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Development of Problem-Based Learning Student Worksheet Integrated with Ethnoscience on Acid-Base Material

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Abstract: This study aims to develop problem-based learning student worksheets integrated with ethnoscience on acid-base materials that are valid and practical. This research uses a development research method (Research and Development) with a 4-D model. The data of this study were collected through validity sheets completed by 4 validators, namely 2 chemistry lecturers and 2 chemistry teachers, and with a practicality questionnaire sheet completed by 2 chemistry teachers and by 35 students of SMAN 1 Batusangkar as respondents. Data were analyzed using quantitative descriptive method, using Aiken's V. The result for content validity is 0.88 and construct validity is 0.90 with valid category. The result for teachers practicality is 0.95 and students practicality is 0.82 with practical category. Based on the results of the research that has been conducted, it can be concluded that the development of problem-based learning-based student worksheets integrated with ethnoscience on acid-base material is valid and practical.

Keywords: Ethnoscience; Practicality; Problem-based learning; Validity; Worksheet

Introduction

The current curriculum in the Indonesian education system is the 'merdeka' curriculum. The merdeka curriculum is given to education units as an effort to recover the learning crisis due to the COVID-19 pandemic (Nugraha, 2022). The merdeka curriculum focuses on essential content so that students have enough time to deepen concepts and strengthen competencies (Kemdikbud, 2021). From the chemistry learning outcomes in phase F, one of the essential contents learned is acid-base material.

Based on the analysis conducted by Ekawisudawati et al. (2021), it is known that acid-base is essential material related to further material or prerequisites for learning further material such as buffer solutions and acid-base titration. It is important to understand acid-base material, to make it easier for students to understand the next material. This material requires a detailed explanation so that students can understand Chemistry learning.

One way to enhance the quality of learning is to use appropriate teaching materials. Teaching materials that are generally used by educators are students' worksheets. In addition to being practical, students' worksheets can facilitate teachers in providing materials and tasks due to the fact that they are more organized. However, student worksheets that are commonly used in schools are still very basic. The student worksheets only consist of general materials cited from textbooks or modules (Fatmawati et al., 2023).

Based on observations conducted at SMAN 1 Batusangkar by disseminating questionnaires. From the results of the questionnaire of students there were few students who comprehended the concepts of Chemistry subject matter through the learning model applied by the teacher. From the results of the Chemistry teacher questionnaire, it is known that the school has implemented an independent curriculum, for 6 months.

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The teaching materials used by teachers are student worksheets and textbooks. In the textbook, not all materials are in compliance with the learning objectives prepared by the teacher. Meanwhile, the student worksheets are only available for certain materials. Due to curriculum changes, teachers have not yet made all teaching materials adapted to the material in the merdeka curriculum.

From the above observations, it is known that teaching materials are needed in the learning process. The results of the students' questionnaire stated that from several student worksheets that had been used by teachers during learning, it was found that the student worksheets helped in the learning process. The learner worksheets developed are customizable with the problem-based learning model. The use of a problem-based learning (PBL) model will assist students in their ability to understand chemistry. PBL is a model of learning that is gaining more and more interest to maximize the advancement of students' knowledge, skills, and character (Aulia et al., 2023; Widowati et al., 2023). PBL is suitable for 21st century learning. Education in the 21st century is concerned with dealing with real-world problems (Edens, 2000; Tan, 2021).

Problem-based learning model is able to be integrated with ethnoscience. Ethnoscience can be interpreted as a set of insights and knowledge that belongs to an ethnic group in a nation obtained by applying certain techniques and taking certain steps that include elements of a particular community tradition, and its 'validity' can be proven by an observation (Abonyi et al., 2014; Fasasi, 2017; Sudarmin, 2014).

The lack of local cultural awareness is a prevalent problem in Indonesia. Students do not know Indonesian culture when compared to foreign cultures. Globalization through the growth of digital technology is the primary factor for cultural acculturation and assimilation in Indonesia. So there needs to be a strategy in the learning process to instill a loyalty and appreciation for the diversity of local culture in every students (Ardianti et al., 2019; Kizgin et al., 2020).

Students are more aware of their culture if the learning can be integrated with ethnoscience. The implementation of ethnoscience-based learning is supposed to encourage students to appreciate Indonesia's cultural heritage (Sumarni, 2018). Learning that is integrated with local culture can improve the potential understanding of students in their studies (Sanova & Malik, 2023). PBL and ethnoscience models are known to have a favorable impact when implemented in learning. The results of the study found that the applied PBL-Based Worksheets Integrated with Green Chemistry and Ethnoscience were practical for cognitive, affective, psychomotor seen from the learning outcomes (Sudarmin et al., 2019). Buffer solution students' worksheet based on problem-based learning with ethnochemistry was valid, practical, and effective to improving students' science literacy ability significantly (Asda, 2023).

However, the development of this student worksheet is different from the development research that has been done before, the ethnoscience used is adapted to the culture of one of the ethnic groups in Indonesia, namely the Minangkabau ethnic culture. Each acid-base learning objective is associated with ethnoscience in Minangkabau. This ethnoscience integration can make students more aware of the culture in the area where they live. The current curriculum in the education system is the merdeka curriculum, so teachers need to prepare learning instruments in accordance with the latest curriculum. From the two schools observed, there has been no use of student worksheets integrated with ethnoscience during teaching and learning activities. The development of this student worksheet has adjusted to the merdeka curriculum. The development of problem-based learning student worksheets integrated with ethnoscience is expected to be valid and practical.

Method

Research Design

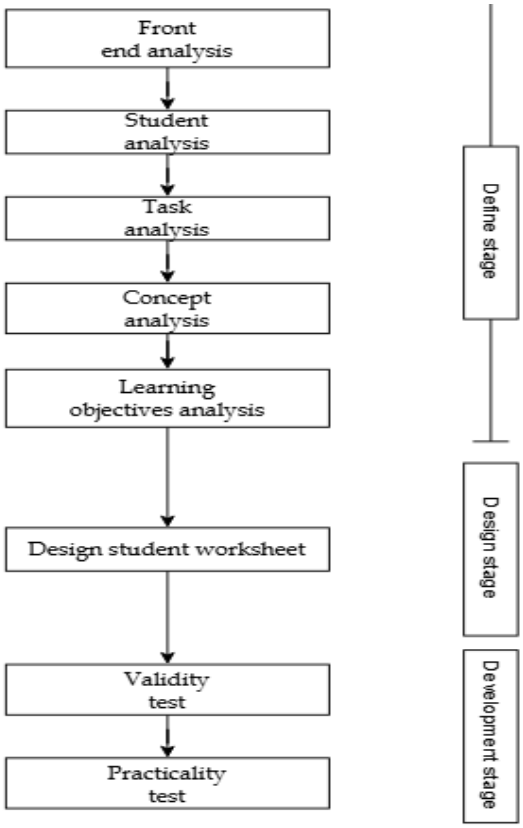

Figure 1. Development procedures

This type of research is research and development (R&D) with 4-D development model. The 4-D development model consists of 4 stages namely define, design, develop, and disseminate. The first stage is definition consists of 5 parts, namely: front end analysis; student analysis; task analysis; concept analysis; learning objectives analysis. The second stage is design, which is the stage of designing student's worksheet. The third stage is development, there are two things that are assessed on the developed student worksheets, namely the assessment of validity and practicality. However, this research was only limited to develop stage, namely by testing the level of validity and practicality of the developed student worksheets, while the dissemination stage was not carried out due to time constraints.

Data Collection Techniques and Instruments

This study data was collected through a validity sheet filled by 4 validators, namely 2 chemistry lecturers and 2 chemistry teachers, as well as a practicality questionnaire sheet filled by 2 chemistry teachers and 35 students of SMAN 1 Batusangkar as respondents.

Research Data Analysis

Data were analyzed using quantitative descriptive method, using aikens V. The formula:

$$V = \frac{\Sigma s}{[n(c-1)]} \quad (1)$$

Description:

V = Aiken V which indicates the validity of the product
s = $r-l_0$
r = the number given by the expert
l^0 = the lowest validity assessment number
n = the number of experts
c = the highest validity assessment number

If the result obtained is close to 1, the higher the validity value. Conversely, if the result obtained is close to 0, then the validity is lower (Aiken, 1985).

Result and Discussion

Define Stage (Definition)

At the front end analysis stage, it was found out some information about teaching and learning activities. Teachers have not developed several teaching materials on chemistry materials in accordance with the independent curriculum, including acid-base materials. Some acid-base subject matter adapted to the teacher's learning objectives is not available in the textbook. The use of teaching materials in the form of student worksheets helps students in the learning process, but student worksheets are not available for every chemistry material. Learning has not been implemented with PBL model. Learning has not been associated with ethnoscience.

At the task analysis stage, learning achievements were analyzed, namely the correlation between the pH of acidic, basic, salt and buffer solutions and their application in everyday life. From the analysis of learning achievements, acid-base learning objectives are formulated. At the concept analysis stage, the main concepts to be implemented were identified. Based on the front end analysis, student analysis, task analysis, concept analysis and learning objectives analysis, teaching materials in the form is developed problem-based learning student worksheets integrated ethnoscience on acid-base material.

Design Stage (Design)

Based on the results of the defining stage, problem-based learning student worksheets integrated with ethnoscience on acid-base material were produced. Here are some parts of the student worksheets that have been designed.

Orient Students to the Problem

At this stage, students observe and understand the problems presented by the teacher or obtained from the student worksheet.

Figure 2. Orient students to the problem

Organize Students to Learn

At this stage, students interact and divide roles to find the information needed to solve the problem.

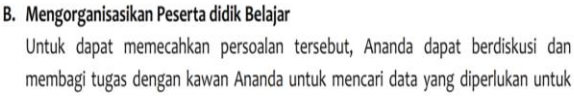

Figure 3. Organize students to learn

Assist Individual and Group Investigations

At this stage, students conduct investigations (looking for data) for the material, which is discussed with the group.

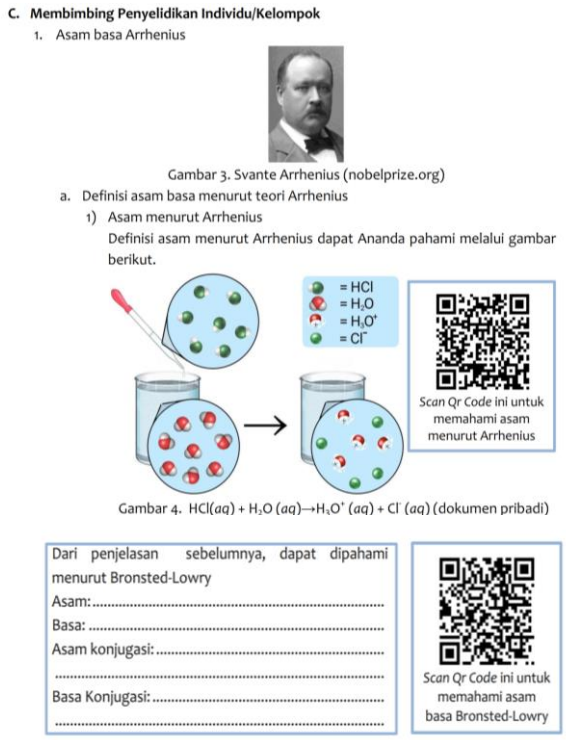

Figure 4. Assist individual and group investigations

Developing and Presenting Work

At this stage, the group conducts a discussion to come up with ideas on how the problem can be solved and the results are presented to the class.

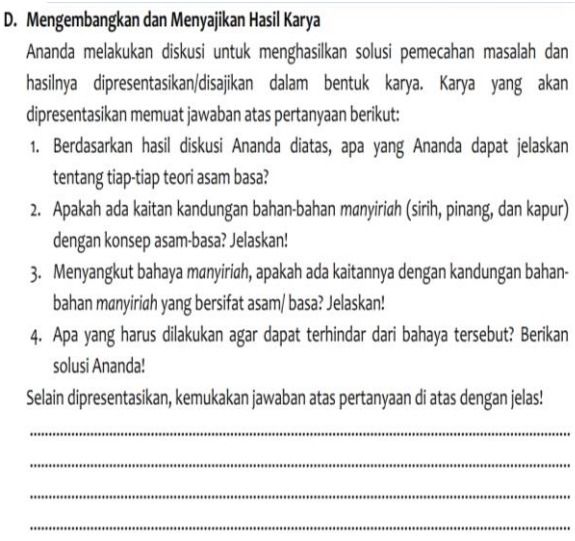

Figure 5. Developing and presenting work

Analyze and Evaluate the Problem Solving Process

At this stage, each group conducts a presentation, the other groups appreciate the team that performs. The next activity determines the conclusion according to the suggestions obtained from other groups.

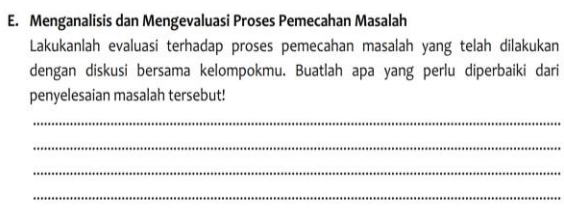

Figure 6. Analyze and evaluate the problem solving process

Develop Stage (Development)
Validity Test

The validity test consists of content validity test and construct validity test. The construct validity test of the student worksheet consists of the validity of the content component, presentation component, linguistic component and graphic component. Content validity test of student worksheets consisting of aspects of the suitability of student worksheet content with problem-based learning syntax and the accuracy of the content of the student worksheet with the scientific content of chemistry.

Based on the results of data analysis, the average construct validation obtained an average value of 0.884 and content validation obtained an average of 0.895 with a valid category. Based on the results of the validity analysis, it shows that the problem-based learning student worksheets integrated with ethnoscience developed are valid and feasible to be tested in learning. The results of the student worksheet content validation test can be seen in Table 1 and the results of the construct validity test can be seen in Table 2.

Table 1. Results of Content Validity Data Analysis

Assessed aspect	V value	Category
Suitability with problem-based learning syntax	0.89	Valid
Suitability with chemistry content knowledge	0.87	Valid
Average	0.88	Valid

The results of the validity test for the suitability with problem-based learning syntax aspect obtained a score of 0.89 from the validator so that it was included in the valid category. This is because the arrangement of the student worksheet implements the right problem-based learning syntax. The learning model has a syntax which is the stages of each activity, so that it can be implemented systematically. Syntax aims to help guide the learning (Arends, 2012; Mihardi et al., 2013).

The results of the validity test for suitability with Chemistry content knowledge aspect obtained a score of 0.87 from the validator so that it was included in the valid category. This is because the material contained in the student worksheet is in accordance with the knowledge in the chemistry discipline. The criteria for a proper student worksheet is that it has conceptual

suitability and scientific truth in each activity procedure (Kosasih, 2021; Mawarnis et al., 2022).

Table 2. Results of construct validity data analysis

Assessed aspect	V value	Category
Content component	0.88	Valid
Presentation component	0.89	Valid
Linguistic component	0.86	Valid
Graphics component	0.95	Valid
Average	0.90	Valid

The results of the validity test for the content component aspect obtained a score of 0.88 from the validator so that it was included in the valid category. This is because the content of the student worksheets is in accordance with the learning objectives. The content on the student worksheet is accurate and in accordance with the students' abilities. Student worksheets are considered to have favorable criteria if the activities on the student worksheet are in accordance with the learning objectives (Kosasih, 2021).

The results of the validity test for the presentation component aspect obtained a value of 0.89 from the validator so that it was included in the valid category. This is because the student worksheet is designed systematically, there are tables and pictures supporting the presentation of the material. The problem-based leaning syntax contained in the student worksheet is appropriate. Problem-based learning can be recommended as a support for the student learning process (Aidoo et al., 2016; Hasanah et al., 2020; Hmelo-Silver, 2004). In addition, when presenting student worksheets in learning, student worksheets can be used independently or in groups.

The validity test results for the linguistic component aspect obtained a value of 0.86 from the validator so that it was included in the valid category. This is because student worksheets use language that is easy to understand and adapted to Bahasa Indonesia guidelines. It is very necessary to use appropriate language in teaching materials. If the subject matter section in teaching materials uses language that is difficult to understand or has multiple meanings, students can misinterpret and have difficulty understanding the content of the material (Silfhout, 2014; Mailani & Wulandari, 2019). In student worksheets, the use of terms and symbols is consistent. Consistent symbols make students comfortable in using student worksheets and students' focus is not distracted (Susanti et al., 2018).

The results of the validity test for the aspects of the graphic component obtained a value of 0.95 from the validator so that it was included in the valid category. This is because the font size on the contents of the student worksheet is 12 pt, this size is common and easy to read. The appearance of teaching materials has an important position, because whether or not teaching materials are attractive is determined by their appearance (Wahyuningtyas et al., 2016). A student worksheet is interesting to study if the pictures in the student worksheet have bright colors instead of black and white. The type and size of the font, page arrangement or numbering system, as well as the use of illustrations and colors of teaching materials are a concern when designing teaching materials. These three things are combined to create attractive and effective teaching materials (Hardiyanto, 2020; Lenzner et al., 2013).

The overall validity test results of the student worksheet obtained a value of 0.88 for content validity and 0.90 for construct validity. This reveals that the student worksheet has met the eligibility requirements, namely being able to measure what will be measured, the material is synchronous with the validity of the science and this student worksheet is suitable for the objectives to be achieved in learning. This corresponds to what Djaali mentioned, namely that an instrument is declared valid if the instrument is able to be applied to measure what should be measured (Fitri et al., 2015).

Practicality Test

The practicality of students' worksheets was measured by giving practicality questionnaires to 2 chemistry teachers and 35 students. Practicality analysis based on ease of use, efficiency of learning time, and benefits. The average practicality test results for 3 teachers obtained 0.95 in the practical category, while the practicality test for 35 students obtained 0.82 in the practical category. The results of the teachers and students practicality questionnaire assessment data on students worksheet for each component can be seen in Table 3 and 4.

Table 3. Result of Data Analysis of Practicality by Teachers

Assessed aspect	V value	Category
Ease of use	0.90	Practical
Efficiency of learning time	0.94	Practical
Benefits	1.00	Practical
Average	0.95	Practical

Table 4. Results of Data Analysis of Practicality by Students

Assessed aspect	V value	Category
Ease of use	0.85	Practical
Efficiency of learning time	0.80	Practical
Benefits	0.81	Practical
Average	0.82	Practical

The results of the practicality test for the ease of use aspect obtained a score of 0.90 from the teacher and 0.85 from the students. This is because the material and language contained in the student worksheet are easy to understand, and the text on the student worksheet is clear and readable. The appropriate language and sentence structure that is easy to understand are able to convey the concept that the author wants to convey to the reader properly (Makkadafi et al., 2017; Nurkhasanah & Rohaeti, 2024).

The results of the practicality test for the Efficiency of learning time aspect obtained a score of 0.94 from the teacher and 0.80 from the students. This is because with the use of student worksheets, learning time is more efficient, and students can learn to use student worksheets at their own pace. Students learn at their own pace and learn with repeated exposure to the same material to reinforce and deepen their understanding (Chen & Hwang, 2020; Johnson, 2002).

The results of the practicality test for the benefits aspect obtained a score of 1.00 from the teacher and 0.81 from the students. This is because with the use of this student worksheet, learning becomes student centered, helps students in understanding acid-base material, and increases knowledge about ethnoscience in their area in accordance with acid-base material. The integration of ethnoscience in learning makes learning more contextual, students are interested in the learning process because they are provided with a tradition in their area that is in accordance with acid-base science. Learners recognize that the acid-base material they learn at school is widely applied in life and has become the original knowledge of the people around their area where they live. The utilization of Ethnoscience learning is very influential on the competence of students seen from the realm of knowledge and attitudes (Hikmawati et al., 2021; Nurcahyani et al., 2021; Pratama & Jumadi, 2023).

The overall practicality test results obtained a score of 0.95 from teachers and 0.82 from students. The teaching materials developed are declared practical when the teaching materials can facilitate teachers during learning and are easily understood by students (Desyandri et al., 2019).

Conclusion

Based on the research that has been conducted, it can be concluded that the development problem-based learning student worksheet integrated with ethnoscience on acid-base material are valid and practical.

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Author Contributions
E. F. M preparation of the original manuscript, results, discussion, methodology, conclusions; perform analysis, proofreading, review, and editing; H: validation, review and supervision; B. O and D. K: validating.

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Conflicts of Interest
The authors declare no conflict of interest.

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