



Development of Student Worksheets Oriented Guided Inquiry to Improve Student's Critical Thinking Skills on Acid Base Material



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ABSTRACT

This research aimed to obtain the validity, practicality, and effectiveness of student worksheets oriented on guided inquiry to improve critical thinking skills in acid-base material. The type of research used was 4D model development research, but it was limited to the third stage, namely Develop. The research sample consisted of 34 students from class XI IPA 4 SMAN 14 Surabaya. The instruments used were validation sheets, student response questionnaires, and pretest and posttest question sheets. The validation results show that the student worksheets 1, 2, and 3 in the content criteria get mode 4 in the good category, and construct criteria get mode 5 in the very good category so that overall the teaching module gets mode ≥ 3 and is declared valid. The overall practicality results of the student worksheets obtained an average percentage of 90.09% with efficient criteria. The results of the overall effectiveness of student worksheets oriented on guided inquiry obtained an n-gain score of 0.71 which is included in the high category. In addition, the sig value. (2-tailed) obtained from the paired sample t-test of 0.000 which shows an increase in students' critical thinking skills and the student worksheets oriented on guided inquiry are effective for use in learning.

Keywords: Student worksheets; guided inquiry; critical thinking skills; acid base.

INTRODUCTION

Every person in the 21st century needs to become proficient in a variety of pertinent skills in order to adapt and contribute effectively. The 4Cs, which are the necessary skills, are as follows: Critical thinking, Creativity, Collaboration, and Communication. Such essential competencies are what are needed to produce top graduates in the implementation of the 2013 curriculum (King et al., 2010). Since critical thinking is not a natural talent, students need to be taught how to examine issues from several angles and to be receptive to new ideas when learning new material. While improving students' conceptual understanding is the primary objective of critical thinking in the educational process (Khasanah et al., 2017) to support students' acquisition of critical thinking skills and insights.

Critical thinking skills can be implemented in chemistry learning, one of which is in acid-base material (Afridayanti & Azizah, 2020).

Acid-base material is found in class XI of Permendikbud Number 37 of 2018. The knowledge domain in KD 3.10, namely describing the ideas of bases and acids, their concentrations and ionization equilibrium in solutions, as well as the ability to domain in KD 4.10, namely examining the course of pH changes for a number of indicators taken from natural materials through experimentation (Kemendikbud, 2018). The ability to interpretation, analysis, and inference is 3 of the 6 skills based on the critical thinking skills section and the 6 skills are interpretation, analysis, evaluating, inference, elucidation, and self-organization (Facione, 2015). As stated by the results of pre-research on March 13, 2023 with 36 student respondents, It was discovered that students analytical abilities with acid-base content at SMAN 14 Surabaya were still lacking with the results of 58% on the interpretation indicator, 59% on the analysis indicator, and 58% on the inference indicator. Because

according to (Riduwan, 2013), the range of 40% to 59% for the percentage of critical thinking abilities is included in the moderate criteria. Based on these findings, it is imperative that students develop their critical thinking abilities because SMAN 14 Surabaya students' thinking abilities remain in the moderate range.

The guided inquiry model is a learning strategy that can be used to foster critical thinking in acid-base content. Because students who prefer to do laboratory experiments with guided inquiry state that this approach inspires students to inquire and reflect (Ural, 2019). Inquiry-based learning provides opportunities for teachers to help students learn the content and concepts of the subject matter by asking them to develop questions and develop hypotheses. At the high school level, the suitable inquiry to use is guided inquiry (Anam, 2015). By actively engaging in learning activities, students can use the guided inquiry learning model to help them develop the critical thinking abilities necessary to find the answers to questions (Ningtiyas & Nasrudin, 2021).

Applying the model of guided inquiry learning, it is necessary to modify the use of suitable teaching materials when using Acid-Base material to exercise critical thinking skills. A student worksheet is one of the instructional resources which is usually referred to as (LKPD) (Badruzzaman, 2018). On March 13, 2023, a pre-research interview with a chemistry teacher at SMAN 14 Surabaya revealed that the teacher exclusively used worksheets and pre-existing teaching materials, particularly the student worksheet book provided by the school. The student worksheet used only contains 1 critical thinking question on the analysis indicator, due to time constraints so the teacher only ever uses worksheets contained in existing textbooks, however since the teacher is aware of the state of his students, the worksheets ought to be created by the teacher, so the student worksheets used can be adjusted to the conditions or abilities of his students.

In light of the above description, it is essential to create instructional resources in the type of worksheets for students that are customized to meet the needs of the students. It is envisaged that the creation of guided inquiry-based student worksheets will enhance students'

critical thinking abilities, especially in terms of acid-base content, which is highly applicable to real-world situations. In order for students to possess the abilities required in the 21st century.

The goals of this research are: (1) to explain the worksheet's validity using content and construct criteria, (2) to provide a response questionnaire describing the worksheet's practicality, and (3) to evaluate the worksheet's effectiveness using the critical thinking abilities of acid-base material on the pretest and posttest.

RESEARCH METHODS

Research Design

The Research and Development method is the research type used in this development study. The 4-D (four-dimensional) model, which Thiagarajan, Semmel, and Semmel (1974) proposed, is the research design employed in this research has four phases: define, design, development, and dissemination.

Date and Place of the Research

In June and July, research was done on the creation of guided inquiry-oriented student worksheets at the review and validation stage, while the trial of guided inquiry-oriented student worksheets was conducted on July 20-27, 2023.

Research Subject

With the purpose of enhancing the critical thinking abilities of students when working with acid-base material, this project created student worksheets with a focus on guided inquiry serve as educational resources. The research subjects for this study were 34 students in class XI IPA 4 at SMAN 14 Surabaya.

Trial Design

The One Group Pretest-Posttest Design research style was applied to assess the effectiveness of the student worksheet in the field test. This involved administering a pretest and posttest without the use of a comparison class.

$$O_1 \times O_2$$

Information:

O_1 : Pretest of critical thinking skills students

before using student worksheet

X : Learning by using student worksheets developed

O₂ : Posttest of critical thinking skills students after using student worksheet

Data Collecting Methods

To explain whether guided inquiry-based student worksheets are feasible, an appropriate data collection method is needed. This study used questionnaire and test data collection techniques.

Research Instruments

Validity, practicality, and effectiveness were examined in order to assess the viability of the guided inquiry-oriented student worksheets created. Numerous tools were used in this study, such as test sheets for critical thinking abilities, student response sheets, and validation sheets. Three validators filled out the validation sheet instrument. The student worksheet's practicality was assessed using the student response instrument. Concurrently, the effectiveness of student worksheets to gauge the development of critical thinking abilities through the use of a skill test sheet instrument consisting of pretest and posttest questions pertaining to acid-base material.

Data Analysis

After all respondents' data or data from other sources has been gathered, data analysis is the next step. In this research, validation, practicality, and effectiveness data analysis were carried out.

1. Validation Data Analysis

The assessment obtained for each aspect contained in the validation sheet refers to the Likert scale as follows:

Table 1. Likert Scale Score

| Scale Value | Category |
|-------------|-----------------|
| 5 | Very Good |
| 4 | Good |
| 3 | Good Enough |
| 2 | Not Good Enough |
| 1 | Bad |

(Riduwan, 2015)

The data from the validation results are ordinal, and they can be analyzed by using the following guidelines to determine the mode of each assessment component: (a) An aspect is deemed valid if the evaluated aspect has a mode

score ≥ 3 ; (b) Aspects that are evaluated and have a mode score < 3 are deemed invalid and require revision and revalidation (Lutfi, 2021).

2. Practicality Data Analysis

Information gleaned from the questionnaire for student responses about the applicability of guided inquiry-oriented student worksheets using a Guttman scale and negative and positive statements with the options to respond "Yes" or "No". The percentage of students who selected "Yes" for each of the positive statements yielded positive responses, while the number of students who selected "No" yielded positive responses for statements that were negative. The table below shows the criteria used to determine the student responses.

Table 2. Guttman Scale Criteria

| Answer | Score | |
|--------|-------------------|-------------------|
| | Positive Question | Negative Question |
| Yes | 1 | 0 |
| No | 0 | 1 |

(Riduwan, 2015)

Calculation of the percentage of data obtained by the formula:

$$\text{Practicality (\%)} = \frac{\text{Total score of each question}}{\text{Total number of respondents}} \times 100\%$$

The criteria table below then provides an interpretation of the percentage calculation results.

Table 3. Practicality Criteria

| Percentage (%) | Practicality Level |
|----------------|--------------------|
| 0-20 | Impractical |
| 21-40 | Less Practical |
| 41-60 | Quite Practical |
| 61-80 | Practical |
| 81-100 | Very Practical |

(Riduwan, 2015)

3. Effectiveness Data Analysis

The effectiveness of the created worksheets was evaluated using data from the students' critical thinking abilities pretest and posttest. Additionally, the Shapiro-Wilk method in SPSS was used to check for normalcy in the pretest and

posttest data pertaining to students' critical thinking abilities. If significant > 0.5 is obtained, it indicates that the distribution of the data is normal. The Paired Sample T-Test test is performed after it has been determined that the data are normally distributed, if the significant value < 0.05 then, depending on the significant performance difference, H_0 is rejected or H_1 is accepted. The n-gain score was evaluated in addition to the Paired Sample T-Test.

The n-gain value can be obtained using the formula below:

$$N-Gain = \frac{Posttest\ Score - Pretest\ Score}{Maximum\ Score - Pretest\ Score}$$

If $n-gain \geq 0.3$ with moderate criteria, it is claimed that the student worksheet created is efficient (Hake, 1999).

RESULT AND DISCUSSION

Using the 4-D model development procedure, the research process was conducted in stages (Four-D Model) from Ibrahim (2014). There are just three stages in the development process: define, design, and develop.

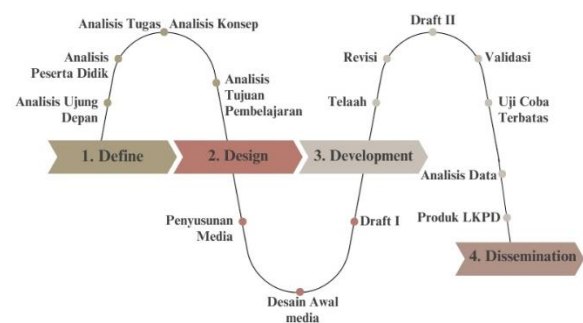


Figure 1. Development Process Flow using a 4D

Define

Pre-research is conducted at this stage with the goal of analyzing and identifying issues that arise during the learning process. Initially, the developer spoke with Chemistry teachers at SMAN 14 Surabaya to learn more about the issues there. Student worksheets, in Trewet's opinion, can improve academic performance and encourage students to be more engaged and productive learners (Utami et al., 2016). However, the information gleaned from the interview is utilized in the teaching materials at SMAN 14 Surabaya, which include worksheets from specific publishing companies and government-supplied chemistry textbooks.

Students cannot develop concepts because the worksheet only offers material; it doesn't have critical thinking exercises and practicum activities. A learning model that puts students in a situation where they have to conduct extensive experiments on their own to see what happens, want to do something, ask questions and come up with their own answers, connect one discovery with another, and compare what they find with what other students find, according to Jean Piaget (Indraliani, 2018). However, a lot of students need to work on improving their critical thinking abilities when it comes to acids and bases, according to student analysis of academic ability.

The researcher created guided inquiry-oriented student worksheets based on the pre-study's findings. Inquiry-based learning was chosen because it provides opportunities for teachers to help students learn the content and concepts of the subject matter by asking them to develop questions and develop hypotheses. (Anam, 2015).

Design

The design stage involves creating the learning tools and instruments, such as student worksheets, from the beginning. The educational resources and tools created in tandem with worksheets are syllabus, lesson plans, and critical thinking skills tests consisting of 15 questions. The preparation of LKPD needs to be mindful of how language and content are presented, as well as how colors and designs are chosen to pique students' interest in learning and inspire them. The created worksheets have 3 titles, each of which is an A4 sheet with 13 to 14 pages.



Figure 2. Student Worksheet Cover Design

The Canva app was used to create the worksheets' cover art, which was then imported into Microsoft Word to produce the finished

product. There were three worksheets developed with different titles. The first worksheet contains natural acid-base indicators, the second contains artificial acid-base indicators, and the third contains pH and the strength of acids and bases. In addition to making the cover, at this stage it is also determined what will be included in the worksheet in the form of phenomena, interpretation indicator questions, practicum activities, analysis indicator questions and inference indicator questions.

Develop

1. Validity

The validation results, which are examined in light of the content and construct validity criteria on the student worksheets that have been developed, are what determine the validity of this guided inquiry-oriented worksheet. contends that all of the components of learning products should be consistently related to one another (construct validation) and that a development result (product) is considered valid if it is founded on sufficient theory (content validation). Argues that all of the components of learning products should be consistently related to each other (construct validation) and that a development result (product) is considered valid if it is based on suitable theory (content validation) (Rochmad, 2012). The appropriateness of worksheets with the 2013 curriculum, KD, and IPK, the accuracy of the content with learning materials, the appropriateness of worksheets with guided inquiry stages, and the appropriateness of worksheets with indicators of critical thinking skills are all covered in the content validation. Meanwhile, the construct validation contains aspects of the worksheet's suitability for linguistic, presentation, and graphical criteria. The following are the results of worksheet validation by 3 validators.

Table 4. Worksheet Validation Results

| Aspects | Score | | | M | Category |
|------------------------------------|-------|----|----|---|----------|
| | V1 | V2 | V3 | | |
| Content Validity | | | | | |
| Conformity of worksheets with K13, | 5 | 4 | 4 | 4 | Valid |

| | | | | | |
|--|---|---|---|---|------------|
| KD, and IPK | | | | | |
| Correctness of substance with learning materials | 5 | 4 | 4 | 4 | Valid |
| Suitability of worksheets with guided inquiry stages | 5 | 4 | 5 | 5 | Very Valid |
| Suitability of worksheets with critical thinking skills indicators | 5 | 4 | 5 | 5 | Very Valid |

| Construct Validity | | | | | |
|--|---|---|---|---|------------|
| Suitability of worksheets with linguistic criteria | 5 | 4 | 5 | 5 | Very Valid |
| Suitability of worksheets with presentation criteria | 5 | 4 | 5 | 5 | Very Valid |
| Suitability of worksheets with graphic criteria | 5 | 4 | 5 | 5 | Very Valid |

Information: V1, V2, and V3=Validator 1,2, and 3; M=Mode

In light of table 4, it can be seen that the worksheets developed received modes 4 and 5 with valid and very valid categories. According to Lutfi (2021), Aspects are considered valid if the validator's assessment of them yields a mode score ≥ 3 . So that the worksheets developed can be used in the next, namely the trial stage.

2. Practicality

This study's limited trial was carried out in SMAN 14 Surabaya's class XI IPA 4. The purpose of this trial was to evaluate the practicality and effectiveness of the guided inquiry-oriented student worksheets that had been developed. The practicality of the worksheet can be measured through a response questionnaire filled out by students.

Table 5. Results of Student Response Questionnaire

| Aspect | Percentage | Criteria |
|----------------|----------------|-----------------------|
| Contents | 90.72 % | Very Practical |
| Construct | 88.73 % | Very Practical |
| Average | 89.73 % | Very Practical |

Table 5's data indicates that the content aspect of the student response questionnaire yielded results that a percentage of 90.72% and in the construct aspect got 88.73%. From this, 89.73% of students respond to questionnaires on average, and the criteria are very practical, in order to support the claim that the guided inquiry-oriented student worksheets that have been created are very practical for teaching chemistry using acid-base materials.

3. Effectiveness

The critical thinking skills pretest and posttest results of the students were utilized for measuring the effectiveness of the students worksheets. Using the prepared worksheets, the pretest was administered before learning, while the posttest was conducted after learning using guided inquiry-oriented worksheets.

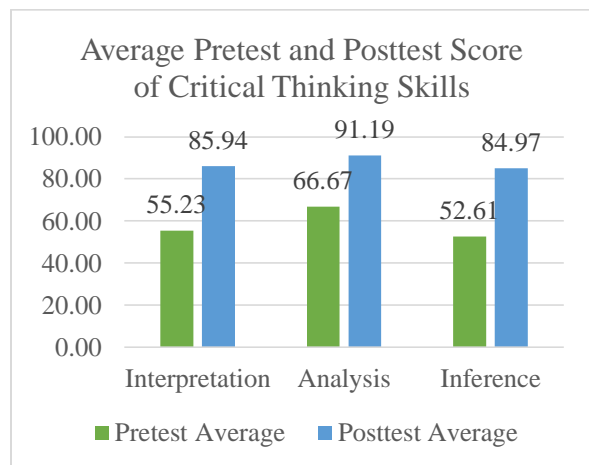


Figure 3. Diagram of Average Increase in Critical Thinking Skills Test Score

Figure 3 demonstrates how each indicator assesses students critical thinking has increased after a limited trial of the guided inquiry-oriented worksheet developed. The green graph shows the pretest and the blue graph shows the posttest. critical thinking skills on the interpretation indicator obtained an average pretest of 55.23

and increased during the posttest to 85.94 and obtained an n-gain score of 0.70 with a high category. In the analysis indicator, the pretest average was 66.67 and increased in the posttest to 91.19 and obtained an n-gain score of 0.77 with a high category. In the inference indicator, the pretest average was 52.61 and increased during the posttest by 84.97 and obtained an n-gain score of 0.70 with a high category. The n-gain score obtained as a whole critical thinking skills indicator is 0.71 with a high category. This is in line with research which indicates that using the guided inquiry model and having an N-gain score that meets the high criteria can help to improve critical thinking skills (Ulya & Nasrudin, 2019). According to additional research, applying the guided inquiry model with an N-gain score of 0.7 high criteria has improved critical thinking skills (Muhan & Nasrudin, 2021).

Next, the data collected from the pretest and posttest were normalized. The results of the critical thinking skills pretest and posttest normalization tests are shown in the table 6.

Table 6. Pretest and Posttest Normality Test Results

| Tests of Normality | Shapiro-Wilk | | |
|-----------------------------|--------------|----|------|
| | Statistic | df | Sig. |
| Pretest Result 11 IPA 4 | .956 | 34 | .181 |
| Posttest Result 11 IPA 4 | .947 | 34 | .099 |

a. Lilliefors Significance Correction

Table 6 displays the outcomes of data normalisation. This shows that the normality test obtained sig. (2-tailed) value > 0.05, consequently it can be said that H₀ is acceptable or that the critical thinking skills pretest and posttest follow a normal distribution (Razali & Wah, 2011). Furthermore, The data was examined Paired Sample T-Test is used to compare the average values of two paired groups (Sugiyono, 2018). The results of the students' paired sample t-test on critical thinking abilities from both the pretest and posttest are shown below.

| | Paired Samples Test | | | | | | t | df | Sig. (2-tailed) |
|--|---------------------|----------------|-----------------|---|---------|---------|----|------|-----------------|
| | Paired Differences | | | | | | | | |
| | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference | | | | | |
| | | | Lower | Upper | | | | | |
| Pretest Result KBKi - Posttest Result KBKi | -30.088 | 3.029 | .519 | -31.145 | -29.031 | -57.924 | 33 | .000 | |

Figure 4. Paired Sample T-Test Results Pretest and Posttest critical thinking skills

From Figure 4, the sig value is obtained. (2-tailed) of 0.000. This shows that the sig. (2-tailed) <0.05 which means H_1 is accepted and H_0 is rejected and the pretest and posttest scores have a significant average difference. According to the findings, students' critical thinking abilities have improved as a result of using guided inquiry-oriented student worksheets that were created so that using student worksheets with a guided inquiry approach to learn acid-base chemistry is effective. This is consistent with the findings of Hafizah and Mawardi's research in (2020) which states that the development of guided inquiry-based student worksheets can improve critical thinking skills on the material of the colligative properties of solutions and is effectively used in learning.

CONCLUSIONS

This study concludes that the results of the validity of the contents and construction validity obtained modes 4 and 5 scores with valid and highly valid categories. The practicality results reviewed from the elevation student response received a positive response of 89.73% with a very practical category. Effectiveness results obtained an average posttest score greater than a pretest score that received an n-gain score of 0.71 with a high category and a significance value in a Paired Sample T-Test test of 0.000, which means there is a significant difference between the pretest value and the post-test value. The results showed that guided inquiry-oriented worksheets developed worthy to enhance students' critical thinking skills on base acid material.

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