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Development of Student Worksheets with Learning Cycle 5E Models on Solubility Product Constant Materials and Their Influence on Student Chemistry Literacy

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Abstract: This study aims to develop a student worksheet (LKPD) based on the learning cycle 5E models. The research utilizes the 4D development model by Thiagarajan, which consists of four stages: Define, Design, Develop, and Dissemination. The sample in this study was chemistry teachers and students of SMA Negeri 1 Ngawi. The results of the validation by media and material experts indicate that the LKPD learning cycle 5E is suitable for use in learning. Readability tests conducted by students and teachers show that the LKPD learning cycle 5E falls into the "very good" category. The results of the effectiveness test, using a Mann-Whitney U test, indicate that the LKPD learning cycle 5E has a very small effect on student chemistry literacy in solubility product constant materials.

Keywords: Development research; Learning cycle 5E; Learning media; Solubility product constant; Student worksheets

Introduction

The subject area of natural sciences (IPA) that is important for high school students to master is chemistry. Chemistry stands as a pivotal subject within high school science education, often hailed as the cornerstone due to its interdisciplinary nature and profound influence on understanding the natural world (Childs et al., 2015; Holbrook et al., 2020; Tai et al., 2005). Despite its significance, students frequently encounter difficulties in mastering chemical concepts, citing its abstract nature and the limited support provided by educators (Atagana et al., 2014; Hemayanti et al., 2020). Research by Cooper et al. (2018) and Ojukwu (2016) has consistently highlighted the struggle students face in applying these concepts to real-life scenarios, underscoring the need for more effective teaching strategies and enhanced teacher training.

Students' mastery of chemistry can be measured through their chemistry literacy scores, assessed by the Programme for International Student Assessment (PISA). According to Shwartz et al. (2005), students' understanding of basic science or chemistry concepts determines their chemistry literacy. PISA, a program by the World Bank, maps the skills of 15-year-old students in reading, mathematics, and science. Indonesia's PISA results show a score 100 points lower than the Organization for Economic Cooperation and Development (OECD) average. This discrepancy equates to a 2.5-year gap in proficiency compared to OECD countries (OECD, 2019). Indonesia's low scores rank it near the bottom, with consecutive rankings of 71st, 74th, and 73rd in science, reading, and mathematics skills among 79 countries (Schleicher, 2019; Tehusijarana, 2019). Low PISA scores in science suggest low chemistry literacy, highlighting the urgency for improvement (Hernani et al., 2017; Imansari et al., 2018; Muntholib et al., 2020; Prastiwi et al., 2018).

Improving students' chemistry literacy can be achieved by teachers through active learning processes. Active learning encourages students to self-evaluate and complete tasks, achieve goals, and overcome obstacles

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(Kustyarini, 2020). According to Hussin (2018), learning experiences that vary can lead to students actively participating in the learning process. From a psychological standpoint, students who actively engage in learning can enhance overall outcomes as well as improve memory, understanding, and active knowledge utilization (Perkins et al., 2008). Both teachers and students benefit from enjoyable active learning experiences, which can stimulate higher-level thinking (Limbach et al., 2010).

The active learning process can be facilitated by teachers through the application of learning models based on constructivist learning theory. This model serves to enhance student activity, motivation, concept understanding, and creativity (Salyani et al., 2020). Students learning based on constructivist learning theory are required to process their understanding and knowledge independently, thus fostering active learning processes (Dagar et al., 2016). Originally consisting of 3 stages, the learning cycle model has undergone development, with the 5E learning cycle proving more successful in science education (Yaman et al., 2018). Previous studies have found that implementing the 5E learning cycle model also optimizes students' chemistry literacy (Nuryadin et al., 2019; M. Sari et al., 2019; Suryawati et al., 2018).

Implementing the 5E learning cycle model requires learning tools to facilitate its application in the classroom. Student Worksheets (LKPD) are learning tools designed to facilitate the learning process (Supeno et al., 2015). LKPD aids teachers in facilitating the learning process and helps students learn independently, understand, and complete tasks (Susanti et al., 2018). Activities within LKPD, such as formulating objectives, conducting investigations, providing reasons, and writing simple articles, can foster self-efficacy (Erika et al., 2019). Previous research has found that developing chemistry literacy LKPD can enhance students' chemistry literacy and is considered suitable as a learning medium (Aisyah et al., 2017; Sunyono et al., 2020; Vienurillah et al., 2016; Zuhro et al., 2017).

Chemistry at the high school level (SMA) comprises a series of topics that students must master. Solubility and solubility product constant (Ksp) are taught to students in the second semester of grade XI. The Ksp material requires students to have a mastery of previously learned material, especially chemical equilibrium and acid-base concepts (Nomilasari et al., 2019). The Ksp material is considered difficult because students need to integrate observed phenomena directly with chemical theory and then apply them using mathematical symbols (Saputri et al., 2016). There are several reasons why students experience difficulties in learning Ksp, including internal and external factors. Internal factors involve a lack of interest in learning chemistry, lack of motivation in learning chemistry, poor understanding of concepts, low understanding of supporting concepts, and poor mathematical abilities (Muderawan et al., 2019). External factors include peer influence and teaching methods of the teacher (Muderawan et al., 2019).

The persistence of lecture-based or teacher-centered teaching methods affects students' chemistry literacy. Observations by researchers with chemistry teachers at SMAN 1 Ngawi reveal a continued reliance on teacher centered methods. This approach fosters dependence on teachers and inhibits direct communication. Teachers predominantly use textbooks as the primary learning resource. Students find solubility and solubility product constant materials challenging due to their reliance on both chemical and mathematical concepts. Teachers note students' low confidence in learning chemistry, indicating potential issues with chemistry literacy. Addressing these challenges requires learning media that align with material characteristics to enhance student achievement. Thus, research titled "Development of Student Worksheets with Learning Cycle 5E Models on Solubility Product Constant Materials and Their Influence on Student Chemistry Literacy" could address these issues.

Method

This study is a Research and Development (R&D) study focused on product development, namely Student Activity Sheets (LKPD) based on the 5E learning cycle. This research adopts the 4D development design introduced by Thiagarajan, which involves four main stages: Define, Design, Develop, and Disseminate. The 4D model is used with the aim of creating and developing learning products. The development of these LKPD aims to 1) testing feasibility by subject matter experts and media experts, 2) testing readability by students and teachers, and 3) testing effectiveness of the developed LKPD. The research design of the 4D development model comprises four stages that can be illustrated in Figure 1.

The participants in this study were chemistry teachers and students from SMA Negeri 1 Ngawi. They included three chemistry teacher and two eleventh-grade classes. The experimental group consisted of 36 students from class XI MIPA 6, while the control group was class XI MIPA 4. The product test results were then analyzed through pre-test and post-test to determine its impact on learning effectiveness. The research subjects, comprising students and chemistry teachers, provided feedback on the developed media during the experiment by completing student questionnaires.

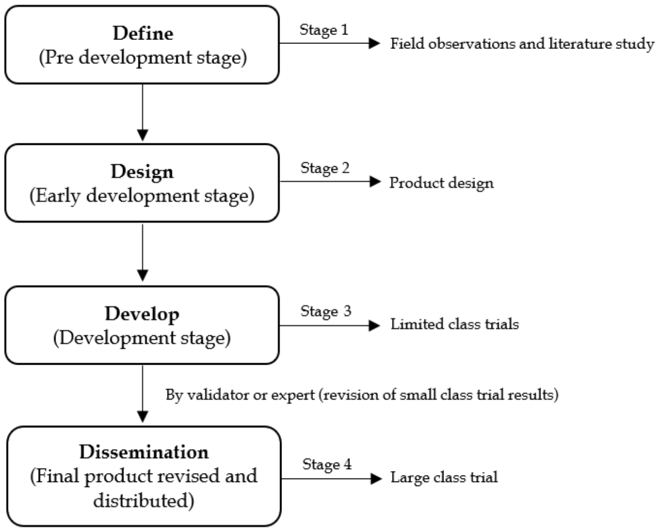

Figure 1. 4D model R&D research design

The data instruments in this study consist of essay and questionnaires. Essay questions are used to assess students' chemistry literacy and consist of 15 questions that utilize chemistry literacy indicators. Questionnaires are given to expert validators to evaluate the instruments and learning materials. Questionnaires are also given to students and teachers to assess the readability of the developed LKPD. Feasibility data are obtained using the following equation (Ihwanudin et al., 2018).

$$P = \frac{F}{N} x\ 100\% \quad (1)$$

Description:
P = Percentage calculated from questionnaire data
F = The count of respondents' responses
N = The number of the highest score

The feasibility of the LKPD is assessed for its suitability by validators, who provide checkmarks in the provided evaluation columns. The analysis conducted after the researcher obtains data from the completion of the questionnaire responses by validators is as follows.

Table 1. Percentage Range of Expert and Qualitative Criteria for Feasibility (Sudjana, 2016)

Percentage Range (%)	Qualitative Criteria
80.00 – 100.00	Very Feasible (Not Revised)
70.00 – 80.00	Feasible (Not Revised)
60.00 – 70.00	Fairly Feasible (Revised)
50.00 – 60.00	Less Feasible (Revised)
< 50%	Not Feasible (Revised)

The readability sheet contains several indicators that will be assessed for their suitability by teachers and students, who provide checkmarks in the provided evaluation columns. The analysis conducted after the researcher obtains data from the completion of the questionnaire responses by teachers and students is as follows.

Table 2. Readability Criteria of the LKPD Based on Teachers (Widyoko, 2009)

Score Interval	Criteria
$\bar{x} > 95.2$	Excellent
$78.4 < \bar{x} \leq 95.2$	Good
$61.6 < \bar{x} \leq 78.4$	Fair
$44.8 < \bar{x} \leq 61.6$	Poor
$\bar{x} \leq 44.8$	Not Good

Table 3. Readability Criteria of the LKPD Based on Students (Widyoko, 2009)

Score Interval	Criteria
$\bar{x} > 50.4$	Excellent
$40.8 < \bar{x} \leq 50.4$	Good
$31.2 < \bar{x} \leq 40.8$	Fair
$21.6 < \bar{x} \leq 31.2$	Poor
$\bar{x} \leq 21.6$	Not Good

The analysis of effectiveness testing using Mann-Whitney U test to assess the difference in means between the experimental and control groups using the LKPD based on the learning cycle 5E concerning chemical literacy. The testing is conducted using SPSS 25 for Windows software at a significance level of 5%.

Result and Discussion

Development Results

The study utilized a research and development (R&D) approach with the aim of designing student worksheet (LKPD) based on learning cycle 5E focusing on chemistry content. These LKPD were intended to serve as a supplementary learning tool for teachers to enhance the educational outcomes of high school students in Ngawi. The Ksp material was chosen due to its difficulty because students need to integrate observed phenomena directly with chemical theory and then apply them using mathematical symbols (Saputri et al., 2016).

This LKPD consists of 3 sub-materials: solubility and solubility product, the effect of ions with the same name and pH, and precipitation reactions. Each sub-material is presented with stages following the learning cycle 5E model. The engagement stage includes readings or literacy materials to capture students' attention and present the problems related to the sub-material to be studied. The Exploration stage contains questions to give students the opportunity to observe, interpret results, formulate hypotheses, and make meaningful learning experiences. In the Explanation stage, students will present the results of group discussions based on the findings from the Exploration stage. The Explanation stage also includes readings or literacy materials about chemical figures used to expand students' knowledge of chemistry and enhance students' literacy. The Elaboration stage is where students apply the new knowledge gained through practical activities. The Evaluation stage includes formative assessment on the development of students' understanding of concepts, principles, and their ability to apply these concepts. The display of LKPD learning cycle 5E is presented in Figure 2.

Figure 2. The display of LKPD learning cycle 5E

Validity Test Results

Media Aspect

After the initial development of the LKPD based on learning cycle 5E, the next stage involved a validation process conducted by learning media experts before testing the media in schools. The validation of the learning media was carried out by lecturers at the Faculty of Mathematics and Natural Sciences, who have extensive knowledge and experience in developing learning media. Validators will determine the feasibility of using the media and provide feedback in the form of information, suggestions, and criticism to refine the LKPD. The following are the results of the expert validity assessments on the media aspects.

The results obtained by media experts indicate that the LKPD learning cycle 5E obtained a total score of 35 and a percentage of 82.81%. This validation result falls into the "Very Feasible" category, indicating that no revision process is required. The validation process by media experts covers aspects of presentation, linguistic, and graphical elements. Almost all aspects evaluated in the questionnaire by media experts attained the maximum score of 4 points.

Table 4. Media Expert Validator Assessment Results

Assessment Items	Score
Presentation Aspect	
Clarity of material presentation is engaging and logical	3
Suitability of concept development related to daily life	4
Suitability of material presentation arrangement from simple to complex	4
Clarity of material presented with supporting images	4
Completeness of concepts regarding solubility and solubility product	4
Development of worksheets places students as the center of learning	4
Presentation of worksheets can guide students to interact with learning objects	4
Presentation of worksheets can guide students to enhance chemical literacy	4
Appropriateness of time used	4
Linguistic Aspect	
Appropriateness of communicative and easily understandable language usage	3
Appropriateness of language usage that is not ambiguous	3
Appropriateness of language usage adhering to standard language	3
Suitability of language used with the developmental stage of eleventh-grade high school students	4
Graphical Aspect	
Suitability of images used	4
Suitability of font types used	4
Suitability of design for each page used	4
Total score	53
Percentage	82.81%

Material Aspect

The validation of the learning material was conducted by professors at the Faculty of Mathematics and Natural Sciences, who possess extensive knowledge and experience in solubility product constant-related material. Validators will assess the feasibility of using the material and provide feedback in the form of information, suggestions, and criticism to refine the LKPD. The following are the results of the expert validity assessments on the material aspects.

Table 5. Material Expert Validator Assessment Results

Assessment Items	Score
Material Aspect	
Suitability of the material with core competencies and basic competencies	4
Suitability of the material with learning objectives	4
Suitability of the material with indicators	4
Accuracy of the presented concepts	4
Depth of material in line with students' educational level	3
Sequential guidance in the worksheet to discover concepts	3
Activities presented in the worksheet align with the syntax of the learning cycle 5E	4

Assessment Items	Score
Activities presented in the worksheet can stimulate students to optimize chemical literacy	3
Presentation Aspect	
Clarity of material presentation, engaging, and logical	4
1Suitability of concept development related to daily life	4
Suitability of material presentation arrangement from simple to complex	3
Clarity of material presented with supporting images	2
Completeness of concepts regarding solubility and solubility product	4
Development of worksheets places students as the center of learning	4
Presentation of worksheets can guide students to interact with learning objects	4
Presentation of worksheets can guide students to enhance chemical literacy	4
Appropriateness of time used	4
Appropriateness of Evaluation Tools Aspect	
Suitability of learning evaluation with basic competencies, core competencies, and learning indicators	2
Suitability of the type/form of evaluation with the presented concepts	4
Accuracy of question measurement in assessing students' understanding of concepts	4
Linguistic Aspect	
Appropriateness of communicative and easily understandable language usage	4
Appropriateness of language usage that is not ambiguous	4
Appropriateness of language usage adhering to standard language	4
Suitability of language used with the developmental stage of eleventh-grade high school students	4
Total score	88
Percentage	90.72%

The results obtained by material experts indicate that the LKPD learning cycle 5E obtained a total score of 88 and a percentage of 90.72%. This validation result falls into the "Very Feasible" category, indicating that no revision process is required. The validation process by material experts covers aspects of material, presentation, Appropriateness of Evaluation Tools, and linguistic. Almost all aspects evaluated in the questionnaire by media experts attained the maximum score of 4 points.

Readability Test Result

Teacher Response

Readability of learning media is confirmed when both teacher and student response feedback from readability tests demonstrate good criteria, indicating its practicality for use in the school learning process by both teachers and students (Dwijayani, 2017; Nabila et al., 2021; Puspitasari et al., 2018). The readability of the developed LKPD was assessed through questionnaires filled out by 4 chemistry teachers. The readability assessment by teachers comprised several aspects, including material, presentation, appropriateness of evaluation tools, language, and graphical elements. The following are the results of the readability questionnaire by teachers based on the developed LKPD learning cycle 5E.

Table 6. Teacher Response Assessment Results

Assessment Items	Score
Material Aspect	
Alignment with core competencies and basic competencies	4
Alignment of material with learning objectives	4
Alignment of material with indicators	4
Accuracy of presented concepts	4
Depth of material in line with students' educational level	3
Sequential guidance in the worksheet to discover concepts	4
Activities presented in the worksheet align with the syntax of the learning cycle 5E	4
Activities presented in the worksheet can stimulate students to optimize chemical literacy	4
Presentation Aspect	
Clarity of material presentation is engaging and logical	4
Suitability of concept development related to daily life	4
Suitability of material presentation arrangement from simple to complex	4
Clarity of material presented with supporting images	4
Completeness of concepts regarding solubility and solubility product	4
Development of worksheets places students as the center of learning	4
Presentation of worksheets can guide students to interact with learning objects	4
Presentation of worksheets can guide students to enhance chemical literacy	4
Appropriateness of time used	4
Appropriateness of Evaluation Tools Aspect	
Suitability of learning evaluation with basic competencies, core competencies, and learning indicators	4
Suitability of the type/form of evaluation with the presented concepts	4
Accuracy of question measurement in assessing students' understanding of concepts	4
Linguistic Aspect	
Appropriateness of communicative and easily understandable language usage	4
Appropriateness of language usage that is not ambiguous	4
Appropriateness of language usage adhering to standard language	4
Suitability of language used with the developmental stage of eleventh-grade high school students	4
Graphical Aspect	
Suitability of images used	4
Suitability of font types used	4
Suitability of design for each page used	4
Total score	102

The results obtained by chemistry teacher indicate that the LKPD learning cycle 5E obtained a total score of 102. This result falls into the "Excellent" category. Almost all aspects evaluated in the questionnaire by chemistry teacher attained the maximum score of 4 points. This assessment result indicates that the developed LKPD learning cycle 5E covers aspects of material, presentation, appropriateness of evaluation tools, language, and graphical elements, and is ready to be tested for its effectiveness.

The readability test aims to assist researchers in identifying parts of the product that may require improvement and ensure clarity of the conveyed information (Riefani, 2020). With this excellent readability test result, it is believed that this product can clarify information, facilitate understanding of the material, and serve as easily accessible reading material for use in the learning process (Yusup et al., 2018).

Students Response

The readability of the developed LKPD was assessed through questionnaires filled out by 32 students of XI MIPA 5. The readability assessment by students comprised several aspects, including material, ease of use, and display elements. The following are the results of the readability questionnaire by students based on the developed LKPD learning cycle 5E.

Table 7. Student Response Assessment Results

Assessment Items	Score
Material Aspect	
The material presented in the LKPD is easy to understand	4
The evaluation questions guide me to understand the material	4
The discourse presented enhances my knowledge	5
Ease of Use Aspect	
The language in the LKPD is simple and easy to understand, motivating me to study it thoroughly	4
When studying, I feel like I'm interacting with this LKPD because the sentences used are communicative	4
The arrangement of sentences in the LKPD is not confusing	4
The usage instructions make it easier for me to study the LKPD	4
Concept maps help me to visualize the content of the LKPD as a whole	4
Display Aspect	
The layout or layout is attractive and does not make me bored studying the LKPD	4
Background color, font color, and image color are appropriate, stimulating me to study the LKPD	4
Font type and size, spacing, and spacing are appropriate, making it easier for me to study the LKPD	4
Images and layouts are presented with proportional sizes (not too large or too small)	4
Total Score	52.53

The results obtained by students indicate that the LKPD learning cycle 5E obtained a total score of 52.53 and falls into the "Excellent" category. Almost all aspects evaluated in the questionnaire by students attained the maximum score. With this excellent readability test result, the learning media is confirmed practical for use in the school learning process by both teachers and students (Dwijayani, 2017; Nabila et al., 2021; Puspitasari et al., 2018).

Effectiveness Test Results

The effectiveness of the LKPD product is tested before dissemination. This effectiveness test aims to evaluate the learning media after validation by experts. The test is conducted using a quasi-experimental method, with one experimental class and one control class. The experimental class uses the LKPD, while the control class uses the school's textbook. Before the lesson, students are given a pretest, and after 3 sessions, they are given a posttest to observe the difference in students' chemical literacy in both classes.

The influence of chemical literacy between students using the LKPD Learning cycle 5E and students using the school textbook can be seen in Table 8. The obtained Asymp. Sig. value (2-tailed) is 0.428 > 0.05, indicating that the H_0 hypothesis is accepted. This means that there is no influence of using the LKPD Learning cycle 5E on chemical literacy, or there is no difference in the average chemical literacy between the experimental and control groups after using the LKPD Learning cycle 5E.

Table 8. Results of the Mann-Whitney Test

Test	Chemical Literacy
Mann-Whitney U	483.000
Wilcoxon W	1044.000
Z	-.793
Asymp. Sig. (2-tailed)	.428

Based on the average scores of the pretest for chemical literacy, the control class obtained an average score of 18.5, which is lower than the experimental class with an average score of 22.3. After the treatment, where the control class used the school textbook and the experimental class used the LKPD Learning cycle 5E, the average score for the control class was 40.8, lower than the experimental class with an average score of 47.6.

These findings indicate that the LKPD Learning cycle 5E has not been able to improve students' chemical literacy due to several factors. The first factor is the time limitation provided by the school to the researcher. The chemistry teacher only allowed three sessions for teaching the solubility product constant material. The researcher negotiated with the chemistry teacher for an additional two sessions to conduct the pre-test and post-test. According to Sari et al. (2021), it is essential to conduct pre-tests and post-tests to assess students' initial abilities regarding the learned material, which serve as the basis for evaluating the learning process, guiding educators in implementing the LKPD Learning cycle 5E.

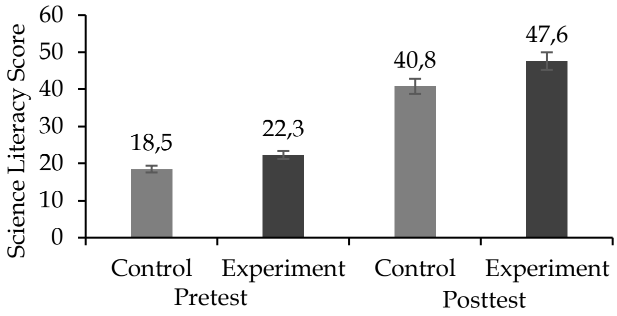

Figure 3. Recap of pretest and posttest results

Theoretically, the solubility product constant material is supposed to be taught over four sessions because it consists of four subtopics. However, due to time constraints, the researcher decided to combine two subtopics into one session. The limited research time hindered students' optimal understanding of the presented material. The developed LKPD Learning cycle 5E has not accurately fulfilled the core competencies and basic competencies of the solubility product constant material. According to Sedi et al. (2023), suboptimal learning media in building learning activities cannot help produce more specific research findings. The time limitation also affected the interaction between students and teachers during the learning process. Students are expected to be more active in constructing their knowledge, which may not be effective due to the time required for adjustment (Ramdani et al., 2019).

The second factor is the limited time for completing the test questions. Data collection for students' chemical literacy abilities using pre-test and post-test designs was conducted for 75 minutes each. Many students complained about not finishing the essay questions because solving the chemical literacy test questions requires high-level thinking skills, which takes time. The researcher provided additional time for students to complete the chemical literacy questions for a full 90 minutes during the post-test. The researcher did not adequately consider the time for solving the test questions during the process of developing the chemical literacy questions, resulting in students feeling overwhelmed. According to Bernando et al. (2022), students tend to answer test questions randomly, which can be caused by a lack of understanding of the material and rushed work. Limited time may lead to the possibility of students answering test questions randomly due to other task demands, resulting in the inability to accurately measure students' chemical literacy abilities.

The third factor is the limited availability of chemicals and equipment in the laboratory. This study used media in the form of LKPD, which includes learning cycle 5E model learning steps. During the learning process, divided into three sessions, students were divided into large groups of 7. Large group division was done due to limited chemicals and equipment in the laboratory of SMAN 1 Ngawi. The large group members resulted in uneven task distribution. The difficulty level of task distribution also varied, resulting in each student having a different learning experience. This difference became more pronounced during the elaboration stage of learning. There were three experimental goals that students accomplished during the elaboration stage: first, to determine the difference between saturated, supersaturated, and unsaturated solutions; second, to determine the effect of pH on the solubility of a compound, and third, to understand the utilization of precipitation reactions. This resulted in uneven learning outcomes and understanding among all group members.

The fourth factor affecting these findings is that students are not accustomed to solving problems through reasoning or high-level thinking processes. Consistent with Wibawa (2016) that in problem-solving, students often start with difficulty in determining problem-solving plans. The analysis of students' answers with low scores resulted from errors in understanding chemical literacy questions. Students' mistakes in translating information into mathematical sentences are due to a lack of attention to the question sentences. Students cannot determine the formula to be used because they do not yet understand the formulas that should be used to solve the problem. This happens because students tend to only memorize the formulas taught by the teacher (Magfirah et al., 2019). Students' mistakes in answering questions are also due to lack of diligence in work, not understanding how to conclude answers, lack of practice in questions, not understanding the use of formula methods, rushing, and students' inconsistency (Maubanu et al., 2022; Nufus et al., 2022).

The fifth factor contributing to the very low effective contribution is students' confidence in their abilities. High self-efficacy significantly influences students' ease in understanding problems or phenomena related to the taught material. Self-efficacy also plays a crucial role in determining how someone thinks, behaves, and motivates themselves, as stated by Basri et al. (2019) and Malahayati et al. (2015). Students with low self-confidence tend to lack motivation, thus becoming obstacles to the development of their chemical literacy skills. Less motivated students will have difficulty in developing precise, careful, and meticulous thinking skills in analyzing problems or phenomena related to the solubility product constant material. Students with low self-efficacy often feel less confident in completing tasks such as formulating problems, making decisions, and analyzing arguments (Agus, 2021; Astriani et al., 2017; Hendi et al., 2020; Kwangmuang et al., 2021). Low self-efficacy cannot provide good feedback on students' learning outcomes and chemical literacy skills, thus hindering the creation of enjoyable learning experiences.

Conclusion

The LKPD learning cycle 5E on solubility product constant materials was developed using 4D development model consisting of define, design, develop and dissemination stages. The validation results from media and material experts were 82.81% and 90.72%, respectively, both falling within the "Very Feasible" category. The assessment of readability from chemistry teachers and students yielded scores of 102 and 52.53, respectively, indicating an "Excellent" category. Furthermore, the effectiveness test using the Mann-Whitney U test revealed no significant impact of implementing the LKPD Learning cycle 5E on the chemical literacy of SMAN 1 Ngawi students.

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Author Contributions
This study presents a significant educational contribution in the form of student worksheets utilizing the learning cycle 5E models for teaching Solubility Product Constant Materials, which can be readily utilized by secondary school educators. The primary author was extensively engaged in developing both the media and the article. The secondary author provided valuable input throughout the research process, including guidance on conceptualization, data collection, analysis, interpretation, and manuscript preparation.

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Conflicts of Interest
The authors affirm that there are no conflicts of interest related to the publication of this article.

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