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The Development of Local Wisdom-Based Chemistry Modules to Improve Students' Science Process Skills

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Abstract: Process skills are essential skills that must be possessed in the chemistry learning process. It is because science process skills are needed in conducting scientific investigations. This study aimed to develop a chemistry subject module based on local wisdom and its effectiveness in improving students' science process skills. The research subjects were 30 eleventh grade senior high school students. This development research used the Borg and Gall model (2003), which adapts the Dick and Carey model, named Instructional System Design which includes ten stages of development. The product of this research and development is a chemistry subject module for the subject of colloid systems. Furthermore, the developed module received a validation test using a questionnaire given to experts and users to determine its feasibility in learning. The results of feasibility validation by learning media experts obtained a percentage of 100%, by chemists on the chemical material presented in the module content of 91%, by chemistry learning experts with a percentage of 82.50%, by 10 students with a percentage of 91.43%. Thus, the module developed is very feasible to be used in learning. After getting validation, the science process skills test results were analyzed on the initial and final tests using the Normalized Gain (N-gain) technique to determine its effectiveness in improving students' science process skills. Data analysis was obtained through one group pre-test and post-test design. Then, the results of the N-gain analysis of 0.74 are categorized as "High." It means that there is an increase in students' science process skills after applying the module. Thus, it can be concluded that the chemistry subject module is suitable for use in learning and affects the effectiveness of learning because it can effectively improve students' science process skills.

Keywords: Chemistry module; Development; Effectiveness; Science process skills; Local wisdom.

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Introduction

Good science learning is science learning that is applied as science was found, namely through the scientific method and using some science process skills. Science process skills are fundamental in this era (Muslimin, 2010). In science learning, the skills needed are science process skills. Scientists use process skills to find, strengthen, and refute existing theories, laws, principles, and science concepts. Science process skills involve not only psychomotor aspects but also cognitive and intellectual aspects (Sari et al., 2017). Science learning is expected to be a vehicle or a means to train students to master science concepts and principles, scientific skills, science process skills, and critical and creative thinking skills (Holbrook, 2005).

The development of science process skills is essential in science learning. It is due to several things: first, the growth of science is accelerating, so it is no longer possible for teachers to teach all facts and concepts to students. Second, children easily understand complex and abstract concepts if accompanied by

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concrete examples experienced through their practice, so they find ideas through science. Third, in the teaching and learning process, concept development should not be separated from the development of skills, attitudes, and values (Risamasu, 2016).

Process skills are essential skills that must be possessed in the chemistry learning process. Science process skills are needed in conducting scientific investigations (Arantika, 2018). Science process skills achieved by students in learning consist of observing, inferring, predicting, classifying, modeling, communicating, measuring, calculating, designing experiments, asking questions, developing hypotheses, controlling variables, formulating operational definitions of variables, interpreting data, drawing conclusions, and making tables or graphs or diagrams (Nur, 2008). Science learning is carried out by actively involving students in understanding scientific concepts through learning experiences. The learning process is designed to stimulate curiosity and provide experience in developing a scientific inquiry process that leads students to find answers to problems related to scientific phenomena in the surrounding environment (Dimyati, 2015). In science process skills-based learning, students are encouraged to know how to obtain information, manage, and convey information and use it to solve problems. It underlines the importance of science process skills for students (Putra, 2013).

Indonesia's achievement in the international arena regarding science process skills is still meager. Indonesia's participation in TIMSS evidences it. TIMSS (Trends In Mathematical and Science Study) is a unique study on learning mathematics and science. The questions in TIMSS are full of science process skills. The Ministry of Education and Culture (2016) regarding the TIMSS Infographic states that Indonesia's achievement, namely the average correct answer of students in science lessons, is 32 with an international average of 50. Indonesia's achievement in science lessons with a gain of 297 points is ranked 45 out of 48 countries in 2015.

Apart from participating in TMSS, Indonesia also engages in PISA. PISA stands for Program for International Student Assessment. PISA is a program launched by the OECD that focuses on measuring the scores of 15-year-old students in the subjects of science, reading, and mathematics. PISA also contains questions that are full of science process skills. Indonesia's achievement in 2015 was ranked 62 out of 69 countries for science material. It shows that according to international standards, the science process skills of Indonesian students are still deficient (Kemendikbud, 2016).

Research by Sukarno et al. (2013), using a test instrument, states that 43.48% of junior high school students have low category science process skills. One of the causes of students' soft science process skills is because science learning still uses conventional learning models. The following learning model places the teacher as a resource, not a facilitator. Students acquire knowledge by transferring knowledge from the teacher and not from scientific process activities and scientific activities. Thus, students' science process skills will be difficult to develop if learning science and its branches of knowledge are carried out using conventional learning models (Wijaya et al., 2014).

Learning resource factors also play a role in the low level of students' science process skills. Research by Endah et al. (2016) stated that the junior high school science textbooks issued by the Ministry of Education and Culture brought up more aspects of scientific knowledge, which was around 46.3%, while the investigative part received a portion of 30.2% and the thinking aspect was only 19.5%. The results of this study indicate that the junior high school science textbooks have not facilitated students to develop science process skills (Endah et al., 2016).

Based on this, it is deemed necessary to develop learning resources in modules to build science process skills. Modules are teaching materials prepared to support independent learning, arranged based on specific learning needs, are complete measuring tools, and can function together as a unit from other units (Sudjana & Rivai, 2009). The use of modules in the learning process has the following advantages: 1) focuses on the individual abilities of students because they can work alone and are more responsible for their actions, 2) control over learning outcomes through the use of competency standards in each module that students, 3 must achieve) the suitability of the curriculum is indicated by the existence of goals and ways of achieving them. Students can find out the relationship between learning and the results obtained (Setiyadi, 2017). The research results by Novana et al. (2014) state that the use of modules in science learning can improve student learning outcomes and skills. Research by Wijaya & Fajar (2020) concluded that the use of modules effectively improved students' science process skills with a significance value of <0.05.

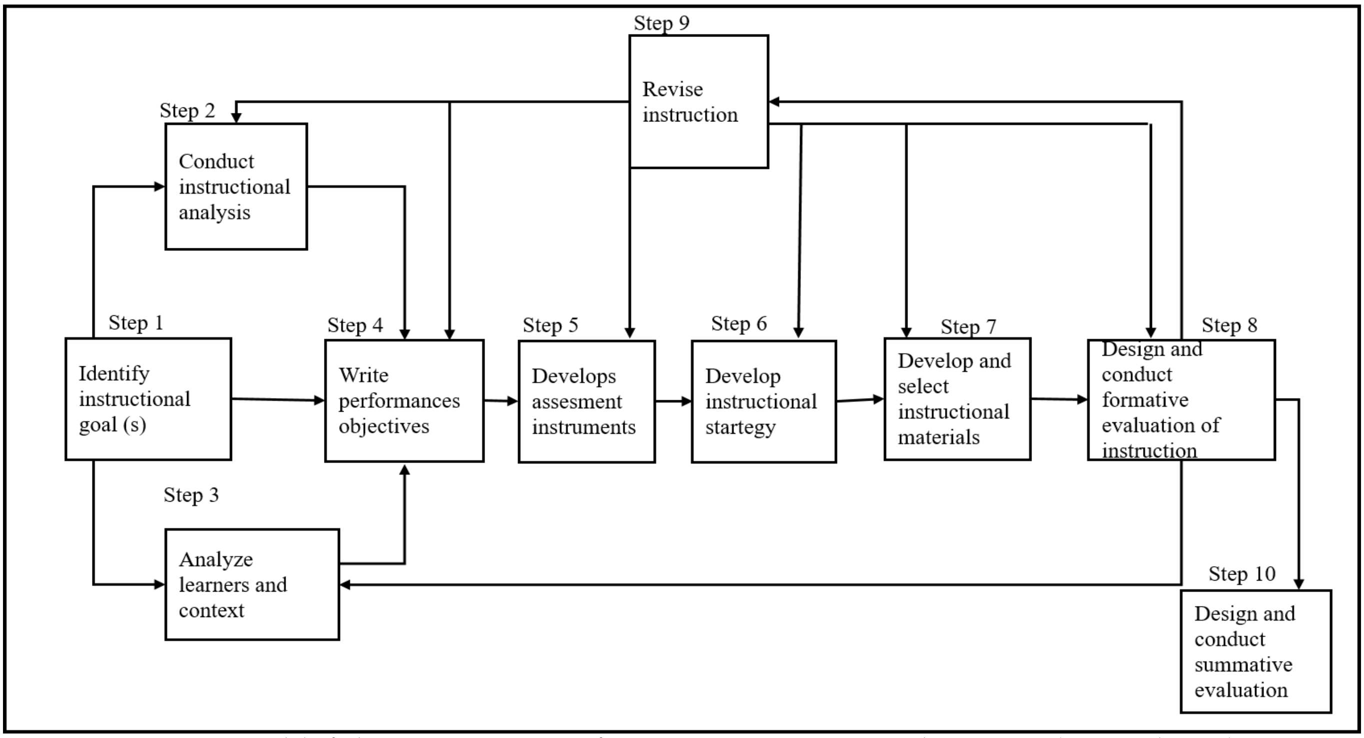
The researcher wants to develop a chemistry module based on local wisdom to improve students' science process skills based on the description above. Modules based on local knowledge and context will be relevant to students' daily lives. Therefore, learning chemistry with this module is expected to increase students' curiosity in studying chemistry so that it is not only knowledge of chemical concepts but also improves students' science process skills (Hernani et al., 2012) . The implementation of local wisdom in the learning process can improve and increase students' character and competence. Suppose the implementation of learning is integrated with hidden patterns. In that case, the teacher can incorporate the values of local wisdom in one or several learning components such as methods, materials, teaching materials, media, or learning evaluation (Wagiran, 2012). Yuliana (2017) states that students' cultural background will positively affect the science learning process in science learning if the material studied at school follows the students' everyday culture.

Students will certainly understand the concept better if the idea is close to students' daily lives and is easily accessible by students in obtaining information through local wisdom, which is part of local material. Local materials consist of local knowledge, local potential, and local environmental problems that can be used as learning resources for students (Yastuti et al., 2014). The module that will be developed is on Colloidal material. The examples of colloids related to students' local wisdom are Papeda (a typical Moluccan food) and Cheese Tofu, which are superior products developed by the community in Gemba village. It was hoped that this research produced modules that could improve students' science process skills in high school.

Method

Research design

This research is development research using the Dick and Carey learning system design model in Borg and Gall (2003) which includes 10 development steps that are shown in figured 1:



Figured 1. Model of The Sistematic Design of Instruction, W., Carey, L., and Carey, J.O. (Borg et al., 2003).

1. Identify general learning objectives. This step is carried out to identify a problem whose solution is by providing learning.
2. Conduct instructional analysis. Identify the knowledge and skills that must exist in learning.
3. Analysis learners and context. Analyzing students' actual abilities, learning styles, attitudes towards learning activities, and conditions related to the skills learned by students and the task situations that students will face.
4. Write performances objectives. This step outlines what students will achieve after participating in the lesson.
5. Develop assessment instruments. It is the process of developing an assessment instrument to measure students' achievement against the learning objectives that have been formulated.
6. Develop learning strategies. Develop learning strategies based on the information that has been collected in the previous steps, taking into account pre-learning activities, presentation of material, student participation, assessment, and follow-up activities.
7. Develop and select teaching materials. This step is to determine teaching materials that follow general goals and specific goals and all things that support the learning process.
8. Design and develop formative evaluations. The formative assessment aims to collect data related to the strengths and weaknesses of learning that are used as input to improve the chemistry module draft. In this study, formative evaluation was carried out using three types of formative assessment: expert evaluation, small group evaluation, and field evaluation. The expert evaluation was carried out by one chemistry learning expert and one chemistry learning expert from the Chemistry Education Study Program, Faculty of Teacher Training and Education, Pattimura University, and one teaching media expert from the Faculty of Teacher Training and Education Pattimura University. The small group evaluation involved 10 eleventh-grade public high school students 1 Seram Barat. The field evaluation was carried out with 1 class consisting of 30 eleventh-

grade public high school students 1 Seram Barat. The field evaluation was carried out to determine the effectiveness of the chemical module developed using a pre-experiment design, namely One Group Pre-test and Post-test Design created by Campbell and Stanley (Arikunto, 2013).

9. Revise the learning program. These are steps to improve the draft of the learning package based on the data obtained from the formative evaluation procedure to enhance the quality of the developed learning package.
10. Design and develop a summative evaluation. This step is the culmination of development activities after the learning package has been evaluated constructively and revised based on the formative evaluation results. Summative evaluation does not involve the designer of the learning package but involves independent assessors and takes a long time, so in this study, this step was not carried out.

Research Instruments

A research instrument is a measuring tool used by researchers to measure the research variables carried out and related to data sources and data collection methods used (Arikunto, 2013). The relationship between research variables, data sources, and research instruments is shown in Table 1.

Table 1. The relationship between variables, data sources, and research instruments

Research variable	Data source	Metode	Instru-ment
Module Eligibility	Chemist Chemistry learning expert Ahli media pembelajaran User student	Questi-onnaire	Rating scale
The effectiveness of the module on science process skills	List of student grades	Test	test questions

Based on table 1, the instruments used in this study are: (1) Questionnaire to determine the experts' assessment on the feasibility of the chemistry module and student responses to the module; (2) Science process skills test sheets to measure students' understanding and test questions in the form of essays regarding the learning objectives made. The test was carried out before learning (pretest) and after learning (posttest)

Data analysis technique

a. Module feasibility analysis

The data analysis technique used for the module feasibility analysis is a descriptive statistical data analysis technique on the percentage of expert questionnaire results and student response questionnaires.

Product validity data analysis using the formula:

$$P = \frac{\sum xi}{\sum x} X\ 100 \quad \ldots\ldots (1)$$

Where:

P = rating percentage

$\sum Xi$ = Number of answers from validator

$\sum Xi$ = Maximum number of answers

Each percentage resulting from the calculation using the above formula was then be associated with the score criteria so that the meaning of the percentage analysis results obtained. The criteria are shown in table 2:

Table 2. Questionnaire score percentage criteria

Precentage (%)	Criteria
81 - 100	Very good, no revision needed
61 - 80	Good, no revision needed
41 - 60	Enough, need revision
21 - 40	Not good, need revision
0 - 20	Not very good, need revision

(Arikunto, 2013)

b. Analysis of the effectiveness of the module in learning science process skills.

Analysis of the module's effectiveness was carried out on the students' initial and final tests. The value of each student, both for the initial test and the final test after learning using the developed chemistry module, can be calculated by the following equation 2:

$$N_k = \frac{S_p}{S_m} x\ 100 \quad \ldots\ldots (2)$$

Where:

N_k : Student scores

S_p : Scores obtained by students

S_m : Maximum score

(Modification of Arikunto, 2013))

The student scores obtained are then used to analyze the effectiveness of the module with an analysis of the improvement scores (gain test). The improvement score analysis was carried out to determine the effectiveness of the chemistry module developed in learning to improve science process skills. An investigation was carried out on the students' initial and final test results in a quantitative description with the N-gain formula by Hake (1999) wich is seen in equation 3:

$$\langle g \rangle = \frac{\langle S_{post} \rangle - \langle S_{pre} \rangle}{\langle S_{max} \rangle - \langle S_{pre} \rangle} \quad \ldots\ldots (3)$$

Where:

$\langle g \rangle$: Gain value

$\langle S_{post} \rangle$: Final test scores (*post-test*)

$\langle S_{pre} \rangle$: Initial test scores (*pre-test*)

$\langle S_{max} \rangle$: Maximum value

The results of the N-gain calculation are then converted by taking into account the following criteria:

Table 3. N-gain score category

Skor Normalized Gain	Category
0.7 < N-Gain	High
0.3 ≤ N-gain ≤ 0.70	Medium
N-Gain < 0.30	Low

(Hake, 1999)

Result and Discussion

Module Feasibility

The chemical module based on local wisdom to improve science process skills in the colloid system material developed was considered appropriate and feasible to use in chemistry learning based on the results of the validation of learning media experts, chemists, validation of chemistry learning experts, and student response questionnaires which are presented in Table 4.

Table 4. Chemistry Module Feasibility Validation Results

Data source	Instructional Media	Rating Percentage (%)	Category
Learning Media Expert	Modul	100	Very feasible
Chemist	Modul	91.00	Very feasible
Chemistry Learning Expert	Modul	82.50	Very feasible
Student Response	Modul	91.43	Very feasible

Table 4. shows that the feasibility of the chemical module based on local wisdom to improve students' science process skills is based on the assessment results by experts, namely learning media experts and chemical material/content experts. The results of the successive assessments of learning media experts are 100%, chemists 91%, chemistry learning experts 82.50%, and student responses are 91.00%, with the interpretation of the assessment percentages being in very feasible criteria. Thus, the chemistry module developed is considered feasible to use in learning chemistry.

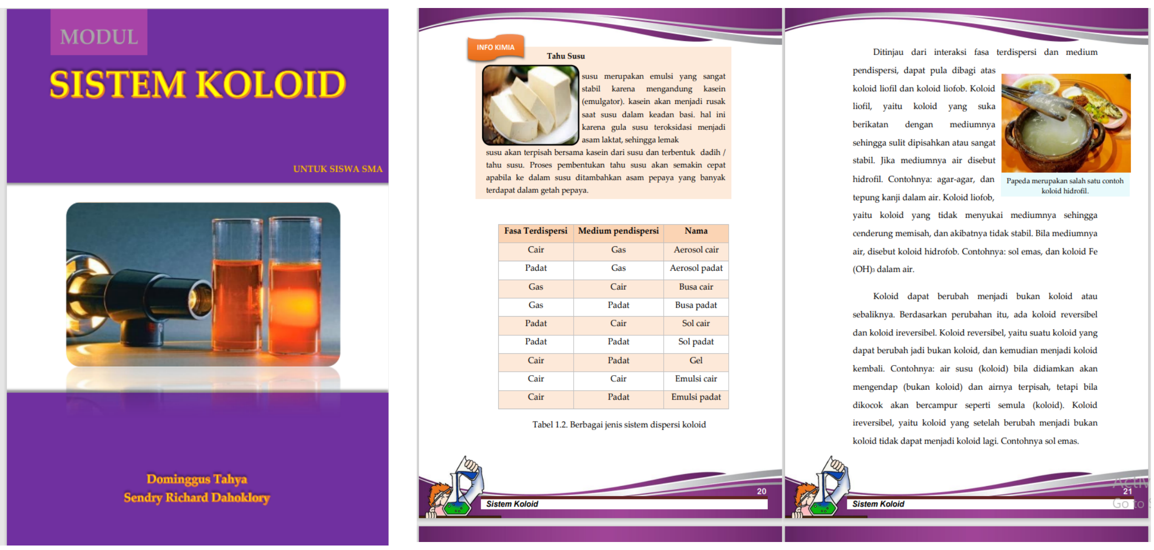


Figure 2. The cover and presentation of the contents of the Chemistry module

Figure 2. shows the cover and presentation of the content of the local wisdom-oriented chemistry module that was developed. Based on the learning needs analysis, the chemistry module developed contains chemical material about colloid systems. The content presentation of the developed module includes the context of local wisdom found in the community where students as targets for development, live, and move so that students not only know the chemical theory but also understand its application in everyday life.

Module Effectiveness in Improving Science Process Skills

Using the chemistry module developed to improve students' science process skills was effective. It was based on the analysis of the results of the science process skills test conducted before and after learning using the chemistry module based on developed local wisdom. Data on the results of the initial and final tests of 30 students are presented in Figure 2.

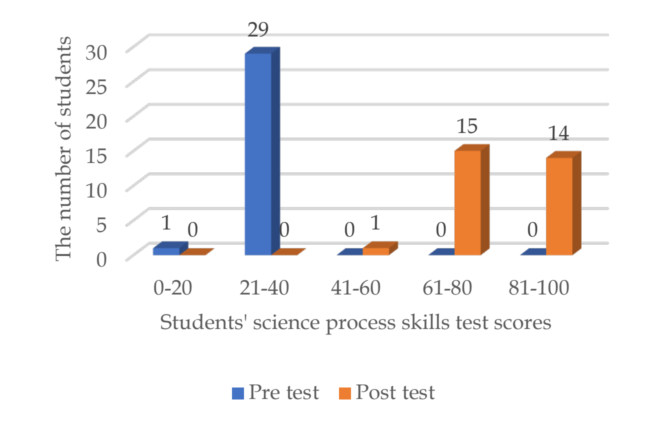


Figure 3. Graph of students' pretest and post test scores

Figure 3. shows that in the initial test before learning, students' understanding of science process skills in chemistry learning is very low, where all 30 students score below 40 from the 0-100 interval. Then, after learning using the chemistry module based on local wisdom developed, students' science process skills have increased. The 15 students scored between 61-80, 14 students scored 81-100, and 1 student scored below 60.

Table 5. Average science process skills test results

Initial test average	Final test average	Average N gain	N-gain interpretation
26.29	80.50	0.74	High

Table 5 shows that the average test results of students' science process skills before learning are meager, 26.29 from the 0-100 value interval. While the average test results of students after learning using the chemistry module developed was on an average value of 80.50.

The science process skills test results were obtained then carried out by an N-gain analyst to determine the increase in science process skills. The results of the N-gain analysis are presented in Figure 3.

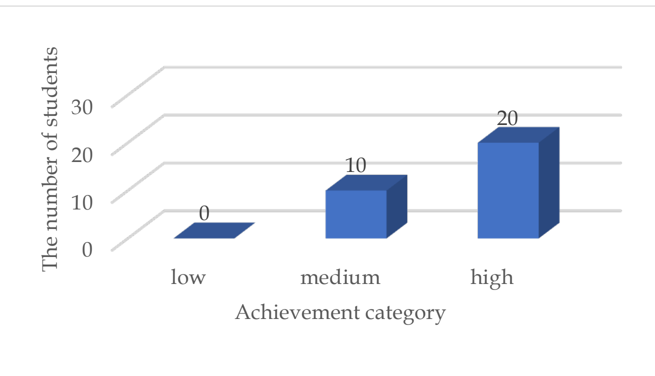


Figure 4. Graph of student's N-gain achievement

Figure 4 shows that the N-gain achievement of students is in the medium and high categories. From a total of 30 students, as many as 10 students are in the medium category, 20 students are in the high category, and no students are in the low category.

The module development that will be used in learning should pay attention to the feasibility element in each module component, namely the graphic components so that the module is genuinely appropriate and feasible to use. Therefore, evaluation by competent experts in the field of learning media was needed to assess the feasibility of the module to be used as teaching material. Based on the results in table 4, the chemistry module was evaluated for feasibility by learning media experts, obtained a 100% percentage, and was declared suitable for learning.

According to Middlecamp and Kean (in Hadiwidodo, 2017)), Chemistry contains abstract concepts such as atoms, molecules, ions, chemical structures, and chemical reactions. Learning can be carried out in the natural environment or in the laboratory. After learning, students are expected to know the laws, theories, and applications. Therefore, chemical material as a module content presentation is assessed and evaluated for the accuracy and clarity of chemical material by chemists. The results in table 4 show that the module is suitable for use with the percentage of assessment by chemists on the chemistry material presented in the module content of 91%.

The modules developed also follow the design of learning strategies that support their use, namely how the material or messages to be conveyed can be accepted by students so that learning objectives are achieved (Dick et al., 2015). The design of the learning strategy was assessed for feasibility before it can be used in learning. The assessment was carried out by a chemistry learning expert with the results as shown in table 4. The chemistry learning expert's evaluation of the presentation of learning activities in the module with 82.50% is in the very feasible criteria for use in learning.

Module development cannot be separated from input from students as users of the modules developed in the learning process. Therefore, the development of the module should consider the target students. It is because the module is expected to increase students' understanding of the presentation of the material content (Andy, 2015). Based on the results in table 4, the chemistry module was developed according to students' abilities. The students' response questionnaire result related to the module given to 10 students was 91.43%. The chemistry module was on target if the approval level was 70%. Therefore, with the percentage obtained, it can be concluded that the chemistry module has been following the target and is used in chemistry learning.

One of the essences of chemistry learning is learning as a process. In chemistry learning, intellectual skills and scientific attitude are emphasized to find facts build concepts and theories (Adnan, 2008). Abungu stated the importance of process skills in science learning is to help students gain a more long-term understanding of material memory. They are expected to solve all kinds of problems of daily life (Yusmar et al., 2018).

According to the Ministry of National Education of the Republic of Indonesia, the concept of organizing teaching materials is that teaching materials are packaged with strategies that provide opportunities for students to practice scientific methodologies and provide opportunities for meaningful learning. Thus, every student activity in the module facilitates and guides students to act as scientists by applying scientific methods to find facts to build chemical concepts, principles, and theories from the learning experiences experienced. By presenting contextual content of the module related to the atmosphere, task, or the context of the activities and environment of the learner, the module will further facilitate the learning process of students (Andy, 2015).

The constructive approach gives students more opportunities to reflect on their learning and understand science concepts. The learning design used to maximize the use of the module is carried out with a constructive learning approach with a guided inquiry strategy where students are guided to create their understanding based on what they know and believe, as well as ideas and environmental phenomena that they experience themselves (Balanay & Roa, 2013).

Based on Figure 3, the students' science process skills in learning chemistry are deficient, where all students get scores below 40 on the initial test. Then in the final test after learning, students' test scores have increased, with 14 students getting scores between 81-100, 15 students getting scores between 61-80, and only 1 student getting scores below 60. Improved process skills in science can occur because in learning using the chemistry module, students gain experience using scientific inquiry methods in finding facts so that understanding of chemistry is obtained through applying science process skills.

Based on the results in table 5, students' test results were analyzed by N-gain scores with an average N-gain score of 0.74, which means that there was an increase in students' science process skills in the high category. It is based on obtaining an N-gain score according to Hake (1999), where the value of the N-gain type is increased if the N-gain result is > 0.70, medium if the N-gain result is 0.3 ≤ N-gain ≤ 0.70, and low if N-gain result < 0.30.

The improvement of students' science process skills is based on the results in table 5. The results of increasing N-gain in Figure 4 show that using the local wisdom-based chemistry module developed is feasible and effective to use in learning to improve students' science process skills. It is in line with Yosef, (2018) in his research to determine the effectiveness of using modules in improving students' science process skills. Research results show that modules effectively improve students' science process skills.

Kirana et al., (2018) also revealed the same thing based on his research that the module effectively improves students' science process skills. In addition, Subiyanto's (2018) research results in a study entitled the development of a chemistry learning module on the periodic material system of elements based on Papuan local wisdom show an increase in student learning outcomes with an average N-gain of 0.62.

Gangne (In Sreetanuka & Tomas, 2012) views process skills as the basis for scientific inquiry, and knowledge is developed inductively from sensory experience. Also, Aydin, (2013) states that science process skills are thinking skills used to create understanding, reflect on problems, and formulate results. The module contains student activities that guide them to use science process skills to provide a science process learning experience to students. Therefore, the students' science process abilities and skills will increase in the process.

Conclusion

The results of research data analysis and discussion of research results conclude that the chemical module based on local wisdom improves students' scientific process skills. The module is feasible and effective for learning in eleventh-grade high school students. It is based on the results of expert questionnaire analysis learning media, chemistry material/content experts, and chemistry teaching experts to show the feasibility level of the module to be used in learning with a very feasible category. Meanwhile, the student response questionnaire analysis obtained strongly agree results, which means the module has been following the development goals. The results of the analysis of the N-gain improvement score on students' science process skills test, the average score of N-gain shows an increase in students' science process skills in the high category.

Based on the results of the research, it is recommended that the chemistry module developed is used properly in learning to provide variety in learning so that chemistry subjects that are often considered boring and difficult to learn in learning will be accepted by students with the abilities and learning styles of each student. In addition, the importance of presenting the module in developing students' science process skills also helps teachers facilitate and develop students' science process skills which are an essential element in studying chemistry.

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