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Student Worksheet Using Toulmin's Argumentation Pattern on Chemical Equilibrium Materials to Improve Critical Thinking Skills

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Abstract: Student Worksheet Using Toulmin's Argumentation Pattern on Chemical Equilibrium Materials to Improve Critical Thinking Skills. This research purpose is to describe the feasibility of student worksheet using Toulmin's Argumentation Pattern on chemical equilibrium materials to improve critical thinking skills. The feasibility includes validity, practicality, and effectiveness. The method is R&D with a 4-D model. Validity in aspects of content, presentation, language, and graphics is very valid with percentages of 86%, 98%, 92%, and 80%. The practicality is very practical in terms of the results of student responses with a percentage of all aspects of 95% supported by observations of students' relevant activities at 3 meetings with percentages of 98%, 97%, and 98%. The effectiveness is very effective in terms of the n-gain score of the critical thinking skills test with an average of 0.72 supported by the Wilcoxon test with an Asymp score. Sig. (2-tailed) of 0.000 (H_a accepted) so the student worksheets have an influence on improving critical thinking skills.

Keywords: Student Worksheets, Toulmin's Argumentation Pattern, Chemical Equilibrium, Critical Thinking Skills.

Abstrak: LKPD dengan Toulmin's Argumentation Pattern (TAP) pada Materi Kesetimbangan Kimia untuk Meningkatkan Keterampilan Berpikir Kritis. *Penelitian ini tujuannya untuk mendeskripsikan kelayakan LKPD dengan Toulmin's Argumentation Pattern (TAP) pada materi kesetimbangan kimia agar keterampilan berpikir kritis dapat meningkat. Kelayakan LKPD meliputi validitas, kepraktisan, dan keefektifan. Metode penelitiannya ialah R&D menggunakan model 4-D. Hasil penelitian didapatkan bahwa validitas pada aspek isi, penyajian, kebahasaan, dan kegrafisan mendapatkan kriteria sangat valid, persentasenya yaitu 86%, 98%, 92%, dan 80%. Kepraktisan mendapatkan kriteria sangat praktis ditinjau dari hasil respon peserta didik terhadap LKPD dengan persentase dari keseluruhan aspek sebesar 94% didukung hasil observasi aktivitas relevan peserta didik pada 3 kali pertemuan dengan persentase 98%, 97%, dan 98%. Keefektifan mendapat kriteria sangat efektif ditinjau dari hasil n-gain score tes keterampilan berpikir kritis dengan rata-rata sebesar 0,72 yang menunjukkan kenaikan pada kategori tinggi didukung hasil uji Wilcoxon dengan nilai Asymp. Sig. (2-tailed) sebesar 0,000 (H_a diterima) yang artinya penggunaan LKPD yang dikembangkan memiliki pengaruh terhadap peningkatan keterampilan berpikir kritis.*

Kata kunci: *LKPD, Kesetimbangan Kimia, Keterampilan Berpikir Kritis, Toulmin's Argumentation Pattern (TAP)*

▪ INTRODUCTION

Education is a fundamental need for the lives of all mankind. Education has a crucial and important role in the civilization of a nation. The benchmark of progress and readiness of a nation to face the times can be seen in the quality of its education. Along with the quick progression of the sciences and technologies, the Indonesian government has to work to maintain the high standard of the national education system. When educational objectives are met, improvements in educational quality can be made. Improving the quality of education can be realized if educational goals are achieved. According to Permendikbud No. 36 of 2018, the goals of national education include efforts to equip students to compete in the 21st century equipped with communication skills, collaboration, critical thinking, and creativity.

Permendikbud No. 22 of 2016 states that the goal of the Indonesian curriculum is to train and enhance the skills of students, which can be achieved through activities that involve observing, analizyng, experimenting, reasoning, presenting, and creating (Kemendikbud, 2016). The curriculum is created to provide students with the broadest learning experience possible as they work to improve their capacity to behave, study, gain skills, and act (Kemendikbud, 2014). Currently, students need to be given opportunities to apply the knowledge they have gained to solve a problem (Cantika, 2022).

Chemistry, including the study of natural sciences, has scientific characteristics that are sequential, abstract, complex, and fast-growing. One of the chemistry topics discussed in high school grade XI is chemical equilibrium. Understanding this topic requires conceptual and algorithmic expertise. Chemical equilibrium has the characteristic of being one of the materials with abstract concepts that, according to most students, are difficult to learn. There are many concepts that must be understood in this chemical equilibrium material (Indriani et al., 2017; Sari et al., 2021).

Students' trouble understanding can be impacted by a variety of things, one of which is low-level thinking skills (Fadiawati et al., 2022). According to Partnership for 21st Century Skills (2009), students are taught scientific knowledge as well as higher-order thinking abilities since these skills are necessary in the competence framework of the 21st century. The ability to think at a higher level is important, one of which is critical thinking. According to the results of a questionnaire distributed to instructors at one of Surabaya's public high schools, pupils' critical thinking abilities remain relatively poor. Chemistry teachers claim that students with strong critical thinking skills are few and far between, with no more than ten students in each class. This statement is supported by data on tracking test results with subjects of 35 grade XI students at state high school in Surabaya. According to indicators of analysis, evaluation, inference, and self-regulation, showing the percentage of critical thinking skills of students with low, medium, and high interpretations of 74%, 20%, and 6%, respectively.

To help students understand chemical concepts and develop their critical thinking abiliti es, teachers need to incorporate media into their lesson plans. One of the learning media that is practical and widely used in learning is the student worksheet (Devy et al., 2020). As a form of innovation by educators, the creation of a student worksheet can be done by integrating various tactics, strategies, methods, or approaches. Integrating the student worksheet with argumentation methods can be an alternative and a strategy to improve critical thinking skills. One of the known methods of argumentation is Toulmin's Argumentation Pattern (TAP). According to some research, it is known that the use of TAP can improve critical thinking skills. Using TAP in learning processes can help to increase student engagement, increase learning effectiveness, and be used to practice, train, or develop students' critical thinking skills (Erduran et al., 2015; Safitri & Admoko, 2020; Mellenia & Admoko, 2022).

As stated by Jimenez-Aleixandre and Puig (2012), supporting the growth of critical thinking is one of the ways that argumentation contributes to the goal of education. The role that

argumentation plays in the critical thinking process, specifically in the use of arguments and evidence to assess knowledge and in the disposition to question conventional wisdom, can be distinguished depending on the task at hand, the context, and the topic under discussion. According to Jiménez-Aleixandre and Erduran (2007), at the argumentation stage, there are several relationships with critical thinking indicators. Student worksheet activities have referred to the intersection of the scientific argumentation stage with indicators of critical thinking skills.

According to Toulmin's argumentation diagram, there are six stages in the argumentation method: claim, data, warrant, backing, rebuttal, and qualifier (Toulmin, 2003). A claim is a statement made to relate two or more variables and is based on the results of scientific observations. To strengthen the stated statement of claims, the collection is carried out by processing facts at the data stage. The goal of the warrant stage is to create explanations that allow data and claims to be connected. Getting further evidence to support statements taken from textbooks and other relevant references is a process of backing. Rebuttal stage statements indicate a rebuttal of evidence or warrants against those deemed inappropriate will be rejected (Erduran & Osborne, 2004). The final step, qualifier, is described as the process of endorsing a claimed statement, which is universal and limited by words such as occasional, usually, mostly, or always (Handayani & Murniati, 2015; Muna & Rusmini, 2021; Jannati & Rusmini, 2022).

In accordance with the background described, research is needed to make a decent student worksheet to be able to improve critical thinking skills. This research was conducted to describe the feasibility of a student worksheet using TAP on the chemical equilibrium material for development.

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▪ METHOD

This research used the R&D method. This kind of research aims to create a product and evaluate its feasibility. The 4-D model devised by Thiagarajan, Semmel, and Semmel (1974) was used for R&D research, with processes comprising define, design, develop, and distribute. In this study, the stages were confined to the development process.

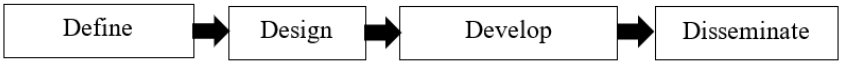

Figure 1. Steps of 4D Development Research Model

The method began with definition, namely, to define learning conditions, devices, and students as the background and basis for the development of the student worksheet. After that, proceed with the design step, namely by making the initial design of the student worksheet adjusted to the characteristics and needs obtained from the results in the define step. From the design that has been made, the next step is to develop the student worksheet. There were two steps in the development process: validation and limited trials. During the validation step, two chemistry lecturers from the State University of Surabaya and one chemistry teacher evaluated the student worksheet. After it was declared valid, the next step was to apply the student worksheet developed in the limited trial stage. In this research, the subjects were class XI students from one of the public high schools in Surabaya. Up to 32 students were used as test participants. The limited trial took place during the even semester of the 2022–2023 school year. The instruments utilized in this research were study sheets, validation sheets, response questionnaire sheets, student activity observation sheets, and critical thinking skills pre-test-post-test question sheets.

Validity was viewed as the result of the data validation score. The developed student worksheet was reviewed by providing suggestions and inputs for improvement, then revised and validated. Validation was carried out by giving scores on aspects of content, presentation, language, and graphics of the student worksheet. The analysis was then carried out with a quantitative descriptive method against the validation score obtained. Here are the score

interpretation guidelines used:

Table 1. Likert Scale

Score	Criteria
1	Unvalid
2	Less valid
3	Quite valid
4	Valid
5	Very valid

(Riduwan, 2013)

Data in the form of scores obtained in validation is ordinal data that has the nature of not being able to perform mathematical operations, namely added, subtracted, multiplied, and divided, so that the determination is done in mode or sees the highest number of score choices. In addition, other conditions are added, for example, the minimum allowable score. An appraiser or validator comes from experts according to the type of product development (Nuryadi et al., 2017). If it has mode 4 or 5, the student worksheet can be said to be valid. Based on the mode obtained, the percentage of the number of values on a scale of 4 (valid) and 5 (very valid) was calculated through the following formula:

$$\%\text{Validation score} = \frac{\text{the number of 4 or 5 scale that appear}}{\text{the number of aspect}} \times 100\%$$

Practicality was viewed from the results of the data analysis of student response questionnaires supported by relevant activity data. A student worksheet can be said to be practical if it gets an average percentage $\geq$ 71% of the results of responses and relevant activities. Questionnaire data were obtained with the following Guttman scale guidelines:

Table 2. Guttman Calculation Scale

Score	**Positive questions**	**Negative questions**
0	No	Yes
1	Yes	No

(Riduwan, 2013)

The formula for calculating the percentage of response questionnaires is as follows:

$$\%\text{Questionnaire score} = \frac{\text{number of scores obtained}}{\text{total score of all aspects}} \times 100\%$$

Then the percentage of response questionnaire results was averaged using the formula below:

$$\text{Average} = \frac{\text{total \% questionnaire score}}{\text{total number of student}}$$

Data on relevant activities of students in this research were obtained from filling out activity observation sheets for 3 meetings by 6 observers. The data obtained is then searched for percentages and averages. The learner relevant activity formula is obtained using the following formula:

$$\%\text{Relevant activities} = \frac{\text{the amount of activity that arises}}{\text{overall activity count}} \text{ x } 100\%$$

The percentage of relevant activity is then averaged using the formula below:

$$\text{Average} = \frac{\text{number of \% student activity}}{\text{total number of student}}$$

Each average of the questionnaire score and relevant activities can be interpreted based

on the criteria and guidelines below:

Table 3. Average Interpretation of Relevant Response and Activity Data

%average	Criteria
0 – 40	Impractical
41 – 55	Less practical
56 – 70	Quite practical
71 – 85	Practical
86 – 100	Very practical

(Riduwan, 2013)

The effectiveness was evaluated based on a comparison of pre-test and post-test scores of critical thinking skills. The one-group pre-test-post-test design was utilized, in which students were given an initial test (pre-test) before treatment, then provided (using the produced student worksheet in the learning process), and then given another test (post-test) after treatment. Four essay questions comprise the exam questions, which include indicators of analysis, explanation, inference, and self-regulation. pre- and post-test scores were examined using quantitative descriptive techniques and n-gain score computations. The formula for determining the n-gain score is as follows:

$$\text{N-gain score} = \frac{\text{post} - \text{pre}}{\text{maximum score (100)} - \text{pre}}$$

The N-gain score was then interpreted according to the following criteria:

Table 4. Score Interpretation

Score	Criteria
g ≥ 0,7	High
0,3 ≤ g < 0,7	Medium
g < 0,3	Low

(Hake, 1998)

According to Table 4, the student worksheet is effective if the results of the test on critical thinking skills have an n-gain score ≥ 0.30 (Riduwan, 2013). In addition, analysis is also carried out through statistical tests on research hypotheses. This statistical test used SPSS version 23. A prerequisite test required for analysis was a test of normality. The Shapiro-Wilk test was used to determine the normality of the data, followed by a hypothesis test. Hypothesis testing for normally distributed data is performed using the t test, but if the data is not normally distributed, then the Wilcoxon test is performed (if the data is abnormally distributed) (Nuryadi et al., 2017). The hypotheses were as follows:

H_0: $\mu 1 = \mu 2$ (there is no effect of using the developed student worksheet on improving students' critical thinking skills),

H_a: $\mu 1 \neq \mu 2$ (there is an effect of using the developed student worksheet on improving students' critical thinking skills).

With the following test criteria:

Asymp value. Sig. (2-tailed) < α (α = 0.05), H_a accepted or H_0 rejected,

Asymp value. Sig. (2-tailed) ≥ α (α = 0.05), H_a rejected or H_0 accepted.

▪ RESULT AND DISCUSSION

Research steps using a 4-D model created by Thiagarajan, Semmel, and Semmel (1974), including define, design, and limit to develop, were used to acquire the results of the research.

1. Define

The first stage is to identify the curriculum analysis, learning needs, students, tasks, and concepts. Based on the research findings, it is clear that the student worksheet must be in line with the times and the relevant curriculum. Students are expected to have 21st-century skills in conformity with the national education system's aims. One factor contributing to students poor critical thinking skills is their use of learning material that hasn't aided their critical thinking abilities. A chemistry teacher at one of the public high schools in Surabaya stated that the learning media used during chemistry lessons were not enough to make students' critical thinking skills improve. The tracking test of 35 learners also showed that 74% of them still did not have strong critical thinking skills. Only 35% of them had critical thinking skills on analysis indicators, 34% on explanation indicators, 59% on inference indicators, and 66% on self-regulation indicators. Based on this, research was conducted on critical thinking skills that need to be improved and how steps can be taken to improve them. The step is then adjusted to the needs and characteristics of the material. The material for the student worksheet is chemical equilibrium, namely sub-factors that affect chemical equilibrium. Material selection is based on the results of student questionnaires and tracking tests. Some studies also state that this material is difficult for students to understand. This material requires deep understanding and critical thinking skills because it presents an abstract and complex concept of equilibrium (Sugiarti & Farida 2013).

2. Design

The next step after defining is designing. The draft of the developed student worksheet will be generated in this step. This research developed 3 student worksheets on chemical equilibrium reaction material. Each student worksheet is created to study one factor that affects the shift of chemical equilibrium reactions. The display of the student worksheet cover design is presented in Figure 2.

(a) (b.1) (b.2) (b.3)

Figure 2. Sub Cover of Student Worksheet
(a) Main Cover
(b.1) Cover for Student Worksheet 1
(b.2) Cover for Student Worksheet 2
(b.3) Cover for Student Worksheet 3

The steps that can be taken when compiling a student worksheet are analyzing the curriculum, designing a map of student worksheet needs, determining the theme or title of the student worksheet, formulating competencies, determining assessment instruments, and compiling the material and structure of the student worksheet (Prastowo, 2011). In this development, the cover of the student worksheet provides an overview of the contents in the

student worksheet. According to the cover, it contains the title "Student Worksheet," a picture, a black label, a student identity column, and the names of the compiler and supervisor. The design of the content section of the student worksheet contains the preface, table of contents, identity of the student worksheet, learning objectives, student worksheet instructions, concept maps, stages of TAP, indicators of critical thinking skills, material summaries, problems or phenomena, and practice questions. Activities on the student worksheet carried out by students follow the stages of TAP, which has been adjusted to indicate indicators of critical thinking skills. There are claims, data, warrants (according to analysis indicators), backing and rebuttal (according to explanation indicators), and qualifiers (according to inference indicators). The view is presented in Figure 3.

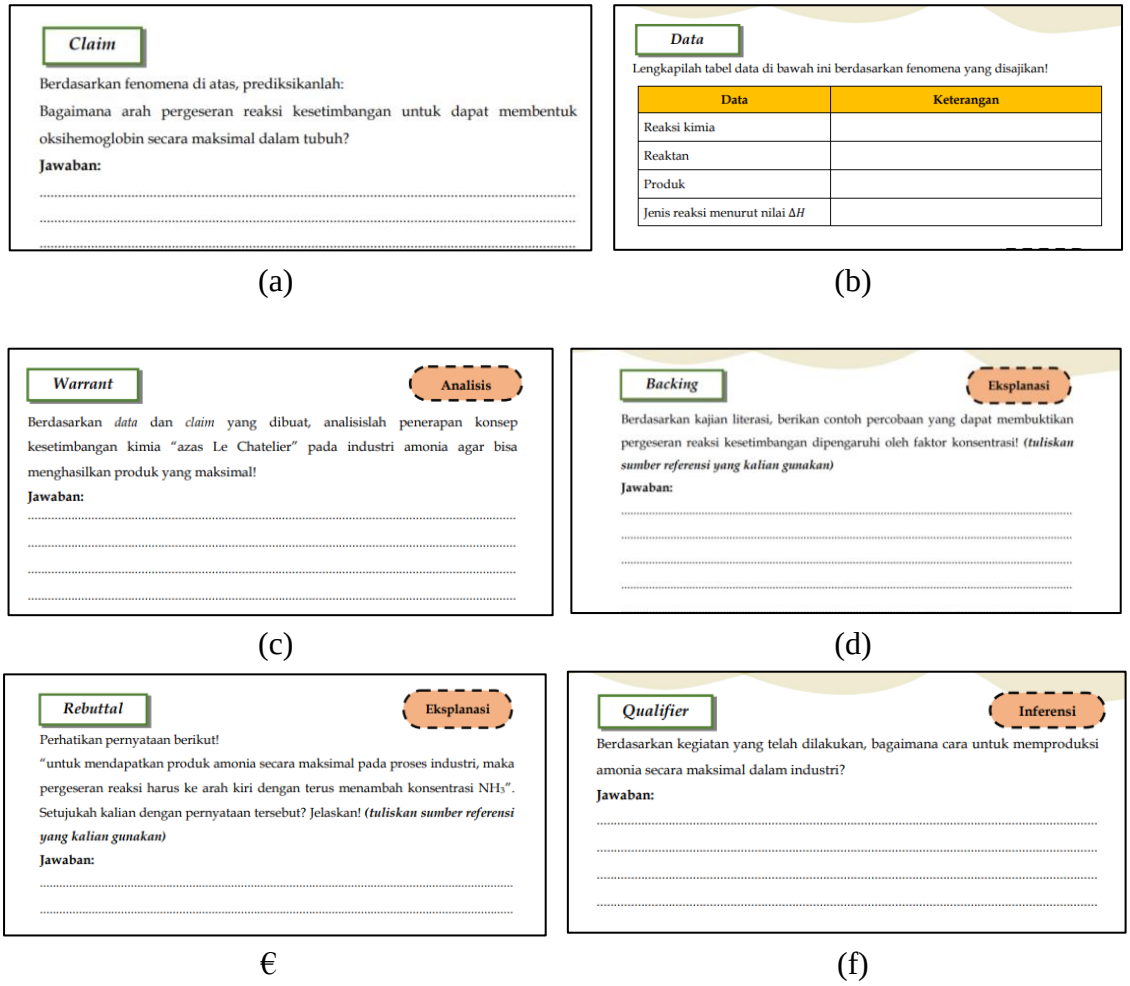

Figure 3. Display of TAP Stages in Student Worksheet
(a) Claim
(b) Data
(c) Warrant (adjusted to analytical indicators)
(d) Backing (in accordance with explanatory indicators)
(e) Rebuttal (in accordance with explanatory indicators)
(f) Qualifier (according to inference indicators)

Jimenez-Aleixandre and Puig (2012) proposed that one of the arguments' contributions to the goal of education is to assist the growth of critical thinking. The contribution of argumentation to critical thinking can be distinguished depending on the nature of the context and its task as well as the topic under discussion. Argumentation contributes to critical thinking

by using criteria and evidence to evaluate knowledge and disposition to search for reason and challenge authority.

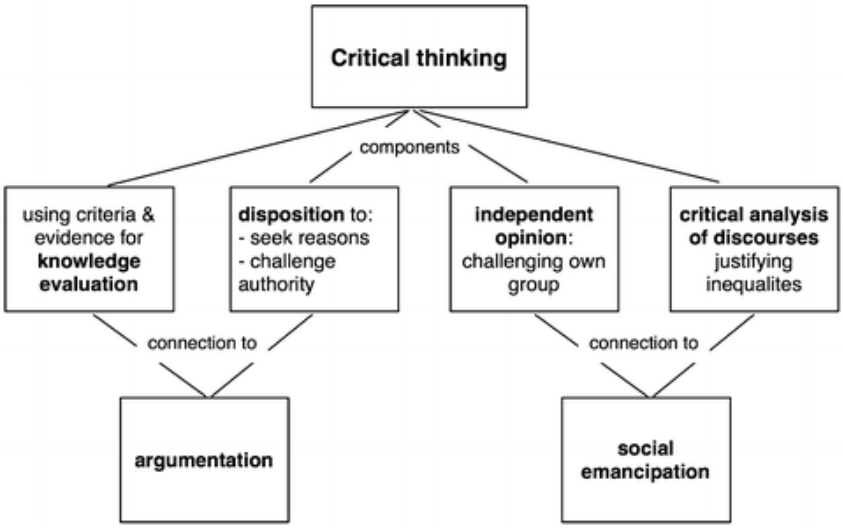

Figure 4. The potential contribution of argumentation to critical thinking (Jiménez-Aleixandre & Erduran, 2007)

Argumentation plays an important role in terms of explanations, models, and theories, as scientists use arguments to link the evidence they choose with the claims they achieve through the use of warrants and backing. Critical thinking is not only committed and based on evidence but also on the development of rational thinking to reflect on the influence of issues or information with relevance in one's life.

At the argumentation stage, there are several relationships with critical thinking indicators. The student worksheet activity has a reference to the intersection of the scientific argumentation stage with indicators of critical thinking skills. The warrant stage (scientific argumentation) has an intersecting relationship with the analysis indicator. Analysis indicators have the characteristic of identifying relationships among statements, questions, or concepts; testing ideas and data; identifying arguments; and analyzing arguments (Facione, 2015). This is in accordance with the warrant stage because this stage includes activities to conduct an analysis in the form of identification activities and data correlation (identification results) with claims (initial statements or hypotheses made) (Toulmin, 2003; Safitri & Admoko, 2020).

At the backing and rebuttal stages, there is conformity with critical thinking indicators, namely explanation. Backing is a stage to gather additional support for warrants for claims made and derived from textbooks and other related articles. Rebuttal is a process of justification in the form of rejection of claims, data, or warrants that are considered inappropriate (Toulmin, 2003; Erduran & Osborne, 2004; Muna & Rusmini, 2021). This is in accordance with the explanatory indicator, where this indicator has the characteristics of the process of stating or explaining the results of reasoning through consideration of evidence: conceptual, methodological, and contextual. Stating results, justifying procedures, and outlining arguments are all parts of an explanation (Facione, 2015).

At the qualifier stage, there is conformity with inference indicators. A qualifier is a statement of solidification or reinforcement of claims made that are universal and limited by words such as sometimes, usually most, or always. The qualifier feature also indicates the decision-making or conclusion on existing claims (Handayani & Murniati, 2015). Inference is defined as the process of identifying and gathering important information needed to make logical conclusions, construct conjectures, take relevant information into account, and infer

consequences or correlations from data, questions, situations, or other forms of representation (Facione, 2015).

3. Develop

The next step is development, which includes reviewing the student worksheet, revising based on the research results, validating the student worksheet, limited trials, and data analysis. Student worksheet draft I was produced after the design process was reviewed and revised, resulting in draft II, which was validated by two chemistry lecturers from the State University of Surabaya and one chemistry teacher. When the student worksheet is declared valid, it can be tested on a limited basis. This stage determines the feasibility, validity, practicality, and effectiveness of the student worksheet.

Validity

The validation process is obtained from the validation sheet instrument. student worksheet is declared valid if the score obtained is at least 4 from the three validators. The results obtained from the validation process are ordinal data, which cannot be performed mathematical operations, namely added, subtracted, multiplied, and divided, so that the determination is carried out in mode. The decision is set referring to the highest number of score choices. In addition, other conditions are added, for example the minimum allowable score. As an appraiser or validator comes from experts according to the type of product development (Nuryadi et al., 2017; Lutfi, 2021). According to Depdiknas (2008), The eligibility of student worksheet is assessed from the content criteria, language, presentation, and graphics. The validation results are presented as follows:

Table 5. Validation Results

No.	Validation aspects	% validation score		Mode	Criteria
		4	5		
1.	Content	14%	86%	5	Very valid
2.	Presentation	2%	98%	5	Very valid
3.	Language	8%	92%	5	Very valid
4.	graphics	20%	80%	5	Very valid

Based on Table 5, it is known that the student worksheet developed has met the criteria of being very valid in the aspects of content, presentation, language, and graphics. Content validity indicates the suitability of the content with the curriculum, the accuracy of information (facts, concepts, problems, questions, and answer keys) with the learning material, the suitability of the content with the stages of TAP, and conformity with critical thinking indicators, which include analysis, exhumation, inference, and self-regulation. There is construct validity in addition to content validity. Construct validity is broken down into presentational, linguistic, and graphical aspects (Prastowo, 2011). The construct validity of the presentation aspect shows the completeness of the features on the student worksheet, the completeness of the components of the TAP stages, and the completeness of critical thinking skills indicators. The construct validity of linguistic aspects shows the suitability of writing words and sentences on the student worksheet with the Indonesian General Spelling Guidelines, spelling correctness, and writing scientific or foreign terms. The construct validity of the graphical aspect shows the suitability of the layout settings on the student worksheet, including the display of images, fonts, symbols, and tables.

Practicality

The practicality of the student worksheet is seen from the results of the analysis of the response questionnaire data supported by relevant activity data obtained from the response questionnaire instrument and activity observation sheet. The response questionnaire is answered using the checklist method by selecting the answer, which is "yes" or "no." The response questionnaire data obtained were as follows:

Table 6. Student Response Results

No.	Statement	Score	% every aspect
1.	Student Worksheet has a cover with a clear title or identity.	32	100%
2.	The instructions on the student worksheet are clear and easy to understand.	31	97%
3.	There are clear learning objectives and activities.	32	100%
4.	The statements on the student worksheet are confusing.	27	84%
5.	There are clear learning resources or bibliographies.	29	91%
6.	The content and material on the student worksheet are useful, coherent, and clear, which helps my understanding of the material.	31	97%
7.	The student worksheet display is appealing and enjoyable.	30	94%
8.	Language is communicative, easy to understand, or does not cause double meanings.	28	88%
9.	The selection of layout, color, spacing, font, and size of writing or numbers is right and pleasing to the eye.	32	100%
10.	The content or material on the student worksheet is not coherent and difficult to understand.	29	91%
11.	Symbols, graphs, drawings, or illustrations on the student worksheet are legible and clearly visible	32	100%
12.	The student worksheet is boring.	28	88%
13.	The student worksheet helped me practice my critical thinking skills (analysis, explanation, inference, and self-regulation).	30	94%
14.	Student worksheet does not assist me in comprehending the material.	31	97%
15.	The student worksheet helped me practice my argumentation skills.	32	100%
	Average =	**0,95**	**95%**

The questionnaire has 15 questions, with 11 positive questions and 4 negative questions. Negative questions lie at points 4, 10, 12, and 14. Data from student response questionnaires is supported by activity observation data. Activity observation is carried out on relevant activities during learning using the developed student worksheet. Relevant activities include every activity related to learning, such as paying attention to teachers, responding to teachers, reading student worksheets, and doing student worksheets according to the stages of argumentation, namely claim, data, warrant, backing, rebuttal, qualifier, and critical thinking skills (analysis, explanation, inference, and self-regulation). Observations were made on each learner for three meetings by six observers. The data obtained are presented in Table 7.

Table 7. Student Activity Data

Meetings	Relevant activities (%)	Irrelevant activities (%)
1	98%	2%
2	97%	3%
3	98%	2%
Average	**97,67%**	**2,33%**

In Tables 6 and 7, it is known that the percentage of responses to questionnaires is 95%, or ≥ 71%, and the percentage of relevant activities among students in 3 meetings is 98%, 97%, and 98%, with the average result being 97,67%, which is ≥ 71%. The results indicate that the developed student worksheet that we use in the learning process was based on very practical criteria (Riduwan, 2013).

The effectiveness of the student worksheet is seen from the calculation of the n-gain score and Wilcoxon's non-parametric test on pre-test-post-test results on indicators of critical thinking skills including analysis, explanation, inference, and self-regulation. The form of the test used is an essay or written test. Here are the results of the learner test analysis:

Table 8. N-gain Score Critical Thinking Skills Test

Range	Frequency	%	Criteria
g ≥ 0,7	20	63%	High
0,3 ≤ g < 0,7	11	34%	Medium
g < 0,3	1	3%	Low
Total	**32**	**100%**	**-**
Average N-gain Score	**0,72**		**High**

Score results for the critical thinking skills test revealed that 63% of students met high criteria, 35% met medium criteria, and 3% met low criteria. The average n-gain score of the critical thinking skills test was 0.72, with interpretation being on the high side. Here are the percentages of each indicator in critical thinking skills:

Table 9. Percentage Comparison of Critical Thinking Components

	Analysis	Explanation	Inference	Self-Regulation
Pre-test	40%	39%	47%	61%
Post-test	83%	81%	88%	91%

Table 9 showed improvement in each indicator of students' critical thinking skills after learning using the developed student worksheet. In the analysis indicators, there was an increase of 43%, explanation by 42%, inference by 41%, and self-regulation by 30%. After the n-gain score analysis, the data analysis continued with a prerequisite test, the Shapiro-Wilk normality test. The results of such tests are presented in Table 10.

Table 10. Normality Test Results

	Shapiro-Wilk		
	Statistic	**df**	**Sig.**
Pre-test	0,940	32	0,75
Post-test	0,869	32	0,002

The criteria for the normality test are whether an asymptotic value is obtained. Sig. (2-tailed) > 0.05, the data is declared normally distributed. In table 10, it is known that the pre-test results are normally distributed, but the post-test results are not normally distributed, so it can be concluded that the data on critical thinking skills test results obtained have an abnormal

distribution. This causes the analysis to be a non-parametric test using Wilcoxon (Nuryadi at al., 2017). The formulation of the hypothesis is as follows:
H_0: $\mu 1 = \mu 2$ (there is no effect of using the developed student worksheet on improving students' critical thinking skills),
H_a: $\mu 1 \neq \mu 2$ (there is an effect of using the developed student worksheet on improving students' critical thinking skills).
With the following test criteria:
H_a accepted or H_0 rejected if the Asymp value. Sig. (2-tailed) < α (α = 0.05), then
H_a rejected or H_0 accepted if the Asymp value. Sig. (2-tailed) ≥ α (α = 0.05).

Test Statistics[a]

	PostKBKi - PreKBKi
Z	-4.947[b]
Asymp. Sig. (2-tailed)	.000

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

Figure 5. Wilcoxon Critical Thinking Skills Test Results

The result of the Wilcoxon test is an Asymp value. Sig. (2-tailed) < 0.05, which is 0.000. This number, with a value < 0.05, satisfies the criteria for accepting the hypothesis. H_a is accepted so that it is understood that using the student worksheet on critical thinking skills that was created the improvement in students' critical thinking abilities on markers of analysis, explanation, inference, and self-regulation demonstrates the impact of the student worksheet. This is consistent with some research that found that using the stages of scientific argumentation can improve students' critical thinking skills (Mellenia & Admoko, 2022; Roviati & Widodo, 2019; Susilawati et al., 2020).

Critical thinking skills are related to the stages of scientific argumentation, so the use of these stages can be done simultaneously to train scientific argumentation itself and critical thinking skills (Roviati & Widodo, 2019; Safitri & Admoko, 2020). The development of student worksheet is carried out to be able to achieve the critical thinking indicator, which is to utilize the intersection of the relationship between the two skills. The warrant stage (scientific argumentation) has relationships that intersect with analytical indicators, such as identifying relationships between variables, statements, questions, or concepts; testing ideas and data; identifying arguments; and analyzing arguments (Toulmin, 2003; Facione, 2015; Susilawati, 2020; Safitri & Admoko, 2020). The backing and rebuttal stages correspond to critical thinking indicators, which are explanations. The characteristics of relationships are the activities of collecting additional support, justification processes in the form of justification or denial of information and making explanations from the results of the analysis of a fact (Erduran & Osborne, 2004; Facione, 2015; Roviati & Widodo, 2019; Safitri & Admoko, 2020; Muna & Rusmini, 2021). At the qualifier stage, there is conformity with inference indicators, both of which have the characteristics of making a final statement or conclusion to a problem or consolidated statements by considering relevant information that has been achieved (Toulmin, 2003; Facione, 2015; Mellenia & Admoko, 2022).

▪ CONCLUSION

The conclusion of this research is that the student worksheet using TAP on the chemical equilibrium material developed is declared feasible, and students' critical thinking skills can

improve. The feasibility achieved meets very valid criteria, very practical, and very effective. The outcomes of this research are believed to be relevant and beneficial, and they could be used as a resource for other similar research requirements. It is suggested that future researchers develop a worksheet for students to hone their critical thinking abilities on additional indicators or by combining the worksheet with other tactics, strategies, methods, or approaches.

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