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An Innovative Guided Inquiry Worksheet Integrated with the Nested Approach to Enhance Students' Critical Thinking Skills in Chemical Equilibrium

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Abstract: This study aims to describe the feasibility of a guided inquiry-based worksheet integrated with a nested approach to train students' critical thinking skills in chemical equilibrium material. The feasibility of the worksheet is assessed from the aspects of validity, practicality, and effectiveness. The research method used is Research and Development (R&D), which uses the 4D development model by Thiagarajan (1974), which is limited to the stages of defining, designing, and developing. A limited trial was conducted in April 2025 on 29 high school students in Surabaya. The results of the study showed that the validity of the worksheet was included in the valid category with a median validity score of 5. The practicality of the worksheet was assessed as practical based on student responses (96.17%), and observation sheets ≥ 61% of student activities were relevant. The effectiveness of the worksheet was proven to be high, as indicated by the N-Gain analysis of the critical thinking skills test, which showed a high category. Based on these findings, it can be concluded that the guided inquiry-based worksheet integrated with a suitable approach for chemical equilibrium learning is suitable for use to improve student's critical thinking skills.

Keywords: Chemical equilibrium; Critical thinking skills; Guided inquiry; Nested approach; Worksheet

Introduction

Education is a systematic activity that encourages students to collaborate in learning to increase their potential and acquire the necessary skills (Sari & Jahro, 2023). The curriculum regulates the educational process and requires students to be able to act and think creatively and effectively through various activities. 4C (Critical Thinking, Creative, Collaborative, and Communication) is the basis of the curriculum based on the amendments made by the Regulation of the Minister of Education and Culture No. 20 to 23 of 2016.

According to the Trend International Mathematics and Science (TIMMS) Study results, Indonesian students are ranked 38th out of 42 countries, with an average score of 386 and a global average score of 500 (Khoeriyah et al., 2025). Meanwhile, the 2018 Program for International Student Assessment (PISA) Survey assessed 600,000 15-year-old students from 79 countries, showing that Indonesian students' mathematics and science abilities were 379, placing them in seventh position from the bottom, while the average for OECD member countries was 489. Based on the results of the PISA survey, the mathematics and science abilities of students in Indonesia are still in the low range because they have to use critical thinking skills to answer PISA questions (Sarifah & Nurita, 2023). Contextual questions from everyday life are HOTS standard questions tested in the PISA survey. This

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significant disparity in scores indicates that students' abilities in Indonesia are in the low category.

Surveys based on PISA and TIMMS focus on mathematics and science skills, and the indicators are closely related to students' thinking skills. Thinking skills are a tool to achieve learning goals. In the 21st century, critical thinking skills are considered fundamental tools, like reading and writing, which are very important. Humans in this century must also be able to think critically and accept rapid technological advances (Azizah et al., 2023). Critical thinking skills are rational and reflective thinking that focuses on deciding what to believe or do (Ali et al., 2023). Rational, logical, and critical thinking are necessary to build students' critical thinking skills. During the learning process, students do not have or are not trained in critical thinking skills because when the lecture method is carried out, they take a passive role, do not think, and receive information to memorize, so their learning process can be very low. Based on research Miftakhurrohmah et al. (2023), Teachers need to facilitate the development of students' critical thinking skills by presenting high-level questions, implementing two-way learning, and encouraging active student participation through scientific methods in the learning process.

Several experts have studied critical thinking skills, one of which is Facione, who identified six leading indicators: interpretation, analysis, explanation, evaluation, and self-regulation (Facione, 2016). Based on the results of the pre-study, the average critical thinking skills were obtained, namely Interpretation at 20.97%, Analysis at 10.75%, Explanation at 17.20%, Evaluation at 15.05%, Inference at 13.98% and Self-regulation at 40.86% which was carried out at one of the Surabaya State High Schools on April 22, 2024, which took a sample of class XI-5 of 31 students through a pre-study questionnaire on critical thinking skills. It can be concluded from the pre-study results that students' critical thinking skills are in the very low category. This is also true of the results of interviews with chemistry teachers who said students' critical thinking skills are low, especially in making analyses and explaining. Because critical thinking skills allow students to learn while working, this ability is considered vital and cannot be separated from the education process. One of the components of thinking that helps overcome obstacles and makes knowledge easier to obtain in everyday life is critical thinking (Solikah et al., 2024).

Critical thinking skills are critical for students to have so that learning runs smoothly. In learning in schools, especially in chemistry material, critical thinking skills are needed by students. Fundamental and complex concepts can make students think, solve, and be critical. One of the chemistry learning materials studied by students is chemical equilibrium. Chemical equilibrium has sub-materials of factors that affect the direction of shifts in chemical equilibrium. There are several reasons why the topic of chemical equilibrium is complex for students to understand, including the difficulty of students in calculating and understanding the concept as a whole because they only memorize (Ayunda & Azhar, 2023). In addition, students showed difficulty in applying the concept of chemical equilibrium in authentic contexts. This indicates that meaningful learning involving clear and concrete objects and contextual materials can significantly improve students' memory. Mastery and understanding of fundamental concepts that are prerequisites for learning advanced concepts are necessary for students (Dewi et al., 2023).

Learning models in chemistry learning are very important to be applied to overcome the problem of students' lack of understanding related to learning materials, especially chemical equilibrium. According to constructivism theory, the inquiry learning paradigm is the most effective learning model. The guided inquiry learning model is a learning model that is centered on students (Faradilla et al., 2023). Inquiry learning teaches students how to create and test hypotheses to solve problems. This can make students more actively involved in the learning process so that they can connect their new ideas with the ones they already have (Royani & Atun, 2023). Arend divides the guided inquiry learning model into six learning syntaxes, including focusing attention and explaining the inquiry process; presenting inquiry problems and phenomena; formulating hypotheses to explain problems or phenomena; collecting data to test hypotheses; formulating explanations or conclusions; and reflecting on the thinking process and problem situations (Arends, 2009). The guided inquiry learning model emphasizes chemistry as a learning process and the critical thinking process of students to seek and find answers to existing problems.

Despite its shortcomings, such as requiring students to have prerequisite skills for the learning process to run smoothly, mental readiness, and adequate facilities, the guided inquiry learning model can highlight critical thinking talents. The nested approach is used as an innovation in guided inquiry learning to cover up these weaknesses. The nested approach integrates curriculum or learning strategies that utilize students' abilities to master a subject through a tiered arrangement approach. The nested integration approach focuses on various combinations of knowledge and skills in one subject. Types of nested approach skills include (a) thinking skills, (b) social skills, and (c) organizational skills. The learning abilities of 21st-century students are enhanced by using the Nested Approach to learning, which combines organizational and cognitive skills (Halimah et al., 2023). This study's nested approach is limited to thinking and organizational skills.

The learning model will be optimal if it uses teaching materials as media in classroom learning activities. Worksheets are printed teaching materials in the form of sheets that contain materials, summaries, and instructions for students to complete tasks related to basic competencies that must be achieved. The development of worksheets is intended to facilitate and assist in teaching and learning activities so that effective and active interactions will be formed between students so that it can improve student learning achievement (Nurlian et al., 2023).

Based on several things described, the development of integrated guided inquiry worksheets with a nested approach aims to train students' critical thinking skills on chemical equilibrium material that combines a guided inquiry learning model with a nested approach and learning media in the form of worksheets. This learning media is expected to train students' critical thinking patterns in analyzing problems in everyday life related to chemical equilibrium material and can improve student learning outcomes.

Method

Research and Development (R&D) is a method used to produce specific products and test the effectiveness of the resulting products (Sugiyono, 2013). The research model used is the 4-D Thiagarajan model. The 4-D model consists of Define, Design, Develop and Disseminate. However, this study is limited to the development stage only. The following is the research flow of Thiagarajan's 4-D model:

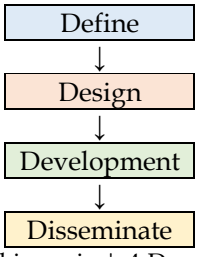

Figure 1. Thiagarajan's 4-D research flow

At the define stage, front-end and student needs analyses are carried out. Media planning is carried out at the design stage, including media selection, format selection, and initial worksheet design. The development stage is to develop worksheets designed and validated by media and content expert validators (two chemistry education lecturers and one chemistry teacher). Furthermore, a feasibility test is carried out by conducting a limited trial on students. The validation data were analyzed using a quantitative descriptive method in the form of a percentage obtained based on calculating the assessment score criteria using the Likert Scale, which can be seen in Table 1.

Table 1. Likert Scale (Riduwan, 2008)

Value	Assessment
1	Very bad
2	Bad
3	Quite good
4	Good
5	Very good

The assessment result data is analyzed on each indicator using the median. It is declared valid if the minimum score is three because a score ≥ 3 has been declared valid. If the score is less than 3 (for example, getting a score of 1 or 2), the media must be returned to the relevant validator for further consultation.

The research design used is One Group Pretest-Posttest. According to Sugiyono (2013), the pretest-posttest group design is a research design with a process of the understanding test (pretest) before the sample is given treatment and the understanding test again after the sample is given treatment (posttest). In contrast, in the study, the treatment tests integrated guided inquiry worksheets with a nested approach to improve critical thinking skills. Therefore, comparing the results before and after the treatment can be known more accurately.

The data collection technique was carried out using a questionnaire method that used an instrument in the form of a student response questionnaire and a test method using a pretest-posttest question instrument for critical thinking skills. The implementation stage of data collection began by providing pretest questions before being given the treatment used to measure students' initial critical thinking skills (Afandi & Dwiningsih, 2023). After conducting the pretest, it continued with learning using worksheets for several meetings designed according to the time allocation in the curriculum. After the learning was completed, students were given posttest questions, which were used to measure students' critical thinking skills after using the worksheets. After conducting the posttest, students at the end of the learning filled out a response questionnaire regarding using worksheets during the learning process.

The data obtained from pretest-posttest scores was analyzed descriptively using the N-Gain Score calculation. The N-Gain Score is used to determine the increase in students' pretest and posttest; here is the N-Gain Score formula:

$$g = \frac{posttest\ score - pretest\ score}{Ideal\ score - pretest\ score} \quad (1)$$

The calculation results of the value (g) are interpreted according to the criteria in Table 2.

Table 2. N-gain Score Interpretation Criteria (Hake, 1998)

Value range	Category
G ≥ 0.7	High
0.3 ≤ G < 0.7	Medium
G < 0.3	Low

Based on these criteria, the worksheet is declared effective if there is an increase in the N-gain Score of 0.3 ≤ G < 0.7 with a medium category and an N-gain score value ≥ 0.7 with a high category.

The data from the student response questionnaire regarding the ease of using LKPD were collected using the Guttman scale. Measurement with the Guttman scale aims to obtain a firm answer as "Yes" or "No". Furthermore, the student response data was analyzed as a percentage and interpreted based on the response criteria in Table 3 below.

Table 3. Response Score Interpretation Criteria (Riduwan, 2008)

Presentation (%)	Assessment
< 61	Impractical, practical
≥ 61	Practical

If the research results percentage is ≥61%, then the LKPD that is developed has practical criteria (Riduwan, 2008).

Result and Discussion

Result

A study was conducted to analyze students' critical thinking skills after using the nested approach integrated inquiry worksheet. The first stage was defining with front-end analysis and student needs analysis. This student analysis was in the form of interviews with chemistry teachers at one of the State Senior High Schools in Surabaya City. Based on the interview results, the characteristics of class XII students, namely learning interest and critical thinking skills, are still relatively low. The results of the pre-research questionnaire evidence this. As many as 74% of students said that Chemistry lessons at school are lessons that are relatively difficult to understand, and the pre-research test of critical thinking skills for all indicators is still below 75%, so based on these findings, learning media is needed can attract students' interest in learning while improving critical thinking skills.

At the design stage, media planning is carried out, which is developed in the form of media selection, format selection, and initial design of the worksheet. The concept of the worksheet used is to train critical thinking skills in the guided inquiry learning model integrated with the nested approach. The worksheet is designed as attractively as possible, so students' interest in learning is high. The worksheet format includes a cover, foreword, table of contents, concept map, worksheet instructions, introduction (CP and TP), learning activities according to the syntax of guided inquiry integrated with the nested approach, and bibliography. The designed worksheet trains critical thinking skills, namely interpretation, analysis, evaluation, inference, explanation, and self-regulation (Facione, 2016). The learning model used is a guided inquiry integrated with a nested approach that appears according to the phase on the worksheet. The following is a display of the developed worksheet.

(a) (b) (c) (d)

Figure 2. LKPD design (a) the main cover of the worksheet, (b) the cover of the worksheet for each factor, (c) indicators of critical thinking skills according to the syntax of guided inquiry, and (d) indicators of the nested organizing approach (making observations bold)

At the development stage, after the worksheet has been developed, validation is carried out with expert media and content validators, namely two chemistry education lecturers and one chemistry teacher.

Validation assesses whether the developed worksheet meets the eligibility standards regarding content and construct aspects. The research instrument, which consists of pretest-posttest questions and student response questionnaires, is also validated.

Validation includes two aspects, namely content and construct validity. The validation data is in the form of ordinal data that has the nature of not being able to perform mathematical operations, so the median determines it. The median obtained is then interpreted on a Likert scale. It is declared valid if the minimum score is three because a score ≥ 3 has been declared valid. If the score is less than 3 (for example, getting a score of 1 or 2), the media must be returned to the relevant validator for further consultation.

Based on the validation results by expert media and content validators (two chemistry education lecturers and one chemistry teacher), the validity of the worksheet content, pretest-posttest questions, and response questionnaires developed obtained a median of 5 with valid criteria. Meanwhile, construct validity obtained a median of 5 with a valid category. This indicates that the worksheet, pretest-posttest questions, and response questionnaire developed is suitable for use in limited trials; however, before the limited trial, the worksheet, pretest-posttest questions, and response questionnaire developed were revised according to the input given by the validator.

The next stage is a limited trial conducted in one of the State Senior High Schools in Surabaya City, which aims to obtain pretest-posttest value data (effectiveness) and student response questionnaires (practicality) after learning the integrated guided inquiry worksheet with a nested approach. Practicality is reviewed by filling out the student response questionnaire, which aims to determine student responses to the integrated guided inquiry worksheet with an approach to train students' critical thinking skills in chemical equilibrium material. The results show that all aspects of the student response questions obtained a percentage of ≥ 61% with an overall average of 96.17%, which is included in the practical category. The results of the student response questionnaire are also supported by the student activity observation sheet filled out by three observers when the limited trial was conducted. Effectiveness is obtained from the results of the pretest and posttest scores of students' critical thinking skills. The critical thinking skills test on chemical equilibrium material has 13 essay questions and three self-regulation questions. After obtaining the pretest and posttest results, it can be concluded that there is an increase in students' critical thinking skills after learning an integrated guided inquiry worksheet approach to train them on chemical equilibrium material. The following is a table 4 of pretest and posttest data processing results according to aspects of critical thinking skills.

Table 4. Recap of Critical Thinking Skills Test Data

Indicator	Score presentation (%) Pretest	Posttest	N-gain score	Category
Interpretation	45.11	93.68	0.88	High
Analysis	30.17	90.23	0.86	High
Explanation	19.54	86.21	0.83	High
Evaluation	18.97	82.76	0.79	High
Inference	22.99	91.95	0.90	High
Self-regulation				89,66 %

In addition, the pretest and posttest results of students were recapitulated using the n-gain test to determine the increase in students' critical thinking skills. The following is the n-gain test data of each student's critical thinking ability test results, as seen in Table 5 and the graph below.

Table 5. Data on Critical Thinking Skills Test Results for Students

Student	Pretest score	Posttest score	N-gain score	Category
1	10	37	0.84	High
2	7	27	0.57	Medium
3	12	36	0.80	High
4	15	38	0.85	High
5	9	38	0.88	High
6	13	35	0.76	High
7	13	36	0.79	High
8	10	35	0.78	High
9	17	38	0.84	High
10	11	38	0.87	High
11	14	34	0.71	High
12	24	37	0.72	High
13	10	38	0.88	High
14	13	37	0.83	High
15	6	30	0.67	Medium
16	12	38	0.87	High
17	3	30	0.69	Medium
18	7	33	0.74	High
19	7	35	0.80	High
20	15	37	0.81	High
21	16	35	0.73	High
22	16	37	0.81	High
23	13	33	0.69	Medium
24	9	29	0.61	Medium
25	14	35	0.75	High
26	10	38	0.88	High
27	19	35	0.70	High
28	19	36	0.74	High
29	8	34	0.76	High

Based on the N-Gain Score data graph of the pretest and post-test results on critical thinking skills questions, five students get an N-Gain score in the range of $0.3 \leq G < 0.7$ with a medium category; this indicates that each student's critical thinking skills have increased in the

medium category. In addition, 24 students get an N-Gain score in the range of G ≥ 0.7 with a high category; this indicates that each student's critical thinking skills have increased in the high category.

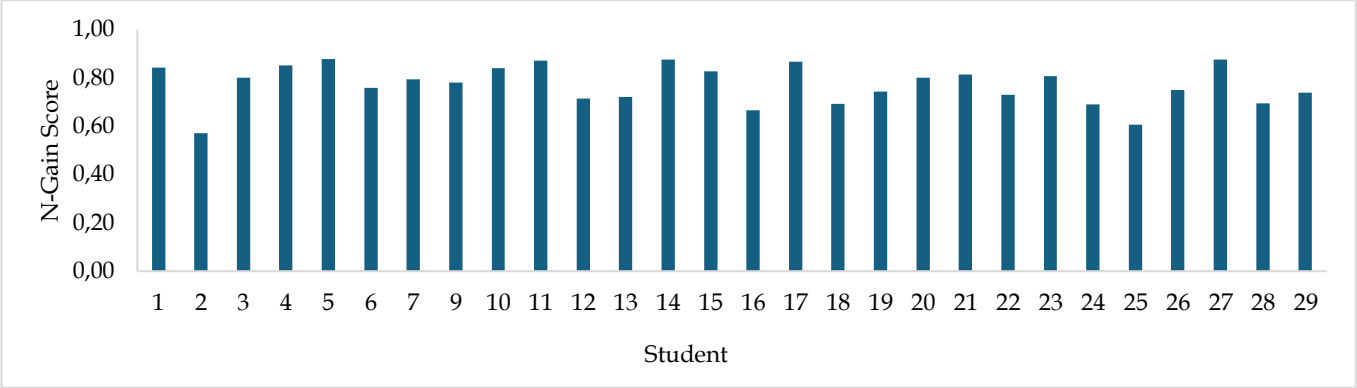

Figure 3. Graph of students' n-gain score results

Discussion

The integrated guided inquiry worksheet with a nested approach developed on chemical equilibrium material is declared feasible for learning based on the research results. The feasibility of this media is proven through content validity with a median of 5 and construct validity with a median of 5, both of which are in the valid category. In terms of practicality, the results of the student response questionnaire showed a score of ≥ 61%, which is 96.17% in each aspect measured so that it is declared practical.

The effectiveness of the worksheet is reviewed from the pretest and posttest scores using the research instrument of the critical thinking skills test sheet. Before learning is carried out using the integrated guided inquiry worksheet with a nested approach to train students' critical thinking skills on chemical equilibrium material. Students are asked to work on the pretest sheet that has been prepared to identify students' initial abilities. Students are then asked to group 6 people in one group to work on the integrated guided inquiry worksheet with a nested approach to train students' critical thinking skills with sub-materials of concentration, temperature, volume, and pressure factors. Students are then asked to complete the posttest sheet that has been filled in to determine the final abilities of students after completing the worksheet.

The pretest and posttest results were then tested descriptively quantitatively using n-gain score analysis. Furthermore, the n-gain score results were interpreted based on the criteria and declared effective if they could increase the n-gain score by more than 0.3 into the medium or high category. After reviewing the pretest and posttest data, it was found that five students got an N-Gain score in the range of 0.3 ≤ G < 0.7 with a medium category; this indicates that each student's critical thinking skills increased in the medium category. In addition, 24 students got an N-Gain score in the range of G ≥ 0.7 with a high category; this indicates that each student's critical thinking skills increased in the high category.

So, the integrated guided inquiry worksheet with a nested approach to train students' critical thinking skills on chemical equilibrium material is said to be effective in developing students' critical thinking skills. The following is a description of the effectiveness of the worksheet in terms of each indicator of critical thinking skills:

Interpretation

The results of the pretest and post-test of critical thinking skills showed an increase in the KBK score on the interpretation indicator with an N-Gain score of 0.88 (high category) after using the worksheet because the range of N-Gain scores ≥ 0.7 is included in the high category. The interpretation indicator trained critical thinking skills in this study with four descriptive questions. Interpretation is understanding and conveying the meaning or significance of various case studies, situations, data, observations, conclusions, beliefs, conventions, procedures, or criteria (Facione, 2016).

After conducting the pretest activity, students are trained in critical thinking skills using a worksheet developed based on integrated guided inquiry with a nested approach. In the integrated inquiry worksheet with a nested approach that was developed, students are trained in critical thinking skills on the interpretation indicator by identifying problems based on the phenomena presented, formulating problems, determining experimental variables, making experimental hypotheses, and making experimental steps according to the presented lab phenomena to making an experimental table.

Students' critical thinking skills on the interpretation indicator are trained through a guided inquiry learning model in phases 1-4. Students are trained to identify problems, formulate problems, determine variables, make hypotheses, arrange experimental steps, and make tables. In addition to the guided inquiry learning model that trains critical thinking skills on interpretation indicators, the nested approach also appears in this case. Making this experimental table, in addition to training the interpretation indicator on critical thinking skills, also trains the organizing indicator, which is included in the nested approach. The organizing indicator trains students to make an experimental table according to the data from the practicum that has been carried out. Students create an experimental table by considering writing down the treatments given and the results of the treatments given in table form.

After being given treatment using worksheets with the help or direction of the teacher, students answered the posttest questions better, so there was an increase. This increase occurred because students gained a deeper understanding of related concepts through learning experiences from discovery-based learning, namely inquiry learning carried out with teacher guidance. Thus, students could solve questions that referred to interpretation indicators correctly. In addition, students also learned to formulate problems involving interrelated manipulation variables and response variables (Ramadhanti & Agustini, 2021).

Analysis

The results of the pretest and post-test of critical thinking skills showed an increase in the KBK score on the analysis indicator with an N-Gain score of 0.86 (high category) after using the worksheet because the range of N-Gain scores ≥ 0.7 is included in the high category. In this study, the analysis indicator was trained in critical thinking skills in as many as four descriptive questions in the pretest and post-test questions.

After carrying out the pretest activities, students were trained in critical thinking skills using worksheets developed based on guided inquiry integrated with a nested approach. In the integrated inquiry worksheet with a nested approach, students were trained in critical thinking skills on the analysis indicator by analyzing several questions related to the practicum results that had been obtained so that they could conclude.

The ability to categorize according to the relationship between concepts, facts, and questions raised by the problem is known as analysis (Facione, 2016). When students work on worksheets, Critical thinking skills are trained in analyzing the results of experiments. Critical thinking skills are trained in phase 5, namely formulating explanations and conclusions on analysis indicators. After being given treatment using worksheets with the help or direction of the teacher, students answered the posttest questions better, so there was an increase. There was an increase in the results of the pretest and posttest of students on the analysis indicator. This is because, during the limited trial, they were trained to analyze the results of experiments included in phase 5 of the guided inquiry model, namely formulating explanations and conclusions on the developed worksheets. The ability to compare facts to determine possible cause-and-effect correlations is known as analytical skills. Examples of students' analytical skills include evaluating concepts, identifying and evaluating arguments, and many more (Zahroh & Yuliani, 2021).

Explanation

The results of the pretest and post-test of critical thinking skills showed an increase in the KBK score on the explanation indicator with an N-Gain score of 0.83 (high category) after using the worksheet because in the range of N-Gain scores ≥ 0.7 it is included in the high category. This study trained the explanation indicator in critical thinking skills with one descriptive question. After carrying out the pretest activity, students were trained in critical thinking skills using a worksheet developed based on guided inquiry integrated with a nested approach. The integrated inquiry worksheet was developed with a nested approach; students were trained in critical thinking skills on the explanation indicator by linking the experiment results with the concept of chemical equilibrium.

The ability to articulate reasoning conclusions when presenting facts or arguments based on concepts, methodologies, evidence, and logical standards obtained from data is known as an explanation (Facione, 2016). When students work on the worksheet, critical thinking skills are practiced to link the experiment results with the concept of chemical equilibrium. The explanation indicator in students' critical thinking skills is practiced in the fifth phase of guided inquiry, namely, making conclusions and formulating explanations.

After being given treatment using the worksheet with the help or direction of the teacher, students answered the posttest questions better, so there was an increase. There was an increase in the results of the students' pretest and posttest scores on the interpretation indicator. This is because, during the limited trial, students were trained to create explanations by linking existing concepts with the results of the experiment, where this activity is included in phase 4 of the guided inquiry model, namely formulating explanations and conclusions. The study's results Ramadhanti et al. (2021) showed that the explanation indicator obtained an n-gain score of 0.86

with a high category so that it was proven that students could connect the results of the experiment with existing theories.

Evaluation

The results of the pretest and post-test of critical thinking skills showed an increase in the KBK score on the evaluation indicator with an N-Gain score of 0.79 (high category) after using the worksheet because the range of N-Gain scores ≥ 0.7 is included in the high category. In this study, the evaluation indicator trained critical thinking skills in as many as two descriptive questions. After completing the pretest activities, students were trained in critical thinking skills using a worksheet developed based on guided inquiry integrated with a nested approach. In the integrated inquiry worksheet, a nested approach was developed, and students were trained in critical thinking skills on the evaluation indicator by linking the experiment results with the concept of chemical equilibrium.

The ability to evaluate statements or other representations that document or describe a person's perspective, experience, situation, judgment, belief, or opinion is known as an evaluation (Facione, 2016). When students work on the worksheet, Critical thinking skills are trained in linking the experiment results with the concept of chemical equilibrium. Students' critical thinking skills in the explanation indicator are trained in guided inquiry, namely formulating explanations and conclusions in the fifth phase.

After being given treatment using the worksheet with the help or direction of the teacher, students answered the posttest questions better, so there was an increase. There was an increase in the results of the students' pretest and post-test scores on the evaluation indicator; this was because, during the limited trial, students were trained to make evaluations by linking the relationship between existing concepts with the results of the experiment and the hypotheses or phenomena presented using the developed worksheet. Research Arini et al. (2018) explains that students critical thinking skills in the evaluation indicator can also be trained by getting used to working on questions with varying levels of completion.

Inference

The results of the pretest and post-test of critical thinking skills showed an increase in the KBK score on the inference indicator with an N-Gain score of 0.90 (high category) after using the worksheet because the range of N-Gain scores ≥ 0.7 is included in the high category. In this study, two descriptive questions trained the inference indicator in critical thinking skills. After completing the pretest activities, students were trained in critical thinking skills using a worksheet developed based on guided inquiry integrated with a nested approach. In the integrated inquiry worksheet with a nested approach that was developed, students were trained in critical thinking skills on the inference indicator by concluding the experiments that had been carried out.

The ability to recognize and obtain the components needed to produce logical conclusions, conjectures, and hypotheses is known as inference (Facione, 2016). When students work on the worksheet, critical thinking skills are used to make conclusions from the experiments that have been carried out. Students' critical thinking skills on the inference indicator are trained in phase 5. Namely, students formulate explanations and conclusions. After being given treatment using the worksheet with the help or direction of the teacher, students answered the posttest questions better, so there was an increase. Because students were given time to make hypotheses according to the syntax of the guided inquiry model during a short trial period, the pretest and posttest results showed an increase in the inference indicator. Providing evidence that the inquiry model can improve critical thinking skills on the inference indicator because students become more confident and sure of their ability to make conclusions (Ramadhanti & Agustini, 2021).

Self-regulation

The results of critical thinking skills on the self-regulation indicator received an average percentage (%) of 89.66, with an outstanding category after using the worksheet. In this study, the regulation indicator was drilled in the posttest critical thinking skills questions in as many as three summary questions. Before the posttest, students carried out learning and filled out the self-regulation sheet on the worksheet.

Self-regulation is the ability of students to review their thoughts, identify errors, and adjust their understanding based on the evaluation (Facione, 2016). Students' critical thinking skills on the self-regulation indicator are trained in phase 6 of the guided inquiry learning model, namely reflecting on problem situations and thinking processes. In addition to linking the relationship of the conclusions made with hypotheses or everyday phenomena, students also provide self-regulation related to understanding after using worksheets in learning.

After being given treatment using worksheets with the help or direction of the teacher, students answered the posttest questions better so that they got a good percentage of self-regulation. Reflecting on oneself or making self-regulation is an activity where students are directed to reflect on themselves regarding the material learned during the learning process. Students fill out the

self-evaluation/self-regulation sheet in the worksheet section provided (Temiyati & Nuryadi, 2022).

According to Husna et al. (2020), the syntax in the guided inquiry model takes place with a minimum good category. Learning activities involving students conducting investigations, such as formulating questions, making temporary hypotheses, collecting and analyzing data, and drawing conclusions based on the results of investigations during the learning process, have been shown to improve student's critical thinking skills. Furthermore, research conducted by Ramadhanti et al. (2021) shows that applying the guided inquiry model contributes to an increase in students' critical thinking skills after learning is carried out. This increase is reflected in the average N-Gain Score in the moderate to high category.

Conclusion

The study showed that the guided inquiry worksheet integrated with the nested approach improved students' critical thinking skills in chemical equilibrium material. This was indicated by an increase in pretest and posttest scores based on the N-gain score, where most students reached the high category and a small number of others reached the medium category. The increase occurred in all indicators of critical thinking skills, namely interpretation (N-Gain score of 0.88), analysis (N-Gain score of 0.88), explanation (N-Gain score of 0.86), evaluation (N-Gain score of 0.83), inference (N-Gain score of 0.79), and self-regulation (percentage of 89.66%) with a high category on the N-Gain score and a good percentage on self-regulation. This success was supported by the syntax of the guided inquiry model and the nested approach that actively trains students in the critical thinking process, from identifying problems to reflecting on learning outcomes. Thus, the developed worksheets effectively stimulate and enhance critical thinking skills, essential competencies in 21st-century education.

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Conflicts of Interest
The authors declare no conflict of interest.

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