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Revolutionizing learning: Enhancing student worksheets on plant tissue structure through vee diagrams in alignment with the merdeka curriculum

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ABSTRACT

Practicum is an important component in biology learning and it helps students to gain hands-on experience. Practicum activities can be provided with the help of student worksheets. Based on observations, the student worksheets used have inadequate quality. This study aims to analyze and reconstruct the student worksheets. The research method applied in this study is a qualitative descriptive method. With the following flow: Analysis, Try, and Reconstruction. The results of the analysis using the laboratory activity analysis form show that there are problems in the student worksheets plant tissue structure from a structural aspect. Problems were also found in conceptual, practical specifications and knowledge construction specs through vee diagram analysis. Therefore, reconstruction was carried out on the student worksheets structure and function of plant tissues. The reconstructed worksheets were developed according to the demands of an independent curriculum that emphasizes students' literacy and numerical reasoning skills. The practical aspect of the worksheets aimed to guide students in discovering factual objects and phenomena through hands-on activities, thereby facilitating the construction of knowledge.

INTRODUCTION

Education is a very important process to create individuals with cognitive knowledge and skills in various things. The main aim of science learning is to help students gain as much scientific knowledge as possible which is in line with developing knowledge about the methods that are used to obtain that scientific knowledge (Millar, 2004). Based on this explanation, one method that is very suitable to be applied in science learning is practicum.

Practicum is a method that focuses on presenting concepts that students are expected to understand through conducting experiments. From the experiments, students will build the expected knowledge through direct experience (Ningrum, 2019). In line with this NABT (2022) explains that practicum through laboratory and field activities is an important component in biology learning and is the most effective means for students to gain direct experience with scientific practice. Through practical activities, students can develop certain skills, namely process skills, thinking skills, and the formation of scientific attitudes, both individually and in groups (Agustina et al., 2021; Haerani et al., 2022; Suryaningsih, 2017).

The Vee diagram is a framework for thinking in research, this framework can be used to identify practical science activities in schools. The Vee diagram consists of two sides, the conceptual side (minds-on) and the methodological side (hands-on). Both sides are very relevant to laboratory-based learning activities. each side helps students to connect their knowledge with what will be done in learning activities (Novak & Gowin, 1984).

Plant tissue structure material is material that contains factual concepts that can be obtained by observing plants as objects of observation. The cognitive aspect and the skills aspect are two components that must work together to obtain this concept. Integration of the two can be achieved through hands-on and minds-on activities. Hands on and minds on are effective activities in practicing learning experiences. both provide freedom for students to organize and observe scientific processes and interact both directly and indirectly with scientific phenomena (Haury & Rillero, 1994).

The synergy between hands-on and minds-on activities in practicum activities can be achieved through structured assignments that are prepared based on in-depth analysis. One of the best-structured tasks to give to students is the Student Worksheet. Previous research shows an increase in learning outcomes by implementing student worksheets containing instructional interactions (Li et al., 2022; Mamonto et al., 2023; Melawati et al., 2022).

Furthermore, it is said that student worksheets can help students to achieve the expected indicators of cognitive, affective and psychomotor abilities through hands-on and minds-on activities (Cahyani et al., 2023; Supriatno, 2018). Several previous studies have proven that student worksheets can help students gain knowledge in learning the structure of plant tissue which also develops critical thinking abilities and science process skills (Melawati et al., 2022). The student worksheets used are obtained from biology textbooks or designed by the teachers themselves so that the forms, structures, and approaches used in student worksheets are varied (Supriatno, 2013).

Empowering student worksheets can influence the implementation of learning in the classroom which previously only used the lecture method, which can switch to learning based on practical activities either in the laboratory or in the classroom to help students gain knowledge. Based on findings in the field, the student worksheets used are still of inadequate quality. student worksheets obtained from published books and student worksheets that have been used by teachers in learning. This is supported by Supriatno (2007) who stated that student worksheets currently circulating on the market and in schools still have many shortcomings that need to be corrected.

The work steps in student worksheets are the main problem that reduces the quality of student worksheets. The work steps presented in the student worksheets are inaccurate and not well structured. The impact is that students cannot identify objects/phenomena to construct their

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knowledge. Apart from that, there are several other problems; work steps in student worksheets are less logical so that students have difficulty carrying out the steps, work steps are not per the focus questions, observation tables do not contain important data related to objects and phenomena, and practical work usually takes too long (Aisya et al., 2016).

After the COVID-19 pandemic, the government through the Ministry of Education, Culture, Research, and Technology issued policies regarding the education system. This policy reviews and develops the Merdeka Curriculum to overcome learning loss as a result of distance learning. The Merdeka Curriculum is a curriculum developed based on the 2013 Curriculum (Jojor & Sihotang, 2022). Therefore, there are still very few learning tools that can be used by teachers in implementing the Merdeka Curriculum. This is proven by previous research which states that teachers have difficulty finding teaching materials and learning tools that can be used as references (Choo et al., 2011; Lee, 2014; Massawet et al., 2018).

The Merdeka Curriculum Program is expected to be able to restore learning by providing three main characteristics. First, learning is carried out through projects designed to develop soft skills and character according to the *Profil Pelajar Pancasila*. Second, focus learning only on essential materials. Third, the curriculum structure is more flexible, allowing it to be adapted to the needs of each educational institution (Jojor & Sihotang, 2022).

In the Independent Curriculum, there are several demands that need to be considered, one of which is numeracy literacy. Numeracy literacy refers to an individual's ability to understand, use and think critically regarding mathematical concepts in everyday life (Yayuk et al., 2023). Most of the biology students' worksheets used in schools do not contain a numeracy literacy aspect (Rizki et al., 2022).

Several researchers focus on analyzing and reconstructing student's worksheets in biology learning, including material on the structure and function of plant tissues (Fattahillah et al., 2021; Nadia et al., 2020; Zidan & Supriatno, 2023). There have been limited studies concerned with student worksheets in alignment with the Merdeka Curriculum. Therefore, this research aims to analyze and reconstruct student worksheets on the structure and function of plant tissue and adapt them to the Merdeka curriculum.

Based on the previous explanation, reconstruction needs to be carried out to obtain student worksheets that are suitable for use in the Merdeka Curriculum. (Alvarez & Risko, 2007) suggest a heuristic thinking framework developed by Novak & Gowin (1984) that can be used to analyze how deeply a worksheet can help students construct knowledge. Therefore, this research aims to present the results of the analysis in conceptual, procedural, and knowledge construction aspects in a student worksheet found in the field specifically on the material Plant Tissue Structure. The results of the analysis will then be used as a reference for carrying out the reconstruction process.

METHODS

This research uses an action research method. Action research is a process created by researchers to study problems scientifically to obtain guidance, correction, and evaluation. Applying the results of corrections and evaluations in the practices can improve the process to be more efficient, faster, and produce better quality (Sugiyono, 2015). This research collects data using observation and documentation techniques. The research stages are; 1) Analysis; 2) Trial; 3) Reconstruction.

1) Analysis

Five samples of student worksheets on Plant Tissue Structure were obtained from publishers which are also used by teachers at school. The samples have been analyzed to assess whether the student worksheets meet the criteria as learning aids that can help students construct knowledge. Analytical steps have been carried out to evaluate the quality of the student worksheet Structure and Function of Plant Tissue used.

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Researchers analyzed the structure of student worksheets using a rubric instrument developed by the main components of student worksheets in general; titles and essential concepts, objectives and relevance to the curriculum, and procedures that students will carry out. Other data was obtained using rubric instruments that had been adapted from the Vee Diagram; focus questions, objects and events, theories/principles/concepts, records and transformations, and knowledge claims (Novak & Gowin, 1984). Each aspect has criteria with a predetermined score from 1 to 5 depending on each aspect. The scores are then described to obtain research results.

2) Trial

Trial is a stage to measure the suitability of student worksheets based on practical time in the laboratory, practical procedures in the laboratory, and the knowledge that students will gain. Trials were carried out three times at the Plant Structure Laboratory, FPMIPA, Universitas Pendidikan Indonesia, with the following details; 1) The first trial was carried out by the researcher; 2) The second trial was carried out by the same researcher but used the Student Worksheet after modification; and 3) The third trial was carried out by a postgraduate student to obtain verification of the modification results. Each trial was carried out within a period of two weeks to identify and analyze problems in the application of student worksheets.

3) Reconstruction

To improve the quality of student worksheets, reconstruction was carried out by correcting problems found in the conceptual, practical, and knowledge construction aspects. For the conceptual aspect, the content and competencies on student worksheets are adjusted to the Basic Competencies set out in the curriculum. Meanwhile, for the practical aspect, work steps were developed that were more precise and structured so that they were easy to execute. Meanwhile, for the knowledge construction aspect, questions on student worksheets are linked to facts found to help students discover concepts, principles, and theories through the data interpretation process. By reconstructing student worksheets, it is hoped that it can increase the effectiveness and efficiency of learning for students.

RESULTS AND DISCUSSION

Five student worksheets were used as samples. Some parts of the student worksheets still need to be revised and improved. Figure 1. shows one of the worksheets. Structurally, the worksheet still needs to be repaired and improved. 1). The title section has explained the essential concept of "plant tissue structure" which will be discussed, but has not described what activities students will carry out. 2). Even though the aim is to construct factual, conceptual, and procedural knowledge, it still needs to be adapted to the curriculum. In the curriculum, students are not required to be able to differentiate between the tissue structures of dicot and monocot plants. 3) The procedures carried out cannot facilitate students to achieve their goals. One of the work steps was considered wrong, causing the objects and phenomena that were intended to be shown to not appear. The addition of water droplets at the beginning of the procedure creates air pockets in the preparation, this makes the object being viewed less clear. The impact is that students cannot achieve the expected activity goals.

The results of the analysis using the Laboratory Activity Analysis form showed that there were problems with the student worksheet on Plant Tissue Structure from the structural aspect. In more detail, it can be seen in Table 1. The student worksheet Structure and Function of Plant Tissue which is circulating and widely used does not match the expected structural aspects. Most of the student worksheets have identifiable titles and contain essential concepts but do not yet

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describe the main activities that will be carried out in the practicum activities. Meanwhile, others got a score of 0 because the title of the student's worksheet could not be identified.

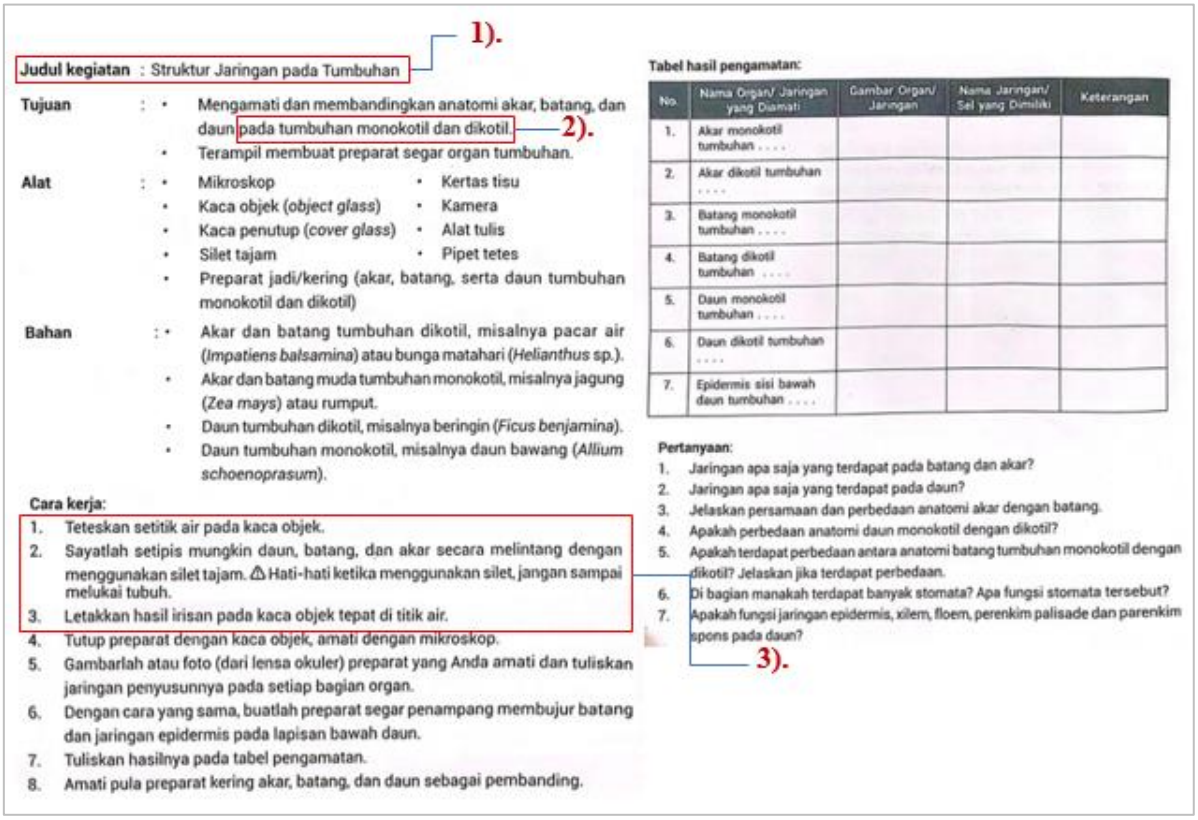

Figure 1. Student worksheets structure of plant tissues

Table 1. Analysis of structural aspects on student worksheets (SW): Structure and function of plant tissues

Aspect	SW 1	SW 2	SW 3	SW 4	SW 5
Title and essential concepts	2	2	2	2	0
Purpose and relevance to the curriculum	4	4	0	3	3
Procedure	0	0	0	1	3
Total Score	**6**	**6**	**2**	**6**	**6**
Maximum Score			**12**		

The objective aspect functions to assess the relevance of activities to basic competencies in the curriculum. Researchers use rubrics to examine how the activity objectives presented on each student worksheet can construct students' factual, conceptual, and procedural knowledge. Based on Table 1, it can be seen that student worksheet 1 and student worksheet 2 show the highest scores, both student worksheets are relevant to the curriculum and focus on activities that construct factual and conceptual knowledge. Both student worksheets display objectives that are in accordance with the essential concepts of plant tissue structure and function. These objectives also focus on activities that construct factual, conceptual and procedural knowledge. The drawback is the development of procedural aspects. In contrast to that, student 3's worksheet shows a score of 0. This happens because no objective can be identified.

In the procedure aspect, student worksheet 5 showed a score of 3, which indicated that the procedures used were relevant to the objectives, structured and logical, and gave rise to objects

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and phenomena observed in practical activities. It's just that the student worksheets do not direct students to construct knowledge and competencies. The shortcomings were found in the data recording table and activity steps. Meanwhile, other student worksheets show a score of 0 because the procedures contained in the student worksheets are not yet relevant to the identified objectives. In the student worksheet there is no objective of the activity explained, students are asked to identify for themselves what the objective of the activity they will carry out is.

Based on this description, there are still several problems with student worksheets which are analyzed from a structural perspective. A good student worksheet structure is very important in learning. The structure of student worksheets must be clear, relevant, and easy to follow to help students understand the concepts being taught and improve their learning skills. Supported by the opinion of Marzano (2001) who states that a good student worksheet must meet certain criteria, such as being clear, relevant, and easy to follow. Apart from that, it also emphasizes that effective student worksheets must be designed taking into account the learning objectives, the content to be studied, and the student's abilities.

Further analysis was then carried out using an Assessment Rubric based on the Vee Diagram developed by Novak & Gowin (1984). The analysis was carried out conceptually, practically, and how all samples of student worksheets used in this research could construct students' knowledge. In more detail, the results of the analysis can be seen in Table 2. Table 2 shows that the focus questions can only be identified on student worksheets 1, 2, and 3. The identified focus questions do not focus on the main things related to objects and events. and/or does not contain conceptual parts, especially principles, so it only shows a score of 1. In the aspect of objects and events that appear, all of the student worksheets used as analysis samples show a score of 1, this indicates that in the student worksheets, the objects or events can be identified.

Table 2. Vee diagram component analysis on student worksheets (SW)

Vee Diagram	SW 1	SW 2	SW 3	SW 4	SW 5
Focus question	1	1	1	0	0
Object event	1	1	1	1	1
Theory/ principle/ concept	1	1	0	0	1
Record/ transformation	3	3	0	1	0
Knowledge claim	0	0	0	0	1
Total Score	**6**	**6**	**2**	**2**	**3**
Maximum Score			**18**		

To support the study of emerging objects and events, it must be accompanied by good conceptual aspects and methods. In the Vee Diagram component, conceptual aspects are studied based on the emergence of theories, principles, and concepts. Only student worksheets 1, 2, and 5 get a score. This shows that the three student worksheets only fulfill one of the three conceptual components that are expected to appear based on the Vee Diagram.

In the data recording and transformation component, student worksheets, student worksheets 1 and student worksheets 2 are the best. Both provide tables of observation results as a place to collect data and questions that adequately describe the data transformation process. The weakness is that data transformation activities are still not by the focus question. The impact is that students have difficulty constructing knowledge. In the knowledge claims aspect, student worksheet 5 shows a score of 1, which indicates that the practical questions have led to the

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formation of knowledge claims, but are not per the data, events recorded and not transformed because they do not have a data recording table.

The trial results

The first trial was carried out using the original work steps on one of the student worksheets that had not been modified or reconstructed previously. After implementation, several obstacles were found, one of the most crucial obstacles was that objects and phenomena did not appear. This happened because the work steps used were less precise and less structured, one of which was the application of water droplets over the preparation. As a result, air pockets are formed under the cover glass which means that the cross-section of the wet preparation cannot be seen clearly (the object of the phenomenon does not appear). This is supported by previous research findings which state that inappropriate work steps/instructions can hinder the learning process (Choo et al., 2011; Li et al., 2022). Apart from these problems, other problems such as the title and objectives of the practicum, supporting materials, selection of tools and materials, and observation results tables are aspects that need to be modified. The results of the third trial showed that the reconstructed student worksheet could be carried out both technically and in time allocation. The modified results are then tested again to resolve technical problems and time allocation, until the final stage of testing by students as verification. The results of the third trial showed that the reconstructed student worksheet could be carried out both technically and in time allocation.

Student worksheet reconstruction results

Laboratory activities in biology learning act as a link between theory/concepts, practice, and existing facts. Apart from that, laboratory activities also aim to increase students' interest in studying biology, develop students' analytical attitudes, and correct misconceptions that may occur during classroom learning (Arifin et al., 2021). Based on the presentation of the results, efforts to reconstruct practicum worksheets need to be made to repair or improve the quality of practicum worksheets used in practicum learning. This is done so that the practicum worksheets are more effective in facilitating students' understanding and mastery of the practicum material.

Structurally, worksheet improvements have been made to the title, purpose, tools and materials used, as well as procedures that must be carried out by students. In Figure 2. it can be identified that; 1) The essential concepts studied are the structure and function of plant tissues; 2) The activity that students will carry out is observation using a microscope; 3) The title is in the form of a question sentence. The form of the question sentence in the title provides orientation for students who will carry out learning activities. An overview of the knowledge that students will gain after carrying out the activity is clearly identified just by reading the title. The results of previous studies state that organized learning activities starting with asking questions can increase motivation, further practical abilities and independence in problem solving (Meulenbroeks et al., 2023; Pratikno et al., 2020; Putri et al., 2017).

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Figure 2. The title student worksheets structure of plant tissues

The aim of the activities in student worksheets is made more specific to developing procedural and factual knowledge. Both simultaneously contribute to constructing students' conceptual knowledge. The selection of tools, materials and work steps is also considered to minimize fatal errors that result in objects and phenomena not appearing.

Reconstruction of student worksheets is carried out based on the solutions to the problems obtained. Of course, this is done after conducting trials that cover problems in the conceptual, practical, and knowledge construction aspects. In the conceptual aspect, practical activities are developed following the demands of the Merdeka Curriculum and increase students' cognitive levels. A scientific paper suggests that conformity between practicum activities and the expected achievement standards in an applicable curriculum will have a positive impact on the expected competencies of students (Agustina, 2016).

In line with the conceptual aspect, the development of the practical aspect is also carried out by arranging work steps that direct students to observe practical phenomenon objects as factual objects. The emphasis on hands-on activities is applied to work steps so that students can experience directly finding facts that will help them construct knowledge. The Merdeka Curriculum also requires the development of process skills in the form of observing, asking and hypothesizing, planning and carrying out investigations, and analyzing data from the results of the investigation. All of this can be achieved through practicum activities through hands-on and minds-on integration which is expected to foster a scientific attitude and realize the *Profil Pelajar Pancasila*.

Furthermore, the knowledge construction aspect is realized through questions that are prepared by paying attention to the Vee Diagram as a reference and consideration. In the practicum, knowledge construction will go through several stages consisting of several important things including creating focused questions that are relevant to the object, recording main events, finding facts, changing data, representing data, interpreting data, finding concepts, principles, and theories, and make knowledge and value claims. All of these elements interact with each other to understand the observed object events in the construction or interpretation of knowledge (Novak & Gowin, 1984).

The activities of transforming data, representing and interpreting data, and making knowledge and value claims can be difficult for students. Therefore, the revised student worksheet contains graded/initial questions that help students to go through these activities (See Figure 3). Initial questions help students convert factual data recorded in the observation results table into concepts that will then be interpreted. Interpreting these concepts will help students gain their own knowledge. This is in accordance with previous research which states that the application of guided questions in student worksheets can improve learning outcomes (Asmawati, 2015; Setiowati et al., 2017; Supriyatno et al., 2020). An increase in learning outcomes indicates an increase in the knowledge that students have successfully acquired. Apart from that, guided

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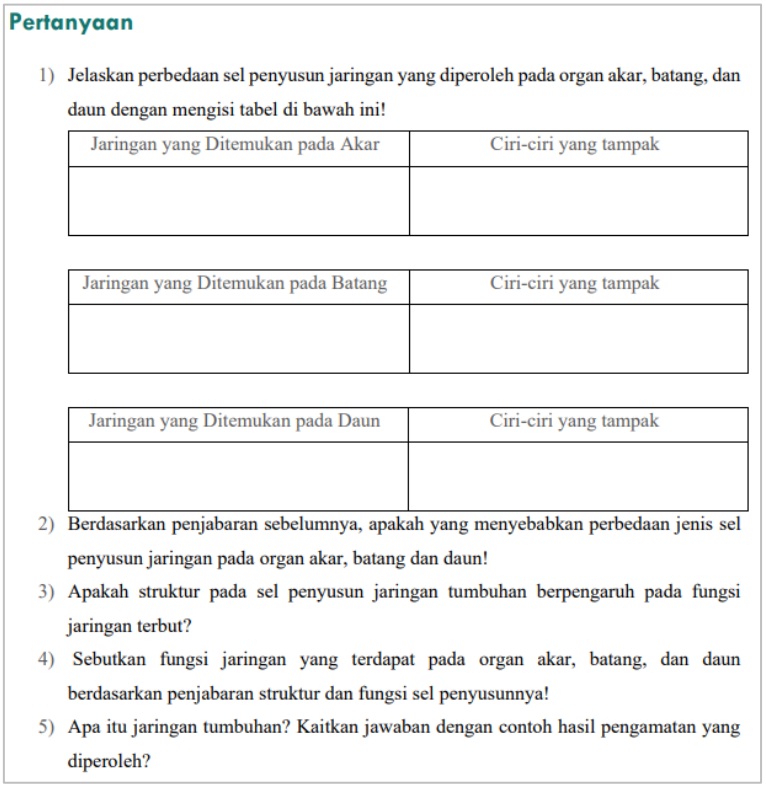
questions can also improve students' science process skills, critical thinking skills and mastery of concepts (Asmawati, 2015; Supriyatno et al., 2020).



Pertanyaan

1) Jelaskan perbedaan sel penyusun jaringan yang diperoleh pada organ akar, batang, dan daun dengan mengisi tabel di bawah ini!

Jaringan yang Ditemukan pada Akar	Ciri-ciri yang tampak

Jaringan yang Ditemukan pada Batang	Ciri-ciri yang tampak

Jaringan yang Ditemukan pada Daun	Ciri-ciri yang tampak

2) Berdasarkan penjabaran sebelumnya, apakah yang menyebabkan perbedaan jenis sel penyusun jaringan pada organ akar, batang dan daun!
3) Apakah struktur pada sel penyusun jaringan tumbuhan berpengaruh pada fungsi jaringan terbut?
4) Sebutkan fungsi jaringan yang terdapat pada organ akar, batang, dan daun berdasarkan penjabaran struktur dan fungsi sel penyusunnya!
5) Apa itu jaringan tumbuhan? Kaitkan jawaban dengan contoh hasil pengamatan yang diperoleh?

Figure 3. Student worksheets structure of plant tissues questions

Based on the explanation of the Minister of Education and Culture and Research and Technology in the narrative delivered in December 2019. In the Merdeka Curriculum, the National Examination is replaced with the Minimum Competency Assessment. This assessment focuses on uncovering students' literacy and numerical reasoning abilities. This can be used as a basis for educators to be able to practice these abilities in every learning activity. Supported by the writings of a psychologist who stated that literacy and numerical reasoning abilities are important cognitive abilities in everyday life. According to him, this ability helps a person make wise decisions and understand information correctly. Therefore, education must pay special attention to the development of literacy and numerical reasoning abilities in students (Stanovich, 2009).

Data taken in practical activities in biology lessons is usually in the form of qualitative data. Qualitative data is considered less able to train students' literacy and numerical skills. This is evidenced by writings that state that students' literacy and numerical abilities in biology subjects are relatively low and need to be improved (Rizki et al., 2022). The reconstructed student worksheet seeks to train these two abilities. Literacy not only measures reading ability but also the ability to analyze reading content and understand the concepts behind it. For numerical abilities, what is assessed is not mathematics lessons, but an assessment of students' ability to apply numerical concepts in real life. The results of the reconstruction of the students' worksheet Structure and Function of Plant Tissue can be seen at the end of the article.

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No.	Nama Organ Tumbuhan	Gambar	Ukuran Sel pada Jaringan	Ketebalan Masing-masing lapisan
1.	Akar bayam (*Amaranthus sp.*)		Jaringan Epidermis;	
			Jaringan Parenkim (Korteks);	
			Jaringan Pembuluh;	
			Jaringan Meristem;	

Figure 4. Revised table of observation results on student worksheet

The table of observation results on student worksheets has been improved. In the work step students are asked to measure the cells visible on the microscope and the thickness of each identified tissue. Data on cell size and tissue thickness are then recorded in the observation results table (Figure 4) as numerical data. Interpretation of numerical data and qualitative data which will later be used by students to understand the relationship between the structure and function of tissues in plants.

Figure 5. Revised student worksheet cover

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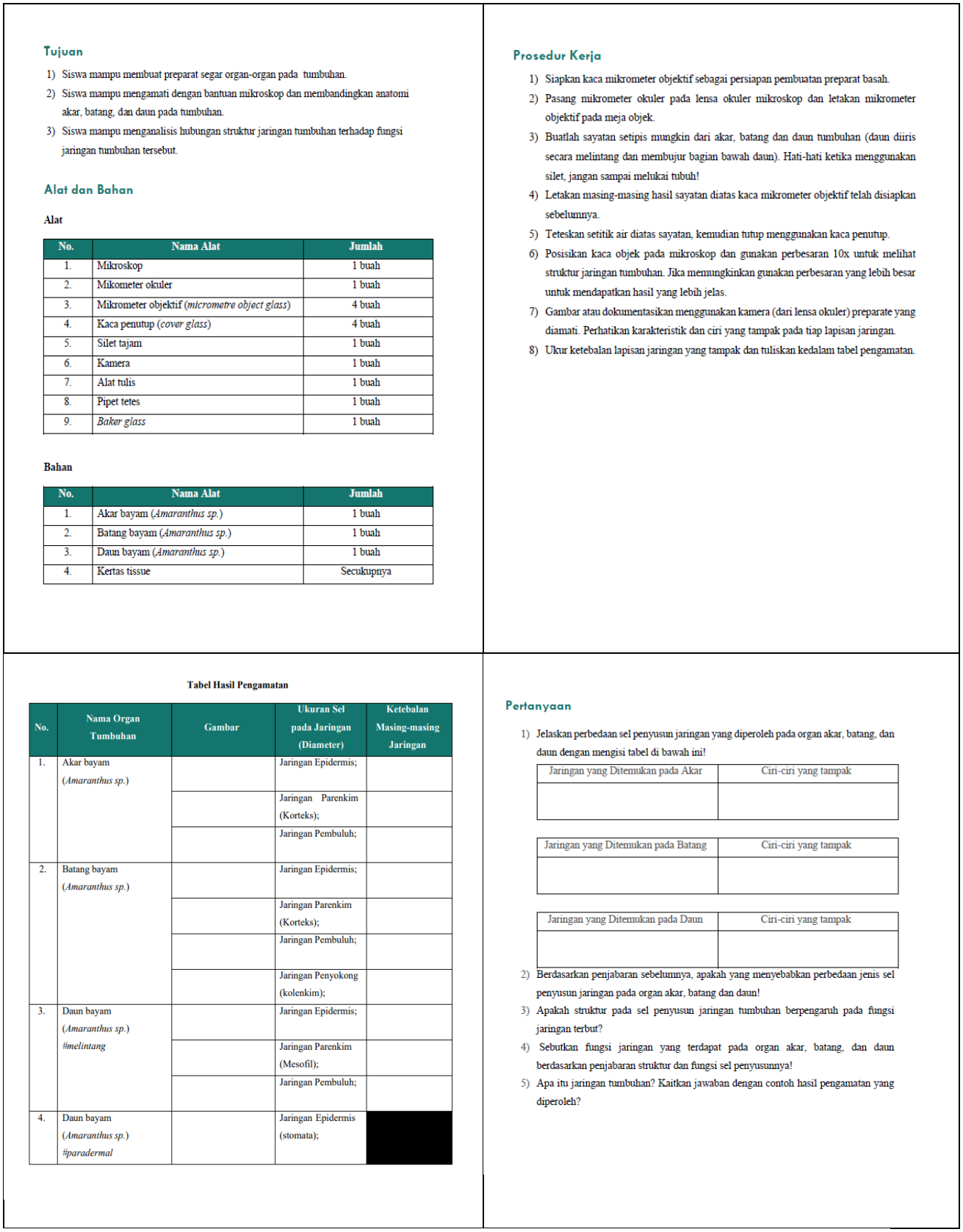

Tujuan

1) Siswa mampu membuat preparat segar organ-organ pada tumbuhan.
2) Siswa mampu mengamati dengan bantuan mikroskop dan membandingkan anatomi akar, batang, dan daun pada tumbuhan.
3) Siswa mampu menganalisis hubungan struktur jaringan tumbuhan terhadap fungsi jaringan tumbuhan tersebut.

Alat dan Bahan

Alat

No.	Nama Alat	Jumlah
1.	Mikroskop	1 buah
2.	Mikometer okuler	1 buah
3.	Mikrometer objektif (*micrometre object glass*)	4 buah
4.	Kaca penutup (*cover glass*)	4 buah
5.	Silet tajam	1 buah
6.	Kamera	1 buah
7.	Alat tulis	1 buah
8.	Pipet tetes	1 buah
9.	*Baker glass*	1 buah

Bahan

No.	Nama Alat	Jumlah
1.	Akar bayam (*Amaranthus sp.*)	1 buah
2.	Batang bayam (*Amaranthus sp.*)	1 buah
3.	Daun bayam (*Amaranthus sp.*)	1 buah
4.	Kertas tissue	Secukupnya

Prosedur Kerja

1) Siapkan kaca mikrometer objektif sebagai persiapan pembuatan preparat basah.
2) Pasang mikrometer okuler pada lensa okuler mikroskop dan letakan mikrometer objektif pada meja objek.
3) Buatlah sayatan setipis mungkin dari akar, batang dan daun tumbuhan (daun diiris secara melintang dan membujur bagian bawah daun). Hati-hati ketika menggunakan silet, jangan sampai melukai tubuh!
4) Letakan masing-masing hasil sayatan diatas kaca mikrometer objektif telah disiapkan sebelumnya.
5) Teteskan setitik air diatas sayatan, kemudian tutup menggunakan kaca penutup.
6) Posisikan kaca objek pada mikroskop dan gunakan perbesaran 10x untuk melihat struktur jaringan tumbuhan. Jika memungkinkan gunakan perbesaran yang lebih besar untuk mendapatkan hasil yang lebih jelas.
7) Gambar atau dokumentasikan menggunakan kamera (dari lensa okuler) preparate yang diamati. Perhatikan karakteristik dan ciri yang tampak pada tiap lapisan jaringan.
8) Ukur ketebalan lapisan jaringan yang tampak dan tuliskan kedalam tabel pengamatan.

Tabel Hasil Pengamatan

No.	Nama Organ Tumbuhan	Gambar	Ukuran Sel pada Jaringan (Diameter)	Ketebalan Masing-masing Jaringan
1.	Akar bayam (*Amaranthus sp.*)		Jaringan Epidermis;	
			Jaringan Parenkim (Korteks);	
			Jaringan Pembuluh;	
2.	Batang bayam (*Amaranthus sp.*)		Jaringan Epidermis;	
			Jaringan Parenkim (Korteks);	
			Jaringan Pembuluh;	
			Jaringan Penyokong (kolenkim);	
3.	Daun bayam (*Amaranthus sp.*) *#melintang*		Jaringan Epidermis;	
			Jaringan Parenkim (Mesofil);	
			Jaringan Pembuluh;	
4.	Daun bayam (*Amaranthus sp.*) *#paradermal*		Jaringan Epidermis (stomata);	

Pertanyaan

1) Jelaskan perbedaan sel penyusun jaringan yang diperoleh pada organ akar, batang, dan daun dengan mengisi tabel di bawah ini!

Jaringan yang Ditemukan pada Akar	Ciri-ciri yang tampak

Jaringan yang Ditemukan pada Batang	Ciri-ciri yang tampak

Jaringan yang Ditemukan pada Daun	Ciri-ciri yang tampak

2) Berdasarkan penjabaran sebelumnya, apakah yang menyebabkan perbedaan jenis sel penyusun jaringan pada organ akar, batang dan daun!
3) Apakah struktur pada sel penyusun jaringan tumbuhan berpengaruh pada fungsi jaringan terbut?
4) Sebutkan fungsi jaringan yang terdapat pada organ akar, batang, dan daun berdasarkan penjabaran struktur dan fungsi sel penyusunnya!
5) Apa itu jaringan tumbuhan? Kaitkan jawaban dengan contoh hasil pengamatan yang diperoleh?

Figure 6. Revised student worksheet

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CONCLUSION

The analysis result of five student worksheets on the Structure and Function of Plant Tissue shows that there are still several problems found in the student worksheets used and circulating in the field based on the structural aspect. From the Vee Diagram aspect, problems were found in the conceptual, practical, and knowledge construction aspects. Therefore, reconstruction is carried out based on structural, conceptual, and practical aspects, and how student worksheets can construct students' knowledge. Reconstruction is also carried out based on the Merdeka Curriculum which develops students' knowledge and processing skills. With targeted modifications to student worksheets, students can also develop their numerical literacy abilities as expected in the Merdeka Curriculum.

REFERENCES

Agustina, E. (2016). Analisis kesesuaian materi kuliah dengan materi praktikum biologi bidang tumbuhan pada program studi pendidikan biologi UIN Ar-Raniry. *Jurnal Biotik*, *4*(2), 156–162.

Agustina, P., Saputra, A., Anif, S., Rayana, A., & Probowati, A. (2021). Analysis science process skills and scientific attitudes of XI grade students of senior high school in biological practice. *Edusains*, *13*(1), 1–7.

Aisya, N. S. M., Saefudin, S., Supriatno, B., & Anggraeni, S. (2016). Penerapan diagram vee dalam model pembelajaran inquiry lab dan group investigation untuk meningkatkan kemampuan literasi kuantitatif siswa kelas VII pada materi pencemaran lingkungan. *Proceeding Biology Education Conference, 13*(1), 112–117.

Alvarez, M. C., & Risko, V. J. (2007). The use of vee diagrams with third graders as a metacognitive tool for learning science concepts. *E-Research Tennessee State Univ*, *5*(5), 1–19.

Arifin, S., Amin, M., Husamah, H., Hudha, A. M., & Miharja, F. J. (2021). Development of a biology practicum module with micro-technical preparations on the structure and function of plant tissue. *Research and Development in Education*, *1*(2), 45–60.

Asmawati, E. Y. (2015). Lembar kerja siswa (LKS) menggunakan model guided inquiry untuk meningkatkan ketrampilan berpikir kritis dan penguasaan konsep siswa. *Jurnal Pendidikan Fisika*, *3*(1), 1–16.

Cahyani, G., Enawaty, E., Erlina, E., Muharini, R., & Ulfah, M. (2023). Pengembangan lembar kerja peserta didik (LKPD) berbasis kearifan lokal pada materi bioteknologi di SMPN 1 Jagoi Babang. *Jurnal Basicedu*, *7*(5), 3004–3017.

Choo, S. S. Y., Rotgans, J. I., Yew, E. H. J., & Schmidt, H. G. (2011). Effect of worksheet scaffolds on student learning in problem-based learning. *Advances in Health Sciences Education*, *16*(4), 517–528.

Fattahillah, N., Supriatno, B., & Anggraeni, S. (2021). The analysis and reconstruction of laboratory activities design on the material of differences between animal and plant cells for tenth grade students. *BIOEDUKASI*, *19*(2), 71-78.

Haerani, R., Kusnadi, K., & Rahman, T. (2022). Improving critical thinking skills of high school students through learning mini research projects on household waste management activities. *Assimilation: Indonesian Journal of Biology Education*, *5*(2), 119–126.

Haury, D. L., & Rillero, P. (1994). *Perspectives of Hands-On Science Teaching*. ERIC Clearinghouse for Science, Mathematics, and Environmental Education.

DOI: https://doi.org/10.17509/aijbe.v7i1.66426
e-ISSN 2621-7260

Jojor, A., & Sihotang, H. (2022). Analisis kurikulum merdeka dalam mengatasi learning loss di masa pandemi Covid-19: Analisis studi kasus kebijakan pendidikan. *Edukatif: Jurnal Ilmu Pendidikan*, *4*(4), 5150–5161.

Lee, C. D. (2014). Worksheet usage, reading achievement, classes' lack of readiness, and science achievement: A cross-country comparison. *International Journal of Education in Mathematics, Science and Technology*, *2*(2). 96-106.

Li, X., Lin, X., Zhang, F., & Tian, Y. (2022). What matters in online education: Exploring the impacts of instructional interactions on learning outcomes. *Frontiers in Psychology*, *12*, 1–13.

Mamonto, S., Kandowangko, N. Y., & Yusuf, F. M. (2023). Development of student worksheet on growth and development of drought-stressed plants. *Assimilation: Indonesian Journal of Biology Education*, *6*(1), 17–32.

Marzano, R. J. (2001). *Designing a New Taxonomy of Educational Objectives*. Corwin Press.

Massawet, E. T., Palenewen, E., & Sari, R. (2018). Analisis permasalahan guru terkait pengembangan perangkat pembelajaran berorientasi kecerdasan majemuk dan permasalahan siswa terkait keterampilan berpikir kritis siswa dalam pembelajaran biologi. *Proceeding Biology Education Conference*, *15*(1), 371–378.

Melawati, O., Evendi, E., Halim, A., Yusrizal, Y., & Elisa, E. (2022). Influence of the use of student worksheet problem-based to increase problem solving skills and learning outcomes. *Jurnal Penelitian Pendidikan IPA*, *8*(1), 346–355.

Meulenbroeks, R., van Rijn, R., & Reijerkerk, M. (2023). Fostering secondary school science students' intrinsic motivation by inquiry-based learning. *Research in Science Education*.

Millar, R. (2004). The role of practical work in the teaching and learning of science. *Commissioned paper-Committee on High School Science Laboratories: Role and Vision. Washington DC: National Academy of Sciences*, *308*, 1-21.

NABT. (2022). *Role of laboratory & field experiences in life science education*. Retrieved from https://Nabt.Org/Position-Statements-Role-of-Laboratory-and-Field-Instruction-in-Biology-Education.

Nadia, N., Supriatno, B., & Anggraeni, S. (2020). Analisis dan rekonstruksi komponen penyusun lembar kerja peserta didik struktur dan fungsi jaringan tumbuhan. *BIODIK*, *6*(2), 187–199.

Ningrum, M. S. (2019). *Analisis keterlaksanaan praktikum biologi sekolah menengah atas swasta se-Kotamadya Bandar Lampung* (Undergraduate Thesis, Universitas Lampung). Retrieved from https://digilib.unila.ac.id/57644/

Novak, J. D., & Gowin, D. B. (1984). *Learning how to learn*. Cambridge University Press.

Pratikno, P., Suyono, S., & Agustini, R. (2020). The validity of student worksheets and student textbooks inquiry training model on the colligative properties of solution. *International Journal for Educational and Vocational Studies*, *2*(11), 935–941.

Putri, H. A., Widodo, E., & Hastuti, P. W. (2017). Development of inquiry science issues-based student worksheet to advance practical skill and environmental attitude in a seventh-grade high school student. *JSER (Journal of Science Education Research)*, *1*(1), 1–4.

Rizki, I. M., Suhendar, & Nuranti, G. (2022). Profil kemampuan literasi numerasi peserta didik SMA pada pembelajaran biologi kelas XII pada materi evolusi. *BIODIK: Jurnal Ilmiah Pendidikan Biologi*, *8*(3), 36–42.

DOI: https://doi.org/10.17509/aijbe.v7i1.66426
e-ISSN 2621-7260

Setiowati, A., Ngabekti, S., & Rahayu, E. S. (2017). Pengembangan lembar kerja siswa (LKS) berbasis guided inquiry untuk meningkatkan hasil belajar siswa materi gerak tumbuhan. *Journal of Biology Education*, *6*(1), 88–94.

Stanovich, K. E. (2009). *What intelligence tests miss: The psychology of rational thought*. Yale University Press.

Sugiyono. (2015). *Metode penelitian tindakan komprehensif: Untuk perbaikan kinerja dan pengembangan ilmu tindakan*. Jakarta: Alfabeta.

Supriatno, B. (2007). Profil lembar kegiatan biologi siswa sekolah menengah. *Proceding Seminar Nasional Jurusan Pendidikan Biologi*.

Supriatno, B. (2013). *Pengembangan Program Perkuliahan Pengembangan Praktikum Biologi Sekolah Berbasis Ancorb Untuk Mengembangkan Kemampuan Merancang Dan Mengembangkan Desain Kegiatan Laboratorium* (Master Thesis, Universitas Pendidikan Indonesia). Retrieved from https://repository.upi.edu/3661/

Supriatno, B. (2018). Praktikum untuk membangun kompetensi. *Proceeding Biology Education Conference*, *15*(1), 1–18.

Supriyatno, T., Lestari, D. A., & Utami, U. (2020). The effectiveness of guided inquiry learning models for students' scientific performances and critical skills. *Madrasah: Jurnal Pendidikan dan Pembelajaran Dasar*, *13*(1), 1–14.

Suryaningsih, Y. (2017). Pembelajaran berbasis praktikum sebagai sarana siswa untuk berlatih menerapkan keterampilan proses sains dalam materi biologi. *Jurnal Bio Educatio*, *2*(2), 49–57.

Yayuk, E., Restian, A., & Ekowati, D. W. (2023). Literasi numerasi dalam kerangka kurikulum merdeka berbasis art education. *Interntional Journal of Community Service Learning*, *7*(2), 228–238.

Zidan, Z., & Supriatno, B. (2023). Analisis dan rekonstruksi desain kegiatan laboratorium mitosis akar bawang merah (*Allium cepa*) melalui model ANCOR. *Biodik*, *9*(3), 37–49.

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