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Development of Cooperative Learning-Based Student Worksheets (LKPD) on Chemical Nomenclature Subject Material for 10th Grade Students

Tri Merry Septiana*, Rody Putra Sartika, Rahmat Rasmawan
Chemistry Education Study Program FKIP Untan Pontianak, Indonesia
* Corresponding Author e-mail: trimeeryseptiana@gmail.com

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Abstract
Research has been done to develop a product in the form of student worksheets chemical compounds for SMA/MA grade X. This research aims to develop students ' worksheets of material nomenclature for SMA/MA grade X, knowing the quality of teaching materials based on expert test (expert judgement), knowing student response, and knowing the implementation of learning process. This research and development (R&D) is conducted based on 4-D models that are limited to the develop stage. The subject of this study is the LKPD based on cooperative learning in compound nomenclature. The product is in the quality of one chemical teacher, one Indonesian teacher, and two chemistry lecturers. Based on the results of the expert quality assessment, the LKPD based cooperative learning in compound name matter got very good/very high category with a percentage of 84.27% worth using as a teaching material in the learning process.

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INTRODUCTION

The naming of chemical compounds is an essential topic in the high school (SMA/MA) curriculum, specifically included in the 2013 curriculum for Grade 10 in the second semester. This subject covers the nomenclature of both organic and inorganic compounds (da Silva Júnior et al., 2018; Henri A., 2014). The process of naming inorganic compounds, in particular, requires extensive memorization, encompassing binary compounds consisting of non-metallic elements, combinations of metallic and non-metallic elements, and polyatomic compounds made up of non-metallic elements (Hepler-Smith, 2015). The challenge of this memorization can lead to students quickly losing interest and struggling with the material if it is not presented effectively. Hence, it is imperative for chemistry teachers to employ innovative and engaging teaching strategies to facilitate better understanding and retention of these concepts (Islamic, 2016). This is done so that students do not experience difficulties when they receive learning materials on the names of compounds, so that the learning outcomes achieved by students can be maximized (Faizah, 2013).

One of the primary challenges in teaching the nomenclature of chemical compounds is maintaining student engagement (Hepler-Smith, 2015). Given the extensive memorization required, students are at risk of becoming bored and disengaged if the material is not presented in an interesting manner. When students lose interest, their understanding of the concepts diminishes, leading to poor academic performance. Therefore, it is crucial for teachers to adopt teaching methods that capture students' attention and sustain their interest throughout the learning process (Froehlich et al., 2014; Rahman et al., 2016). The complexity of chemical

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nomenclature necessitates a deep understanding of the underlying principles (Hamerská et al., 2024). Without a strong grasp of these fundamentals, students are likely to encounter difficulties when dealing with more advanced topics. Effective teaching strategies can help students build a solid foundation, making it easier for them to learn and apply the rules of chemical nomenclature (Sáiz Manzanares et al., 2017).

(Yeung et al., 2021) state the ultimate goal of any educational strategy is to maximize student learning outcomes. When students are engaged and have a clear understanding of the material, they are more likely to perform well academically. (Sivarajah et al., 2019) state innovative teaching methods can help bridge the gap between rote memorization and meaningful learning, leading to better retention and application of knowledge. Interactive learning involves engaging students in activities that promote active participation and collaboration. This can include group work, discussions, and hands-on experiments. By involving students in the learning process, teachers can make the material more relatable and easier to understand

Based on the author's observations at SMA Pancasetya Sintang on compound naming material, the teacher did not prepare and develop his own LKPD, but used the LKPD in the textbooks available at the school. Teachers should develop the used LKPD and be able to guide students to be more active in learning activities in class and to be able to construct sssssssssssconcepts independently but still under the guidance of the teacher. In the learning process, the teacher still uses the lecture method where students sit quietly and listen to information from the teacher. During the learning process, the teacher tends to be centered and the students are passive. They just listen to the teacher who imparts the learning. In this learning process, there is a lack of student activity to learn the material provided. Students tend to get bored and lack understanding by just listening. This is due to students' lack of understanding of the learning material.

Low learning activities and students' understanding of learning materials make the learning process boring, and students' learning achievement is not optimal and does not reach the predetermined completeness. In its implementation, school education that involves teachers as educators and students as learners is realized through teaching and learning interactions or a systematic learning process that is guided by the current curriculum. In its implementation in the field, the existing learning process still applies a lot of conventional methods by using lectures in teaching material, so that students become passive individuals. Meanwhile, the current curriculum, the 2013 curriculum, requires students to play an active role in building concepts within themselves. Learning activities are student-centered, with the teacher as a motivator and facilitator, so that the classroom atmosphere becomes lively.

Based on these problems, it is necessary to support teachers' creativity to be able to create a learning atmosphere that attracts students' attention in learning chemical compound naming material that is considered difficult (Henriksen et al., 2021). A teacher must at least meet the criteria of four roles to guide students in the teaching and learning process (Jordan, 2021). First, the teacher must be able to organize students well. Second, the teacher must facilitate students in learning activities. Third, the teacher has a role as a motivator. Fourth, the teacher also has a role as an evaluator and a measure of student success (Mulyani, 2015).

This excerpt emphasizes the importance of supporting teachers in enhancing their creativity to make learning engaging, particularly when teaching challenging subjects like chemical compound naming. It outlines four key roles that a teacher should fulfill to effectively guide students (Sánchez et al., 2022). The teacher should be able to manage and organize students well during the learning process (Ata-Akturk & Sevimli-Celik, 2023). The teacher should provide the necessary support and resources to facilitate students' learning activities.The teacher should inspire and motivate students to engage with the material and stay interested

in the subject (Fredagsvik, 2023). The teacher should assess students' progress and understanding, serving as a measure of their success (Rostini et al., 2022; Schoenfeld, 2020). These roles highlight the multifaceted responsibilities of teachers in ensuring that students are not only taught effectively but also motivated and supported throughout their learning journey.

Related to the role of the teacher as a motivator, one that can attract the attention of students is the media. Media in the learning process is referred to as teaching materials (Arsyad, 2008). In this case, LKPD is used as a guide for students in carrying out learning activities. LKPD is one of the teaching materials in which there are instructions, materials and learning steps that function as a guide for students in carrying out the learning process. Through LKPD, the activity and creativity of students in learning can be increased, the delivery of learning materials can be facilitated by using LKPD (Nuransyoria yulisa, 2017). In reality, teachers still use printed materials from publishers. The LKS display at Pancasetya Sintang High School is shown in Table 1.

Picture	weakness of LKPD
	The LKPD display is too simple, the colors used are monotonous black and white, and the explanation of the material presented is too singular.

Based on the analysis of the teaching materials used, the teaching materials used do not attract students' attention, and the components contained in them are incomplete, so students have difficulty in understanding learning. Therefore, the creativity of teachers in the learning process and the development of teaching materials is needed to motivate students in the teaching and learning process. Using this learning model can improve students' learning activities and students' learning presentations. In addition, this learning can also improve students' communication because they dare to share what they have learned with other groups and their own groups, so students who lack confidence to share can be more courageous by using this model. A learning model is a pattern used as a guide in classroom and tutorial learning. The learning model must relate to the approach that will be used, including learning objectives, environment, and classroom management. Through learning, teachers can help students acquire information, ideas, skills, ways of thinking, and ways of expressing ideas. It also serves as a guide for learning designers. Based on this explanation, the development of cooperative learning based LKPD is a solution to overcome the problems faced by students. Therefore, the author is interested in conducting a study entitled "Development of Cooperative Learning-based Learner Worksheets (LKPD) on Compound Name System Material at SMAN 5 Pontianak".

METHOD

The research flow should be presented in this section with an image caption. The image caption is placed as part of the image *title (figure caption*) instead of part of the image. The methods used in completing the study are written in this section. The form of research used

in this study is a research and development model. In this study, the product developed was a cooperative learning based chemistry student worksheet on compound names material. The instrument used to collect data is a student worksheet feasibility questionnaire. The feasibility questionnaire was designed with the intention of evaluating the quality of the developed chemistry teaching materials.

Research Preparation Phase

The steps in the research preparation stage include: (1) conducting preliminary research at SMA Pancasetya Sintang by identifying potentials and problems and collecting data; (2) making research instruments in the form of a questionnaire for the feasibility of student worksheets.

Research Procedure

The research procedures carried out by the researchers in this development were adapted from the development steps developed by Borg & Gall with limitations. Borg & Gall (in Emzir, 2013: 271) state that it is possible to limit research on a small scale, including limiting research steps. The application of development steps is adapted to the needs of researchers. Given the limited time and resources that researchers have, the development steps that are carried out by researchers are:

Data Collection Stage

The data collection stage is carried out to find out the learning needs in the field. The data collection stage is carried out by means of field studies and literature studies. a) Field studies are carried out to find out the needs of learning resources in high schools. Field studies are carried out by analyzing the curriculum used in the schools, analyzing the stages of students' development, and analyzing the availability of learning resources in the field. b) Literature study is about theories related to learning resources and forms of learning, as well as literature studies on materials for interaction between students and the environment.

Design Phase

Media selection is used to identify learning media that match the characteristics of the material. The media are used to assist students in carrying out the learning. The media used in this development research is in the form of student worksheets. The media is suitable for use because the worksheets made are equipped with material, and images that can facilitate students in carrying out learning in accordance with the title of the product developed, namely the development of cooperative learning-based student worksheets on compound names material for Class X students. In addition to media selection, format selection is intended to design or design the content of the LKPD both the objectives developed and the material in the learning LKPD. The LKPD format used is the LKPD format that has been previously validated, then adapted to the curriculum and syllabus of high school chemistry subjects.

Development Stage (Develop)

The purpose of the development phase is to produce a product that will be revised based on expert input. The development stage in this study includes: a) Expert validation. According to Thiagarajan, et al (1974: 8), "expert appraisal is a technique for obtaining suggestions for the improvement of the material" Is a technique for validating or assessing the feasibility of the product design. In this activity, an evaluation is carried out by experts in their field. The experts' evaluation includes: language format and content, presentation and graphics of the developed product. The developed prototype is then validated by experts (validators) according to their respective areas of expertise.

Product Revision

At this stage, revisions are made to improve and perfect the product in the form of Learner Worksheets (LKPD) based on comments and suggestions from the results of expert validation. Revisions are made based on the results of the analysis of the expert/expert validation. This revision is done once and then must be reviewed by an expert. The revised results, which have received feasibility approval from the expert, are then tested on a small scale.

Product Testing

Model or product testing aims to find out whether or not the manufactured product can be used. Model or product testing also determines the extent to which the manufactured product can achieve goals and objectives. No product trials were conducted in this study.

Final Product Revision

At this stage, revisions are made to improve and perfect the product in the form of LKPD based on comments and suggestions from the limited test results.

Final product

Products in the form of LKPDs that have been improved and refined in the second revision stage are packaged into teaching materials that are then booked according to a predetermined format.

RESULTS AND DISCUSSION

Research Results

This research is in the form of research and development (R & D). Where the products produced are in the form of cooperative learning based student sheets (LKPD) on chemical compound naming material at Pancasetya Sintang High School. This development research refers to the development steps according to Borg & Gall, which include a) research and information gathering stage; b) planning stage; c) development stage of the initial form of the product; d) initial field test stage; e) product revision stage; f) main field test stage; g) operational product revision stage. The research model used in this study is based on the development research model developed by Thiagarajan (Trianto, 2010), which is a modification of the 4D model (define, design, develop, and disseminate) to the 3D model (define, design, and develop).

Research results

Based on the validation results obtained from the experts, it can be said that the teaching materials developed in the form of student worksheets are in the very feasible category, so it can be concluded that the LKPD comics are suitable for use. However, these results cannot be separated from the process of developing materials, which is carried out systematically and follows the suggestions of experts.

Material Expert Validation

The content feasibility assessment was conducted from June 4 to July 20, 2020. The validation was conducted by three material experts consisting of two chemistry teachers from FKIP UNTAN Pontianak namely Dewi Pratiwi, M.Si. and Husna Amalya Melati, S.Si., M.Si. and one chemistry teacher from SMA Pancasetya Sintang namely Desi Kartila, S.Pd.

The evaluation of the content feasibility has four evaluation indicators, namely the suitability of the material with KD, the accuracy of the material, the timeliness of the material, and the stimulation of curiosity. In the indicator of the suitability of the material with KD includes three criteria, namely the completeness of the material with KD includes material, breadth of material, and depth of material, where each score percentage is 80%, 80% 80% with a high category.

Based on the results of calculating the average of all indicators, a score of 80.67% was obtained with very high criteria. This shows that the content of the cooperative learning-based LKPD on compound nomenclature material is categorized as very suitable for use as teaching material in the learning process. The results of the feasibility questionnaire assessment are as follows.

Table 2. Results of Material Expert Assessment of Product Content Aspects.

Assessment Items	Assessment Score					Criteria
	V1	V2	V3	∑X	P(%)	
1. Material completeness	4	4	4	12	80	High
2. Breadth of material	4	4	4	12	80	High
3. Depth of material	4	4	4	12	80	High
4. Accuracy of definition	4	4	4	12	80	High
5. Accuracy of facts and data	4	4	5	13	86,7	Very High
6. Image accuracy	4	3	5	12	80	High
7. Accuracy of terms	4	4	4	12	80	High
8. Accuracy of library references	4	4	5	13	86,7	Very High
9. Suitability of material with scientific developments	4	4	4	12	80	High
courage curiosity	3	4	4	11	73.3	High
Jumlah Skor	**39**	**39**	**43**	**121**	**806,7**	
Rata-rata	3,9	3,9	4,3	12,1	80,67	Very high

Feasibility of Presentation

In assessing the appropriateness of presentation, there are four assessment indicators, namely presentation technique, presentation support, learning presentation, and presentation completeness. The presentation technique indicators include assessment, namely the systematic consistency of presentation, where a percentage score of 93.3% was obtained in the very high category. This shows that learning activities using LKPD are very effective and logical in the teaching and learning process so that students can understand the learning material well. The supporting indicators for presentation include six categories, namely the identity of the LKPD, foreword, instructions for using the LKPD, table of contents, student activities, and bibliography, respectively, the percentage scores are 100%, 93.3%, 86.7%, 100%, 73 .3%, and 86.7%. With a very high average category. In point 2 there is an identity presented in the LKPD, such as the name of the author, the name of the supervisor and the name of the validator for each respective expert. Based on the results of calculating the average of all indicators, a score of 88.14 was obtained with very high eligibility criteria. The results of the assessment of the feasibility aspect of the material are as follows.

Table 3. Results of the assessment of the appropriateness aspect of the presentation material.

Assessment Items	Assessment Score					Criteria
	V1	V2	V3	∑X	P(%)	
1. Systematic consistency of presentation	5	5	4	14	93,3	Very High
2. LKPD identity	5	5	5	15	100	Very High
3. Foreword	5	5	4	14	93,3	Very High
4. Instructions for Using LKPD	4	5	4	13	86,7	Very High
5. List of contents	5	5	5	15	100	Very High
6. Student Activities	4	4	3	11	73,3	High
7. Bibliography	4	5	4	13	86,7	Very High
8. Student involvement	4	3	4	11	73,3	High
9. The integrity of meaning in learning activities/sub-learning activities	4	5	4	13	86,7	Very High
Total score	**40**	**42**	**37**	**119**	**793,3**	
Average	**4,0**	**4,2**	**3,7**	**13,2**	**88,14**	**Very High**

Linguist Validation

The language suitability assessment was carried out from 18 June to 10 July 2020. Validation was carried out three times by one Indonesian language expert, namely Rosa Osmawarni, S.Pd, Indonesian language teacher at Pancasetya Sintang High School. In assessing linguistic suitability there are five assessment indicators, namely straightforward, communicative, dialogic and interactive, suitability to student development and conformity to Indonesian language rules. The results of the expert assessment are as follows:

Table 4. Results of the linguists assessment of linguistic aspects

Assessment Items	Assessment Score					Criteria
	1	2	3	4	5	
1. Accuracy of sentence structure						Good
2. Sentence effectiveness						Good
3. Standardity of terms						Good
4. Understanding the message or information						Very Good
5. Accuracy in the use of language rules						Good
6. Ability to motivate students						Very Good
7. Compliance with intellectual development						Good
8. Suitability to the level of emotional development of students						Good
9. Grammatical correctness						Good
10. Spelling accuracy						Good
Total score	**42**					
Average	**84%**					

Table 5. The item aspects are assessing material aspects, assessing feasibility aspects, and assessing language aspects

No	Feasibility Aspect	Average (%)	Criteria
1	Contens	80,67	Very High/Very Decent
2	Appropriateness	88,14	Very High/Very Decent
3	Language	84	Very High/Very Decent
	Overall average	84,27	Very High/Very Decent

Product Revision

After assessing the feasibility of the cooperative learning-based LKPD with material experts, feasibility and language experts, then revisions were made to the cooperative learning-based LKPD. Apart from conducting feasibility assessments, experts also provide suggestions. These expert suggestions are very useful for improving the quality of the LKPD that we make. The following are the results and discussion of the product revision.

Material Expert Revision

Based on suggestions from material experts regarding aspects of content and presentation, there are several parts that need to be improved. The first part, namely in naming binary compounds, there is a table with a concept map for naming binary compounds which is not very clear, which should be accompanied by an explanation of the material.

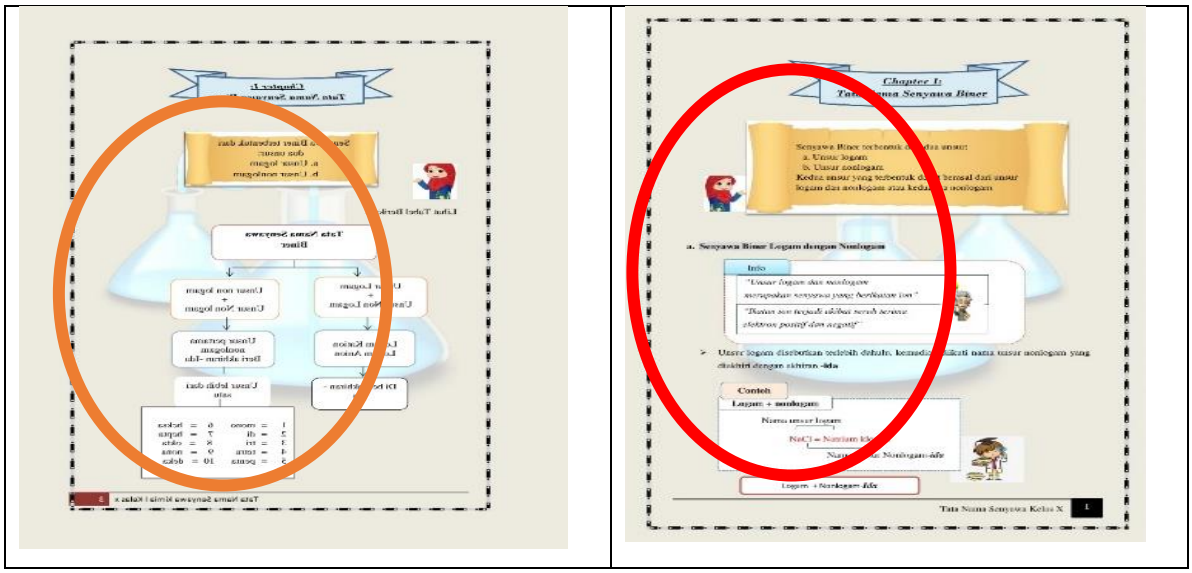
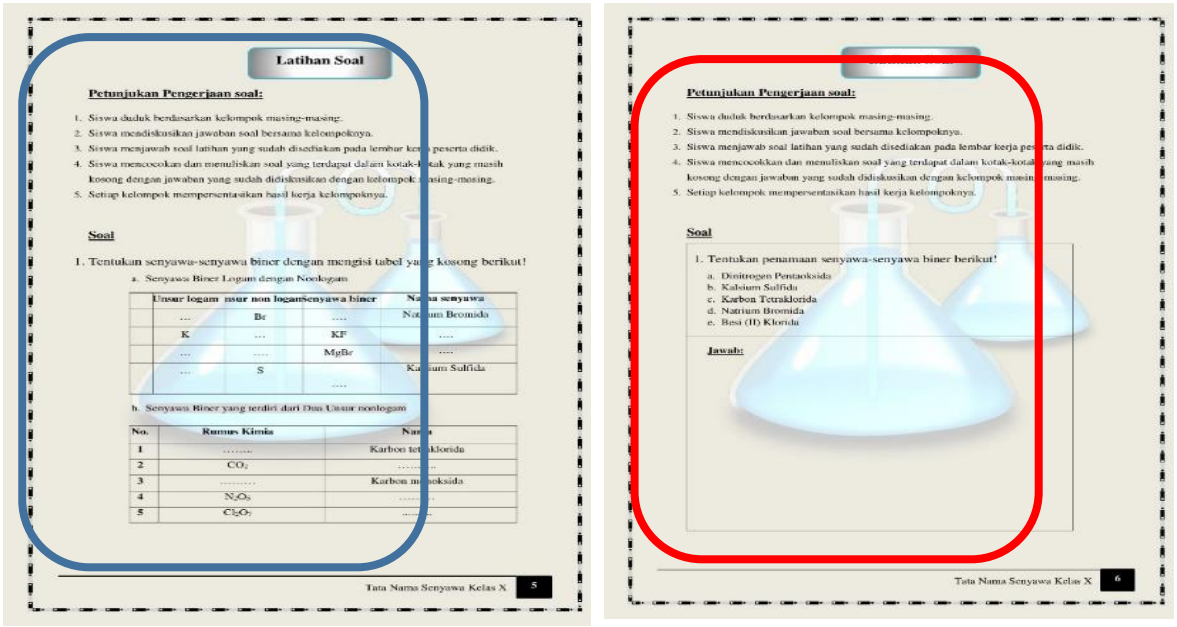
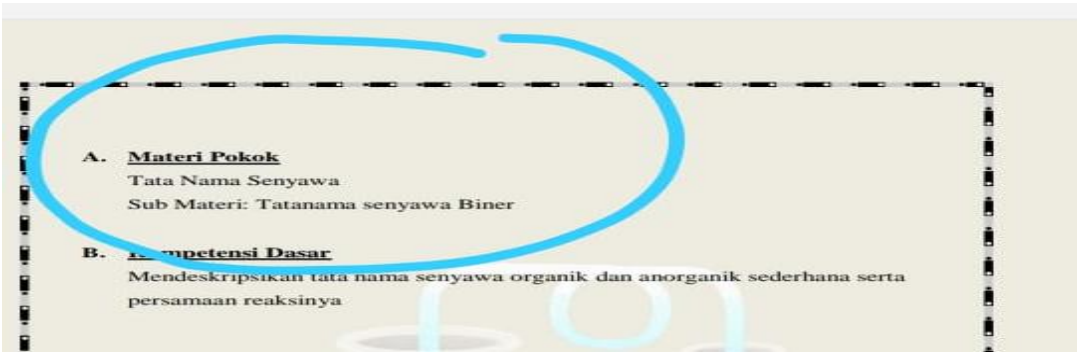


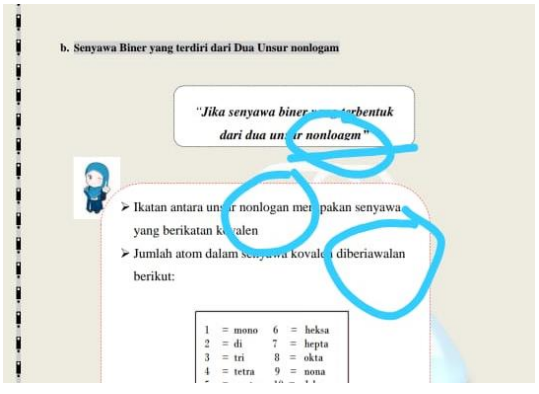
Figure 1. Manufacturing design (a) before revision (b) after revision

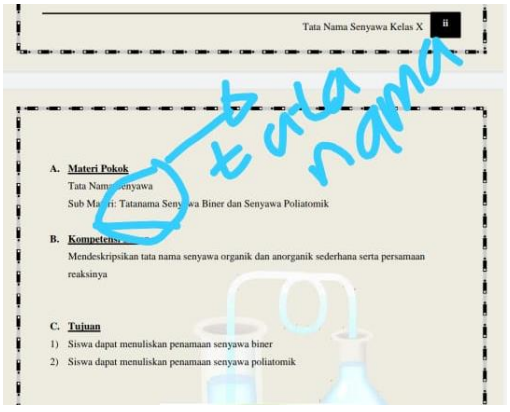


Linguist

Based on advice from language experts, there are several parts that need to be corrected, especially writing errors that often occur on certain pages that need attention.







There are several errors in writing words or sentences that we sometimes don't know about. Word or sentence errors usually occur when errors in writing words or punctuation in a sentence are made.

CONCLUSION

Based on the results of the research and development that has been carried out, it can be concluded that the Student Worksheet Based on Cooperative Learning on Compound Nomenclature Material is suitable for use as teaching material in the learning process with a score of 84.27% which has very high criteria. Can be a reference source in developing research to a further stage. In this research, it was only carried out to develop (development) because it was limited by expert testing, so it needed to be carried out to the product trial stage in developing learning media on certain materials.

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