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Development of Chemistry Module for Junior High School Based on Inquiry Accompanied by Performance-Based Assessment

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Abstract

The learning process in the chemistry for junior high school course emphasizes the concept discovery process, so inquiry learning is one alternative solution that can be done. The purpose of this study is to develop inquiry-based chemistry for junior high school course modules along with performance assessment. This research includes development research (Research and Development) which is generally divided into three stages, namely draft development, validation, and readability test. In the development phase of the draft module, a questionnaire, observation, and documentation technique were selected, in addition to the literature review (theory and previous research). The validation stage used validation sheets and interviews. In the readability, the phase uses the module readability questionnaire. The results showed that the developed and valid SMP chemistry modules were used from the aspects of objectives to be achieved, writing approach, truth, and depth of concepts, language clarity, the suitability of inquiry models with learning stages, physical appearance and appropriateness of performance appraisal with the learning process if the module was applied. The readability test results show that students give positive responses to the module in terms of their interest in content and appearance, renewability of content, interest in solving problems, ease of understanding the content and direction of completion.

Keywords*: Module; Inquiry; Performance-Based Assessment*

1. Introduction

Chemistry is better known as a science that can explain answers to natural phenomena (Ulya, 2018). The chemistry education study program FKIP Tanjungpura University is in charge of preparing prospective chemistry teachers who excel both in designing the learning process and understanding the concepts of chemistry subjects in junior high and high school levels. As prospective teachers, FKIP Untan chemistry education students must have pedagogical, personality, social and professional competency (Law No. 14 of 2005 concerning Teachers and Lecturers). Of the four competencies, professional competence plays an important role because each teacher must be able to master the learning material widely and deeply which allows him to guide students to meet the competency standards set out in the National Education Standards. Students of prospective chemistry studies must have the mindset as chemistry is found and the aim of chemistry is taught in schools so that professional competencies can be mastered well. According to Bretz (2008), chemistry has two characteristics, namely chemistry as a product (chemistry related to several concepts, theories, laws, and postulates that compose natural phenomena) and chemistry as a process (an organized and organized scientific method so that new findings in the field of chemistry). The purpose of teaching chemistry subjects in high school / MA emphasizes that the learning process must be able to foster the ability to think, work and be scientific and the ability to communicate as an important aspect of life skills (Kemendikbud, 2013). Thus, students who are prospective chemistry teachers must be able to master extensive and in-depth chemical material and inquiry skills. Middle school chemistry courses are compulsory subjects taught at the FKIP Untan chemistry education program in semester 4. The subject studies include (a) the scope of chemical material in Integrated Science subjects at the junior secondary level, (b) Content or chemical concepts that studied in Integrated Science subjects at the junior high school level, (c) simple experiments to support the understanding of chemical content or concepts studied in Integrated Science subjects at the junior secondary level, and (d) Strategies for delivering chemical materials studied in Integrated Science subjects at junior high school level (Curriculum of Chemical Education Study Program FKIP Untan, 2015). Thus, student inquiry skills need to be done so that the objectives of junior high school

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chemistry courses are achieved, among others, can design simple experiments and strategies for delivering science lessons through investigations to support the understanding of content or concepts of chemistry at the junior high school.

Based on observations during learning, interviews with lecturers and students of FKIP Untan's chemistry education study program which took SMP Chemistry courses can be summed up in several ways, namely: (a) the unavailability of adequate teaching materials, namely available teaching materials only from lecturers in the form of PowerPoint slides containing concepts, theories or facts and junior high school science books that are not suitable to be used at the lecture level, (b) the learning process carried out by lecturers only conveys concepts that must be mastered by students from the PowerPoint slide given by the lecturer , (c) evaluation of student success is only seen to what extent they master the concepts measured during the Mid Semester Examination and Final Semester Exams and (d) Practicums supporting SMP chemistry courses are only verificative, namely practicum which only tests a concept or theory has been studied and not in the process of seeking knowledge or doing any education.

The learning process and practical activities carried out by lecturers at the junior high school chemistry subject have an impact on students' relatively low inquiry skills. The results of the research conducted by Rasmawan (2015) on the inquiry skills of semester V students were in the less skilled category.

The learning pattern of the Middle School Chemistry courses that have been carried out so far needs to be corrected immediately. Students should be allowed to explore understanding, develop thinking skills and inquiry skills, especially in terms of problem-solving. Thus, lecturers must provide opportunities for students to be able to understand, design, solve problems, know-how, and why to do, analyze, monitor, evaluate and develop an understanding of concepts (Permendiknas number 41 the year 2007). This is following the aim of being taught the chemistry course in junior high school, namely students are taught techniques and strategies for delivering chemical material that is studied in Integrated Science subjects at the junior high school level, namely through discovery.

One of the things that can be done is to develop teaching materials that can provide opportunities for students to actively build knowledge and develop inquiry skills, namely inquiry-based modules. According to Lasmiyati and Harta (2014) modules are teaching materials that contain learning objectives to be achieved, learning materials, student activities in learning, evaluation, and feedback. Furthermore, the activities carried out by students are investigative or inquiry activities. According to the National Research Council (2000) inquiry is an activity that involves students making observations, asking questions, examining books and other sources of information, planning investigations, reviewing experimental results, analyzing or interpreting data, proposing answers to data, providing explanations for predictions and communicate results. Inquiry-based learning models begin with a problem or question to then find the answers through a scientific procedure. Inquiry-based modules are teaching materials that contain the learning objectives to be achieved, investigative or inquiry activities that are accompanied by an assessment of investigations (performance appraisal). Therefore, this study will develop an inquiry-based SMP chemistry course module accompanied by performance-based assessment. It is hoped that through the development of the lecture module it will provide an alternative learning model in junior high school chemistry courses and the availability of reference materials in developing learning modules with inquiry models along with performance assessment.

2. Methods

Research and Development is a research method used to produce certain products and test the effectiveness of these products (Sugiono, 2011). This study will be developed an inquiry-based SMP chemistry course module with a performance-based assessment. The steps of development research that will be carried out starting from a) Potential and Problem Analysis, b) Initial data collection, c) Product Design, d) Design Validation, e) Revision of Design, and f) Product Testing. In the product design phase, use the Kemp (2010) model as a reference, namely the determination of themes (sorting content), concept analysis,

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formulation of indicators, strategies to introduce constants, preparation of assessment instruments, and learning resources. Kemp's model was chosen because each stage that was followed was more systematic, giving a pretty clear reference in designing learning devices and each development step was directly related to the revision activity. The stages of developing learning devices can be seen in Figure 1. Modules that have been developed at the product design stage, then validated by experts, including experts in the fields of education, learning, and chemists. Furthermore, the modules made are given to students of chemical education study programs to determine the readability of the module. The results of the validation and readability test are used as the basis for conducting module revisions and a module draft will be used to be used in the learning process in junior high school chemistry courses. Data collection in research and development is carried out at the stage of draft development, validation, and readability test. At this stage, certain data collection techniques are selected according to their respective objectives. In the development phase of the draft module, questionnaires, observation, and documentary techniques were selected, in addition to the literature review (theory and previous research). Furthermore, the validation stage is used in the validation sheet and interview. In the readability, the phase uses the module readability questionnaire. Data analysis was carried out by qualitative and quantitative analysis. In the development phase of the initial draft module, data analysis was carried out with qualitative analysis to obtain an overview of the inquiry model and performance appraisal in learning junior high school chemistry courses as well as material characteristics of food additives. The results obtained later became the basis for the development of the initial draft module. The next step is to conduct an analysis based on an assessment of the draft learning device and proceed with the improvement of the draft learning device. Analysis of the draft module is done quantitatively by determining the validity and level of readability of the module.

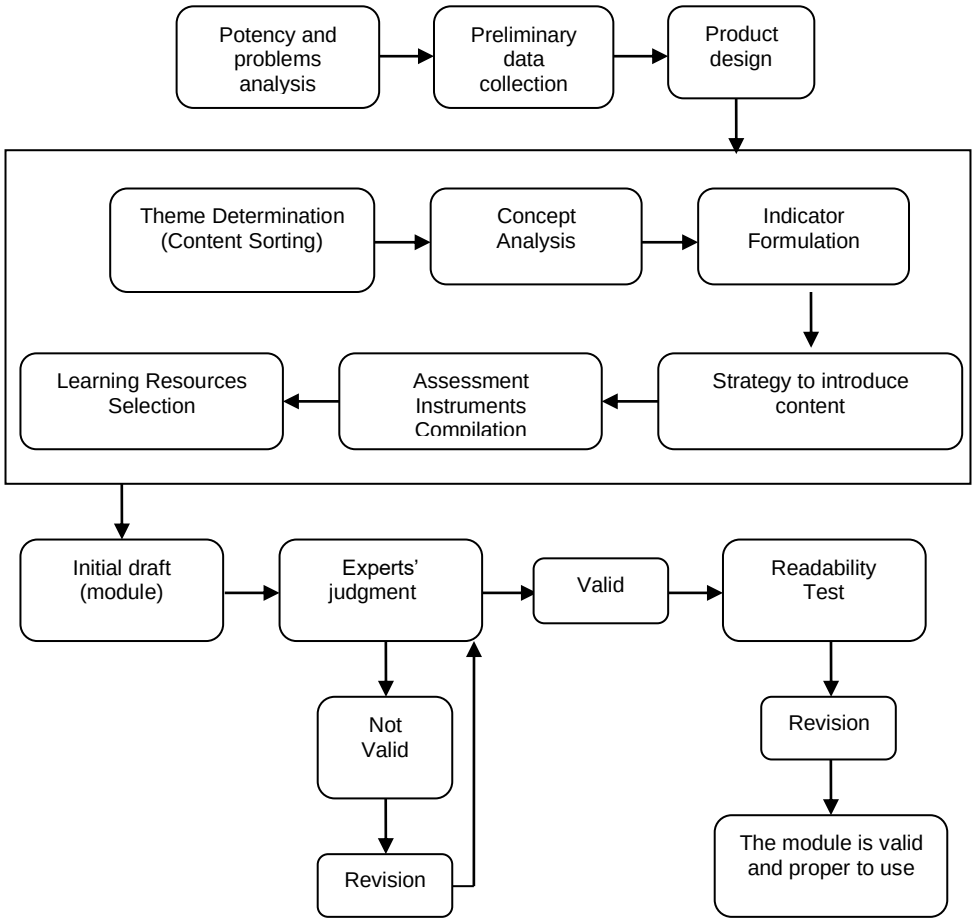

Figure 1. Stages of Development Research Module

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The module developed is reviewed by the validator to provide an assessment of the feasibility of its use. In this study, the Passing Grade is the percentage of the average score () of the results of the validator's assessment. The values obtained are then determined by the criteria as shown in Table 1. Determination of Passing Grade uses the following formula:

$$P = \frac{\Sigma(skor\ rerata\ dari\ seluruh\ validator)}{\sum N(total\ skor)}\ x\ 100\% \quad (1)$$

Table 1. Module Categorization Criteria

Range	0 – 20	21 – 40	41 – 60	61 – 80	81 – 100
Category	Not proper	Less proper	Proper enough	Proper	Very proper

The measurement phase of modulation readiness begins with asking students to give their opinions by filling out the module readability questionnaire. The responses of students are assessed by the provisions of the Linkert scale following the criteria listed in Table 2. Next, determine the percentage of the readability of the module using the formula:

$$Nilai = \frac{Jumlah\ Total\ Skor}{Skor\ Maksimal\ x\ Jumlah\ Koresponden} x100\% \quad (2)$$

Table 2. Determination of the value of the module readability questionnaire with a Likert scale

Category	Strongly agree	Agree	Less Agree	Disagree	Strongly Disagree
Score	5	4	3	2	1

3. Results and Discussion

The research phase begins with an analysis of the potential and problems faced in junior high school chemistry lectures at the Chemistry Education Study Program FKIP Untan. Based on observations it is known that in the learning process, teaching materials used by lecturers only use PowerPoint slides that contain concepts, theories, or laws that are studied in junior high school chemistry courses. In addition to the PowerPoint slides, additional teaching materials used by lecturers are junior high school science package books. Further interviews with lecturers obtained information that the weak availability of teaching materials specifically discussing chemical materials studied at the junior high school level is still relatively poor, the use of SMP science books is based on the depth and scope of the material to be studied in junior high school chemistry as well as the usual learning process done is the lecturer delivering a description of the material printed on the PowerPoint slide along with a question and answer and rarely associating the concept with the daily lives of students. Based on the results of observations and interviews, it can be concluded that in junior high school chemistry lectures do not yet have teaching materials that can make students actively involved in the learning process and associate material learned with students' real life. According to Jazadi (2005) the learning process which is merely conveying concepts or knowledge that must be mastered by students will form a mindset that learning is sufficient by memorizing and practicing questions. Holbrook (2005) added that chemistry subject matter (especially junior high school chemistry) which is not directly related to daily life can form the mindset that chemistry is a branch of science that does not have a direct connection with their lives and can result in a lack of student creativity in completing their life problems using concepts that have been learned.

The subject matter in the junior high school chemistry course that has the potential to be developed is the concept of food additives. This is because the material is very close to the daily lives of students. Foods that are eaten can have positive and negative effects on the body. This can be seen by looking at the composition of these food products. Besides, there are many cases of abuse of hazardous chemicals added to food products, such as Rodhamin B or Formalin. In learning, these two things can be investigated through scientific

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inquiry. For example, the determination of addictive substances can be seen from food products, while negative impacts can be seen from the literature search. Besides, the use of hazardous chemicals in food can be traced by doing simple experiments. for example, identification of borax can be done using the indicator of turmeric (Astuti and Nugroho, 2017). Based on this potential, in this study, we will develop an inquiry-based SMP Chemistry module specifically for food additives.

After an analysis of problems and potential, the next step is to design the product. The product to be developed is inquiry-based junior high school chemistry modules. The outline of the product development stage is divided into six (6) main stages, namely the determination of themes, analysis of concepts, formulation of indicators of learning, task analysis, strategies for introducing content, and determining evaluation of learning (Kemp, 2010). The theme selection is done by considering the conditions that occur in the daily lives of students. After the theme was determined, concepts were then chosen that were directly related to the theme. then identify indicators of learning. After learning indicators have been obtained, then the tasks that must be completed by the students are determined by adjusting the task with investigation or inquiry along with an assessment of its performance.

The first part of each study theme is given the situation or the conditions that exist in the daily lives of students. The situation or condition some problems must be resolved by students through the process of investigation, both investigations from literature studies and experiments. Presenting problems that are directly related to everyday life can form a mindset for students that the content or concepts learned can be used in real life in their daily lives so learning becomes more meaningful and memorable (Holbrook, 2005). In line with this, Arends (2012) states that the willingness of students to complete their investigations depends on the formulation of the problem to be resolved and the best way is that the problem is authentic or truly real and experienced by students.

The first activity of students in the module developed is to formulate a problem. In this step, students determine the main problem to be solved based on the situation or condition given. The step in formulating a problem is important in the investigation. By knowing the main problem to be solved can form thoughts about temporary answers to solve the problem, arrange ways to solve problems, and become a reference in making conclusions (Bailin, 2002). Furthermore, Flik and Lederman (2006) stated that the investigation process requires finding the main problem as a guide and direction in determining the steps of further investigation and can train students to think deeply and critically about what must be solved through investigation. After students can determine the formulation of the problem, then the student's activity is to formulate a hypothesis. The formulated hypothesis must have a clear and reliable theoretical basis or literature review. This is done to form a pattern of thinking in students that every argument used must have a strong foundation. This is in line with the opinion of Yadav and Misra (2013) that hypotheses or predictions are good if they have a strong basis so that these allegations have scientific values and are not merely guessing without basis on how to solve problems.

The hypothesis that students have made will be tested at the data collection stage. In the module developed, data collection is done in two types. The first type is by conducting a literature review in-depth and proof through experiments. this is reflected in solving problems in the first theme (Food additives for food products) and the second theme (Maximum limit for consuming food or beverage products that contain certain additives). to solve problems in the first and second themes, students conduct a study of the results obtained using data or rules that have been stated by BPOM. It can be concluded that the investigation process can be carried out by conducting a literature review in-depth even without conducting experiments or experiments. This is in line with the opinion of Raabany (2014) which states that the process of proof or effort to answer the problems faced can use data from research results or experiments of someone whose truth value can be accounted for and has truth values in obtaining these results. The third theme (Identification of Borax and Formalin in Market Snacks) investigated experiments. In this module, students are asked to independently design appropriate work procedures to identify the presence or absence of borax and formalin in market snacks. The final step of the inquiry process is to form a

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conclusion. In the module developed, formulating conclusions focuses on answering problems that arise based on the results of the analysis of collected data (data collection) and proving the hypothesis.

The product design that has been developed (inquiry-based junior high school chemistry module) has differences with teaching materials commonly used by lecturers in learning. This is illustrated by the stages or steps of the activity that will appear if applied to learn. In the module developed, knowledge is built by students following the path of inquiry or inquiry. This is different from the teaching materials developed by lecturers during learning, namely the activities of students only listen to lecturers' explanations from the PowerPoint slides that are displayed and practicum activities focus on proving a concept that has been learned. From the results of the development of inquiry-based junior high school chemistry modules, it is hoped that it can be used and become an alternative for lecturers in learning junior high school subjects to be able to improve students' skills in conducting investigations.

After the module draft was produced, the next step was to carry out validation carried out by experts. The purpose of validation is to determine the feasibility of using the draft module developed in the learning process. Validation carried out to assess modules was developed based on aspects of writing objectives, truth, and depth of concepts, language clarity, learning activities that could arise from the use of modules, physical appearance, and suitability of performance assessment with learning activities. Details of the results of module validation are presented in Table 3. Based on results validation is known that the draft module developed is very feasible to use. Based on the validator suggestions there are small revision activities without changing the module. The revisions made include changing the display format of the module to make it more interesting by including images that are following the daily lives of students as well as repairs to words that are not yet standardized.

Table 3. Results of Feasibility of Using Modules Validation

Aspect	Criteria	Score	Category
The goal to be achieved	Clarity of basic competencies.	84	Very proper
	Clarity of learning objectives.	88	Very proper
	Conformity between competence and purpose.	96	Very proper
	Conformity between objectives and study material.	88	Very proper
	Conformity between goals and learning activities.	84	Very proper
Writing approach	Emphasize the investigation process.	84	Very proper
	Connect science and technology with life.	80	Proper
	Inviting an active role in learning.	88	Very proper
	Encourage seeking more information.	88	Very proper
	Growing curiosity and thinking.	88	Very proper
Truth and depth of concept	Conformity to the concept of chemists.	88	Very proper
	The truth of the arrangement of matter	84	Very proper
	Guiding finding concepts	76	Proper
	Conformity of competence with the material.	84	Very proper
	The concept according to the times.	80	Proper
	Linkages to concepts with everyday life.	84	Very proper
Language clarity	The sentence does not cause a double meaning.	84	Very proper
	The sentence used is easy to understand.	92	Very proper
	The sentence used is interactive.	80	Proper
	The sentence used is raw and interesting.	88	Very proper
	Suitability of questions with the purpose	80	Proper
	Questions according to the concepts learned	76	Proper
Learning Activities	Providing a direct learning experience.	76	Proper
	Encourage application concepts	80	Proper
	Learning activities learning objectives.	92	Very proper
	Encourage to find concepts	88	Very proper
	Investigative activity.	80	Proper
Physical appearance	Consistency, format, organization, and attractiveness.	88	Very proper
	Clarity of writing and images	96	Very proper
	attract student reading interest.	80	Proper

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Aspect	Criteria	Score	Category
Performance assessment	Assessment is based on performance	76	Proper
	Suitability of the rubric with learning.	80	Proper
	Affective is measured in learning.	76	Proper
	Suitability of objectives with concept understanding tests	80	Proper
	Clarity of performance assessment rubrics	88	Very proper
	Affective assessment rubric clarity	88	Very proper
	Clarity of concept understanding tests.	84	Very proper
Average		**84**	**Very proper**

The readability of the module is known by requesting 30 chemistry education students from FKIP Untan who are currently following the Field Recognition Program (PPL) to assess the modules that have been developed. Readability tests include aspects of interest in content and appearance, renewability of content, interest in solving problems, ease of understanding the content and direction of completion. The results obtained are presented in Figure 2. The results obtained indicate that students provide positive responses to the modules developed. Interest in content (83%) and the display shows that the modules developed have content that is in accordance with their daily living conditions and packaged in an attractive appearance (84%). According to This is reinforced by the results of student interest in solving problems in the module by 93%.

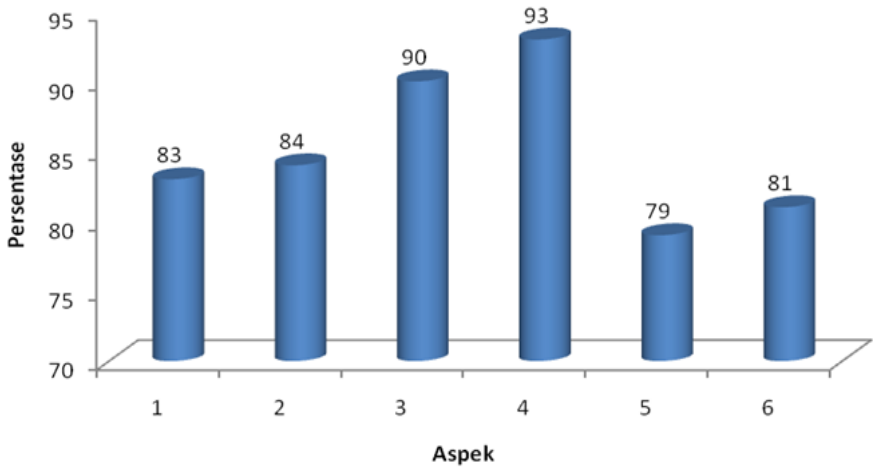

Figure 2. Results of Module Readability Assessment

Description:
Aspect 1: Interest in content
Aspect 2: Interest in appearance
Aspect 3: Renewal of contents
Aspect 4: Interest resolves problems
Aspect 5: Ease of understanding content
Aspect 6: Ease of understanding settlement directions

The results of the module readability assessment indicate that students easily understand the material to be studied (79%). This is because the material is related to their daily lives and is directly related to the situation they experience so that they will be more aware of learning, easier to understand and analyze, so they can observe, ask questions, submit hypotheses, collect data, and conclude (Suyanti, 2010). This is reinforced by the ease of students in understanding the direction of problem-solving in the module by 81%) so that they can guide them in solving existing problems. The results of the module readability assessment also show the renewal of content (90%) which shows that the learning process that can emerge from the use of modules is new, different from the learning process that has been done so far.

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4. Conclusion

A junior high school chemistry course module has been developed on food additive material that follows the inquiry learning model along with the performance-based assessment that is appropriate to activities that can arise when using the module in the learning process. The results of expert validation show that the module accompanied by performance-based assessment is valid and feasible to use in terms of the objectives to be achieved, writing approach, truth, and depth of concepts, language clarity, the suitability of inquiry stages with learning stages, physical appearance and suitability of performance appraisal with learning process if the module is applied. The readability test results show that students give positive responses to the module in terms of their interest in content and appearance, renewability of content, interest in solving problems, ease of understanding the content and direction of completion.

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