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Development of Inquiry-Based Student Worksheets on Chemical Bonding Material

Nur istiqomah[1]*, Das Salirawati[2]

[1] Master of Chemistry Education, Yogyakarta State University, Jalan Colombo No. 1 Karang Malang, Sleman, Yogyakarta, Indonesia.
[2] Chemistry Education, Yogyakarta State University, Jalan Colombo No. 1 Karang Malang, Sleman, Yogyakarta, Indonesia.

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Corresponding Author:
Nur istiqomah
nuristiqomah.10497@gmail.com

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Abstract: This research is a type of development research that uses the Four-D development model to produce inquiry-based worksheets on chemical bonding material. This study aims to produce inquiry-based worksheets that are suitable for use in the chemistry learning process. Media quality assessment is based on due diligence by material experts and media experts. The practicality test assessment was carried out by three reviewers and two Peer reviewers, and the readability test was carried out by students. The results of the study were declared feasible with several inputs and suggestions provided by media experts and material experts. The results of the practicality test of inquiry-based worksheets by reviewers and peer reviewers showed a very good category with a total average score of 77.7 and 73.0, respectively. The results of the product readability test by students for all aspects, namely learning, visual display, and software engineering, obtained an average total score of 33.03 out of 9 indicators which were categorized as very good.

Keywords: Chemical bonds; Inquiry models; Student worksheets

Introduction

The existence of the Covid 19 pandemic is a worldwide disease outbreak that has a significant impact, especially in the education sector, which has an impact on the learning process in schools, one of which is learning loss and learning gaps (Nugraha, 2022). This lag was caused by changes in the learning process from face-to-face to distance learning (online). During the recovery period, the learning process from online learning to face-to-face is limited. This change in the learning process causes a lack of achievement of student competence.

The success of education is seen from the learning process carried out in class. The learning process is closely related to the quality of learning carried out by teachers and students in the classroom. Quality human resources are the result of a quality education process (Zubaidah et al., 2017).

The quality and method of teaching teachers is one of the causes of the success of the learning process (Tanti et al., 2020). The teaching materials used also play an important role in assisting the learning process to achieve Core Competencies (KI) and Basic Competencies (KD) (Nishfiya et al., 2019). Teachers can innovate by making teaching materials in accordance with the applicable curriculum, the level of ability of students and the conditions in which students learn to achieve learning competence (Widodo, 2017).

Learning that requires experimental activities requires teaching materials that support the learning process. One of them is Student Worksheets (LKPD). The development of LKPD cannot be separated from the integration of learning models to achieve the stated goals (Fahlevi et al., 2022). In strengthening the scientific approach used in the 2013 curriculum, it is necessary to apply a learning model that is appropriate to learning, namely inquiry/research-based learning, one of which is with teaching materials integrated with inquiry models (Sri et al., 2019).

Selection of an inappropriate learning model in the learning process can cause boredom, boredom, lack of understanding of concepts and motivation to learn. One of the appropriate models for student effectiveness is inquiry. This model only develops intellectual abilities

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but all competencies, including emotional and skill development (Andrini, 2016).

Inquiry is an activity that involves observing, asking questions, checking books, and other sources of information to see what is already known. Review what is already known based on experimental evidence, using tools to collect, analyze and interpret data. In addition, provide answers, explain, and predict, and communicate the results. Inquiry requires the identification of assumptions, the use of critical and logical thinking (Walker, 2015).

Inquiry refers to student activities where they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study nature (National Research Council, 2000). Implementing inquiry activities in science classes is very beneficial because it can emphasize the development of scientific thinking (Dewey, 1910; Teig et al., 2018).

Guided inquiry-based worksheets are teaching materials designed to develop individual abilities in investigating objects, symptoms, and issues related to science. Using this LKPD in the learning process students will more easily understand concepts, increase the effectiveness of interactions, groups, learning and interest through structured group work (Mawardi et al., 2020). The teacher acts as a facilitator and commentator on the problems faced by students (Siska Puti, 2015). LKPD is a teaching material that supports experimental activities, because student worksheets are very well used to improve students' learning, whether used in the application of guided methods or providing development exercises (Sudarmini et al., 2015).

The structure of student worksheets in general includes titles, study instructions, competencies to be achieved, supporting information, assignments, work steps, and assessment (Nationa Research Council, 2000). The ideal LKPD standards are in accordance with the standards stipulated in PP (Government Regulation) No. 19 of 2005 article 43 point 5 concerning national education standards, which include content feasibility, language feasibility, graphic feasibility and presentation feasibility (Widodo, 2017).

Based on the initial analysis conducted at Senior High School (SMAN) 1 Prambanan. The initial analysis aims to obtain problems that are being faced in the learning process. Preliminary analysis was carried out through interviews with chemistry teachers. The results of the interviews obtained were: (1) the curriculum used was the 2013 curriculum, (2) the learning process was carried out face to face, (3) the learning resources used were in the form of chemistry package books, modules, student worksheets (LKPD), and other sources. Others from the internet, (5) the method used is the lecture method and the discussion method.

Based on the results of the initial analysis carried out by the researcher, problems were obtained in the learning process and the solutions used to overcome these problems. This research was conducted to overcome problems in the learning process and improve student competency achievement by developing inquiry-based worksheets on chemical bonding material.

Method

Development research or research and development (R & D) uses the 4D development model. The four stages of 4D development are: Define, Design, Develop and Disseminate. The development flow is carried out as follows.

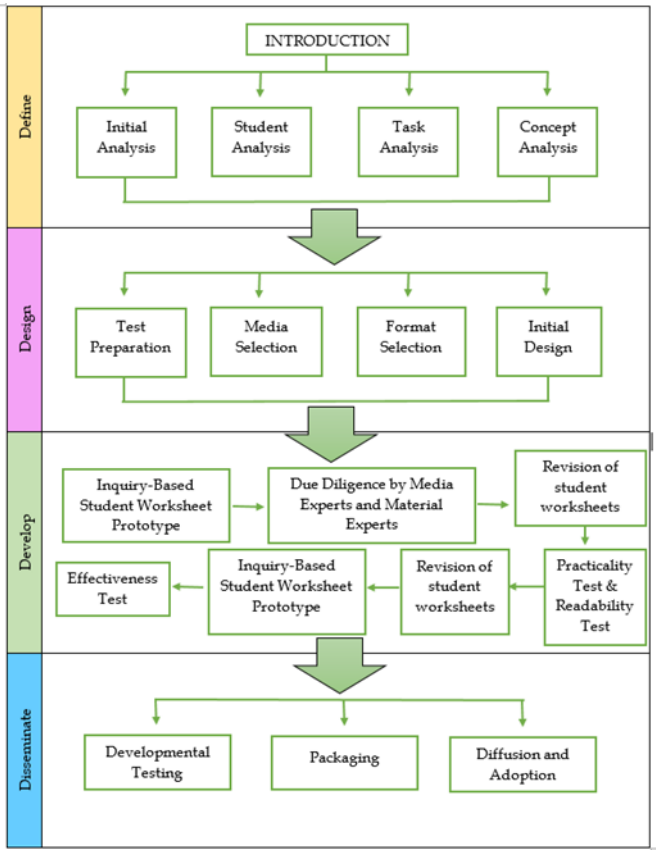

Figure 1. Research flow

The test subjects of the inquiry-based LKPD were students of class X IPA-2 at SMAN 1 Prambanan Sleman. The type of data used consists of two types, namely qualitative data and quantitative data. The research instruments used in this study consisted of learning instruments and data collection instruments. The learning instruments are lesson plans and worksheets. Data collection instruments were validation sheets by two experts, namely material experts and media experts in the form of input and suggestions, practicality test questionnaires by three chemistry educators (reviewers) and two colleagues (peer reviewers) using four aspects of product feasibility consisting of learning aspects ,

linguistic aspects, presentation aspects and software engineering aspects. The readability test was carried out by 66 students in class XI IPA-1 and XI IPA-2.

Based on the assessment data obtained, the average score is then calculated by dividing the total score by the appraiser to show the feasibility of the product to be developed.

$$\overline{X} = \frac{\sum X}{n} \quad (1)$$

Description: $\overline{X}$ = Mean (average) rating score; $\sum X$ = The total score of each component; n = Number of appraisers. The data in the form of scores obtained are then converted into interval data. Calculation of scores into 4 categories referring to Mardapi (20083) is shown in Table 1.

Table 1. Conversion of Scores with a Scale of 4

Score Range	Category
X ≥ (Yi + 1.Sbi)	Very good
(Yi + 1.Sbi) > X ≥ Yi	Good
Yi > X ≥ (Yi - 1Sbi)	Less
X < (Yi - 1.Sbi)	Very less

Description: X = mean; Yi = (ideal average score) = 1/2 (S.Max ideal + S.min ideal); Ideal standard deviation (Sbi) = 1/6 (S.Max ideal - S.min ideal).

$$\text{Perfection percentage} = \frac{\text{Average score}}{\text{Ideal score}} \times 100\% \quad (2)$$

The ideal score is a score that is determined by the assumption that each respondent in each question gives the answer with the highest score. Determine the quality of the developed LKPD product by comparing the average score obtained with the ideal assessment criteria.

Result and Discussion

The stages of developing inquiry-based worksheets consist of four stages according to the stages of the 4D model, namely: 1) Define, 2) Design, 3) Develop, and 4) Disseminate (Thiagarajan S, 1976).

The process of developing inquiry-based worksheets in the early stages of Define. At this stage there are several analyzes that will be carried out. The first is an initial analysis that aims to determine the problems that occur in schools. From the results of the interviews, information was obtained regarding the curriculum being implemented in schools, namely the 2013 curriculum, the learning process carried out was face-to-face learning.

Second: the analysis of students is done by interviewing and observing that it is known that the ability of students to receive and respond to the learning process varies. This is because the learning process, which is usually carried out remotely, returns to normal during the post-pandemic recovery period with face-to-face learning in class. The learning process re-trains students to remain active in the learning process. Students are less enthusiastic both in asking questions and expressing opinions. In line with research Subekti al. (2016) on the results of observations made in a school in Yogyakarta that learning in class is still teacher-centered.

Third: task analysis, the product developed in the form of inquiry-based worksheets is expected to improve students' science process skills. aspects of science process skills include observing, predicting, formulating hypotheses, conducting experiments, interpreting data, concluding and communicating (Duruk et al., 2017).

The four concept analysts are analyzing the chemical material that will be used in LKPD. The materials used are chemical bonds with sub-chapters on atomic stability, ionic bonds, and covalent bonds. With reference to basic competencies (KD) 3.5 and KD 4.5 in the revised 2013 curriculum. The last analysis is the specification of objectives to determine indicators of achievement of competencies and learning objectives that will be used in the learning process.

Design stage, there are several things that affect the learning process, namely: methods of delivering material, attractiveness of material, learning resources, and learning time. Therefore, inquiry-based worksheets were developed in such a way as to contain activities to encourage students to be more active and interactive during the learning process. Inquiry is a learner-centered learning model that demands activeness in the learning process as well as the teacher as a facilitator guiding if there are obstacles in the learning process (Sri et al., 2019).

The second stage of Design aims to design and create inquiry-based worksheets. The inquiry-based worksheet design was made based on the results of the define stage. There are four stages in the design stage, namely test preparation, media selection, format selection, and initial design.

In the preparation stage of the test used is a description test based on several indicators of science process skills. Then, selecting the media, the product to be developed is in the form of a portable document format (PDF). At the format selection stage through the use of technology as a learning resource with the practicality that the resulting LKPD can be accessed via a smartphone. The inquiry-based LKPD design can be seen in the following figure.

Figure 2. Front cover

The front cover contains the description of the LKPD, namely the title of the material, the agency logo, and the name of the author of the LKPD.

Figure 3. Preface

A word from the author for gratitude for completing learning media that can help students in learning.

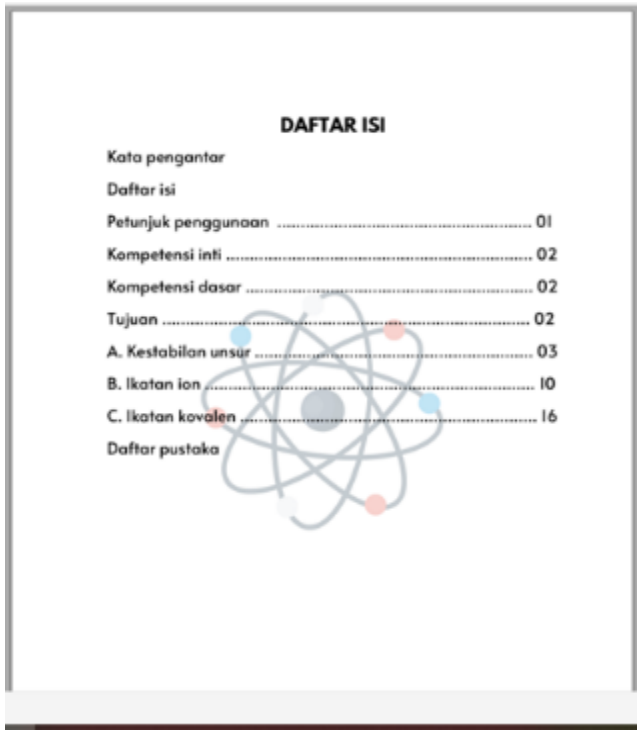

Figure 4. Table of content

This page contains a table of contents and page numbers for each sub-material contained in each LKPD.

Figure 5. Instructions for use

This page contains instructions for using the LKPD which will be carried out by students in the learning process.

Figure 6. Learning materials

This page contains learning materials, namely chemical bonds and their submaterials.

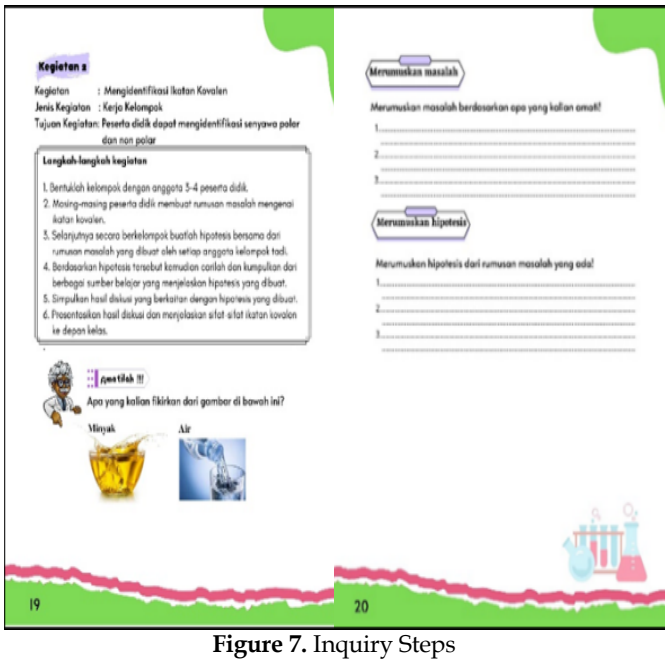

Figure 7. Inquiry Steps

This page contains the steps of inquiry-based learning that will be carried out by students in the learning process.

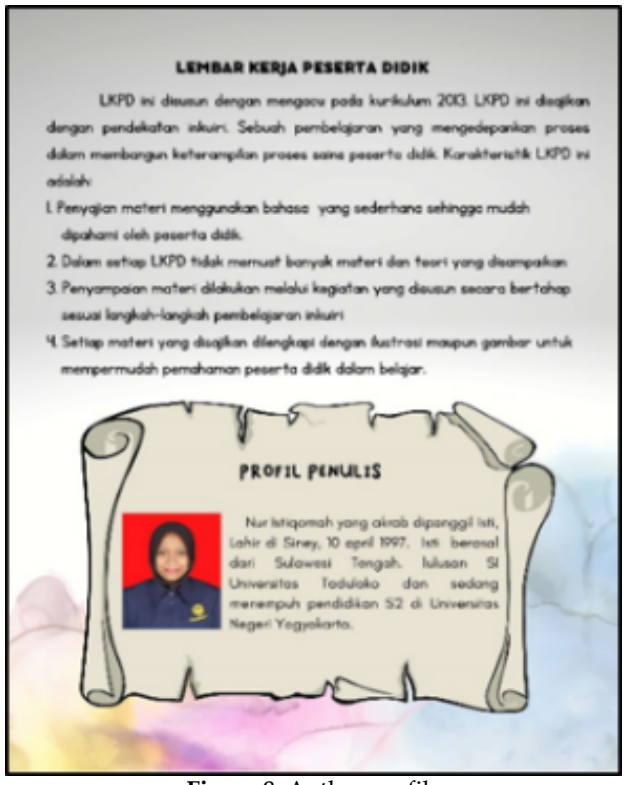

Figure 8. Author profile

This page contains the author's identity in inquiry-based worksheets accompanied by a photo of the author's profile.

In the third stage (Develop), the feasibility assessment of media experts uses validation sheets related to several aspects, namely: learning, materials, and graphics. Material experts use validation sheets related to two aspects, namely learning and material. The feasibility assessment was carried out by two expert validators (lecturers) in the form of suggestions and input used to improve the inquiry-based LKPD on chemical bonding material, so that a product was obtained that was ready to be used to retrieve feasibility data.

The next step is to find out the quality of the product, a practicality test is carried out. This practicality test was carried out by three chemistry educators (reviewers) and two graduate student colleagues (peer reviewers). The practicality test assessment uses four aspects consisting of: learning, language, presentation and software engineering. Ratings were analyzed using four scales to determine the category of eligibility or quality. The results obtained are presented in Table 2.

Based on Table 2, the four aspects for the practicality test of inquiry-based LKPD by reviewers and peer reviewers respectively show a very good category with an average score of 77.7 and 73.0. Practicality is shown at the level of ease of use in its implementation (Priscylio et al., 2019).

Table 2. Practicality Test Results by Reviewers and Peer Reviewers

Aspect	Reviewer	Peer Reviewer	Category
Material	24.0	22.5	Very good
Language	19.7	18.5	Very good
Presentation	23.0	20.5	Very good
Software engineering	11.3	11.5	Very good
Total Average	77.7	73.0	Very good

After being revised based on input and suggestions from reviewers and peer reviewers, the researcher then made improvements. After the corrections were made, the students carried out a readability test. This readability test aims to determine the response of students. The readability test is in the form of a questionnaire with nine statements related to inquiry-based LKPD. This test was carried out by 66 students of class XI IPA-1 and IPA-2. The results of the assessment of the readability test were then analyzed using a scale of four to determine the feasibility or quality. The results of student responses to product legibility are as follows.

Table 3. Readability Results by Students

Aspect	Average Score	Category
Material	11.06	Very good
Visual Display	14.68	Very good
Software engineering	7.29	Very good
Total Average	33.03	Very good

Based on Table 3, it can be seen that the results of the product readability test by students for all aspects obtained an average total score of 33.03 with a very good category. Based on these results it was concluded that the product readability test was very good for use in the learning process.

In line with the research of Hamidah et al. (2018) which showed that students were interested in using inquiry-based worksheets, because students not only learned theory, but they gained experience about how to think through the stages of inquiry each individual determines their own concept of the material being studied. Research (Maharani et al., (2020) with integrated inquiry models can make students in the learning process far more active than passive ones. This shows that the learning process by making students more active because learning is student-centered.

In line with the research of Damaianti et al. (2019) the development of inquiry-based worksheets that are implemented in learning can make students enthusiastic and active in the learning process. According to Kardena et al. (2021) the inquiry learning model is a learning model that can activate student activities.

The Disseminate stage is the last stage. This stage consists of several stages, namely testing the effectiveness, packaging and dissemination. The effectiveness test aims to test the effectiveness of LKPD whether there are differences in the learning outcomes of students who use inquiry-based LKPD and those who do not. At the packaging stage, the products developed are packaged neatly and then disseminated to students and chemistry educators. The dissemination stage is carried out to educators and students, besides that the dissemination is also carried out via the internet.

The stages of inquiry applied to LKPD in this study include problem formulation, formulating hypotheses, collecting data, analyzing data, and concluding. In line with the research of Anindita et al. (2021), the stages of inquiry applied in LKPD are: (1) asking questions/problems; (2) formulate hypotheses; (3) collect data; (4) data analysis; (5) formulate conclusions.

United States National Research Council (2000) states that there are three main reasons for the importance of implementing inquiry learning, namely: improving skills and changing students' behavior; engage each individual in reading, writing and participating in critical discussions; participate in critical argumentation and reasoning (Khalaf et al., 2018). Creating a fun and not boring atmosphere is seen when students demonstrate experiments and communicate good and in-depth understanding and can distinguish ideas clearly, put forward hypotheses well, are able to solve problems, and are able to understand complex things more clearly (Wulantri et al., 2020).

According to Yusra et al. (2021) through inquiry learning, they are able to increase self-confidence, are able to formulate their own findings well, and are able to maximize their abilities systematically, critically, logically, and analytically to find and investigate a problem. Such learning can build understanding and initial knowledge. Also, students are given the flexibility to create perceptions, conduct in-depth studies, assume and formulate hypotheses based on observed patterns (Parta, 2017).

The learner-centered learning process is shown in several activities, for example in the process of observing, analyzing data, discussing, and presenting results (Margunayasa et al., 2019). Learner-oriented learning is believed to be more effective because it focuses more on their learning (Devlin & Samarawickrema, 2010; Rohaeti et al., 2020).

Various research results show that applying inquiry that is integrated with inquiry-based teaching materials in chemistry learning is effective and efficient for learning outcomes of the highest quality (Aulia et al., 2018). LKPD allows students to participate actively in the learning process and improve learning achievement (Çelikler, 2010).

Conclusion

Based on the results of the research and discussion, it can be concluded that inquiry-based Student Worksheets (LKPD) are feasible and practical to use in

the learning process. The stages of inquiry applied to LKPD in this study include problem formulation, formulating hypotheses, collecting data, analyzing data, and giving conclusions.

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