan Teknologi Republik Indonesia.

[6] Nilakusumawati, Desak Putu Eka; Asih, Ni Made. (2012). Kajian Teoritis Beberapa Model Pembelajaran. Bali: Universitas Udayana

[7] Novitasari, P. & Muchlis. (2020). Penerapan Model Pembelajaran Inkuiri Terbimbing untuk Meningkatkan Keterampilan Berpikir Analisis Siswa pada Materi Kesetimbangan Kimia Kelas XI SMA Negeri 4 Sidoarjo. *UNESA Journal of Chemical Education*. Vol. 9 (1): hal. 16-20.

[8] Milman, N. B. (2012). The Flipped Classroom Strategy, What is it and Can it Best be Used? *Jurnal International, IX*(3), 85-87.

[9] Ruwaidah, H. (2019). Proses Kognitif dalam Taksonomi Bloom Revisi: Analisis Kemampuan Mencipta (C6) Pada Pembelajaran Fikih di MI Miftahul Anwar Desa Banua Lawas. *Jurnal Pendidikan Madrasah Ibtidaiyah* , 51-76.

[10] Hazlita, S. (2021). Implementasi Pembelajaran dalam Jaringan dengan Menggunakan Instagram

dan Liveworksheet Pada Masa Pandemi. *Jurnal Inovasi dan Riset Akademi. JRA, II*(7): 1142-1150.
[11] Maullidyawati, T., Maulidiya, L., Rahmadani, R., & Hidayah, R. (2022). Pengembangan E-LKPD berbasis inkuiri flipped classroom pada materi kesetimbangan kimia untuk melatihkan literasi sains di era Merdeka Belajar. *UNESA Journal of Chemical Education*, *11*(2), 104-112.
[12] Thiagarajan, S., Semmel, D. S., & Semmel , M. I. (1974). *Intructional Development for Training Teacher of Exceptional Children* . Bloomington Indiana: Indiana University.
[13] Trianto. (2012). *Model Pembelajaran Terpadu*. Jakarta: Bumi Aksara.
[14] Sugiyono. (2016). *Metode Penelitian Kuantitatif, Kualitatif, dan R&D.* Bandung: Remaja Rosdakarya.
[15] Lutfi, A. (2021). *Research and Development (R&D): Implikasi dalam Pendidikan Kimia*. Surabaya: Jurusan Kimia FMIPA Unesa.
[16] Riduwan. (2015). *Dasar-Dasar Statistika.* Bandung: Alfabeta.
[17] Hake, R. R. (1999). *Analyzing Change/Gain Scores*. USA: Dept of Physics Indiana.
[18] Sugiyono. (2017). *Metode Penelitian Kuantitatif, Kualitatif, dan R&D.* Bandung: Remaja Rosdakarya.
[19] Katauhi, R. C., Widodo, W., & Sari, D. A. P. (2022). Implementation of the science e-module based on guided inquiry with the flipped classroom strategy to improve students science process skills. *Jurnal Pijar Mipa*, *17*(5), 657-665.
[20] Chemistry Smulation CK-12 Foundation. Diakses pada 10 Februari 2023, dari https://interactives.ck12.org/simulations/chemistry.html
[21] Anisah, D. C., & Nasrudin, H. (2023). Development of guided inquiry-oriented e-worksheets to improve students' science process skills in acid-base material. *Jurnal Pijar Mipa*, *18*(4), 449-458.