Development of plant physiology practical guide book with scientific approach for education

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Abstract. The main problem in the several high school in Padang is their Plant Physiology Lab Work Guide still made in cookery book type. This is affected to the less activity of student in the practice activity. The lab work guide with cookery book type is not optimal to develop students’ skill in science process. This research goals was to produce valid, practical, and effective plant physiology practical guide with scientific approach for university. The research use the Plomp’s development model that has 3 phases; the preliminary research, the prototype phase, and assessment phase. The data collection instruments are validator sheet of lab work guidance, practicalities of lecturer and student questionnaire, observation of student’s psychomotor and affective sheet and the test result of student study. The data were analysed with the description of the percentage results that was got on the field. The validation score is 81,20% with very valid category, the practicalities score 90% by lecturer with very practical category and 82,78 % by students with very practical category too. The conclusion of this research is the plant physiology lab work guide with scientific approach for university developed is valid practical, and effective.

1. Introduction
The rapid development of science and technology and the rapid flow of globalization, provide various kinds of challenges for each country to face. One of them is the challenge in the field of science education which demands that students have good skills in the science process. [1] Lecturers have to able to guide students to be more active and critical in the science lecturing process. Therefore lecturer-centered lecture approaches and strategies are no longer in line with developments facing the world of education.

Along with the rapid development of science and technology, Educational Institutions as teacher-producing institutions and scientists are always working to produce future professional teachers and scientists to face the new era. One of them is teachers and scientists in the field of biology. Science is defined as knowledge obtained from data collection through experimental activities, observation, and deduction to produce a reliable explanation of a phenomenon [2]. Data collection through practical activities is used as a vehicle for training to make biological observations or experiments. Through practical activities, students can formulate problems, develop a frame of mind, test hypotheses and draw conclusions. As stated by [2] that practical activities can develop basic skills in conducting experiments.

One of the subjects in the course of conducting practical activities is the Plant Physiology course. Plant Physiology is one of the compulsory subjects for biology students and is included in the science and skills course. The scientific process is obtained through the provision of theory in lecture activities,
while the process of skills is obtained through practical activities to provide laboratory skills for prospective scientists and biology teachers.

Based on the fact in the several high school in Padang, practical activities using a prescription model practical guide, make practical activities more emphasize the results (products) and not on the process because students are only guided to follow the steps provided in the guide to obtain data. This results in very few opportunities given to students to experience for themselves the actual scientific efforts in solving new problems as prospective teachers and scientists. According to [3], practical activities should provide opportunities for students to experiment on their own in practical activities, making students feel like scientists who are conducting investigations.

In addition, the authors also found that some students tended to be inactive during practical activities. They rely more on their group friends to carry out practical activities. This will result in the practical activities being unable to develop students' science skills. The practical guide used only provides steps to be carried out during the practical activities, so that students tend to memorize the work procedures without thinking and analyze the activities carried out. [4] stated that practical activities should provide opportunities for students to find theories and prove theories. He also stated that one of the objectives of the practical is to provide real experiences to students, as well as formulate it operationally, design the best way to break it down, implement it in the laboratory, and analyze and evaluate the results. Thus the active involvement of students during practical activities is needed. Based on this problem, a solution is needed to solve it. One of the solution is to develop a practical guide with a scientific approach.

The active involvement of students during practical activities is needed. Based on this problem, a solution is needed to solve it. One of the solution is to develop a practical guide with a scientific approach. The scientific approach is expected to be able to improve science skills and student activeness in practical. According to [5], lectures with a scientific approach emphasize providing direct experience using either observation, experiments or other means, by developing scientific skills so students become creative, and are able to learn science at a higher level in a short time. This is supported by [6] which states that scientific lectures involve process skills, such as observing, classifying, measuring, predicting, explaining and concluding. The scientific approach is an approach that is equipped with activities to observe, ask questions, gather information, reason, and communicate. In line with this, according to [7] the scientific approach is an approach characterized by the accentuation of the dimensions of observation, reasoning, discovery, validation, and explanation of a truth where the lecture process must be carried out guided by scientific values, principles or criteria. Thus the scientific approach is also able to increase student activeness in practical activities.

2. Methods
This type of research is development research. The development model in this study uses the Plomp model. This model was developed by Tjeerd Plomp. The Plomp model consists of 3 stages, Those are preliminary research phase, the development or prototyping phase, and the assessment phase [8]. The selection of the trial subjects was carried out by purposive sampling, which is a sampling technique that the researcher deliberately selected based on certain characteristics.

The data used in this study are data validity, practicality, and effectiveness. The instruments used to collect the research data were the validation sheet by the lecturer, the practicality test questionnaire by the lecturers and students on the practical guide developed, and the effectiveness observation sheet in the form of an affective observation sheet, a psychomotor observation sheet, and a learning outcome test after using a guide book. Validation sheets and practicality tests by teachers and students are arranged according to a Likert scale with the following four alternative answers.

- SS = very agree (score 4)
- S = agree (score 3)
- TS = disagree (score 2)
- STS = very disagree (score 1)

The research data were analyzed using quantitative analysis. Analysis of the validity of the plant physiology practical guide with a scientific approach was carried out by scoring the answers of each item and adding them up.

The validity, practicality and effectivity value is obtained by the formula:
Value = \frac{\text{total score}}{\text{higher score}} \times 100 \%

3. Results and Discussion

3.1. Preliminary research

3.1.1 Curriculum Analysis. At the curriculum analysis stage, the steps taken are carrying out an analysis of learning outcomes to find materials that require practical in lectures. Based on the analysis of plant physiology material, practical topics were developed to guide the plant physiology practical which were developed including diffusion and osmosis, the relationship of plants with water, soil, nutrition, photosynthesis, respiration, enzymes, growth and movement in plants.

3.1.2. Student Analysis. The condition and characteristics of students are one of the considerations that must be considered in development research [9]. Student analysis is used as an illustration to develop a plant physiology practical guide with a scientific approach. In this study, the research subjects were students majoring in Biology UNP in 5th semester, whose average age was 20-21 years and were at the formal operational stage. According to Piaget's learning theory [10] at the formal operational stage, the main characteristics of child development able to think abstractly, logically, draw conclusions, interpret and develop hypotheses. At this age students are included in the category of individuals who are able to develop their psychomotor potential so that they are skilled in using media including self-instruction teaching materials such as practical guides. Students at this stage generally prefer to learn by providing opportunities for them to work independently rather than being explained in detail by the lecturer. To develop this potential, this guide is equipped with a scientific approach. According to [11] the scientific approach is able to encourage and inspire students to think critically, analytically, and accurately in identifying, understanding, solving problems, and applying lecture materials. The results of other student analysis are also known that students prefer practical guides that can build student scientific work in practical such as providing opportunities for students to develop their own abilities in experimenting by discussing to do practical activities such as directions in the form of questions so that students are more focused on analysing data and discuss the results of practical activities.

3.1.3. Guide book analysis. The guide book analysis was carried out to determine the presentation of the content of the practical guide used by students. This analysis is carried out by looking at several components contained in the guide book, Those are the title, introduction, objectives, tools and materials, work steps, observation columns, and questions [12].

3.2. Develop

3.2.1. The validity of plant physiology guide book with a scientific approach. The validation test of the plant physiology guide book with a scientific approach was carried out by 3 validators. The validity results of the plant physiology guide book with this scientific approach can be seen in Table 1.

| No. | Aspect                  | Validity (%) | Assessment   |
|-----|-------------------------|--------------|--------------|
| 1.  | Didactic requirements   | 81.06        | Very valid   |
| 2.  | Construction requirements| 83.33        | Very valid   |
| 3.  | Technical requirements  | 81.25        | Valid        |
| 4.  | Language Requirements   | 79.17        | Valid        |
|     | **Average**             | **81.20**    | **Very valid**|
Overall, the average value of the validation results of the plant physiology practical guide with the scientific approach was 81.20%. Therefore, it can be said that the developed practical guide is valid and can be used in plant physiology lesson.

Based on the results of the validation of 3 validators, it was found that the plant physiology practical guide with the resulting scientific approach had a very valid category with a value of 81.20%. This means that the developed practical guide is of good quality, reliable and valid and can be used as a guide in plant physiology practical activities.

The four validation assessments of the practical guide above are a mutually supportive unit for the perfection of the practical guide developed. It can be concluded that the practical guide developed has met the eligibility criteria for the practical guide with a valid category [13]. According to [14] the validation of a practical guide and other teaching materials is very important to obtain recognition of the suitability of teaching materials and the resulting practical guide is suitable and suitable for use in lectures.

3.2.2. Practicality of plant physiology guide book with a scientific approach.

The practicality test of the plant physiology guide book with a scientific approach was carried out by Lecturers and 32 Biology UNP students. The practical results of the plant physiology lab guide with a scientific approach by the lecturer can be seen in Table 2.

| No | Aspect                        | Value (%) | Assessment     |
|----|-------------------------------|-----------|----------------|
| 1  | Ease of use                   | 85        | Very practice  |
| 2  | The effectiveness of learning time | 75      | Practice       |
| 3  | Ease of interpretation        | 100       | Very practice  |
| 4  | Has an equivalent             | 100       | Very practice  |
|    | Average                       | 90        | Very practice  |

From the results of the practicality questionnaire analysis of the practical guide by the lecturer, the developed plant physiology practical guide has very practical criteria with a value of 90%. These results indicate that the practical guide developed can help lecturers in carrying out practical. According to [15], a product can be said to be practical if the product is realistic and usable. Practicality tests were also carried out on Biology UNP students. Practicality data by students were obtained through practicality questionnaires. Data on practicality results by students can be seen in Table 3.

| No | Aspect                        | Value (%) | Assessment     |
|----|-------------------------------|-----------|----------------|
| 1  | Didactic requirements         | 84,24     | Very practice  |
| 2  | Construction requirements     | 82,81     | Very practice  |
| 3  | Technical requirements        | 83,59     | Very practice  |
| 4  | Has an equivalent             | 80,47     | Very practice  |
|    | Average                       | 82,78     | Very practice  |

Based on the practicality test results, it can be seen that the average percentage of student practicality questionnaires is 82.78% with very practical criteria. The practicality test by students was carried out through a student response questionnaire to the growth physiology practical guide with a scientific approach. This questionnaire was given to 32 students whose aim was to see student responses after going through 2 practical activities. From the results of the student response questionnaire, it was found that the practicality of the practical guide was 82.78% with very practical criteria.

3.2.3. The effectiveness of plant physiology guide book with a scientific approach
- Affective
  Data on student affective learning outcomes were obtained from observers' observations. Affective assessment data can be seen in Table 4.

| No. | Attitude Assessment                                    | Average (%) | Assessment |
|-----|--------------------------------------------------------|-------------|------------|
| 1   | Attitudes during Lesson                                | 77.34       | Effective  |
| 2   | Ability to work in groups                              | 78.91       | Effective  |
| 3   | Ability to manage time during lesson                   | 79.69       | Effective  |
| 4   | Diligence                                              | 76.17       | Effective  |
|     | **Average**                                            | **78.03**   | Effective  |

The affective domain is related to student attitudes during the learning process. Based on the observer's assessment during the implementation of the practical 2 times, the average value was 75.39% with effective criteria. This means that the plant physiology practical guide with a scientific approach is able to build students' scientific attitudes and improve learning outcomes in the affective domain.

- Psychomotor

Student psychomotor learning outcomes data were obtained from observers' observations. Psychomotor domain assessment data can be seen in Table 5.

| No. | Assessed Skills                                      | Average (%) | Assessment    |
|-----|-------------------------------------------------------|-------------|---------------|
| 1   | Skills to prepare tools and materials                 | 75          | Effective     |
| 2   | Practical skills                                      | 75.39       | Effective     |
| 3   | Skills to present the results                         | 85.94       | Very Effective|
| 4   | Practical writing skills                              | 84.38       | Very Effective|
|     | **Average**                                           | **80.18**   | Very Effective|

Psychomotor aspects that are used as indicators of observers in observing students during the implementation of practical activities consist of 4 aspects of observation. The observations of the psychomotor domain analyzed by the observer consisted of skills in preparing tools and materials, skills for doing practical, skills in presenting lab results and writing skills for practical results. From these four aspects, the psychomotor domain value of 2 practical times was obtained, namely 80.18% in the very practical category. The first practical on growth obtained an average of 80.27% with very effective criteria. In the second practical, the practical of motion in plants obtained an average value of 80.08% with very effective criteria. According to [13] the scientific approach can improve students' psychomotor abilities. Students who understand the scientific approach have better practical activity reports than students who do not understand the scientific approach. This happens because student motivation is higher when attending lectures with a scientific approach.

- Cognitive

Cognitive learning outcomes are obtained from tests given in the form of tests at the end of practical activities.

| Aspect                        | Value         |
|-------------------------------|---------------|
| Number of Students            | 32            |
| Final Grade Average           | 80.55 (A-)    |
| Highest Final Grade           | 92.5 (A)      |
| Lowest Final Grade            | 70 (B-)       |
| Percentage of Students Passing| 100           |
| Percentage of Students Not Passing | 0            |
The learning outcomes of the cognitive aspects of students from the 2 practiced materials obtained an average value of 80.45 (A-) with the passing criteria. The analysis is used to determine students' mastery of concepts after carrying out practical activities using plant physiology lab guides with a scientific approach. According to [5] the test is a systematic procedure in which the tested individual is represented with a set of stimuli for their answers that can be expressed in numbers so that the researcher gets the level of understanding of the variables being tested.

Based on the results of cognitive learning, it is known that overall, students get good grades. Student cognitive learning outcomes are influenced by the physical condition of students during practical. According [7] student learning completeness is influenced by several factors. These factors consist of input components in education itself. Broadly speaking, the factors affecting student learning can be classified into 2, namely internal factors and external factors. Internal factors are factors that exist within students such as motivation, while external factors are factors that come from outside of students such as learning methods, family environment and school environment [8]. Based on these factors, the factors that affect students' cognitive are more external factors.

Students' classical graduation has met the indicators of success. Therefore lectures can be said to be complete. Classical graduation of students in this study proves that learning through a scientific approach can be used as a method to improve students' understanding of the material being studied.

4. Conclusion
Based on the research that has been done, it can be concluded that:

1. The development or prototyping phase (Development or Prototyping Phase), the results of the design and realization phases obtained by a plant physiology practical guide with a scientific approach. The formative results of plant physiology practical guidance with a scientific approach were produced through self-evaluation, expert reviews by 3 validators, and one-on-one evaluation by 3 students. The validity of the plant physiology practical guide with the resulting scientific approach has valid criteria.

2. The assessment phase, at this stage of the assessment, a large group trial was carried out through practicality trials and the effectiveness of the plant physiology practice guide using a scientific approach. The practicality of the plant physiology practical guide with the resulting scientific approach is very practical based on the responses of lecturers and students. The effectiveness of plant physiology practical guides with a scientific approach that results from cognitive, affective, and psychomotor aspects is effective.

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