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Development of Student Worksheet Based on Learning Cycle 5E on Stoichiometry Material

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Abstract
This study addresses the insufficiency of teaching materials in the learning process and its negative impact on students' comprehension of provided material. To alleviate this issue, student worksheets based on Learning Cycle 5E were developed to be used as a learning resource for 10th-grade students studying stoichiometry at State Senior High School (SMAN) 1 X Koto Singkarak. The aim of this research was to create a valid and practical Student worksheet based on Learning Cycle 5E. Development research with the 4-D development model (define, design, development, and disseminate) was employed, with the first three stages executed. The define stage was conducted to identify the school's conditions and problems, while the design stage was used to create the initial student worksheet based on Learning Cycle 5E for stoichiometry material. The develop stage was carried out to refine the worksheet. Data were gathered using validation sheets and practicality questionnaires filled out by two chemistry lecturers, one chemistry teacher, and 10th-grade students of SMAN 1 X Koto Singkarak. Data analysis was conducted using a quantitative descriptive method. Results indicated that the Student worksheet based on Learning Cycle 5E met the valid criteria with a validation score of 91.37% and the practical criteria with a student response questionnaire score of 82.09%. Thus, the worksheet can be used as a learning resource.

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INTRODUCTION

Teaching materials are one of the most important components in supporting the learning process. Teaching materials help educators in carrying out teaching and learning activities in the classroom, which also allows students to be able to be able to learn independently in accordance with the applicable curriculum (Nuryasana & Desiningrum, 2020). One of the teaching materials that is suitable for schools is the Student Worksheet. Student Worksheet is printed teaching material in the form of sheets containing material, summaries and instructions for carrying out exercises that must be done by students who refer to the basic competencies achieved (Natalia Diyah, Mohammad, & Sri, 2016).

Based on previous research, the problem that teachers often face during the learning process is choosing and determining appropriate teaching materials to help students acquire competencies, namely competency standards (SK) and basic competencies (KD) (Ilahi, Mawarnis, & Herman, 2023). The tendency of using teaching materials is still dominated by textbooks, even though there are still many learning resources besides textbooks that can be used (Siama, 2016). The limitations of teaching materials result in the teaching and learning process being ineffective and have an impact on students who are not enthusiastic about

learning chemistry lessons, resulting in a less than optimal learning process in the classroom(Herawati & Muhtadi, 2018).

Based on observations at SMAN 1 X Koto Singkarak, it was found that the teaching materials at the school were inadequate, and the teaching materials used were only in the form of printed books / packages. The package book contains material and exercises only, there are no experiments or experiments in the material taught so that students do not understand the material taught and make students bored in the learning process. Meanwhile, students are more interested in learning practically so that students can quickly understand the material being taught.

To overcome the above problems, the use of more effective and interesting teaching materials must be done, based on the needs and desires of students, so that it has its own appeal by students to understand the lesson. Teaching materials that can be developed include student worksheet (Arthamena, Anwar, & Rasmiwetti, 2023; Putri, Abdullah, & Albeta, 2022). The development of an student worksheet must be based on a Scientific learning approach that starts from observing, asking, reasoning, collecting data and communicating. The use of student worksheet will not provide satisfactory results without being accompanied by a learning model in the learning process. One of the learning models that uses the Scientific approach is combining student worksheet with the Learning Cycle 5E learning model.

The Learning Cycle 5E teaching model is a learning activity in the form of stages of a series of activities that have been organised/structured in such a way that students can master the basic competencies that must be mastered in the learning process actively (Winarno, Toheri, & Hendri Raharjo, 2015). The stages of the Learning Cycle 5E learning model are Engagement, Exploration, Explanation, Elaboration and Evaluation (Natalia Diyah et al., 2016). The advantages of Learning Cycle 5E are that the stages of Learning Cycle 5E can make students' involvement active and the Learning Cycle 5E learning model is able to provide understanding to students through the cultivation of thinking concepts (Ratiyani, 2014). The role of the teacher in this Learning Cycle 5E learning model is only as a facilitator in the learning process (Natalia Diyah et al., 2016).

The development of student worksheet based on Learning Cycle 5E as teaching material has been supported by several studies, including stating that the design and trial of student worksheet based on Learning Cycle 5E on buffer solution material has a validity percentage of 90.9% in the excellent validity category (Utami, 2021). The Learning Cycle 5E learning model on solubility and solubility product can improve students' learning outcomes and attitudes, and overall the application of the learning cycle 5E model received positive responses from both teachers and students (Rejeki, Hasan, & Gani, 2015). From several studies conducted, it can be seen that the results of the research are good, but the student worksheet development research conducted has not been carried out on stoicometry material. The development of student worksheet needs to be done on this material because stoichiometry material is one of the learning materials that is considered difficult by students (Zakiyah, Ibnu, & Subandi, 2018). So that teaching materials are needed that can overcome students' learning difficulties.

Based on the description above, the researcher is interested in developing a student worksheet based on Learning Cycle 5E on stoichiometry material. The purpose of this development is to determine the validity and practicality of the student worksheet. If you look at the various existing development studies, student worksheet based on Learning Cycle 5E on stoichiometry material has never been developed before.

METHOD

The research method used in this study is the research and development method, or commonly known as Reasearch and Development (R&D). The development model in this research is the 4-D model. The stages in the 4-D model consist of define, design, develop and disseminate. The data collection instruments used were interviews, validity and practicality questionnaires. Questionnaires were used to measure the validity and practicality of the products developed.

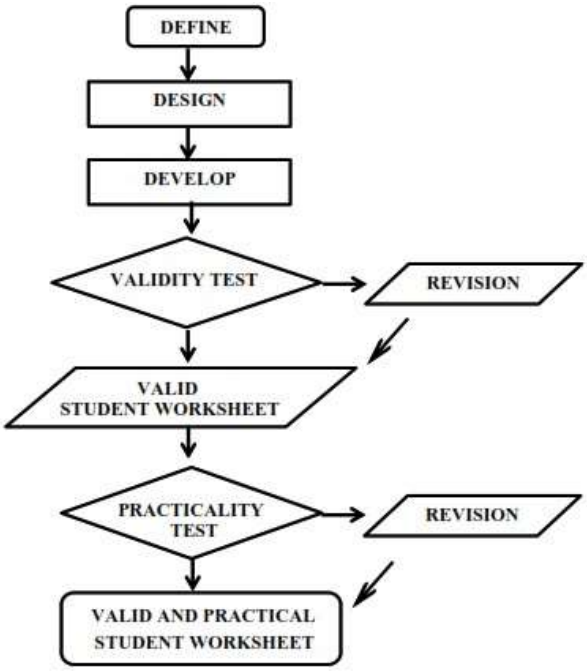

Figure 1. Research procedures

The data analysis technique used was descriptive quantitative, by analysing validity and practicality. Instrument validation was carried out by applying a validation questionnaire. The validation questionnaire given to the validator includes material substance validation, presentation feasibility aspect validation, language validation, and display feasibility validation (Haspen, Syafriani, & Ramli, 2021). To get the percentage of validity and practicality, use the formula:

$$P = \frac{\text{score of each item}}{\text{maximum score of each item}} \times 100\%$$

Table 1. Scoring Categories

Categories	Score
Not valid/practical	0%-20%
Less valid/practical	21%-40%
Fairly valid/practical	41%-60%
Valid/practical	61%-80%
Highly valid/practical	81%-100%

RESULTS AND DISCUSSION

Results are detailed as follows.

Define

The define stage is carried out to find out the problems obtained in the field and find solutions to these problems. The define stage was conducted to obtain an overview of the implementation of learning conducted at SMAN 1 X Koto Singkarak. At this stage, steps were taken including observation and interviews, syllabus analysis, learner analysis, teaching material analysis and student worksheet literature analysis. Initial analysis was conducted through interviews with educators in the field of study, obtained information that the learning method often used by educators is the lecture method, so that educators are more active than students in learning. Teaching materials used in the form of textbooks only, making students monotonous and bored in learning. Package books available at school are limited in number, so not all students get the opportunity to borrow and use them. Educators also use learning media in the form of PPT and videos on YouTube, so that educators are not very capable of teaching only guided by package books and also internet assistance. In general, it is known that educators are constrained in teaching due to the lack of teaching materials that can be used in the learning process.

Based on curriculum analysis, 10^{th} grade chemistry learning contains 10 KD. The KD focused on in this research is KD 3.10 and KD 4.10 which are related to stoichiometry. KD 3. 10 Apply the basic laws of chemistry, the concept of relative molecular mass, chemical equations, the concept of moles, and substance levels to solve chemical calculations and KD 4.10 Analyse experimental data using the basic laws of quantitative chemistry.

Based on the analysis of students, it is known that students during the chemistry learning process use only package books and are assisted using the internet by educators. The package books used by educators are very limited in number, so not all students can get the package books and students also lack or even do not understand the material taught by educators. The attitude of students is good in participating in learning. This is known from students who have obeyed the instructions of educators during learning. When doing group assignments, students have been able to divide tasks and cooperate with their colleagues.

Based on the analysis of teaching materials, it is known that the teaching materials used by educators during learning are in the form of chemistry package books only. The package book is also in accordance with the 2013 curriculum with the publisher Bailmu. This package book is not owned by all students. In the package book, students are required to do exercises only, there is no experiment either at school or at home. This package book only contains material, sample problems and exercises. But there are no experiments in the package book. The package book is not facilitated with the Learning Cycle 5E learning model to make it easier for students to understand stoichiometry material and when learning students play an active role.

Based on the literature analysis, student worksheet is a teaching material in the form of sheets that are composed of learning materials, summaries and instructions for implementing learning tasks that must be done by students who are guided by the basic competencies that must be achieved. student worksheet components: a) title, b) instructions for using basic competencies or subject matter, c) supporting information, d) tasks to be done and assessment. If based on the format, student worksheet consists of several elements, namely title, basic competencies, completion time, equipment / materials needed to complete the task, brief information, work steps, tasks to be completed and reports to be done. The student worksheet uses the Learning Cycle 5E learning model, which is a cooperative learner-centred learning model so that students play a more active role in learning.

The beginning of this research is the define stage. The define stage is carried out to examine the learning process. According to Thiagarajan, at the define stage there is a needs analysis

conducted by observation and interviews so that it can be determined what will be developed in the study (Wijayanti & Sungkono, 2017). Based on the needs analysis, it is known that teaching materials are still lacking in the learning process. Teaching materials that are often used are only packaged books. Therefore, the researcher intends to develop student worksheet teaching materials based on Learning Cycle 5E. The material included in the student worksheet is more concise, dense and clear so that it is easy for students to understand. The student worksheet developed uses the Learning Cycle 5E learning model so that students can play an active role in learning (Rachman, Ahsanunnisa, & Nawawi, 2017).

In the define stage, learner analysis and student worksheet literature analysis were also conducted. In the analysis of learners, it is known that students do not understand the material because the teaching materials used by educators are limited, such as textbooks, so that students feel bored, monotonous and uninterested in the lesson. Analysis of student worksheet literature to find out the format, learning model used in making student worksheet and how to make student worksheet, so that the products developed can be made in an appropriate format.

Design

This stage is carried out to design student worksheet based on Learning Cycle 5E on stoichiometry material and design research instruments. The activity at this stage is to design the cover and background of the student worksheet with Corel Draw, then continue using Microsoft Word for the material, after which it is converted into PDF after that it is printed. The composition of the student worksheet based on Learning Cycle 5E on stoichiometry material can be seen as follows:

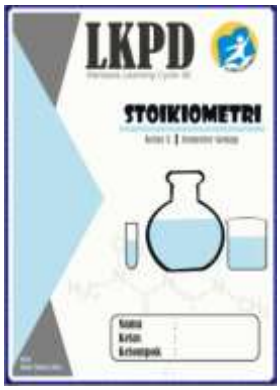

Figure 2. *Cover*

Figure 3. *Background*

Figure 4. Preface

Figure 5. Table of Content

Figure 6. Product profile

Figure 7. Instruction for use

Figure 8. KI and KD

Figure 9. Concept Map

Figure 10. Material

Figure 11. *Games Times*

Figure 12. References

Figure 13. Author profile

The design of the research instrument consists of a validation sheet for student worksheet based on Learning Cycle 5E and a validation sheet for student worksheet validity test instruments as well as a student response questionnaire sheet and a validation sheet for student response questionnaires.

The design stage can be done after the define stage. The purpose of this stage is to design the initial design of the student worksheet. The design of the Learning Cycle 5E-based student worksheet is adjusted to the core competencies, basic competencies and indicators of competency achievement in the 2013 curriculum. This is done so that the contents of the student worksheet have material coverage in accordance with the demands of the curriculum. The material included in the designed student worksheet is stoichiometry material. Stoichiometry material is divided into five sub-chapters of material.

Student worksheet based on Learning Cycle 5E on stoichiometry material is designed in accordance with the components of student worksheet in general. Student worksheet is designed according to the Learning Cycle 5E learning model in which from each material sub chapter there are 5E stages (Engagement, Exploration, Explanation, Elaboration and Evaluation). There are several of the sub-chapters of the material there are game times, which aim to keep students from mononton in the learning process and see the results of students' achievements. Making student worksheet based on Learning Cycle 5E pays attention to the basic competencies in stoichiometry material and the stages of Learning Cycle 5E in accordance with the stages in the scientific approach used in the 2013 curriculum. Learning Cycle 5E-based LKPD is able to activate students and be able to provide understanding to students through the cultivation of thinking concepts (Soffa, 2016).

Develop

At this stage, two stages are carried out, namely validity test and practicality tests.

Validation Test Results

Table 2. Validation Test Results

No	Aspects that were validated	Sum	Max Score	%	Remarks
1	Content Feasibility	97	108	89,81	Highly valid
2	Presentation Feasibility	89	96	92,70	Highly valid
3	Linguistic Feasibility	65	72	90,27	Highly valid
4	Graphics Feasibility	67	72	93,05	Highly valid
Total		318	348	91,37	Highly valid

Based on table 2, the percentage of content feasibility is 89.81% with a highly valid category, the percentage of feasibility of presenters obtaining a value of 92.70% is categorised as highly valid, linguistic feasibility obtaining a percentage of 90.27% is categorised as highly valid and for graphics feasibility with a percentage of 93.05% is categorised as highly valid. Based on the table above, the overall percentage with a value of 91.37% is included in the highly valid category.

Practicality Test Results

Table 3. Practicality Test Results

No	Practicality Aspect	Sum	Max Score	%	Remarks
1	Ease of use	392	480	81,67	Highly practical
2	Display	608	720	84,4	Highly practical
3	Learning material	480	600	80	Practical
4	Language	293	360	81,39	Highly practical
Total		1773	2160	82,09	Highly practical

Based on table 3, the ease of use is 81.67% categorised as highly practical, the display gets a percentage of 84.4% categorised as highly practical, the learning material with a percentage of 80% is categorised as practical and the language with a percentage value of 81.39% is categorised as highly practical. Based on the table above, the overall percentage obtained with a value of 82.09% is categorised as highly practical.

Based on the results found, it can be explained that the process of developing this teaching material has been carried out in accordance with the rules of development research using the 4D model.

At Develop stage, the initial student worksheet produced from the design stage will be tested for validity and practicality. To see the validity of the student worksheet, a validity test was conducted with several experts. After going through the validation and revision process, the practicality test was carried out on the student worksheet to see its practicality.

The validation process was carried out on research instruments and Learning Cycle 5E-based student worksheet. Before the research instruments in the validity test and practicality test are used, they will first be validated. The research instrument is validated in order to find out whether the research instrument is valid for use. The research instrument validation process was carried out through a validation sheet in the form of a questionnaire. Aspects of validation of research instruments in the form of format, language and statements from the questionnaire. After the research instruments in the validity test and practicality test are valid, the instruments can be used. The validation process of Learning Cycle 5E-based student worksheet involved three validators, consisting of two lecturers and one chemistry educator. The validity test instrument is a validation sheet questionnaire with a Likert scale. Before the LKPD validation sheet was filled in by the validator, the validation sheet had been validated and obtained highly valid results.

CONCLUSION

In light of the data analysis, it can be concluded that the developed student worksheet based on Learning Cycle 5E for stoichiometry material has achieved both validity and practicality criteria. Hence, it can be regarded as a suitable learning resource for students.

RECOMMENDATIONS

Although this study has reached the development stage and completed validation and practicality tests, it is suggested that future research undertake an effectiveness test and implement the disseminate stage. This will ensure a more comprehensive evaluation of the effectiveness and potential impact of the developed student worksheet, thereby contributing to the advancement of teaching and learning practices in the field of chemistry education.

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