

Development of SETS (Science, Environment, Technology and Society) Based Student Worksheet on the Subject of Ion Equilibrium and pH of Buffer Solutions

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Received: October 17, 2023

Revised: November 18, 2023

Accepted: December 25, 2023

Published: December 31, 2023

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DOI: [10.29303/jppipa.v9iSpecialIssue.6154](https://doi.org/10.29303/jppipa.v9iSpecialIssue.6154)

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Abstract: This research aims to produce a student worksheet based SETS on a valid ion balance and pH of buffer solutions for class XI SMA/MA and knows user's response. This research is development research (R&D) that adapts the 4-D development model. The data collection instruments used in the form of validation sheets and user response questionnaires. The research results showed that the percentage of appropriateness of content, SETS characteristics, language and presentation was 91.66; 97.91; 89.58 and 91.67%. with valid criteria. One-on-one trials were carried out on 3 students with different abilities to get comments that were used to improve the student worksheet. The results of teacher and student responses were respectively 97.17% and 84.34% with very good criteria.

Keywords: Ion Balance; pH of Buffer Solution; Student Worksheet; SETS

Introduction

The learning process involves interaction between teachers and students to achieve learning goals. The learning process provides information to achieve students' thinking patterns regarding a material. Teachers need to prepare the learning process so that learning objectives are achieved. Maximum planning will have an impact on the learning process and outcomes. Planning the learning process can start by designing essential learning tools (Setiawati & Senam, 2015). Teaching materials are an example of learning tools that can be designed by teachers. The development of teaching materials will be beneficial in the learning process (Komalasari et al., 2019). Teaching materials are prepared systematically by paying attention to quality in terms of language, graphic design, images as well as the suitability of the material and development methods (Murdiandari et al., 2015). Teaching materials can be in the form of books, modules, student worksheet and

PowerPoint (Prastowo, 2016). Teaching materials include knowledge, skills and attitudes that students learn to achieve competency standards in learning (Aisyah et al., 2020). Student Worksheets are one of the teaching materials that teachers can use in the learning process. Preparing the student worksheet in accordance with the requirements for preparing the student worksheet will make the LKPD of higher quality (Nurdin & Adriantoni, 2016). The use of student worksheet in the learning process will make students actively involved and increase students' independence in carrying out assignments to obtain good learning results (Fitria et al., 2015).

Apart from that, the use of student worksheet in the learning process helps teachers to direct students in discovering learning concepts (Rosa et al., 2022). Student worksheet contains a collection of learning activities that guide students to read, calculate, write, discuss, analyze or evaluate. Learning activities in this student worksheet are carried out to maximize students'

How to Cite:

Putri, A.F., Herdini, H., & Linda, R. (2023). Development of SETS (Science, Environment, Technology and Society) Based Student Worksheet on the Subject of Ion Equilibrium and pH of Buffer Solutions. *Jurnal Penelitian Pendidikan IPA*, 9(SpecialIssue), 143-148. <https://doi.org/10.29303/jppipa.v9iSpecialIssue.6154>

understanding of learning concepts (Trianto, 2014). The results of interviews conducted with chemistry teachers at SMA Muhammadiyah 1 Pekanbaru and SMAN 9 Pekanbaru revealed that students had used LKPD but had not used LKPD using the SETS approach in the learning process. Students tend to memorize learning rather than understanding learning concepts. Student learning outcomes when learning evaluations are carried out are also less than satisfactory. The use of student worksheet in learning has not been effective because it is not in accordance with students' needs to understand chemistry learning concepts. The student worksheet used should contain a collection of learning activities that encourage students to understand learning concepts.

The development of student worksheet based on a learning approach can be carried out by teachers to increase direct student involvement in the learning process, increase understanding of concepts and increase students' learning motivation. One approach that can be applied in developing student worksheet is the Science, Environment, Technology and Society or SETS approach. The Science, Environment, Technology and Society or SETS approach involves science, environment, technology and society in the learning process. The delivery of material in this SETS approach links issues or phenomena in society and then links these issues or phenomena with concepts related to learning (Istarani, 2014). The SETS approach makes learning interesting, fun and meaningful because the material is linked to technology, the environment and society (Widiantini et al., 2017). Through the application of this approach, it is hoped that it can motivate students to form their own knowledge that exists in their environment and apply it in everyday life (Fatchan and Soekamto, 2018)

This connection between learning and the surrounding environment can also make students interested during learning and increase student activity. This approach can also encourage students to think creatively and critically to provide solutions to environmental problems (Pranowo et al., 2021). The SETS approach shows that the knowledge students learn will be useful in everyday life. The SETS approach will train students to assess the positive and negative impacts of a science and technology product and its impact on the environment and society. Through learning with the SETS approach, students are expected to be able to make wise decisions and create solutions when facing problems in their environment (Khasanah, N, 2013). This approach can help students to apply the knowledge they have in everyday life to improve the quality of human life (Winaryati, 2012).

The material characteristics of buffer solutions involve chemical reaction mechanisms, calculations and

involve various stages and contextual material. Buffer solution material is a complex material in chemistry learning. Buffer solutions relate to basic acid bases, titration processes, pH calculations and their application in everyday life (Setiadi & Irhasyuarna, 2017). During the buffer solution learning process, teachers rarely relate the material to events in everyday life. The teacher only explains theory and solves calculation problems (Harpiyani et al., 2021). The use of the SETS approach in student worksheet is expected to be in accordance with the characteristics of the buffer solution. The use of student worksheet on buffer solution material using the SETS approach makes it easier for students to understand learning concepts and apply them in everyday life. The use of student worksheet on buffer solution material using the SETS approach is able to improve students' learning outcomes, critical and creative thinking skills.

Research regarding the development of SETS-based student worksheet was carried out by Syuhaif Al Afsyah (2022) on petroleum material with the research results of the LKPD being developed obtaining a percentage of suitability for content, language and graphics of 92% respectively; 93% and 95%. The teacher response results in this research were 98%, so the student worksheet was suitable for use with a very good response. Another research regarding the development of SETS-based LKPD was carried out by Refdiati Wirdani (2019) on colloidal materials with the research results of the LKPD being developed being very valid with a percentage of 88.125% and very practical with a percentage of 90.4%.

Based on the presentation that has been put forward, researchers are interested in carrying out research regarding the development of Science, Environment, Technology and Society (SETS) based LKPD on the subject of Ion Equilibrium and pH of Buffer Solutions for class XI SMA/MA equivalent.

Method

This research uses research and development (R&D) methods with a 4-D research model. The 4-D model consists of four stages, namely Define, Design, Develop and Disseminate (Trianto, 2014). This research was only carried out up to the Develop stage because the aim of this research was only to develop valid student worksheet and find out user responses. The subjects of this research were students in class XI SMA/MA equivalent. The research instruments used were validation questionnaires, teacher response questionnaires and student response questionnaires.

At the define stage there are 3 steps, namely front end analysis, student analysis and task analysis. The task analysis step is divided into several analyses, namely,

content structure analysis, concept analysis, procedural analysis and goal analysis. At the design stage, initial planning of the student worksheet is carried out which meets the feasibility criteria in the student worksheet. At the development stage there are 2 steps, namely expert validity and trial.

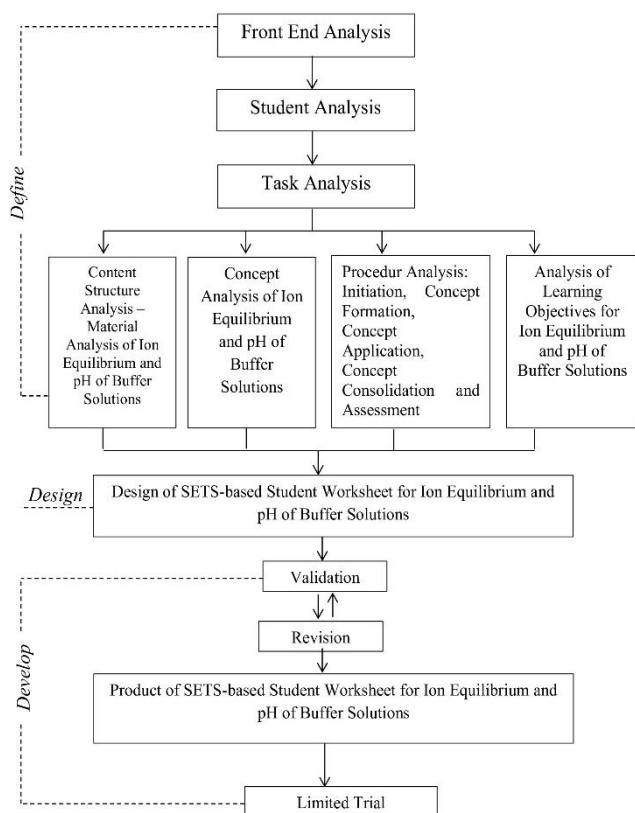


Figure 1. Develop Flow of SETS-based Student Worksheet for Ion Equilibrium and pH of Buffer Solution

Expert validity is carried out by three material expert validators. Validation of student worksheet is carried out based on aspects of suitability of content, SETS characteristics, language and presentation. Validation aims to obtain suitability of the student worksheet to needs so that the student worksheet is appropriate and suitable for use in the learning process. At this stage, the suitability of the learning material with the SETS approach is determined. Data analysis of validation results was carried out on each aspect of the validation sheet. Based on the results of the assessment sheet, the average percentage for each component will be calculated. The criteria for making decisions for the validity of the student worksheet can be seen in table 1.

Table 1. Validity Criteria, (Rohmad et al., 2013)

Percentage	Category
75.00 - 100	Valid
50.00 - 75	Valid
25.00 - 50	Less Valid
0.00 - 25	Invalid

The trials in this research were carried out 3 times, namely one-on-one testing, teacher response testing and small group testing. The one-on-one test was carried out by 3 students with different levels of ability. The purpose of conducting one-on-one tests is to improve product use procedures, identify and eliminate errors in product use and obtain information about user reactions to the material and messages that the product wants to convey (Rusdi, 2019).

The teacher response test was carried out on 2 chemistry teachers with the aim of obtaining assessments, comments and suggestions from chemistry teachers regarding the student worksheet that had been developed. Teachers are asked to provide an assessment on the student worksheet by filling out a teacher response questionnaire regarding the appropriateness of the contents of the student worksheet. The small group test was carried out by 20 students who had studied the material on ionic balance and pH of buffer solutions with the aim of knowing the students' responses to the student worksheet that had been developed. Students are asked to use the student worksheet and fill in student user questionnaire responses. The assessment of teacher and student response questionnaires is based on a Likert scale which can be seen in table 2.

Table 2. User Response Categories, (Sugiyono, 2017)

Scoring scale	Category
4	SS: Strongly agree
3	S: Agreed
2	KS: Disagree
1	TS: Disagree

Based on the Likert scale assessment category table in table 2, the average percentage of user responses will be calculated. The percentage results of the user response questionnaire assessment on the student worksheet are converted into qualitative values as in table 3 below.

Table 3. User Response Criteria, (Sari et al., 2016)

Percentage	Category
75.00 - 100	Very good
50.00 - 74.99	Good
25.00 - 49.99	Not good
0.00 - 24.99	Not good

Results and Discussion

Define Stage

In the define stage, interviews were conducted with chemistry teachers at SMA Muhammadiyah 1 Pekanbaru and SMAN 9 Pekanbaru. Based on the interview results, it was found that teachers had used student worksheet in the learning process but had not

used model-based student worksheet or learning approaches and the results of student evaluations were less than satisfactory. The development of teaching materials needs to be carried out by teachers because teaching materials play a role in determining the success of learning (Ramdoniati, et al. 2019). Teaching materials that can be developed are student worksheet based on Science, Environment, Technology and Society which can help students understand learning concepts and increase student involvement in the learning process.

The subject of ion equilibrium and pH of buffer solutions is a subject studied in class XI Science SMA/MA in the even semester with ages 16-17 years. According to Piaget's developmental theory, students aged 16-17 are included in cognitive development at the formal operational stage (Siswoyo, 2013). At this age, students can also develop deductive hypotheses regarding problem solving and draw conclusions systematically (Miranda, 2020).

At this stage, literature analysis and learning objectives are also carried out based on the 2017 Ministry of Education and Culture syllabus. The aim is to find out Content Competencies, Basic Competencies and Indicators of Competency Achievement as well as learning objectives for the material to be studied (Warti et al., 2023).

Design Stage

At this stage, an initial student worksheet design is carried out in accordance with the student worksheet eligibility criteria. In this initial draft, the student worksheet title, study instructions, KD formulation, GPA and learning objectives, student activities, short material and bibliography were produced. The preparation of this student worksheet is based on the stages of the SETS approach, namely initiation, concept formation, concept application, concept consolidation and assessment (Azzahra et al., 2022)..

Development Stage

In the development stage, validation and trials are carried out on the student worksheet that has been developed. The results of the SETS-based student worksheet validation analyzed by the validator team can be seen in Table 4. Based on the material validation results table in validation I, it is known that the average percentage is 74.83% with the criteria being quite valid so improvements are needed. The lowest percentage in validation I lies in the language feasibility aspect. The validator said that the editors of several discourses and questions also needed to pay attention to word choice so as not to make students confused in understanding the discourse. The use of language in student worksheet must be appropriate to the level of maturity of students and use clear sentence structures (Pawestri and Zulfiati,

2020). Validators also provide comments to pay more attention to errors in writing words on the student worksheet.

Table 4. Material Validation Results

Assessment Aspects	Validation Score	
	I (%)	II (%)
Content Eligibility	78.57	91.66
Eligibility	83.33	97.91
Characteristics of SETS		
Aspects of Language		89.58
Feasibility	66.67	
Aspects of Feasibility of Presentation	70.83	91.67
Average Percentage Score	74.85	92.71
Validity Criteria	Fairly Valid	Valid
Average of All Aspects		

The suggestions and comments given by the validator become a reference for making improvements to the student worksheet so that the student worksheet is suitable for testing. Improvements are made to improve the student worksheet. Validation II was carried out after improvements were made to the student worksheet. The results of validation II show that the average percentage is 92.71% with valid criteria so that the student worksheet is suitable for testing. After the student worksheet was declared valid, a one-on-one trial was carried out on 3 students who had studied ionic balance and pH of buffer solutions. The purpose of conducting one-on-one tests is to identify and eliminate errors in product use and obtain information about user reactions to the material and messages that product users want to convey. In this one-on-one test, students said that this SETS-based student worksheet made them gain new knowledge about learning chemistry, especially the application of buffer solutions in everyday life. Students become motivated to take chemistry lessons. The interrelationship of each element in the SETS approach creates a good impression on students and encourage more active, creative and critical thinking. The SETS approach helps students to understand topics in depth and improves student learning achievement (Rolin and Suryawati, 2017). Improvements to the student worksheet are carried out based on the results of one-on-one tests. The time limit for working on the student worksheet at meeting 3 was not enough, so additional time was given to work on the student worksheet. The time limit in working on the student worksheet will have an impact on the results of the work so that the time allocated for working on the student worksheet needs to be considered (Suharman, 2018).

Next, teacher response tests and small group tests were carried out. The teacher response test was carried out on 2 different chemistry teachers and the small group test was carried out by 20 students who had studied ionic balance and pH of buffer solutions. Below are presented in a table the results obtained from the teacher response test and small group test

Table 5. Recapitulation of Teacher Response Test Results and Small Group Tests

Respondent	Results (%)	Category
Teacher	97.17	Very good
Learners	84.38	Very good

Overall, the teachers considered that the SETS-based student worksheet on the subject of ionic balance and pH of buffer solutions was interesting and in accordance with the syllabus in the 2013 curriculum and the questions contained in the student worksheet were directed towards analytical questions. student worksheet can be used in learning to achieve the expected learning outcomes because it is easy for students to understand. The use of the SETS approach provides students with the opportunity to develop a holistic and integrated understanding of scientific concepts and their applications (Mahlianurrahman, 2017). This is in line with research (Redhana, 2019) which states that SETS-based student worksheet helps students understand the material because it presents information related to people's lives. The SETS approach can help students understand problems in the surrounding environment so that students can explore their ideas so as to gain new knowledge and get students used to thinking independently and critically (Al Af Syah, et al. 2022).

Students said that the appearance of the student worksheet was attractive, making students more enthusiastic and motivated to work on the student worksheet. This is in line with research conducted by (Wirdani et al., 2019). In his research, it was said that student worksheet designed with an attractive appearance will make it easier for students to work on questions and make students more enthusiastic. student worksheet that has an attractive design can stimulate students to be interested in taking part in learning by (Abd.Rachman et al., 2017).

Conclusion

Based on the results of the research that has been carried out, it can be concluded that: The development of SETS-based student worksheet on ionic balance and pH of buffer solutions for class amounting to 91.66; 97.91; 89.58 and 91.67 %. The teacher response test and

small group test obtained percentages of 97.17 % and 84.34 % respectively with very good criteria.

Acknowledgments

Thanks to all parties who have supported the implementation of this research. I hope this research can be useful.

Author Contributions

Conceptualization; A. F. P.; methodology.; H.; validation; R. L.; formal analysis; A. F. P.; investigation.; H.; resources; R. L.; data curation: A. F. P.; writing—original draft preparation. H.; writing—review and editing: R. L.; visualization: A. F. P. All authors have read and agreed to the published version of the manuscript.

Funding

Researchers independently funded this research.

Conflicts of Interest

The authors declare no conflict of interest.

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