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Practical innovation in measuring chlorophyll content of Peranggi chili (*Capsicum annuum* L. Var Chinense) toward the student learning outcomes

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Abstract

Practicum is a learning method that involves students in an experiment to understand concepts in depth. Chlorophyll is an essential substance in plants, but cannot be seen directly, so its function is not understood (abstract) to students. To demonstrate how chlorophyll formation is influenced by the environment, a practicum can be conducted to show the formation of chlorophyll influenced by environmental factors, such as water stress, using peranggi chili (Capsicum annuum L. var. chinense) as a local plant with high economic potential. The innovation in this practicum lies in the use of color reference sheets as visual indicators in biology learning. This study aimed to measure learning outcomes and students' responses to the practicum. This study used a quantitative descriptive method with teaching modules and student worksheets as learning tools. The research instruments were psychomotor and affective observation sheets, and response questionnaires. This research consisted of three stages. The first stage of preparation included making and validating learning tools and instruments. The implementation stage included chlorophyll extraction activities, observations with color reference, psychomotor and affective assessments, and completion of questionnaires. Data analysis was conducted by calculating and categorizing the data based on Riduwan's categories. The results showed the acquisition of cognitive (85.85), psychomotor (95%), and affective (93%) scores in a very high category, as well as a student response of 81% in a very high category. This practicum is an innovation in chlorophyll observation with a simple method and low cost, so that it can be applied in schools.

Keywords: chlorophyll, color reference, learning outcomes, peranggi chili, practicum

INTRODUCTION

Biology is a branch of natural science that studies living things and the various processes that occur in them, including the process of growth and development in plants (Ikhtiara et al., 2022). Growth is defined as an increase in size and biomass due to cell division and elongation, while development includes changes towards maturity, which allows plants to carry out their vital functions (Hapsari et al., 2018). Both processes are influenced by various factors, including those within the plant body itself, such as hormones and genetic factors, as well as those from the environment, such as light, water, and nutrients (Ningsih, 2019). One factor that plays a significant role in plant growth and development is chlorophyll. Chlorophyll plays a crucial role in photosynthesis, the process by which sunlight energy is converted into chemical energy in the form of organic compounds (Khafid et al., 2021).

Chlorophyll is a very important pigment in the photosynthesis process, but its existence is not visible, so it is abstract for learners. Although students are taught about this pigment through theory in the classroom, they often struggle to visualize how it works in the photosynthesis process (Svandova, 2014; Diknasari, 2020). The learning process is often limited to theoretical explanations, which may

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result in a less in-depth understanding of chlorophyll among learners. Based on various studies, students' understanding of the concept of photosynthesis, especially regarding chlorophyll, is still low and often accompanied by misconceptions. Research by Mustaqim (2014) at SMAN in South Tangerang City showed that only 11.66% of students really understood the concept of photosynthesis and plant respiration. As many as 37.99% of students had misconceptions, and the other 48.61% did not understand the concept at all. Research by Diknasari (2020) revealed that students' misconceptions about photosynthesis material were very high, with a percentage reaching 74.157% for the definition of photosynthesis and the factors that influence it. Misconceptions also occur in the function of chlorophyll (61.797%) in the photosynthesis process. Efforts to improve this understanding have been made through learning initiatives, such as the use of PBL (Project-Based Learning) models (Nurfiyanti et al., 2019) and word wall media (Khanifah et al., 2024). The results have increased by 85% and 82% of the concept. Another effort involves students learning through the inquiry method, but this method also cannot directly demonstrate the presence of chlorophyll (Janah, 2017). Therefore, it is necessary to have a breakthrough to involve students directly studying chlorophyll by extracting and observing themselves, one of which is through practicum. Through a practicum, students can extract chlorophyll from leaves, observe the differences under various conditions, and understand how environmental factors, such as light and water, affect chlorophyll content (Ai et al., 2021). Through this method, concepts that were initially abstract become genuine and easier to understand. Thus, learning about chlorophyll is not just a theoretical concept, but also a real-world experience that can enhance students' understanding and interest in biology (Nuai & Nurkamiden, 2022).

Practicum is a learning method that connects theory and practice through direct observation, experimentation, and analysis. In science learning, especially biology, practicum improves students' understanding, memory, and science process and communication skills (Adillah et al., 2025; Wahyudi, 2025). This hands-on activity also fosters cooperation in groups, increases motivation, and makes learning more effective. Practicum is not just an additional activity in science learning, but an important part that can improve overall student learning outcomes. Through practicum, students not only gain theoretical understanding but also develop practical skills and positive scientific attitudes (Suryaningsih, 2017). This improvement in learning outcomes can be seen in three main domains, namely cognitive, psychomotor, and affective. Based on research by Nursapikka et al. (2018), Ramadhan & Daningsih (2019), and Kurnia et al. (2021), it has been shown that practicum can improve student learning outcomes and is supported by very high student responses.

Research on chlorophyll content testing has been conducted using various modern scientific methods, such as spectrophotometry. Various studies have examined chlorophyll levels in different types of plants, the factors that affect them, and their impact on the photosynthesis process and plant growth (Wang et al., 2024; Alfisyahrin et al., 2025). However, in the school environment, the practice of testing chlorophyll content involving students directly has never been done. Chlorophyll has a very important role in the photosynthesis process (Khafid et al.,2021) and is valuable to be thoroughly studied (Dwilestari & Desstya, 2022). Chlorophyll content in plants is usually measured using a spectrophotometer, a device that can detect and measure the absorbance level of light at a certain wavelength (Nuriyah et al., 2015). Through this method, the chlorophyll content in leaves can be calculated accurately. However, a spectrophotometer is an expensive laboratory tool that is not necessarily available in high schools. As a result, students only understand the concept of chlorophyll from theory without ever making direct observations or measurements.

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To overcome this limitation, an innovation or update in the chlorophyll measurement method is needed so that it can be performed in the school environment in a simpler and more affordable manner. This new method utilizes a color reference sheet that visually represents the chlorophyll content. The simplicity of this method gives students the opportunity to observe, compare, and analyze the chlorophyll content extracted by themselves. With this new method, students do not need expensive equipment such as a spectrophotometer. This method is not only easy to implement in schools, but also provides a more realistic learning experience for students in understanding the importance of chlorophyll in plant life and the influence of the environment on chlorophyll content (Shibghatallah et al., 2013).

Drought stress is one of the environmental factors that can significantly impact chlorophyll formation in plants. When plants experience water shortage, their physiological processes are disrupted, including chlorophyll synthesis. This happens because water not only serves as a solvent for nutrients needed in chlorophyll synthesis, but also as the main medium in biochemical reactions in cells (Yusuf, 2020). When the water supply is reduced, the availability of essential nutrients such as nitrogen, magnesium, and iron for chlorophyll formation can also be inhibited, resulting in lower chlorophyll production (Sumiati et al., 2023). To better understand how these environmental factors affect chlorophyll content, it is necessary to conduct a practical experiment by comparing drought-stressed plants with plants that receive sufficient water. Through this practicum, students not only understand the relationship between environmental factors and chlorophyll formation theoretically, but also gain direct experience in testing and proving the effect of drought stress.

The practicum of making chlorophyll extract uses *peranggi* chili plants (*Capsicum annuum* L. Var Chinense) because it is to introduce students to local plants cultivated in West Kalimantan, especially in the Sambas area. The plant has a fruit with a very spicy taste and distinctive aroma, but it is not yet widely known by the public. *Peranggi* chili plants are local plants that are sensitive to drought, so their chlorophyll content is easily affected by environmental conditions. Sampling of *peranggi* chili leaves was carried out at the 4th to 7th order of the shoot, with consideration of physiological and optimal leaf maturity for the observation of chlorophyll content. Leaves in that order are generally in the active growth phase and have reached functional maturity, but have not yet experienced the aging process (Khafid et al., 2021). Young leaves at the top of the sequence tend not to have a stable chlorophyll content because the chlorophyll formation process is still ongoing. Meanwhile, leaves that are too old or at the bottom of the sequence have begun to experience natural chlorophyll degradation, which can affect measurement accuracy (Zhang et al., 2024). *Peranggi* chili plants in this practicum are given drought stress treatment in the form of watering every three days and compared with plants that are watered every day to show the effect of external factors in the form of water on photosynthesis, in this case, the formation of chlorophyll (Shin et al., 2021). The treatment was given one month before the implementation of the practicum at school.

The practicum of measuring chlorophyll levels using *peranggi* chili leaves with drought stress has never been done. This chlorophyll practicum can be carried out because many students still misunderstand the basic concepts of photosynthesis, especially the function of chlorophyll, when explained solely through theory without any real learning experience (Diknasari, 2020). Practical implementation can be a solution to deepen the understanding of these concepts. In the practicum, students not only know chlorophyll by observation but also have the ability to extract it and the attitude that supports the implementation of the scientific approach. So that the implementation of practicum can be an assessment of learning outcomes in the form of cognitive, psychomotor, and affective. A practicum that can provide new nuances with skills and techniques that have never been

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done by students needs to be evaluated. Through the implementation of this practicum, it is also necessary to measure the response of students to the implementation of the practicum. So as to provide information on the applicability of practicum and its usefulness. The application of the practicum of making chlorophyll extract is expected to provide students with an understanding of the content of chlorophyll in plants, knowledge of the factors that affect it, and training skills in conducting experiments (Nuai & Nurkamiden, 2022). Thus, the purpose of this study was to determine the learning outcomes and students' responses to the practicum of making *peranggi* chili chlorophyll extract using a color reference sheet. This method bridges the shortcomings of spectrophotometer facilities, which are expensive and many are not available in schools. The use of color reference sheets that were inexpensive, simple, and easy to make can help students observe, compare, and analyze the results of chlorophyll extracts.

RESEARCH METHOD

This research is a quantitative descriptive study. This research was conducted in February 2025 at SMA Negeri 1 Sungai Raya. The subjects in this study were students of class XII MIPA 4, which amounted to 32 students. Students were divided into six groups of 5 to 6 students, determined by random sampling. The instruments in this study were student worksheets, psychomotor and affective observation sheets, and response questionnaires to the practicum of making chlorophyll extract of *peranggi* chili plants in the growth and development material. The student worksheet was used as a guide for students to carry out the practicum and to assess the cognitive abilities of students, as obtained from the results of observations and the answers to questions on the student worksheet. Psychomotor and affective observation sheets were used to assess the skills and attitudes of students during practicum activities.

The assessment was carried out by the observer based on the aspects that were determined. The assessment aspects on the psychomotor observation sheet included activities to prepare tools and materials, use of practicum tools, implementation of practicum procedures, and observation and recording of practicum results. Meanwhile, the affective observation sheet included aspects of attitudes such as discipline, responsibility, cooperation, and thoroughness. Each aspect on both observation sheets has an assessment indicator with a score range of 1 to 4, which was given according to the level of fulfillment of the criteria. The psychomotor indicators of each aspect that get the highest score (score 4) include the ability to prepare tools and materials completely, using tools correctly, implementing all stages of the practicum coherently and precisely, and making careful observations and recording the results completely and correctly. At the same time, the affective assessment indicators were given based on observations of student attitudes, with indicators that were adjusted to each aspect. The response questionnaire was used to determine students' responses to the practicum of making chlorophyll extracts, which consisted of four aspects of assessment. These aspects included motivation, developing skills in conducting experiments, and using the practicum as a tool for learning, with four statements for each aspect and three statements for supporting learning materials. Therefore, the response questionnaire had a total of 15 statements. The answer to each response questionnaire statement used a Likert scale, which has a gradation of answers from high to low with a scalar range of 1-4 consisting of Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD). The response questionnaire consists of a positive or negative response, where the assessment is the opposite. The rating scale was written in Table 1.

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Table 1. Rating Scale for Student Response Questionnaire

Positive Statement		Score	Negative Statement		Score
Strongly Agree	(SA)	= 4	Strongly Agree	(SA)	= 1
Agree	(A)	= 3	Agree	(A)	= 2
Disagree	(D)	= 2	Disagree	(D)	= 3
Strongly Disagree	(SD)	= 1	Strongly Disagree	(SD)	= 4

(Source: Ramadhan & Daningsih, 2019)

This research consists of preparation, implementation, and data analysis stages. In the preparation stage, four activities were carried out including: (1) compiling a lattice of research instruments; (2) preparing devices and research instruments in the form of teaching modules, student worksheet, psychomotor and affective observation sheets, and response questionnaires; (3) validating research instruments conducted by two Biology Education lecturers; (4) preparing tools and materials used. The tools in this research were a mortar and pestle, 50 ml Erlenmeyer flask, measuring cup, beaker, balance, drop pipette, funnel, and scissors. The materials were the leaves of *peranggi* chili plants with sufficient water and dry conditions, 80% acetone, Whattman filter paper no 1, label paper, aluminum foil, HVS paper, color reference sheet (green color gradient), and tissue. At the implementation stage, this research was carried out in one meeting with a time of 2 hours of lessons (2x45 minutes). The procedure for implementing this practicum was as follows: (1) students joined the group that had been determined and given directions; (2) students prepared the tools and materials to be used; (3) students carried out practicum activities for making chlorophyll extracts with their groups. The practicum procedure was as follows: a) Samples were taken from the leaves of *peranggi* chili peppers at the 4th to 7th position from the tip of the shoot; b) Samples from each treatment were weighed as much as 1 gram. The sample was cut into small pieces before being crushed using a mortar and pestle while 5 ml of acetone was added; c) the crushed sample that has already smooth were added with acetone up to 50ml; d) Using a funnel equipped with Whattman no 1 filter paper the samples were then filtered into a 100ml erlenmeyer; e) Usually, the chlorophyll measurement procedure requires a maceration time of 1 to 2 weeks. For the simplicity of this color reference method, observations were made directly after filtration. Observation of chlorophyll content in each sample was done by comparing the color of the sample against the color reference sheet (Figure 1); f) Observations were then recorded and analyzed.

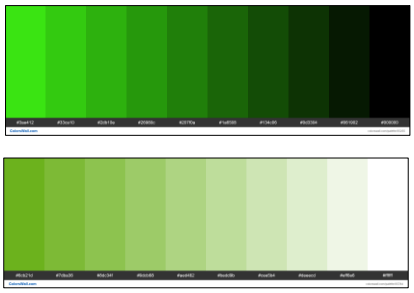

Figure 1. Color reference sheet
(Color gradation selected from the source https://ColorsWall.com)

(4) During the implementation of the practicum, psychomotor and affective assessments were carried out by observers; (5) Students answered questions from the student worksheet. (6) Finally, students filled out a response questionnaire to the practicum activities that have been carried out.

The data obtained from each cognitive, psychomotor, and affective assessment instrument were analyzed. The scores obtained by students were calculated using the formula:

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$$\text{Score} = \frac{\text{Number of Scores Obtained}}{\text{Maximum Score}} \text{ x } 100\% \quad (1)$$

For psychomotor and affective assessments, an assessment calculation was carried out according to each aspect before going further to the categorization. For the results of students' responses, a recapitulation of the results of filling out the response questionnaire from each student is provided. The percentage of each aspect was then calculated with the formula:

$$\text{Score} = \frac{\text{Number of Scores Obtained}}{\text{Maximum Score}} \text{ x } 100\% \quad (2)$$

The cognitive, psychomotor, affective, and response questionnaire scores obtained were categorized referring to the modified Riduwan (2016) (Table 2).

Table 2. Assessment Categorization

Percentage Number	Category
80% ≤ 100%	Very high
60% ≤ 80%	High
40% ≤ 60%	Enough
20% ≤ 40%	Low
0% ≤ 20%	Very Low

(Source: Riduwan, 2016)

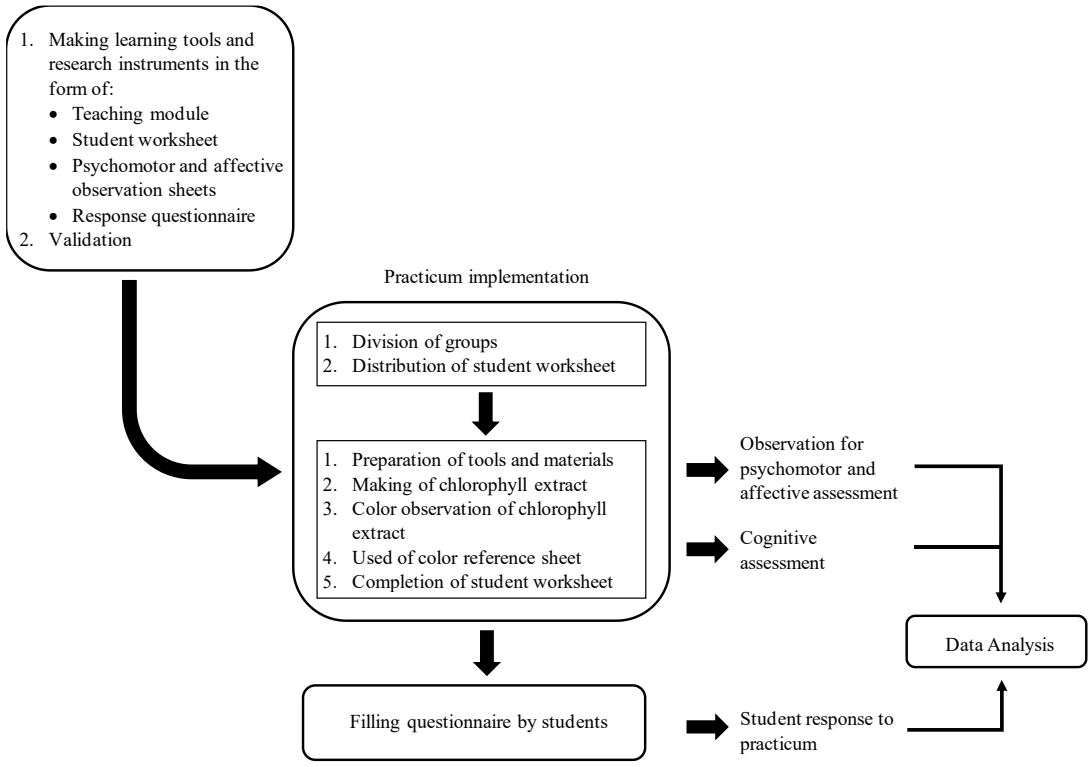

Figure 2. Scheme of research implementation

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RESULT AND DISCUSSION

The practicum of making chlorophyll extracts from *peranggi* chili plants under drought and sufficient water conditions was carried out at SMA Negeri 1 Sungai Raya. The practicum process was carried out in the classroom because the laboratory was being used for other activities. The practicum began with preparing the tools and materials, then performing each procedure contained in the student worksheets. Procedures in the practicum include weighing leaves, grinding, filtering, and observation (Figure 3).

Figure 3. Practical implementation (a) preparing tools and materials, (b) collecting leaves, (c) weighing, (d) grinding, (e) filtering, and (f) making observations

After that, students filled in the student worksheet according to the results of observations and answered the questions available with group members. The results of the student worksheet work were used as a cognitive assessment of students. After all practicum activities were completed, students filled out a response questionnaire to find out what they thought of the practicum that had been done. In its implementation, filling out this questionnaire was carried out on the next day.

In this study, assessments were conducted for the cognitive, psychomotor, and affective domains. Cognitive assessment was obtained from the results of observations and answering questions contained in student worksheets that were conducted in groups.

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Table 3. The cognitive scores of students in the practicum of making chlorophyll extracts

MCC	Average	Category	Number of completeness of students		Percentage
			Completed	Not Completed	
75	85,85	Very High	32	0	100%

Note: MCC = minimum completeness criteria

Table 4. The results of the psychomotor assessment of students in the chlorophyll extract practicum

No	Aspect	Percentage Score	Category
1	Preparing tools and materials	100%	Very High
2	Using practicum equipment	92,9%	Very High
3	Performing lab procedures	92,2%	Very High
4	Observe the results of the practicum	95,3%	Very High
	Average	95%	Very High

Table 5. The results of the affective assessment of students in the practicum of making chlorophyll extracts

No	Aspect	Percentage Score	Category
1	Discipline	93%	Very High
2	Responsibility	93%	Very High
3	Cooperation	95,3%	Very High
4	Thorough	90,6%	Very High
	Average	93%	Very High

Practicum is a learning activity that involves students directly in experiments or scientific activities to explore concepts that have been learned in theory (Mulia & Murni, 2022). Practicum-based learning is an effective method in improving students' understanding of science concepts, especially in biology subjects (Suryaningsih, 2017). By doing practicum, students not only understand the theory but can also improve concept understanding, develop laboratory skills, increase learning motivation, increase analytical and problem-solving power, and gain hands-on experience (Nuai & Nurkamiden, 2022). Practicum also helps students to better understand concepts that are often difficult to explain only with theory, so that they can clarify the concepts studied. One of these concepts is about chlorophyll.

The practicum of chlorophyll content testing is one of the experiments that has never been done at school, which involves students directly in the process. One of the obstacles faced is the limitation of spectrophotometer equipment, which is known to be expensive and is hardly available in the school. As a result, learning about chlorophyll content in plants is often only theoretical without any in-depth practical experience. Khairani et al. (2024) stated that limited facilities and uninteresting learning methods can lead to low student activity and involvement in learning. For this reason, this practicum provides a simple innovation in observing chlorophyll extracts, namely by using a color reference sheet as a substitute for a spectrophotometer.

In addition to observing chlorophyll and using the color reference method, this practicum also introduces students to local plants in West Kalimantan, namely *peranggi* chili plants (*Capsicum annuum* L. Var Chinense). This can increase students' knowledge of existing local plants. The *Peranggi* chili has a distinctive spicy taste and is shaped like a small bell pepper. *Peranggi* chili plants are classified as plants that are sensitive to environmental conditions. *Peranggi* chili does not tolerate hot weather and is prone to stress if it lacks water. Therefore, this practicum also provides further understanding to students about environmental factors that affect chlorophyll content in plants. One of them is water availability (Sun et al., 2020). To directly observe the effect of water availability on chlorophyll content, this practicum was conducted on *peranggi* chili plants with two different

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conditions, namely plants with sufficient water availability and plants with drought conditions. By comparing chlorophyll levels in both conditions, students can understand how water shortage affects chlorophyll content and gain new skills in using the color reference method in observing these differences.

Observations in this practicum were made by referring to the color changes that occurred in the *peranggi* chili leaf extract after going through the process of grinding, adding 80% acetone, and filtering. The color of the resulting extract will indicate the concentration of chlorophyll present in the leaves, which can then be used to understand the relationship between chlorophyll formation and water deficit conditions. The more concentrated the color of the chlorophyll extract, the higher the chlorophyll content; conversely, the less chlorophyll there is, the lighter the color of the extract. (Dharmadewi, 2020). In other words, the intensity of the green color in the solution can be a visual indicator to estimate the chlorophyll content in it.

This color observation is an important part of the practicum because it can provide a direct picture of the processes that occur, even though it does not use modern laboratory equipment such as spectrophotometers, which are usually used for more in-depth analysis. The observation in this practicum used a color reference sheet and was an alternative that can be used as a method in observing chlorophyll content because spectrophotometer equipment is not always available at school. Although not as accurate as a spectrophotometer in measuring chlorophyll concentration, this method still provides good qualitative results and improves students' skills in conducting experiments. The advantages of this method are that it is easier to implement, less expensive, and allows students to develop observation skills in comparing colors as well as understanding basic concepts about chlorophyll. In addition, this method can be used as a first step in analyzing chlorophyll content before using more accurate techniques. In this method, students are trained to be more careful in observing color changes, understanding the relationship between color and chlorophyll concentration, and recognizing factors that can affect the results of observations. This helps them develop sharper and more analytical observation skills. This method also teaches students that in science, innovation in experimental methods is very important to adapt to the situation at hand without reducing the quality of the results obtained, as supported by Suryaningsih (2022).

The color reference method used a qualitative approach because the observation results were only based on visual color differences without clear numbers or numerical data. However, students can use the codes on the color reference sheet to categorize them (Figure 1). The color reference method was feasible to use in practical learning in high school because it is easy to implement and still provides experimental experience. Nevertheless, this method has several weaknesses. One of them is subjectivity in observation, where color perception can differ between individuals, especially if the lighting is not uniform. However, to avoid the influence of lighting, students observe the color of the sample by using white paper as a background, thus avoiding the influence of other background colors on the sample. In addition, this method cannot provide accurate results and is highly dependent on external factors such as light intensity and environmental conditions. Another drawback is its limitation in in-depth analysis, as it can only provide a rough estimate without precise results. Therefore, although the color reference method can be used as an alternative, schools still need to introduce the principles of spectrophotometry so that students understand the importance of quantitative approaches in scientific measurements.

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Assessment of students' cognitive, psychomotor, and affective abilities.
Based on the results of the study, the average cognitive score of students in the practicum of making chlorophyll extract reached 85.85 and fell into the very high category (Table 3). In addition, all students achieved learning completeness with a percentage of 100%, which shows that they were able to understand the material well. The range of scores obtained was between 75 and 95. This showed that although there were variations in individual achievement, all students still achieved the minimum completion criteria (MCC) that had been set. The minimum completeness criteria were the lowest grade standards that must be achieved by students to be declared complete in understanding a subject in the Indonesian education system. The minimum completeness criteria were determined by each education unit based on the characteristics of the subject, the level of difficulty of the material, and the average ability of students (Putri et al., 2025).

This very high cognitive achievement showed that practicum played a major role in improving students' understanding of the concept of chlorophyll extraction. In line with the opinion of Pahliwandari (2016), higher cognitive development allowed students to better process information and understand concepts in depth. Practicum not only provides theoretical insights but also gives real experiences that help students connect theory with practice. In addition, practicum encourages students to think critically and solve problems. They not only observe the experimental results but are also required to analyze the data and draw conclusions from it. This process trains analytical and logical thinking skills, which ultimately contributes to improving cognitive scores (Ramadhan & Daningsih, 2019). This shows that experiment-based learning experiences are more effective than conventional learning methods, as stated by Sitio (2022).

Psychomotor assessment is the skill of students in carrying out the practicum of making chlorophyll extract. The psychomotor assessment of students was divided into four aspects, namely the preparation of tools and materials, the use of practicum tools, performing practicum procedures, and observing the results of practicum. The results of the psychomotor scores of students averaged 95% with a very high category (Table 4). The very high psychomotor scores of students indicated that the implementation of practicum can foster students' skills. This is in line with Wahyuningsih et al. (2020), which states that practicum is a series of activities that can foster basic psychomotor experimentation. The aspect of preparing tools and materials obtained the highest score of 100%. This shows that students are able to understand and prepare for practicum needs well, including the selection of appropriate tools and materials. Careful preparation is an important factor in the success of the practicum because it ensures the smooth implementation of the procedure and minimizes errors in the experiment. The aspects of using practicum tools and implementing practicum procedures also obtained very high scores, 92.9% and 92.2% respectively. This reflects that students have good skills in operating the tools correctly and following the practicum stages according to the established procedures. The use of the right tools greatly affects the accuracy of the practicum results, while the application of the correct procedures ensures that the data obtained is valid and can be analyzed properly. In addition, the observation aspect of the practicum results also received a very high score of 95.3%. This shows that students were able to make careful observations, especially in observing the color comparison of chlorophyll extracts using a color reference. Good observation ability is a basic skill in experimentation because it is the basis for drawing accurate conclusions based on observations. Although the results of the psychomotor assessment reached a very high category, in the aspects of using practicum tools and performing practicum procedures, there were variations in the assessment for each group (Table 6).

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Table 6. Assessment results for aspects of using practicum tools and performing practicum procedures

Group	Aspect		Average
	Using practicum equipment	Implementation of practicum procedures	
1	85%	85%	85%
2	95,8%	95,8%	95,8%
3	100%	100%	100%
4	100%	95%	97,5%
5	100%	100%	100%
6	75%	75%	75%

Although the overall psychomotor assessment results showed a very high category, there were variations in the aspects of using the tools and following the procedures amongst the groups of students. The observation indicators in the aspect of using practicum tools with the highest score (4) were using all practicum tools correctly, and getting a score of less than 4 if only using some practicum tools in accordance with the indicators that have been made. Whereas in the aspect of implementation of practicum procedures, the observation indicators were in the form of having implemented all stages of the practicum coherently and correctly. From Table 6, it can be seen that some groups obtained very high scores (100), while other groups obtained lower scores, such as 75% and 85%. This variation indicated that not all students have the same skills in operating the tools and following the practicum procedures correctly. This difference can be caused by several factors. One of them is the students' lack of experience in conducting a simple experiment-based practicum. Groups with lower scores may not be accustomed to using laboratory equipment independently, so they face difficulties in operating tools appropriately and carrying out procedures correctly. This is in line with the opinion of Nuai & Nurkamiden (2022), which states that direct experience in experiments plays an important role in building students' psychomotor skills.

In addition, teacher guidance can also have an effect. If the instructions or demonstrations are unclear, students may experience confusion or uncertainty in carrying out the lab steps. This can cause them to lack confidence in using the tools or hesitate in following the procedure. Therefore, more effective guidance, such as providing hands-on examples, mentoring during the lab, and reflection sessions after the experiment, can help improve their skills. Despite the variations, these results still show that most groups have mastered psychomotor skills very well. A more adaptive approach could be applied to improve the skills of groups that are still having difficulties, for example, by providing additional practice for students who need it, increasing practical sessions to enhance experience, and applying more interactive guidance methods. In this way, it is expected that all students can achieve more equitable and optimal psychomotor skills in laboratory experiments (Nisa, 2017).

Affective assessment of students was obtained by conducting observations during the practicum, which was assisted by observers. The affective assessment of students comes from 4 aspects, namely discipline, responsibility, cooperation, and thoroughness (Table 5). Data on the results of affective assessment of students showed an average of 93% included in the very high category. The aspects of discipline and responsibility that both received a score of 93% reflected that students were able to follow the practicum rules properly, arrive on time, and carry out the assigned tasks with full seriousness. The ability to work together, which received the highest score of 95.3%, showed that students were able to communicate well in the team, share tasks fairly, and support each other in achieving practicum goals. Meanwhile, the accuracy aspect scored 90% which was still in the very high category but slightly lower than other aspects. The possible causes of imperfect scores, especially in the aspect of accuracy, can be caused by several factors such as the lack of double-checking the procedures carried out and time constraints that make students have to work faster (Putra et al., 2022).

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The high average affective score of students is due to the implementation of practicum, which can foster scientific attitudes such as cooperation, discipline, responsibility, and thoroughness. In practicum activities, students maintain, work on, and follow the practicum responsibly. Interaction in groups can train students to discuss and cooperate with their group friends based on curiosity, such as by asking questions, being enthusiastic, and paying close attention to directions. In addition, practicum trains students to attend according to a predetermined time so as to foster an attitude of discipline, do tasks according to the steps, and obey the directions of the practicum.

In a practicum, success is not only determined by understanding the theory, but also skills in carrying out procedures and attitudes that support the course of activities (Nisa, 2017). This can be seen in the relationship between cognitive, psychomotor, and affective assessments of the practicum results of chlorophyll extract production. Cognitive assessment reflects the extent to which students understand the basic concepts underlying the practicum. A good understanding of the principles of chlorophyll extraction, the function of the tools, and the procedures that must be followed allows participants to carry out the practicum more systematically and efficiently. When students have a strong theoretical basis, they easily apply the steps correctly, avoid mistakes, and understand the results obtained. These three aspects are interconnected and form a unity that cannot be separated. A good understanding of theory (cognitive) becomes the basis for practical skills (psychomotor), while a good attitude (affective) ensures that the practicum is carried out with full responsibility and thoroughness. When these three aspects are balanced, practicum results can be obtained optimally (Sitepu et al., 2022).

Student response to practicum implementation.
In addition to learning outcomes, students' responses are also an assessment and a benchmark for the effectiveness of this chlorophyll extraction practicum on growth and development material.

Table 7. The results of the students' response questionnaire to the practicum of making chlorophyll extracts

No	Aspect	Percentage Score	Category
1	Motivation	81,4 %	Very High
2	Experimental skills	79,2 %	High
3	Become a tool for learning	83,2 %	Very High
4	Support learning materials	80,2 %	Very High
	Average	81 %	Very High

The results of students' responses to the practicum implementation of chlorophyll extract making obtained an average of 4 aspects of 81% including a very high category (Table 7). There are three aspects that reach a very high category, namely motivation with a value of 81.4%, which shows that this practicum can increase the enthusiasm for learning of students. Susanti & Hadi (2022) revealed that practicum activities play a role in increasing students' learning motivation. In addition, practicum also helps students remember and understand information that has been learned more effectively. The next aspect is to be a vehicle for learning, with an average score of 83.2%. Through the practicum of making chlorophyll extract, students can develop observation, analysis, and problem-solving skills. They learn how to collect data, interpret the results, and draw conclusions based on the experiments conducted. The third aspect supports learning materials with an average of 80.2%, making this practicum more engaging and less limited to theory.

However, there was one aspect that only reached the high category, namely experimental skills. The result indicates that although students have a good understanding of the theory and practical procedures for making chlorophyll extracts, the application of their experimental skills still needs to

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be improved. In the context of psychomotor abilities, experimental skills are closely related to how students prepare tools and materials, use tools appropriately, and carry out practical procedures systematically (Nuai & Nurkamiden, 2022). Lower scores in this aspect indicate that there are still some challenges faced, such as a lack of accuracy in following procedural steps and limited experience in using laboratory equipment independently.

To improve experimental skills, more opportunities are needed for students to do lab work independently and repeatedly (Komisia et al., 2023). More intensive assistance and additional training in the use of tools and observation of results can also help improve their psychomotor skills. With this improvement, it is expected that students can be more confident in conducting experiments and obtain more optimal results in the practicum of making chlorophyll extract. This research was simple, easy to do in the school, but there were other obstacles that limited the implementation of the practicum. Some students are still not familiar with laboratory equipment and did not understand the practicum procedures well, so it was recommended that students familiarize themselves with laboratory equipment and raise their understanding by giving a clear explanation.

The implementation of the chlorophyll extraction practicum has an impact on students' learning outcomes in terms of cognitive, affective, and psychomotor aspects, and has received a positive response (very high response), despite some obstacles that still need to be considered. Students found that this activity offered an engaging learning experience and was easier to understand than simply reading theory in class. This practicum can serve as an alternative to testing chlorophyll content by using the color reference method alone. Further research can be carried out by expanding the context of using this practicum on various types of plants other than chili peppers in the surrounding environment to see the consistency of results and the flexibility of the chlorophyll extract observation method using a color reference sheet.

CONCLUSION

In conclusion, the practicum of making chlorophyll extract from *peranggi* chili under different conditions and observing the color reference is effective in providing students with an understanding of the concept of chlorophyll. This is evident in the learning outcomes, which encompass cognitive (85%), psychomotor (95%), and affective (93%) aspects, as well as student responses (81%) to the practicum of making chlorophyll extracts, which achieved a score in the very high category. Students' cognitive achievement exceeded the minimum completeness criteria (MCC) that had been set. In this practicum, students prove the difference in the amount of chlorophyll due to the effect of drought by using a color reference sheet instead of a spectrophotometer. The implementation of the chlorophyll practicum not only achieves high cognitive, psychomotor, and affective abilities but also allows students to use this method inexpensively, simply, and easily. Therefore, this chlorophyll practicum method is recommended for use in plant growth and development materials.

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