Quagga
Jurnal Pendidikan dan Biologi

p-ISSN 1907-3089, e-ISSN 2615-5869
Vol 16, No. 2, 2024, pp 193 - 202
Available online https://journal.fkip.uniku.ac.id/quagga/index
DOI: 10.25134/quagga.v16i2.341

Analysis and Reconstruction of Student Practicum Worksheets on Food Carbohydrate Testing

Ghurrotul Bariroh[1], Widi Purwianingsih[2]*, Kusnadi[3]
[1,2,3] Master Program of Biology Education, Faculty of Mathematic and Natural Science Education, Universitas Pendidikan Indonesia
*Corresponding author: widipurwianingsih@upi.edu

APA Citation: Bariroh, G., Purwianingsih, W., & Kusnadi. (2024). Analysis and Reconstruction of Student Practicum Worksheet on Food Carbohydrate Testing. *Quagga: Journal of Education and Biology*, 16(2), 193-202. DOI: 10.25134/quagga.v16i2.341.

Received: 29-05-2024 Accepted: 06-06-2024 Published: 01-07-2024

Abstract: *Practicum worksheets are a tool used by students to increase their understanding of various biological concepts through experiments and direct observation. However, there are many biology practicum worksheets used today often do not meet the appropriate standards. Therefore, this research aims to analyze conceptual, procedural, and knowledge construction aspects based on vee diagrams on students' practicum worksheets. The method used in this research is qualitative-descriptive. The samples were selected using purposive sampling so that six samples of practicum worksheets for phase F students in the Merdeka Curriculum were obtained with material testing carbohydrates in food. The research results show that conceptually, the practicum content is not in accordance with the learning outcomes in the Merdeka Curriculum. Procedurally, the practicum worksheets still need to be improved in terms of tools, materials, procedures, phenomenon objects, and data recording. This has an impact on students' difficulties in constructing their knowledge. It is hoped that the results of the reconstruction of practicum worksheets based on conceptual, procedural, and knowledge construction analysis can be used as a reference and basis for teachers in designing practicum activities specifically on digestive system material.*

Keywords: *Carbohydrate Testing, Digestive System, Vee Diagram, Practicum Worksheet.*

1. INTRODUCTION

Biology learning as part of science learning is an effort to develop a deep understanding of life and real biological processes through a scientific approach. Biology learning teaches students to apply scientific methods to exploring and understanding various natural phenomena related to living things (Utomo, 2018). This supports Sari *et al* (2020) that biology learning is not just mastery of facts, concepts, or principles (cognitive), but should be given direct experience that involves interaction between students and learning objects so that it can provide meaningful learning for students in the aspects of skills and attitudes. The Merdeka Curriculum provides a solution for achieving meaningful biology learning through a more dynamic and contextual approach (Kemdikbud, 2024). Students not only learn through textbooks and materials presented by teachers but also through direct experiences that trigger curiosity and active involvement in the learning process, such as practicum activities. Practicum activities allow students to observe, explore, and connect conceptual aspects studied in class with methodological aspects studied in the laboratory and in the field (Hindriana, 2016; Nuai & Nurkamiden, 2022; Suryaningsih, 2017).

Practicum activities are part of the inquiry approach, especially in science subjects such as biology (Agustina & Anggraini, 2018). The term inquiry is not a foreign term, because the essence of science, especially biology, is inquiry itself (Rustaman, 2005). The scientific skills developed during practicum, such as designing experiments, collecting and analyzing data, and drawing conclusions based on empirical evidence, are the core of the inquiry approach. Through inquiry-based practicum activities, students directly learn

Quagga
Jurnal Pendidikan dan Biologi
p-ISSN 1907-3089, e-ISSN 2615-5869
Vol 16, No. 2, 2024, pp 193 - 202
Available online https://journal.fkip.uniku.ac.id/quagga/index
DOI: 10.25134/quagga.v16i2.341

to apply scientific methods (Afifah *et al*., 2022; Sundari *et al*., 2017). In the context of biology learning, students not only learn theory but also understand how the theory is tested and validated through practicum activities. This is in line with what was stated by Leite & Dourado (2013) that the main aim of practicum (laboratory activities) is to help students connect real objects with ideas (concepts).

Practicum activities in the learning process not only practice hands-on activities but also provide opportunities for students to hone minds-on skills (Aqib & Murtadlo, 2016; Suryaningsih, 2017). This supports research by Abrahams & Millar (2008) which states that effective practicum not only improves technical skills but also strengthens in-depth understanding of concepts through the integration of theory and practice. Practicum learning that integrates minds-on and hands-on elements significantly improves student learning outcomes compared to learning methods that only focus on one aspect (Langitsari *et al*., 2021). In practicum activities, students not only carry out experiments, but need to plan, analyze data, and draw conclusions, all of which are key competencies in science. Student involvement in the planning process to carrying out experiments requires students to think critically and creatively in integrating the theoretical knowledge they have with the reality they observe (Walker *et al*., 2019). After the practicum is complete, students must evaluate the results obtained and interpret the data in depth. This reflection process strengthens students' minds such as analytical skills and conceptual understanding because students are required to make conclusions based on the empirical evidence they have collected (Cheung, 2020).

Practicum activities organized by teachers in biology learning must pay attention to meeting minimum standards for practicum implementation, one of which is student practicum worksheets (Agustina & Anggraini, 2018; Fahmin & Ardyati., 2020).Practicum worksheets are a tool used by students to improve their understanding of various biological concepts through experiments and direct observation. Practicum worksheets provide a structured framework for students to follow and ensure they cover all important aspects of practicum activities to achieve the desired learning objectives (Sumarmin & Roza, 2020; Zahra *et al*., 2021). Apart from that, practicum worksheets also play an important role in helping students construct their knowledge to support the achievement of indicators of students' cognitive, affective, and psychomotor abilities through hands-on and minds-on activities (Andriana *et al*., 2017; Dewi *et al*., 2017; Normarita *et al*., 2015).

Practicum worksheets used by students can be sourced from biology textbooks or designed by the teachers themselves so that the form, structure, and approaches used in the worksheets are varied (Supriatno, 2013). However, the many biology practicum worksheets used today often do not meet the appropriate standards. Biology practicum worksheets often do not provide clear and structured instructions, so students have difficulty understanding the objectives and steps that must be taken (Hasni *et al*., 2019; Titisari, 2019). In addition, the practicum worksheets used by several schools focus too much on mechanical procedures without providing adequate conceptual context, as a result, students' understanding of the biological concepts being taught becomes less in-depth (Chutami & Suhartini, 2021; Irawan *et al*., 2023). Lack of understanding of biological concepts resulting from not achieving practicum objectives is also influenced by pedagogical factors such as a lack of integration between theory and practice, as well as the absence of guidance for reflection and analysis of experimental results (Hindriana, 2016; Khan & Ahmad, 2020). These errors indicate the need to reconstruct the preparation of biology practicum worksheets to suit learning needs and increase student understanding.

The various problems regarding biology practicum worksheets that have been described require immediate reconstruction to ensure the effectiveness of learning and the success of students' practicum. In the reconstruction process, an in-depth analysis must first be carried out regarding the conceptual, procedural, and knowledge construction aspects that underlie the formation of students' practicum worksheets (Ramadhayanti *et al*., 2020; Zahra *et al*., 2021). Heuristics proposed by Novak & Gowin (1984) are tools that can be used to understand the structure of knowledge and the process of knowledge construction in students. This framework is based on constructivist theory which

Quagga
Jurnal Pendidikan dan Biologi
p-ISSN 1907-3089, e-ISSN 2615-5869
Vol 16, No. 2, 2024, pp 193 - 202
Available online https://journal.fkip.uniku.ac.id/quagga/index
DOI: 10.25134/quagga.v16i2.341

emphasizes that knowledge is constructed by individuals based on their experiences and interactions with the environment. By using these heuristics, teachers can help students not only master information but also develop the critical and analytical thinking skills needed to construct and apply knowledge effectively in a variety of situations.

One of the achievements of biology learning in phase F in the Merdeka Curriculum is that students can analyze the relationship between the structure of organs in organ systems and their functions as well as abnormalities or disorders that arise in these organ systems (Badan Standar Kurikulum dan Asesmen Pendidikan, 2022). One of the organ systems referred to in these learning outcomes is the digestive system. Digestive system material is an essential material that has been taught from the junior high school level. At the junior high school level or phase D, the focus of learning is more on introducing the basic anatomy and function of the digestive organs. Meanwhile, at the high school level the material is expanded by studying the biochemical processes that occur in the digestive system and involves more complex practicum activities, such as laboratory experiments that test digestive enzymes. Thus, the level of material and practicum activities carried out should be adjusted to the learning outcomes and cognitive development of students at each level. Based on the explanation above, this research aims to analyze conceptual, procedural, and knowledge construction aspects based on the vee diagram developed by Novak & Gowin (1984) on students' practicum worksheets on food testing materials. After the analysis and trials are carried out, reconstruction is carried out so that practicum worksheets are obtained that are effective and able to construct students' knowledge.

2. RESEARCH METHOD

The method in this research is descriptive qualitative, namely by analyzing students' practicum worksheets based on conceptual, procedural, and knowledge construction analysis. The population in this research is the practicum worksheets of phase F students in the Merdeka Curriculum used in biology learning. The samples were chosen using purposive sampling so that 6 samples of practicum worksheets for phase F students in the Merdeka Curriculum were obtained with material testing carbohydrates in food. Data were obtained using two instruments. The first instrument is a rubric developed by the researcher himself regarding the conceptual and procedural analysis of students' practicum worksheets. Meanwhile, the second instrument is a knowledge construction rubric on students' practicum worksheets based on vee diagrams adapted from Novak & Gowin (1984).

The technique in this research uses the ANCOR (Analysis, Try and Reconstruction) stages developed by Supriatno (2013). This research begins with the analysis stage, namely by analyzing conceptual and procedural suitability, as well as understanding the knowledge construction process through the practicum worksheet. The next stage is to try out the practicum worksheet for testing carbohydrates in food without making any changes to the tools and materials, procedures, or other practicum worksheet components. After carrying out all stages of analysis and testing, the researcher reconstructed the practicum worksheet for testing carbohydrates in food so that it meets the conceptual, procedural, and knowledge construction aspects for students.

3. RESULTS AND DISCUSSION

Conceptual Analysis

Conceptual analysis of students' practicum worksheet material testing carbohydrates in food includes suitability of practicum content with learning outcomes, suitability of practicum title with practicum activities, suitability of practicum objectives with practicum procedures, and suitability of practicum activities with students' cognitive level. The results of the conceptual analysis regarding the practicum worksheet for testing carbohydrates in food can be seen in Table 1.

Quagga
Jurnal Pendidikan dan Biologi
p-ISSN 1907-3089, e-ISSN 2615-5869
Vol 16, No. 2, 2024, pp 193 - 202
Available online https://journal.fkip.uniku.ac.id/quagga/index
DOI: 10.25134/quagga.v16i2.341

Table 1. Conceptual Analysis of Practicum Worksheet for Carbohydrate Testing in Food

No.	Indicator	Number of Worksheet	
		Appropriate	Inappropriate
1	Compatibility of practicum content with learning outcomes	-	6
2	Compatibility of practicum title with practicum activities	5	1
3	Compatibility of practicum objectives with practicum procedures	2	4
4	Compatibility of practical activities to students' cognitive level	1	5

Based on the data in Table 1, it can be seen that of the total sample of practicum worksheets used, all of them did not lead to biology learning outcomes in phase F of the Merdeka Curriculum. The achievement of learning biology in phase F specifically on organ system material is that students can analyze the relationship between the structure of organs in the organ system and their function as well as abnormalities or disorders that arise in the organ system. Meanwhile, all of the practicum worksheets found only discussed the content of the food being tested, such as whether there was carbohydrate content or the type of carbohydrate in the food being tested. This practicum worksheet does not yet relate to the role of organs in the digestive process. This supports Hindriana (2016) research that practicum worksheets are often created with a focus on experimental steps only so that they do not provide enough space for students to understand the relevance of biological concepts in everyday life and their relationship to Basic Competencies (KD). set. The incompatibility of content on practicum worksheets with CP has an impact on students' lack of understanding of concepts and failure to achieve learning objectives (Apriani *et al.*, 2021; Mislia, 2017).

In research, Ramadhayanti *et al* (2020) stated that a mismatch between content and CP on students' practicum worksheets could result in the required cognitive level not reaching the expected level in achieving CP. This also supports the data from conceptual analysis where the mismatch between content and CP is also followed by a mismatch in students' cognitive levels. When practicum worksheets do not integrate concepts relevant to CP, the cognitive level required is likely only at a low level. This is similar to the expected achievement of competency in the digestive system material in that students can analyze the relationship between organ structure and function. However, the practicum worksheet is only limited to identifying types of food that contain carbohydrates or following instructions mechanically. This does not allow students to develop critical thinking, analytical, or synthesis skills that may be necessary to achieve higher CP.

Most of the practicum worksheets have titles that match the practicum activities, however, there are still practicum worksheets with practicum titles that do not reflect the practicum activities. The practicum title listed is very simple so it cannot describe what kind of practicum activities will be carried out by students. Besides that, most of the practicum worksheets do not have practicum objectives that are relevant to the procedures. On the other hand, the success of practicum learning is greatly influenced by the suitability between the practicum objectives and the procedures set. The mismatch between the objectives and steps of practicum work has an impact on students' lack of understanding of concepts (Rahmah *et al.*, 2021). Therefore, teachers need to ensure that each element in the practicum worksheet supports each other to achieve the expected educational goals (Capah & Fuadiyah, 2021).

Procedural Analysis

Procedural analysis of students' practicum worksheets on carbohydrate testing material in food including tools and materials, procedures, objects or phenomena that appear, and arriving at data records. The results of the procedural analysis regarding the practicum worksheet for testing carbohydrates in food can be seen in Table 2.

Quagga
Jurnal Pendidikan dan Biologi

p-ISSN 1907-3089, e-ISSN 2615-5869
Vol 16, No. 2, 2024, pp 193 - 202
Available online https://journal.fkip.uniku.ac.id/quagga/index
DOI: 10.25134/quagga.v16i2.341

Table 2. Procedural Analysis of Practicum Worksheet for Carbohydrate Testing in Food

No.	Indicator	Number of Worksheet	
		Appropriate	Inappropriate
1	The tools and materials used are in accordance with school standards	6	-
2	The tools and materials used are accompanied by clear specifications and units	-	6
3	Practical work steps are presented in a structured manner	4	2
4	Practical work steps can be carried out without difficulty and endangering students	4	2
5	The object of the phenomenon can be identified	5	1
6	Phenomenon objects support data acquisition	2	4
7	Phenomenon objects help in answering questions	3	3
8	There are data recording activities	2	4
9	Some questions are appropriate to the practical topic	5	1

Based on Table 2, procedural analysis of students' practicum worksheets on carbohydrate testing material in food, we can see that in terms of tools and materials used, all samples meet school standards, so students have no difficulty in finding tools and materials to be used in carrying out practicum activities. However, the tools and materials used in all samples of practicum worksheets for testing carbohydrates in food are not equipped with specifications for the tools or units of materials needed. Practicum worksheets that do not include equipment specifications or units of materials needed cause students difficulty in replicating experiments and have the potential to reduce the validity of the results obtained. This supports Darmayanti *et al* (2023) that lack of clarity in the specifications of tools and materials can hinder the learning process and reduce the effectiveness of practicum as a means of scientific education.

Judging from the procedures in the practicum worksheet for testing carbohydrates in food, most of them are written in a structured manner and can be followed by students easily. However, there are still some practicum worksheets that are written in a less structured manner. Procedures that are written in an unstructured manner will have an impact on students' difficulties in carrying out practicums. This can be seen from the practicum worksheets that were found, where worksheets with less structured writing of procedures also had indicators for procedures that were difficult for students to follow. Ambiguity in practicum instructions causes student confusion, errors in procedures, and results that do not align with learning objectives. This is because students need clear and systematic guidance to understand each stage in the practicum, from preparation to data analysis. Thus, systematic procedures are needed to reduce error rates and better organize student activities (Anggraeni *et al*., 2024; Hamim, 2021).

The practicum worksheet for testing carbohydrates in the food being analyzed can bring out real-world phenomena. However, this object or phenomenon is less helpful in interpreting the data and answering the questions provided on the practicum worksheet. One of the influencing factors is that the practicum worksheets do not contain instructions for recording data or what data students must collect in more detail. This will also influence students' interpretations in building concepts or knowledge and how they answer questions. Thus, practicum worksheets must be accompanied by data-recording activities so that experimental results can be analyzed accurately and objectively. Data recording allows researchers to document each stage of an experiment in detail, including initial conditions, changes that occur, and final results. By recording data systematically, errors and variability that may arise can be identified and corrected more easily (Nasrudin *et al*., 2019).

Quagga
Jurnal Pendidikan dan Biologi

p-ISSN 1907-3089, e-ISSN 2615-5869
Vol 16, No. 2, 2024, pp 193 - 202
Available online https://journal.fkip.uniku.ac.id/quagga/index
DOI: 10.25134/quagga.v16i2.341

Vee Diagram Knowledge Construction Analysis

Knowledge construction analysis is based on the vee heuristic developed by Novak & Gowin (1984). Vee diagram components include focus questions, objects/ events, theories/ principles/ concepts, recordings/ transformations, and sentences of knowledge.

Table 3. Vee Diagram Indicator Scores Practicum Worksheet for Carbohydrate Testing in Food

No.	Indicator	Practical Worksheet Scores						Percentage (%)
		-1	-2	-3	-4	-5	-6	
1	Focus question	2	1	1	1	2	2	50
2	Object/ Event	1	1	1	2	2	3	55
3	Theory/ principle/ concept	2	2	2	1	1	2	41
4	Recording/transformation	1	1	1	2	2	3	41
5	Knowledge claims	1	1	1	1	1	2	29

All practicum worksheets have a focus question component and has raised an object or phenomenon. However, evaluation of the scoring data shows that the focus of the questions is still less effective in guiding students to obtain the expected concepts. This indicates the need for improvements in the design of focus questions to better support a deeper conceptual learning process. Apart from that, the object or event component also produces a score that is less than optimal. Based on the test results, data on one of the practicum worksheets for testing carbohydrates in food, objects, or events has appeared. However, because the practicum objectives are not determined by the procedures or practicum activities as explained in the conceptual analysis sub-discussion, it can be judged that the objects or events that appear are not determined by the focus question.

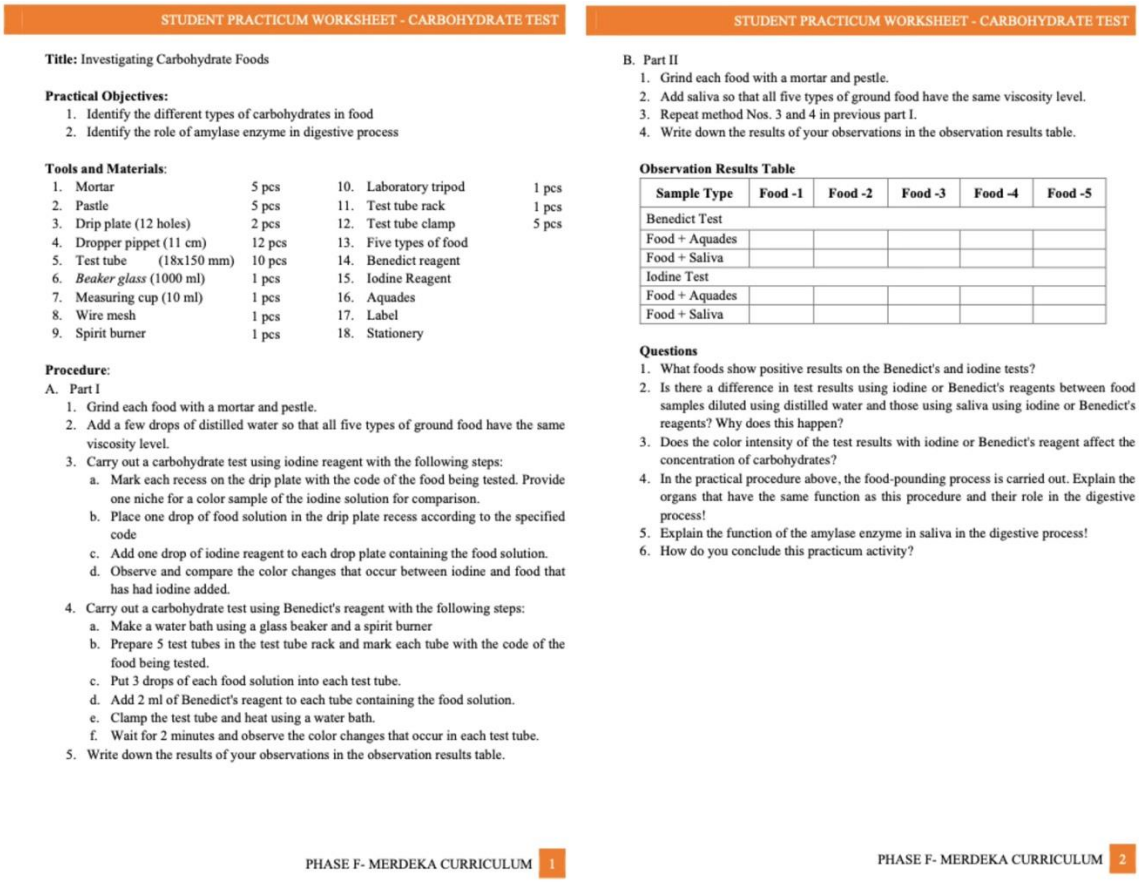
In the practicum for carbohydrate testing in food, students are invited to identify types of carbohydrates such as monosaccharides, disaccharides, and polysaccharides contained in food samples through a series of chemical tests, such as the Benedict test, Barfoed test, and iodine test. Based on the results of practicum worksheet trials, all worksheets relate to the basic principles of chemical reaction tests that produce color changes as an indicator of the presence of certain carbohydrates. However, almost all of the practicum worksheets analyzed did not relate to biological theories or concepts in the digestive system material. Thus, this worksheet only acts as a practicum guide, so it does not play a role in integrating theoretical knowledge and practicum application into the digestive system material. Based on the data in Table 3, it can be seen that some of the worksheets have instructions for recording data, even though they are not accompanied by tables with details of what data is needed to analyze and reflect on the practicum results. And some worksheets don't instruct this activity at all. Without recording data, students find it difficult to develop analytical and critical skills that are essential in scientific methods (Ariyani *et al.*, 2021; Susanti, 2023). Therefore, practicum worksheets should always include data-recording activities so that the learning process becomes more comprehensive.

Based on the evaluation results, the knowledge claims indicator has the lowest score compared to other indicators. After further exploration, this indicator is influenced by other indicators. Starting from focus questions, practicum objectives, and procedures to the data transformation of the practicum activity for testing carbohydrates in food, this simply aims to identify what foods contain carbohydrates or what types of carbohydrates are contained in each food without involving how the macronutrient elements are related. plays a role in digestive system processes. As a result, students cannot transform factual knowledge into conceptual knowledge. Students may be able to identify color changes that occur in the test but have difficulty understanding how carbohydrates are processed in the digestive system and how this relates to the role of the digestive organs and the enzymes that play a role.

Quagga
Jurnal Pendidikan dan Biologi
p-ISSN 1907-3089, e-ISSN 2615-5869
Vol 16, No. 2, 2024, pp 193 - 202
Available online https://journal.fkip.uniku.ac.id/quagga/index
DOI: 10.25134/quagga.v16i2.341

Alternative Reconstruction Practicum Worksheet for Carbohydrate Testing in Food

Based on the results of the conceptual, procedural, and knowledge construction analysis that has been carried out, the researcher tries to provide an alternative reconstruction based on Vee Diagrams for students' practicum worksheets for testing carbohydrates in food. This reconstruction aims to ensure that students' practicum worksheets are not only conceptually, procedurally, and knowledge-constructionally appropriate but also meet curriculum demands and achieve learning objectives.



STUDENT PRACTICUM WORKSHEET - CARBOHYDRATE TEST

Title: Investigating Carbohydrate Foods

Practical Objectives:
1. Identify the different types of carbohydrates in food
2. Identify the role of amylase enzyme in digestive process

Tools and Materials:

1. Mortar	5 pcs	10. Laboratory tripod	1 pcs
2. Pastle	5 pcs	11. Test tube rack	1 pcs
3. Drip plate (12 holes)	2 pcs	12. Test tube clamp	5 pcs
4. Dropper pippet (11 cm)	12 pcs	13. Five types of food	
5. Test tube (18x150 mm)	10 pcs	14. Benedict reagent	
6. *Beaker glass* (1000 ml)	1 pcs	15. Iodine Reagent	
7. Measuring cup (10 ml)	1 pcs	16. Aquades	
8. Wire mesh	1 pcs	17. Label	
9. Spirit burner	1 pcs	18. Stationery	

Procedure:

A. Part I
1. Grind each food with a mortar and pestle.
2. Add a few drops of distilled water so that all five types of ground food have the same viscosity level.
3. Carry out a carbohydrate test using iodine reagent with the following steps:
   a. Mark each recess on the drip plate with the code of the food being tested. Provide one niche for a color sample of the iodine solution for comparison.
   b. Place one drop of food solution in the drip plate recess according to the specified code
   c. Add one drop of iodine reagent to each drop plate containing the food solution.
   d. Observe and compare the color changes that occur between iodine and food that has had iodine added.
4. Carry out a carbohydrate test using Benedict's reagent with the following steps:
   a. Make a water bath using a glass beaker and a spirit burner
   b. Prepare 5 test tubes in the test tube rack and mark each tube with the code of the food being tested.
   c. Put 3 drops of each food solution into each test tube.
   d. Add 2 ml of Benedict's reagent to each tube containing the food solution.
   e. Clamp the test tube and heat using a water bath.
   f. Wait for 2 minutes and observe the color changes that occur in each test tube.
5. Write down the results of your observations in the observation results table.

PHASE F- MERDEKA CURRICULUM 1

STUDENT PRACTICUM WORKSHEET - CARBOHYDRATE TEST

B. Part II
1. Grind each food with a mortar and pestle.
2. Add saliva so that all five types of ground food have the same viscosity level.
3. Repeat method Nos. 3 and 4 in previous part I.
4. Write down the results of your observations in the observation results table.

Observation Results Table

Sample Type	Food -1	Food -2	Food -3	Food -4	Food -5
Benedict Test					
Food + Aquades					
Food + Saliva					
Iodine Test					
Food + Aquades					
Food + Saliva					

Questions
1. What foods show positive results on the Benedict's and iodine tests?
2. Is there a difference in test results using iodine or Benedict's reagents between food samples diluted using distilled water and those using saliva using iodine or Benedict's reagents? Why does this happen?
3. Does the color intensity of the test results with iodine or Benedict's reagent affect the concentration of carbohydrates?
4. In the practical procedure above, the food-pounding process is carried out. Explain the organs that have the same function as this procedure and their role in the digestive process!
5. Explain the function of the amylase enzyme in saliva in the digestive process!
6. How do you conclude this practicum activity?

PHASE F- MERDEKA CURRICULUM 2

Figure 1. Reconstruction of Practical Worksheet for Carbohydrate Testing in Food

4. CONCLUSION

Most of the practicum worksheets for testing carbohydrates in the food analyzed do not contain content that is relevant to the practicum objectives or learning outcomes in the Merdeka Curriculum. Apart from that, the practicum worksheet for testing carbohydrates in food also does not help students construct knowledge through the various facts produced. So students cannot transform knowledge from factual to conceptual. These findings help researchers construct practicum worksheets by adopting the vee heuristic based on biology learning outcomes in the Merdeka Curriculum. Through the results of this reconstruction, researchers hope that it can be used as a recommendation as well as contribute for teachers in designing more structured and focused practicum activities on digestive system material. In this way, students can construct their knowledge and more easily see the relevance of practicum in the context of holistic biology learning.

5. REFERENCES

Abrahams, I., & Millar, R. (2008). Does practicum work really work? A study of the effectiveness of practicum work as a teaching and learning method in school science.

p-ISSN 1907-3089, e-ISSN 2615-5869
Vol 16, No. 2, 2024, pp 193 - 202
Available online https://journal.fkip.uniku.ac.id/quagga/index
DOI: 10.25134/quagga.v16i2.341

International Journal of Science Education, 30(14), 1945–1969. https://doi.org/10.1080/09500690701749305

Afifah, N., Octaviani, T.P., Sholikhah, U., Ismawati, R. (2022). Analisis Pemahaman Konsep IPA pada Siswa SMP dengan Kegiatan Praktikum. *Jurnal Pendidikan IPA*, 11(2), 84-88, https://doi.org/10.20961/inkuiri.v10i2.57258

Agustina, D.K. & Anggraini, D.P. (2018). Penerapan Pembelajaran Praktikum Berbasis Inkuiri Terbimbing untuk Meningkatkan Ketrampilan Proses Mahasiswa pada Materi Fermentasi. *Konstruktivisme*, 10(2), 144-153. https://doi.org/10.35457/konstruk.v10i2.508

Andriana, E., Vitasari, M., Oktarisa, Y., & Damayanti, D. C. (2017). Pengembangan Lembar Kerja Siswa (LKS) Berbasis Kearifan Lokal pada Mata Pelajaran IPA. *Prosiding Seminar Nasional Inovasi Pendidikan*, 318–325.

Anggraini, P., Supriatno, B., Gusti, U.A. (2024). Analisis Kualitas Lembar Kerja Siswa Berbasis Diagram Vee pada Praktikum SMA Materi Plasmolisis. *Jurnal ilmiah Pendidikan IPA*, 6(1), 27-34. https://doi.org/10.29100/.v6i1.4238

Apriani, F.N., Novaliyosi., & Jaenudin. (2021). Pengembangan Lembar Kerja Peserta Didik (LKPD) dengan Problem Based Learning Terhadap Kemampuan Pemahaman Konsep Matematis. *Wilangan*, 2(1), 88-96. http://dx.doi.org/10.56704/jirpm.v2i2.11658

Aqib, Z., & Murtadlo, A. (2016). *Kumpulan Metode Pembelajaran Kreatif dan Inovatif*. Bandung: Yrama Widya.

Ariyani, N.P.A.T., Suastra, I.W., Adnyana, P.B. (2021). Pengembangan Instrumen Kemampuan Berpikir Kritis dan Keterampilan Proses Sains Siswa Kelas V SD. *Jurnal penelitian dan Evaluasi Pendidikan Indonesia*, 11(2), 69-80.

Badan Standar Kurikulum dan Asesmen Pendidikan. (2022). *Panduan pembelajaran dan asesmen*. Kementerian Pendidikan Kebudayaan Riset dan teknologi.

Capah, J. & Fuadiyah, S. (2021). Analisis Kualitas Lembar Kerja Praktikum pada Materi Sel Menggunakan Diagram Vee. *Journal for Lesson and Learning Studies*, 4(2), 238-245. https://doi.org/10.23887/jlls.v4i2.38271

Cheung, D. (2020). The impact of interactive engagement methods on students' learning of high school physics. *Journal of Research in Science Teaching*, 57(5), 673-689.

Chutami, F. & Suhartini. (2021). The Effectiveness of Using Student Worksheets in Science Learning on Student Learning Outcomes. *Jurnal Penelitian Pendidikan IPA*, 7(4), 587-592. https://doi.org/10.29303/jppipa.v7i4.768

Darmayanti, N.W.S., Janawati, D.P.A., Sudirman, I.N., Nismayanti, N.L., Persi, N.L. (2021). Overcoming Hurdles in Science Practicum: Exploring Challenges and Solutions for Fifth Grade Students. *Jurnal Pendidikan/ Pedagogia*, 12(2), 128-136. https://doi.org/10.21070/pedagogia.v12i2.1602

Dewi, R., Budiarti, R. S., & Aina, M. (2017). Pengembangan lembar kegiatan peserta didik (LKPD) bermuatan pendidikan karakter dengan model pembelajaran guided inquiry pada materi bakteri bagi siswa kelas X sekolah menengah atas. *BIODIK*, 3(1), 17-26. https://doi.org/10.22437/bio.v3i1.4878

Fahmin, S.R. & Ardyati, D.P.I. (2020). Pengembangan Lembar Kerja Peserta Didik (LKPD) Berbasis Praktikum Dipadu Mind Map pada Materi Fungsi Kelas X di SMAN 6 Baubau. *Jurnal Edukasi Cendekia*, 4(2), 31-41. https://www.jurnal-umbuton.ac.id/index.php/JEC

Hamim, L., Fajarianingtyas, D.A., Hidayat, J.N. (2021). Pengembangan Petunjuk Praktikum Berbasis Masalah Memuat Literasi Sains Siswa SMP Kelas VIII. *Jurnal Pendidikan IPA*, 11(1), 31-37. https://doi.org/10.24929/lens.v11i1.155

Hasni, A., Roy, P., & Dumais, N. (2019). Designing effective science laboratory activities: Issues and perspectives. *International Journal of Science Education*, 41(4), 518-537.

Hindriana, A.F. (2016). The Development of Biology Practicum Learning based on Vee Diagram for Reducing Student Cognitive Load. *Journal of Education, Teaching and*

p-ISSN 1907-3089, e-ISSN 2615-5869
Vol 16, No. 2, 2024, pp 193 - 202
Available online https://journal.fkip.uniku.ac.id/quagga/index
DOI: 10.25134/quagga.v16i2.341

Learning, 1(2), 61-65. http://dx.doi.org/10.26737/jetl.v1i2.39

Irawan, N., Zaini, M., Winarti, A. (2023). The effectiveness of student worksheets based on critical thinking skills in biology class XI high school odd semester. *Jurnal Biologi-Inovasi Pendidikan*, 5(3), 273-280. https://doi.org/10.20527/bino.v5i3.15393

Kementerian Pendidikan Kebudayaan Riset dan Teknologi Republik Indonesia. (2024). *Kajian Akdemik Kurikulum merdeka*. Jakarta: Pusat Kurikulum dan Pembelajaran Badan Standar Kurikulum dan Asesmen Pendidikan Kementerian Pendidikan Kebudayaan Riset dan Teknologi.

Khan, M. J., & Ahmad, N. (2020). Evaluation of the effectiveness of laboratory manuals for biology education at the secondary level. *Journal of Biological Education*, 54(4), 425-437.

Langitsari, I., Aisyah, R.S.S., Permandhana, R.N., Nursaadah, E. (2024). Enhancing Students' Conceptual Understanding of Chemistry in a SiMaYang Learning Environment. *International Conference On Mathematics And Science Education,* 191-200, https://doi.org/10.18502/kss.v9i13.15919

Leite, L., & Dourado, L. (2013). Laboratory activities, science education and problem-solving skills. *Procedia Social and Behavioral Sciences*, 106, 1677–1686. https://doi.org/10.1016/j.sbspro.2013.12.190

Mislia, Qurbaniah, M., Kahar, A.P. (2017). Pengembangan Petunjuk Praktikum Biologi Berbasis Inkuiri Terbimbing Pada Materi Sistem Pencernaan. *Jurnal Bioeducation*, 4(1), 13-17. http://dx.doi.org/10.29406/516

Nasrudin (2019). *Metodologi Penelitian Pendidikan*. PT. Panca Terra Farma, Bandung.

Normarita, F. I., Nyeneng, I. D. P., & Ertikanto, C. (2015). Pengembangan LKS dengan Scientific Approach untuk Meningkatkan Keterampilan Berpikir Kreatif Siswa. *Jurnal Pembelajaran Fisika,* 3(3), 43–52.

Novak, J. D., & Gowin, D. B. (1984). *Learning How to Learn*. Cambridge University.

Nuai, A. & Nurkamiden, S. (2022). Urgensi Kegiatan Praktikum dalam Pembelajaran Ilmu Pengetahuan Alam di Sekolah Menengah Pertama. *Science Education Research (Search) Journal, 48-63.*

Rahmah, N., Iswadi, Asiah, Hasanuddin, Syafrianti, D. (2021). Analisis Kendala Praktikum Biologi di Sekolah Menengah Atas. *Biodik*, 7(2), 169-178. https://doi.org/10.22437/bio.v7i2.12777

Ramadhayanti, Anggraeni, S., & Supriatno, B. (2020). Analisis dan Rekonstruksi Lembar Kerja Peserta Didik Indra Pengecap Berbasis Diagram Vee. *Biodik*, 6(2), 95–108. https://doi.org/10.22437/bio.v6i2.9441

Rustaman, N.Y. (2005). Perkembangan penelitian pembelajaran berbasis inkuiri dalam pendidikan sains. *Prosiding Seminar Nasional II*. Himpunan Ikatan Sarjana dan Pemerhati Pendidikan IPA Indonesia bekerjasama dengan FPMIPA Universitas Pendidikan Indonesia.

Sari, D.S., Auliandari, L., Nawawi, S. (2020). Pelaksanaan Praktikum pada Pembelajaran Biologi di SMA Negeri Bingin Teluk dengan Analisis Model Rasch. *Jurnal Penelitian Pendidikan Biologi*, 4(1), 45-50. https://doi.org/10.32502/dikbio.v4i1.3300

Sumarmin, R., dan Roza, R.K. (2019). Pengembangan Penuntun Praktikum Biologi Berbasis Pendekatan Saintifik untuk MTs./SMP Kelas VII Semester II. *JEP (Jurnal Eksakta Pendidikan)*, 3(2), 152-158 https://doi.org/10.24036/jep/vol3-iss2/334

Sundari, T., Pursitasari, I.D., Heliawati, L. (2017). Pembelajaran Inkuiri Terbimbing Berbasis Praktikum pada Topik Laju Reaksi. *Pendidikan Sains Pascasarjana Universitas Negeri Surabaya*, 6(2), 1340-1347. https://doi.org/10.26740/jpps.v6n2.p1340-1347

Supriatno, B. (2013). Pengembangan Program Perkuliahan Pengembangan Praktikum Biologi Sekolah Berbasis Ancorb Untuk Mengembangkan Kemampuan Merancang Dan Mengembangkan Lembar kerja siswa. *Disertasi*. Sekolah pascasarjana Universitas pendidikan Indonesia, Bandung.

Suryaningsih, Y. (2017). Pembelajaran Berbasis Praktikum sebagai Sarana Siswa untuk Berlatih Menerapkan Keterampilan Proses Sains dalam Materi Biologi. *Jurnal Bio*

p-ISSN 1907-3089, e-ISSN 2615-5869
Vol 16, No. 2, 2024, pp 193 - 202
Available online https://journal.fkip.uniku.ac.id/quagga/index
DOI: 10.25134/quagga.v16i2.341

Educatio, 2(2), 49-57. http://dx.doi.org/10.31949/be.v2i2.759

Susanti, R.H. (2023). Penulisan Karya Ilmiah sebagai Salah Satu Tools Meningkatkan Kemampuan Berpikir Kritis. *Jurnal Inovasi Edukasi*, 6(1), 1-11. https://doi.org/10.35141/jie.v6i1.652

Titisari, P.W. (2019). Laboratory hands-on activity: A case study in senior high school of Pekanbaru-Indonesia. *Jurnal Pendidikan Biologi Indonesia*, 5(2), 253-268. https://doi.org/10.22219/jpbi.v5i2.8457

Utomo, E.N.P. (2018). Pengembangan Modul Berbasis Inquiry Lesson untuk Meningkatkan Literasi Sains Dimensi Proses dan Hasil Belajar Kompetensi Keterampilan pada Materi Sistem Pencernaan Kelas XI. *Jurnal Tadris Pendidikan Biologi*, 9(1), 45-60. http://dx.doi.org/10.24042/biosf.v9i1.2878

Walker, J. P., Sampson, V., Grooms, J., Anderson, B., & Zimmerman, C. O. (2019).