DEVELOPMENT OF STUDENT WORKSHEET (LKPD) BASED ON A SCIENTIFIC APPROACH ON COLLOID CONCEPT: MAKING CRACKERS FROM GREEN MUSSEL (*PERNA VIRIDIS*) SHELL

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Abstract.*This study aims to develop LKPD based on a scientific approach to the colloid concept for the practice of making green mussel shell crackers. This type of research was conducted using the Four-D model which was adapted from Thiagarajan which consisted of four stages: define, design, development, and disseminate. However, this research is limited only to the development stage. The LKPD eligibility criteria developed were reviewed from several aspects, namely the feasibility aspect of the content, the presentation feasibility aspect, the language aspect, the graphic aspect, the teacher and student responses. The product has been validated and continued with a limited trial phase was carried out on 16 high school/MA chemistry teachers in the Jabodetabek area and 36 students in class XII science at SMAN 4 Tangerang City. Data were collected using a validation questionnaire which was prepared using the Guttman scale and the teacher and student response sheets were compiled using a Likert scale. The results of the limited trial through the teacher's response questionnaire to the LKPD developed were 86%; and the results of the student questionnaire of 83.5% which are included in the very good category and are suitable for use in learning the colloid concept.*

Keywords: *LKPD, Scientific Approach, Colloids, Green Mussel Shells, 4D development*

INTRODUCTION

In 2045 Indonesia dreams of becoming a golden generation of Indonesia where even one century of Indonesia's independence has been completed [1]. For this reason, Indonesia must be able to create quality human resources. In improving the quality of human resources in Indonesia, it must be accompanied by an increase in the quality and quality of national education. Various efforts to improve the quality of learning are continuously carried out in order to improve the quality of education in Indonesia [2]. One of the government policies is to develop a curriculum.

The latest curriculum has been set by the government as stated in Permendikbud No. 59 of 2013 which is named the 2013 curriculum. In the 2013 curriculum mandates educators to encourage students to be able to prioritize personal experiences through the process of observing, asking, reasoning, and communicating in increasing student creativity [3]. Therefore, learning activities in the 2013 curriculum are carried out using a scientific approach.

Rusman [1] said that the implementation of the 2013 curriculum with a scientific approach was believed to be a golden bridge for the development of students' attitudes, skills and knowledge in meeting scientific criteria. There are several stages of the scientific approach, including observing, asking, collecting data, processing data, concluding and communicating. If the stages of this scientific approach are implemented properly, students can develop attitudes and experiences according to the differences in their potential, because the teacher's role is no longer as a transferor of knowledge, but rather as a facilitator or helping students to be able to master the various competencies expected [4].

In the 2013 curriculum, one of the subjects that can apply a scientific approach is chemistry. The application of a scientific approach to learning chemistry is in line with the characteristics of chemistry, namely chemistry as a process and chemistry as a product [5]. According to Pradilasari, Gani & Khaldun [6] Chemistry material consists of a combination of abstract calculations and theoretical concepts, so

that chemistry is considered difficult and boring to study. In order for students to more easily understand a complex or abstract concept, they can use concrete examples, for example through practicum activities. In order for practicum activities to be more effective and of better quality, teachers need a learning tool, in this case a practicum worksheet. Basically, LKPD is the same as LKS, but in the 2013 curriculum, LKS is replaced with the name of the student's worksheet or abbreviated as LKPD [7].

In the learning process LKPD is not a new tool anymore. However, the LKPD currently circulating in schools only contains a summary of the material and contains exercises on questions compiled and designed by the publisher [7]. Nurhasanah, Nawawi, & Susanti [8] also explained that there were several weaknesses in the LKPD used by students at this time, including LKPD which tended to be colorless, contained material descriptions in foreign terms that were not explained in detail, there were no examples, tables, as well as study instructions and work steps that were not clear. Similar to the results of the questionnaire analysis that the researcher gave to a chemistry teacher at SMAN 4 Tangsel, he explained that the LKPD used did not accommodate the application of a scientific approach to learning. In addition, there are weaknesses in the LKPD used by students at this time, namely study instructions and work steps that are not clear.

Based on the results of the analysis of the characteristics of the students that the researchers did at SMAN 4 South Tangerang, one of the chemistry materials that they were interested in learning was colloidal material, but students found it difficult because the material was rote. Even though colloid material is actually related to everyday life, not many students are aware of it. As stated in KD 4.14, namely asking students to make food or other products in the form of colloids or involving colloid principles [9]. These basic competencies require students to be able to make food products or other products that involve the colloid principle.

One of the preparations that involve the colloid principle in its manufacture is green clam shell crackers. Green mussel (*Perna viridis*) is a type of shellfish that is popular with the public, has economic value and contains good nutrients for consumption [10]. Of the many potential green mussels produced by Indonesia, most people only use the shell meat, while the shells have not been used optimally. Even though clam shells that look like they don't have many uses can be sought by utilizing their nutritional content. Green mussel shell nutrition has a high mineral content of calcium which can be used as a new breakthrough in dealing with bone-related problems including osteoporosis [10].

Table 1. Chemical Composition of Green Mussel Shell Powder

Component	Content (%)
Water	0.76
Proteins	4.97
Fat	0.09
Carbohydrate	28,17
Ash	67.01
Calcium	**11.66**
White degrees	60,8

[11]

One of the efforts made to overcome the problem of green mussel shell waste is food diversification, namely processing green mussel shell waste into new products that have high selling value [12]. Efforts to utilize the calcium content in the shells can be in the form of crackers formulated with shell flour as a natural source of calcium [13]. Crackers are one of the snacks that are much loved by the people of Indonesia. However, less attention is paid to its nutritional value. Therefore diversified products in the form of calcium-rich crackers are expected to be accepted by consumers of all ages and become one of the solutions in overcoming the problem of calcium deficiency in the body [13].

The making of green mussel shell flour crackers is one of the implications of the colloidal material chosen because the process is relatively easy to practice for high school students. However, it is very unfortunate that until now there is no teaching material in the form of LKPD based on a scientific approach to colloid material through making green mussel shells.

Based on the explanation above, the author tried to adapt the research on making green mussel shell flour crackers conducted by Fitriah et al [10] and Permana [14] to be used as a worksheet design as a source of learning the colloid concept. For this reason, researchers are interested in conducting research with the title "Development of LKPD Based on a Scientific Approach to the Colloid Concept by Making Green Shell Crackers (Perna viridis)".

METHOD

This research is a type of research development or Research & Development (R&D). The development process carried out by researchers refers to the steps of the research model developed by Thiagarajan, Semmel, and Semmel, namely the Four-D development model. The development model consists of 4 stages of development, namely define, design, develop, and disseminate or adapt it to a 4-D model [15]. However, in this study it only reached the develop stage, namely until the expert validation stage.

Data collection methods in this study consist of; (1) Questionnaire and (2) validation. This research requires some data, namely in the form of front end analysis data conducted by one chemistry teacher, analysis of student characteristics conducted by six students, validation of research instruments validated by one expert lecturer, product validation carried out by two expert lecturers and one chemistry teacher, student and teacher response questionnaire data validated by one expert lecturer each. The LKPD product validation instrument refers to the instrument made by the BSNP. The data analysis technique used in LKPD validation is the Guttman scale with alternative answers "Yes" or "No". Sugiyono [16] to make it easier to interpret the calculated LKPD eligibility percentage data are then categorized into the interpretation criteria in table 2 below.

Table 2. Learning Devices Validity Criteria

Percentage (%)	Criteria
0-20	Very Invalid
21-40	Less valid
41-60	Valid Enough
61-80	Valid
81-100	Very Valid

Riduwan inside Adilah & Suliyanah [17]

Furthermore, the LKPD that had been validated by the validator was given to 36 students at SMAN 4 Kota Tangerang Selatan and 16 high school/MA chemistry teachers spread across the Jabodetabek area. For data analysis techniques used to find out the responses of students and teachers in determining the eligibility of LKPD, namely using a Likert scale according to Sugiyono [18] presented in table 3 below.

Table 3. Guidelines for Scoring Student and Teacher Response Questionnaire Data

Alternative Answers	Score Weight
Strongly Agree (SS)	5
Agree (S)	4
Undecided (R)	3
Disagree (TS)	2
Strongly Disagree (STS)	1

Then to obtain feasibility data from each aspect of the questionnaire the responses were converted into percentages and analyzed. The calculation of the data value of the questionnaire results is analyzed on a scale (0-100%) using the formula below [19]:

$$P = \frac{X}{Y} \times 100\%$$

Information:

P = Value of the aspect being measured

X = Score obtained

Y = Maximum score

The data whose percentages have been calculated are then interpreted using the interpretation of the percentage score of the questionnaire answers according to [20] which translates into “very invalid to very valid”:

Table 4. Criteria for scoring results of student and teacher response questionnaire data

Evaluation (%)	Interpretation Criteria
81-100	Very Valid
61-80	Valid
41-60	Valid Enough
21-40	Invalid
0-20	Totally Invalid

Then the data obtained is analyzed by simplifying it into a percentage form using a formula Suastika & Rahmawati [21]:

$$\mathbf{P = \frac{\sum X}{N} \times 100\%}$$

Information:

P = Percentage score

$\sum X$ = Total score obtained

N = Maximum score

RESULTS AND DISCUSSION

This study aims to develop Practical Worksheets Based on a Scientific Approach on Colloidal System Material by Making Green Shell Crackers (Perna viridis). The process of developing this practicum LKPD goes through several stages, namely define, design, and development. From the results of research and discussion of each stage of 4D development will be presented as follows:

Define

The purpose of doing this stage is to determine and define the learning [22]. This stage includes five steps, namely front end analysis, student analysis, concept analysis, task analysis and formulation of learning objectives. These five steps can be described as follows:

Front End Analysis

This stage aims to emerge and determine the basic problems faced by the teacher or an educator during the teaching and learning process [15]. At this stage a needs analysis questionnaire was given to 1 chemistry teacher at SMAN 4 Kota Tangerang Selatan. The following needs analysis questionnaire is shown in table 4.

Table 4. Results of the Teacher Needs Analysis Questionnaire

Aspect	Questionnaire Filling Results
Colloid Material Learning	• Colloid material is considered interesting for students because it relates to everyday life • Students experience difficulties in colloid material, namely the sub-material on how to make and types of colloids because it is rote and the approach used when teaching is not appropriate
Learning with a Scientific Approach	• When teaching, especially in KD 4, the teacher uses PPT teaching materials and learning videos • Teaching materials based on a scientific approach to colloid material do not yet exist. However, the teacher has implemented learning based on a scientific approach to colloidal material. • The teacher has implemented practicum and students are given LKPD, but the teacher did not make it.
LKPD display	• Teachers are interested in using LKPD as teaching materials • There are weaknesses in the LKPD used by students, namely learning instructions and work steps that are not clear • The LKPD display that the teacher expects is to display pictures
Utilization of Green Clam Shell Waste	• The teacher has carried out practicum using materials that are no longer used (acid-base) • According to the teacher, green mussel shell waste has not been used properly and the teacher does not know the benefits of green mussel shell waste. • According to the teacher, it is necessary to have worksheets based on a scientific approach combined with the manufacture of food products that involve colloidal principles using green mussel shell waste because it can improve students' skills.

The results of the front end analysis show that teachers need worksheets based on a scientific approach to colloidal system material by making green mussel shell crackers (*Perna viridis*). This development is necessary because there is no LKPD based on a scientific approach to colloidal material. According to the teacher, LKPD based on a scientific approach is one type of teaching material that is deemed necessary to be developed because it can improve students' skills.

Analysis of Student Characteristics

Student analysis is carried out with the aim of examining the characteristics of students so that they are relevant to the teaching materials to be developed [15]. From the results of the study it was found that students were interested in learning colloid material because it was related to everyday life and the methods that teachers used when teaching. However, there are also difficulties in studying colloidal material, namely there are sub-materials that are rote and referencing extensive learning resources. When carrying out practicum activities students are given LKPD but according to students the LKPD has a weakness, namely it is not colored and contains material descriptions in foreign terms which are not explained in detail. In addition, students never use materials that are no longer used and are used as new products that are more useful.

Concept Analysis

Concept analysis is carried out to identify the main concepts to be taught, arrange them in a hierarchical form, and break down individual concepts into important and irrelevant matters [15]. This stage is carried out by analyzing basic competencies to become indicators of achievement, this basic competency analysis process is carried out based on the 2013 curriculum Minister of Education and Culture, where KD 4.14 is selected for grade 11 in semester 2. This basic competency requires students to be able to make food or other products in the form of colloids or involves the colloid principle. This competency was chosen because the material is very close to everyday life. The results of the concept analysis are obtained indicators of learning activities after KI

and KD analysis on colloidal material. Then, based on the preparation of the indicators from KD above, the researcher made a concept map as an illustration of the main concepts that must be mastered by students. The concept of colloids in the manufacture of green mussel shell crackers is shown in table 1.

Table 1. The concept of colloids in the manufacture of green clam shell crackers

Colloid Sub Matter	Explanation
Definition of Colloid	The main ingredient used in making crackers is a food ingredient that contains a high enough carbohydrate, namely starch, in this case tapioca flour. When tapioca flour is mixed with cold water, a solution does not form but a suspension because starch does not dissolve in cold water [23]. If starch is heated it will form a very viscous solution, forming a single phase and cannot be separated. Based on the existing properties, starch is one example of a colloid.
Properties of Colloids	**Tyndal effect** If the beam of light coming from the flashlight is passed on the cracker mixture, it will cause the light to be scattered and the beam of light on the screen widens. **brown motion** It is known that cracker dough can scatter light. Colloidal particles can scatter light due to Brownian motion [24]
Types of Colloids	**Liquid sole** When viewed from the dispersed phase which is solid (tapioca flour) then dissolved in water will form a suspension which when heated forms a sol type colloid. **Dense foam** Crackers are a type of solid foam colloidal dispersion with solid dispersion medium and gas dispersed phase [25]. Crackers are colloidal types of solid foam because the gas is trapped in the cracker dough.
How to make colloids	**Dispersion** The process of smoothing the spices from the previously coarse particles and stirring is classified as a dispersion method by mechanical means.

Task Analysis

Task analysis aims to identify the main skills that will be studied in this study and analyze them into a set of additional skills that may be required [15]. The activities in the task analysis are divided into two, namely: 1) Analysis of the content structure, namely determining the sub-material of the indicators that have been set. The task of the students is to carry out the practicum of making green mussel shell flour crackers which are divided into three activities. Activity 1 is making green mussel flour, activity 2 is identifying the colloid system of each material used, and activity 3 is making green mussel flour crackers; 2) Procedural analysis obtained from the stages of the scientific approach used to prepare LKPD. The stages of the scientific approach include; 1) Observing, identifying the discourse provided for the next; 2) Asking, students can write down 3 questions from the results of identifying; 3) Trying, namely conducting an experiment to get concrete information based on the results of the experiment; 4) Reasoning, students process the information that has been obtained and answer the available analytical questions then write down the discussion; 5) Communicating, making conclusions from the results of the experiment. Based on the analysis of the concept, it can be formulated in the form of a concept map of the contents of the LKPD which will be developed as shown in Figure 1.

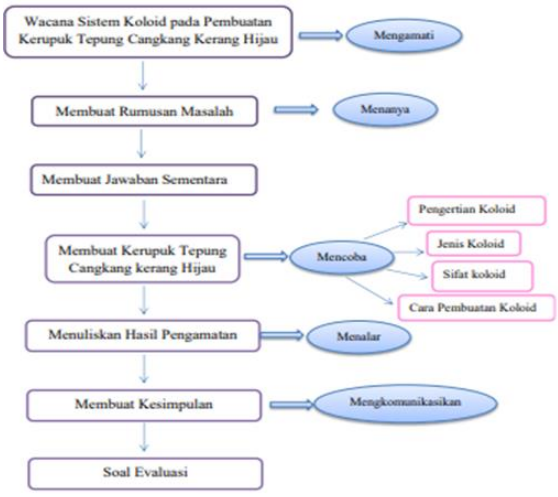

Figure 1. Concept Map

Formulation of Learning Objectives

Learning objectives are formulated based on basic competencies (KD) and learning indicators based on a scientific approach which will be included in the LKPD so that the reader knows what needs to be mastered in the LKPD as shown in Figure 2.

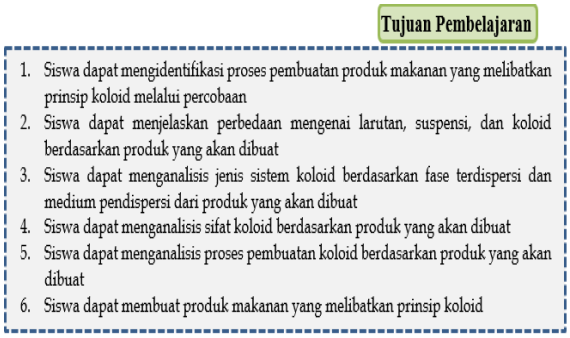

Figure 2. Learning Objectives on LKPD

Design

The planning or design stage aims to prepare a prototype or draft of the LKPD to be developed [15]. According to Rosidah [26] There are four steps that must be done at this stage, namely:

Preparation of Benchmark Reference Tests

The preparation of test standards or benchmark reference tests aims to produce questions that will be included in the LKPD, at this stage essay exercises are arranged at the end of the activity. The test made is a test that has elements of a scientific approach where students are required to observe the discourse provided to further seek answers to the questions given.

Media Selection

The stages aim to choose media that matches the learning content. In addition, it is tailored to the needs of teachers and students. Because the learning content is practicum, the media chosen in this development is LKPD. Next, the selection of tools and materials needed by students in practicum activities is carried out.

Format Selection

The LKPD design was designed using the help of Microsoft Word 2019 and Canva. The selection of the LKPD format is based on consideration of the quality of the LKPD, which includes format, layout, type, font size, content feasibility, language, presentation, and graphics following the descriptions of the text book assessment instrument items stipulated by the National Education Standards Agency (BSNP).

Development

The Development stage is the stage for producing product development which is carried out through two steps, namely: expert appraisal followed by revision and developmental testing [26].

Initial Plan

Before carrying out expert validation and limited trials, it is necessary to prepare the contents of the LKPD according to the results of the analysis that was carried out in the previous stage as a form of initial design. During the process of preparing this initial design, the researcher was guided by a supervisor in order to obtain a product in the form of an initial design that was feasible to use.

Expert Validation

After preparing the initial design, it was followed by validation by 2 expert lecturers and 1 chemistry teacher. At the validation stage, the researcher made several improvements according to the suggestions from the validator. The following are suggestions and comments from validators related to the developed LKPD which are presented in table 5.

Table 1 Revision During Preparation of LKPD

No.	Before Revision	After Revision
1	LKPD will be used by students, so that the background content is focused on the objectives of developing LKPD (figure 2)	Make a background that is in accordance with the objectives of developing LKPD
2	Students have not been given space to carry out activities according to the indicators made (figure 3)	Students are given space to carry out activities according to the indicators made (replacing sentences based on the discourse provided with the word experiment)
3	LKPD is given a theoretical basis in the form of colloid material and green shell material (picture 4)	LKPD is made in accordance with the LKPD components based on a scientific approach (theory is replaced in the form of discourse)
4	Writing references from journals is not quite right (figure 5)	Fixed writing references from journals

Aspects that underwent changes in the LKPD preparation process can be seen in Figure 2 below.

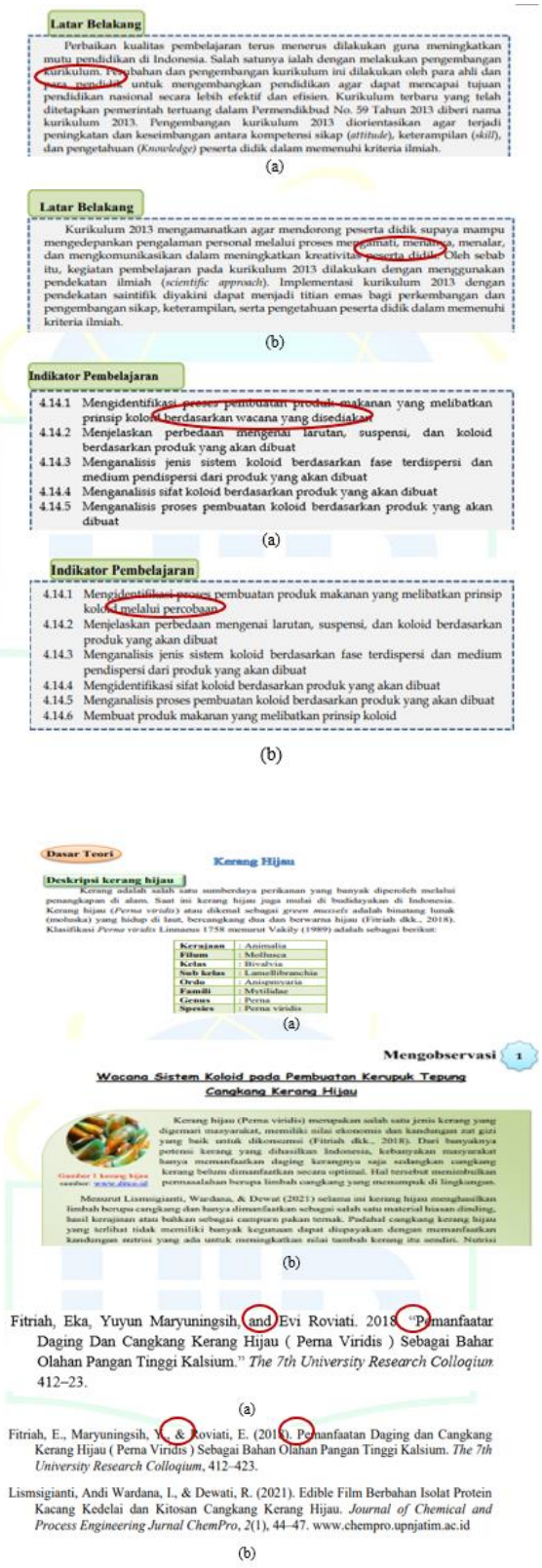

Figure 3 (a) Before revision; (b) After revision

There are several aspects that are validated by the validator including aspects of material, presentation, language, cover design, and content topography. LKPD is declared valid if the percentage is more than 61%. The following is the development of product validation values that have been carried out by the three validators shown in table 7.

Table 7. Product Validation Value Development

Validators	Validation I	Validation II
1	100%	100%
2	93.15%	100%
3	100%	100%
Average	**97.72%**	**100%**

Based on table 7 above, the validation results obtained by three validators for the LKPD that have been developed, all aspects get a percentage of 100% with very decent criteria.

Limited Trial

This stage aims to determine the quality of the developed LKPD from the perspective of teachers and students.

Teacher Response Questionnaire

At this stage a limited test was carried out by giving a response questionnaire to sixteen chemistry teacher respondents in the Jakarta, Bogor, Depok, Tangerang and Bekasi areas. There are several aspects that were tested in a limited way on teacher respondents including the feasibility of the content, the ease of understanding the LKPD, the suitability of the LKPD with a scientific approach, presentation, language, and graphics. The following results of the chemistry teacher's response questionnaire obtained in all aspects of the developed LKPD are shown in Figure 3

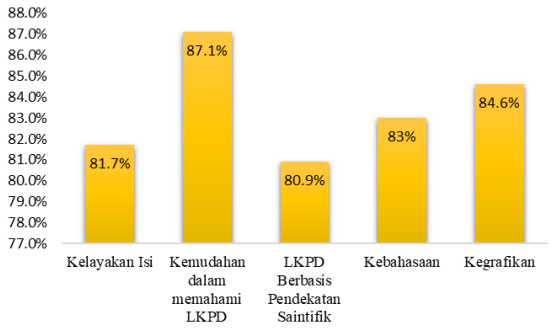

Figure 4 Graph of the Average Percentage of Teacher Response Questionnaires

Based on the results of the questionnaire analysis, the chemistry teacher's response to the LKPD that has been developed has a very good feasible category. This can be seen in the average percentage of all aspects which show a very feasible category, namely 86%. If the percentage

score is in the interval of 81-100% then it is included in the very decent category [20].

From the results of the calculation of the teacher's response questionnaire data shown in Figure 3, the highest average percentage of assessment is the content feasibility aspect, which is 88.3%, followed by the suitability aspect with a scientific approach of 86.5%, then the graphical aspect is 86.3 %, the ease of understanding LKPD and language is 85.9%, and the presentation aspect is 82.8%. The content feasibility aspect obtained the highest percentage. This indicated that the practicum worksheets developed were in accordance with student needs, learning objectives, and were up to date. This is in accordance with the eligibility requirements of LKPD, namely the didactic requirements where LKPD must be able to be used by all students, emphasizing the process, being able to develop students' abilities, having a variety of learning activities [27].

Student Response Questionnaire

At this stage, limited testing was carried out on thirty-six students in class XII IPA at SMAN 4 Kota Tangerang Selatan. There are several aspects that are tested in a limited way to student respondents including the feasibility of the content, the ease of understanding the LKPD, the suitability of the LKPD with a scientific approach, language, and graphics. The following results of the chemistry teacher's response questionnaire obtained in all aspects of the developed LKPD are shown in Figure 4.

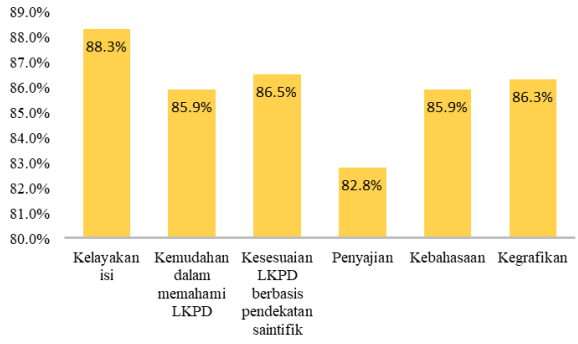

Figure 5 Graph of Average Percentage of Student Response Questionnaire Results

The aspect of ease of understanding LKPD ranks highest with a percentage of 87.1% with very decent criteria. This shows that it is easy for students to learn the contents of the LKPD besides that the LKPD is arranged sequentially and logically according to the contents of the colloidal material. This is in accordance with the purpose of preparing LKPD according to Prastowo [28] namely LKPD must make it easier for students to interact with the material provided. Besides that Pawestri & Zulfiati [29] explained that with the help of student worksheets it would be easier for students to understand the material presented and could play a more active role in the learning process.

Overall, from the results of the analysis of student response questionnaire data, the average percentage of all aspects was 83.5%. If the percentage score is in the interval of 81-100% then it is included in the very decent category [20].

CONCLUSION

The LKPD was produced based on a scientific approach to colloidal matter by making green mussel shell crackers (Perna viridis) which were developed using the Four-D model. The first stage is define, at this stage it can be concluded that it is necessary to develop LKPD based on a scientific approach to colloid material through the manufacture of green mussel shell crackers (Perna viridis). The second stage is design, at this stage assignments and evaluation questions, media, structure and layout are produced which will be included in the LKPD to then be prepared as an initial design. The third stage is development, at this stage validation tests and limited trials are carried out to find out whether the product being developed is feasible or not. LKPD validation is carried out by 3 experts who get an average percentage of 100%, this shows that the LKPD is included in the very good category and is suitable for use. Furthermore, the LKPD was tested in a limited manner by 36 students from SMAN 4 Kota Tangerang Selatan and 16 chemistry teachers spread across the Jakarta, Bogor, Depok, Tangerang and Bekasi areas. In the limited trial, the average percentage for student responses was 83.5% in the very good category, and the average percentage for teacher response questionnaires was 86% which was also in the very good category. Furthermore, the LKPD was tested in a limited manner by 36 students from SMAN 4 Kota Tangerang Selatan and 16 chemistry teachers spread across the Jakarta, Bogor, Depok, Tangerang and Bekasi areas. In the limited trial, the average percentage for student responses was 83.5% in the very good category, and the average percentage for teacher response questionnaires was 86% which was also in the very good category. Furthermore, the LKPD was tested in a limited manner by 36

students from SMAN 4 Kota Tangerang Selatan and 16 chemistry teachers spread across the Jakarta, Bogor, Depok, Tangerang and Bekasi areas. In the limited trial, the average percentage for student responses was 83.5% in the very good category, and the average percentage for teacher response questionnaires was 86% which was also in the very good category.

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