IJIS Edu : Indonesian J. Integr. Sci. Education, 3 (2) 2021

Analysis and Reconstruction Design of Laboratory Activities in Osmosis Materials

Rifda Tanfiziyah[1] , Bambang Supriatno[2], Sri Anggraeni[3]
Department of Science Education, Indonesia Education University. Jl. Dr. Setiabudhi No. 229 Bandung, Indonesia

Coressponding Author. E-mail:
rifdatanfiziyah@upi.edu

Received: May 25th, 2020 *Accepted:* June 28th, 2021 *Online Published:* July 1st, 2021

Abstract

Practicum and laboratory activities cannot be taken from biology learning. Activities require Laboratory Activity Designs and Student Worksheets as instructions for their implementation. Based on the results of a field study) that student worksheet measured in the field has several problems. Therefore, to overcome this, an in-depth analysis and reconstruction of student worksheet is needed. This study aims to describe the results of the analysis, trials and reconstruction of student worksheet osmosis to meet the requirements of the 2013 curriculum. The research method used is descriptive qualitative with a sample of 8 student worksheet from the 2004 curriculum, school based curriculum and 2013 curriculum. The selected student worksheet uses purposive sampling technique. The research instrument used was in the form of practical analysis, knowledge construction, and the relevance of the curriculum and content. Based on the results of the relevance analysis, most of the student worksheet are relevant to the curriculum. From the aspect of knowledge construction, student worksheet cannot yet describe the development of student skills. The results of the reconstruction that have been made have been assessed by experts. The research method used is descriptive qualitative with a sample of 8 student worksheet from the 2004 curriculum, school based curriculum and 2013 curriculum. Based on the results of the relevance analysis, most of the student worksheet are relevant to the curriculum. From the aspect of knowledge construction, student worksheet cannot yet describe the development of student skills. The results of the reconstruction that have been made have been assessed by experts..

Keywords: *Laboratory Activity Design; Student Worksheet Reconstruction; Osmosis*

How to cite this article :

Tanfiziyah, R., Supriatno, B. & Anggraeni, S. (2021). Analysis and Reconstruction Design of Laboratory Activities in Osmosis Materials. *IJIS Edu : Indonesian Journal of Integrated Science Education, 3*(2), 115-124 . doi:http://dx.doi.org/10.29300/ijisedu.v3i2.4570

INTRODUCTION

The industrial revolution resulted in various changes including science education, including biology education, which must be transformed according to the times. Education 4.0 does not only aim at mastering concepts but focuses more on improving skills that students need to have. This is in line with the demands of 21st Century learning(Zubaidah, 2019). Biology learning is a vehicle for increasing knowledge, skills, attitudes and values as well as responsibility for the environment (Siburian, 2015). According to Piaget in learning, teachers are required to be able to provide concrete experiences to students through observations or experiments to solve science problems, so that later students can link new material to material that has been previously studied, and in the end meaningful learning can be achieved.(Suparno, 2000).

So that learning can provide a concrete experience and can improve student skills so practicum activities are needed. Practicum or laboratory activities can improve student academic achievement (Shana & Abulibdeh, 2020). In line with the phrase Supriatno (2009) the existence of practicum can give a complete and more meaningful impression to students, because during learning students tend to involve various senses. Erwinsyah et al., (2016) This is because practicum activities are a way to change minds on learning biology into hands-on learning.

On Generally, practicum or laboratory activities carried out by students refer to the Design of Laboratory Activities. The content of design of Laboratory Activities is usually in the form of work steps that can guide students in carrying out activities in the laboratory (Laelasari & Supriatno, 2018). Design of Laboratory Activities or what most people usually call Student Worksheet used can be sourced from biology textbooks or can be designed by the teacher himself (Supriatno, 2013). In fact, in the field the student worksheet used in schools still have problems. This is based on the results of field studies Supriatno (2013)who revealed these problems that: (1) The objectives of the practicum emphasize more on cognitive aspects than psychomotor aspects; (2) Most of them use a deductive approach with an expository model; (3) Even though detailed practicum procedures, some of them are not structured and the orders are confusing, giving rise to multiple interpretations; and (4) The selection of material does not consider its essence, suitability, depth and complexity. Also supported by the research conducted Ramadhayanti et al., (2020) often in student worksheet the objectives of the practicum are not clear, sometimes it is not in accordance with the events or objects observed. Then, often the desired facts do not appear in accordance with the objectives of the practicum and are not in accordance with the theories, principles or concepts related to the material. In addition, often in practicum students are not instructed to note what phenomena are found during the practicum, most of them are just observing it. This will clearly affect the conclusion made by students because the conclusions must be in accordance with the objectives of the practicum.

Based on this, student worksheet is needed which can be a guide for students to be able to construct their knowledge, contribute to the development of basic skills and students' thinking abilities. Therefore, this paper aims to analyze and study the student worksheet osmosis in the field and then carry out the reconstruction design of the osmosis student worksheet.

The concept of osmosis is a basic concept or prerequisite concept that students need to understand because it is a basic concept for learning the next concept (Allard & Granberry, 2017). However, students often misconceptions on the concept of osmosis, this is in accordance with the findings Emriyuni et al., (2018) Misconceptions among students on substance transport material are often found in the concepts of diffusion and osmosis.

METHOD

The research method used is descriptive qualitative through the stages of analysis, testing, and reconstruction. This research begins with the analysis of student worksheet found in the field, both from textbooks and from the internet. The research was continued by conducting tests on the work steps of the sample student worksheet without making any changes from the student worksheet. After analyzing and testing, the researcher reconstructed student worksheet osmosis. Reconstruction is carried out by conducting trials of the existing design of laboratory activities, then analyzing the design of laboratory activities from different years, then asking for advice from experts

The sample used in this study amounted to 8 student worksheet including 1 student worksheet 2004 curriculum, 5 student worksheet

school based curriculum and 2 student worksheet 2013 curriculum. The sampling technique was carried out by purposive sampling. The research instrument used in this study has been validated by a team of lecturers which includes a practical analysis rubric, knowledge construction and a rubric of relevance to the curriculum. The rubric consists of several scores ranging from 0-4 and then the total is calculated divided by the maximum score.

RESULTS AND DISCUSSION

The findings show that there are still problems with the work steps in student worksheet osmosis senior high school. The problems that arise are described in table 1 in detail. Problems that arise during the test work steps are when making plant cells to be observed, unrepresentative time in practicum activities, making solutions that do not include the solute to be used. Several problems were caused because the instructions given were not detailed and structured, which could lead to multiple interpretations. This is consistent with the findings (Laelasari & Supriatno, 2018). Most of the biology worksheets in the field have work steps that do not lead to obtaining correct data and several steps are not structured. Some of these problems arise because student worksheet that is made usually does not go through the laboratory testing stage. Likely, the design of laboratory activities made by the teacher or publisher is a copy of the existing laboratory activity designs (Vikram et al., 2020). This is in line with the statement Laelasari & Supriatno (2018) that the design of existing laboratory activities in schools has been adopted without adaptation and reconstruction.

Table 1.The results of the analysis of the work step test problems

Student worksheet code	Troubled instructions	Description of the problem
1	Prepare four apple slices, noting their shape	It is not specifically explained what form this means makes researchers confused about it because what will be seen later is the change in shape after being immersed in salt water overnight without weighing the size or measuring the change in length so that the results will be very subjective.
2	Put distilled water into beaker A; enter 10% sugar solution into beaker B, enter 20% sugar solution in beaker C.	Making a 10% and 20% sugar solution is difficult to do when using the tools listed in the student worksheet. The only tools listed in the student worksheet are ruler, beaker, potato, distilled water, and sugar. How can you make a solution when the ingredients that are dissolved are not listed
3	Cut the potatoes into cubes, measuring 1cm x 1 cm x 1 cm	This activity is difficult to do to make cubes with an exact and homogeneous size using the tools (knife / cutter) listed in the student worksheet.
4	Make a well on both potatoes about one-third the size of the potato	This is difficult to do because when cutting the bottom to make a well can make the thickness underneath different so it is difficult to make homogeneity between one potato tuber and another.
5	Cut 9 pieces of potato into cubes with a size of 3x3x3 cm	This activity is difficult to do to make cubes that are exactly the same size and homogeneous, let alone make a large quantity of 9 cubes
6	Cut the 2x2 potato into 3 pieces	This activity is difficult to do to make 3 pieces of potato size 2x2
7	Soak the potato pieces in the salt solution for ten minutes	There was no change whatsoever when the potatoes were put in salt water and only 10 minutes so the data did not support the expected results

8	Every 5 minute interval, remove a potato or carrot cube from each beaker and cut it in half with a razor blade. Next, measure the distance of the iodine solution that enters the cube starting from the edge of the kunus slice towards the middle area where the iodine color is still observed. Calculate the average distance for 25 minutes	Researchers found it difficult when measuring the distance of the iodine solution that entered the cube because the initial pieces instructed by the cube was 3x3x3 cm, meaning that the size was very small and it was difficult to make a homogeneous size. Moreover, the steps are instructed to make the average distance. How is it possible to make an average distance if the distance measured from the start is not too clear how much.

The results of the competency analysis on student worksheet Osmosis (Table 2) show that for the components of the relevance aspect of activities and the curriculum which consists of indicators of compliance with student worksheet with KD demands of 50%, meaning that out of 8 student worksheet analyzed, most of the competencies developed in practicum meet the minimum KD standards. For example, the basic competencies of the 2013 curriculum on osmosis material for class XI with KD 3.2 which reads "analyzing various bioprocesses in cells including membrane transport mechanisms, reproduction and protein synthesis" and KD 4.2 "making models of bioprocesses that occur in cells based on literature studies and experiments ". In order to achieve the expected basic competencies, several practicum activities are required.

Table 2. Competency Analysis Results

Indicator	Result
Competence at worksheet in accordance with the demands of basic competence	50%
Content on worksheet in accordance with basic competencies	50%
Observation	33,3%
Data transformation	20,8%
Data interpretation	25%

Meanwhile, the indicator of content suitability with KD obtained a percentage of 50%, meaning that the content in practicum activities meets the minimum standard of KD. The student worksheet analyzed, the content is on average only in the form of observations of the osmosis process that occurs in plant cells without explaining how the bioprocess occurs in them. According to Rahmatilla, et al., (2017); Ansyar (2017) in designing laboratory activity designs for practicum activities should make basic competencies as benchmarks for the goals and cognitive achievements of students. The implementation of the curriculum must also lead to interaction between students and content. The results of this interaction can make student knowledge which is then transformed or constructed into an experience or competence.

Assessed from the competency aspect (hands on and minds on) the ability of observation as presented in Table 2. It can be seen that 33.3% of the observation abilities developed from each student worksheet mean that on average the existing student worksheet only observes the general character of the object or phenomenon not observing the specific character of objects and phenomena. According to Wahidah et al., (2018) very important objects and events appear in the observation of practicum activities, meaning that the main object or event as well as the accompanying event objects can be identified and consistent with the focus question. This is in line with the statement Eka Astika et al., (2020) the object / phenomenon does not appear due to inappropriate procedures.

In the aspect of student competence as listed in Table 2, regarding the transformation of the data for the acquisition of a score of zero (0) on student worksheet, it means that there are no identifiable records or data transformations. Then, for a score of 1, it means that both qualitative and quantitative data are represented in standard forms (descriptions for qualitative data and graphs and tables for quantitative data). According to Supriatno (2013) If the notes and transformation components are not owned, student worksheet cannot increase students' self-awareness so that the metacognitive process to understand and interpret the results of observations is not facilitated. This is in accordance with the statement Handayanie et al., (2020) if in a practicum there is no process of recording and transforming data, then the

knowledge claim made can be wrong or irrelevant to the conceptual side of Vee. The two statements agree with Novak & Gowin (1984) which states that data recording and / or data transformation can determine the extent to which students can combine the theories, principles and concepts they know into the design notes of their observations. In fact, the existence of orders to record and / or transform data can help students shape their knowledge in answering focus questions so that practicum activities will be more meaningful.

The results of the analysis on the interpretation aspect of 25%, the score obtained is very diverse, there is a student worksheet score of zero (0) where the data cannot be interpreted, then a score of 1 only reads the data component (quantitative data). This means that students only read the virgin components without making comparisons. Furthermore, based on Table 2, on the aspects of competence (hands on and minds on) the level of average thinking ability of student worksheet analyzed only in the process of observing without being asked to connect with the bioprocess that occurs in cells. It can be interpreted that the current circulating student worksheet of osmosis tends to be less varied in the verification model so that the skills that are displayed are only limited to observations. This is because the form of practicum which refers to the design of laboratory activities basically does not provide experience and observation up to the analysis process. This is in accordance with the explanation put forward by Woolnough that the form of practice practicum is used to develop basic skills, the form of investigative practicum is used to train skills in problem solving, and the form of practicum that is giving experience is used to help understand the subject matter (Rustaman & Wulan, 2007).

Result of Knowledge Construction Analysis

Knowledge construction analysis aims to analyze the knowledge construction process which is ideally formed based on objects / phenomena that appear, are recorded and used to construct knowledge (Kurniasih et al., 2020). The results of the knowledge construction analysis are shown in table 3.

Table 3. Knowledge Construction Analysis Results

Indicator	Result
Title / Purpose / Focus question	45.8%
The object of the phenomenon	25%
Theories, principles and concepts	43.75%
Data recording and transformation	40.6%
Acquisition of knowledge	34.3%

The results of the analysis of knowledge construction on the first indicator related to the title or focus question were 45.8%, meaning that part of the student worksheet analyzed had titles or object that focused on the main things both objects and phenomena that supported the observation process however. Meanwhile, some of the other student worksheet had already included the title or goal, however, they had not focused on the object or phenomenon being observed. According to Wahidah et al., (2018) often in the design of laboratory activities the objectives of the practicum are not clear, sometimes it is not in accordance with the events or objects observed. Then the expected facts do not appear in accordance with the objectives of the practicum and are not in accordance with the theories, principles, and concepts related to the material.

In the object / phenomenon aspect of student worksheet which is analyzed as much as 25% can bring up objects and phenomena, it's just not consistent with the focus question, meaning that laboratory activities that aim to observe objects / phenomena can be identified but not consistent with the title or focus question. As many as 75% of student worksheet have not been able to bring up the object / phenomenon observed and in accordance with the focus question, even though motorcycle taxis and events are very important from laboratory activities obtained from the results of observations (Novak & Gowin, 1984).

Then, examined from the aspects of theory, principles and concepts in Table 4. only 43.75 student worksheet where data transformation activities can be identified. According to Swami & Shields (2006) If in the practicum there is no process of recording and transforming data, then the knowledge claim made can be wrong or irrelevant to the conceptual side of Vee. This means that in the student worksheet variety generally there are theories, principles and concepts that can provide

a basis for students to construct new knowledge or as a basis for further learning. This is as stated Nadia et al., (2020) that these theories, principles and concepts will also support the process of data recording and data transformation, because an understanding of theory, principles and concepts is initial knowledge that will help and direct students to more easily organize the data obtained so that the data obtained can support the formation of knowledge claims . The results of the analysis of data recording and transformation were 40.6%, meaning that recording activities could be identified but not consistent with the main activities.

Assessed from the aspect of knowledge construction as listed in Table 3, it can be seen that as much as 34.3% of the existing student worksheet reflect knowledge claims (acquisition of knowledge). student worksheet which has a score of 1 means that the acquisition of knowledge is not in accordance with the left side of the Vee Diagram, while for student worksheet which has a score of 2 it means that the acquisition of knowledge is inconsistent with the data and / or events that are recorded and transformed or the acquisition of knowledge already contains a conceptual side. According to Eka Astika et al., (2020) Acquisition of knowledge that is used in inappropriate contexts can occur because there is no recording or transformation of data obtained in practicum activities. There are only instructions for observing it.

Results of Practical Analysis

Practical analysis according to Kurniasih et al., (2020) aims to analyze the implementation of laboratory activities in presenting objects / phenomena. Practical analysis was carried out on 8 samples of student worksheet, each of which consisted of the 2004 curriculum, the school based curicullum and the 2013 curriculum. The results of the analysis are in table 4.

Table 4. Practical Analysis Results

Indicator	Result
Tools and materials are in accordance with school standards and are easily available.	95.8%
Tools and materials have clear units.	79.1%
Work procedures are structured and do not cause errors.	58.3%
Objects and phenomena emerge and are easily observed through work procedures.	62.5%
The data recording table corresponds to the phenomenon object that appears and is easy to interpret.	50%

The study of the results of practical analysis, from the aspect of material tools, has the highest score among others. In the student worksheet analyzed the tools and materials requested were all in accordance with school laboratory standards and were easy to obtain. Easy to get here, it means that if there is no tool in school, it can be replaced flexibly using a similar tool that has the same function. In table 3, for the material tools listed in student worksheet, only a few tools and materials have a clear unit.

Based on the results of the analysis of work procedures / work steps it is partially clear with a percentage of 58.3%, but it is not equipped with pictures / illustrations or charts. According to Millar (2004) the effectiveness / effectiveness of a practicum work can be measured in terms of (1) activity procedures, which are related to what students are doing, and (2) the results of practicum work, in this case related to what students learn The effectiveness of the work steps in question is the implementation of steps / work procedures in the design of laboratory activities and can also produce expected data / facts. This is in accordance with the opinion Laelasari & Supriatno (2018)there is a wrong work step in an student worksheet can result in a reduced level of work effectiveness. If the effectiveness of work decreases, then basically the students do a lot that should not be done. Thus students learn not about what should be learned.

The results of the analysis of the existence of the data recording table by 50% means that there is a data recording table, it's just not suitable and can only record some objects and phenomena. According to Novak & Gowin (1984) recording data transformations can be used to determine the extent to which students can combine theories, principles and concepts that students know into a draft of observation notes. With the command to record or transform data, it can help students shape their knowledge

in answering focus questions so that practicum activities are more meaningful (Meirin Dwiningtyas Putri et al., 2020).

Results of Student Worksheet Reconstruction

Often, in carrying out laboratory activities students are confused by unstructured steps. This causes uselessness in doing practicum (Novak & Gowin, 1985). One of the causes of the meaninglessness of the practical is the design of the practical activity which cannot be an accurate guide, which causes students to not be able to construct concepts, principles, and theories and does not involve students' thinking processes. So in order for laboratory activities to be more effective and meaningful for students, teachers need to analyze the application of the feasibility of laboratory activity designs and want to carry out trials so that they can adopt the design of laboratory activities by adapting and reconstructing. It would be better if the teacher was able to design and develop laboratory activities on their own (Eka Astika et al., 2020).

Based on the results of trials and analysis of the design of laboratory activities that have been carried out by researchers, the following is suggested to reconstruct the design of laboratory activities. The reconstruction made is for the design of the pandemic period laboratory activities so that students can still do it in their own homes. In the reconstruction, an expert judgment has been made. Following are the results of the suggested student worksheet reconstruction:

What happens if potatoes are soaked in salt water with different concentrations?

Aim:

1. Determine the effect of different concentrations on potatoes
2. Observe the facts of the symptoms of osmosis

Time Allocation:

2x45 minutes

Tool:

Tweezers 1 piece
1 piece ruler
Mixer (spoon)
Pens / markers (stationery)
Cork borer / potato cutter
5 measuring cups
Analytical balance
1 knife/ scalpel
stopwatch

Materials:

1. 2 potato tubers
2. Distilled water
3. Salt
4. Label
5. Tissue

Attention!

Be careful using sharp objects not to injure the limbs!

Procedure

1. Make a salt solution in the five measuring cups with a concentration of 0 mol / dm3 each; 0.25 mol / dm3; 0.5 mol / dm3; 0.75 mol / dm3; 1.00 mol / dm3 and give a label in the form of writing to mark each glass
2. Use a cork borer to cut 5 cylinders of potato

3. Use a knife / cutter and ruler to cut the ends of the potato cylinders so they are the same length
4. Weigh the weight of the potatoes that have been cut one by one then record the weight in the table (Remember not to mix the potatoes that have been weighed to be put into a different solution)
5. Then put the potatoes one by one in the glass, let stand for 45 minutes
6. After 45 minutes, remove the potatoes using a piset then store them on tissue paper to avoid excess water
7. Observe and weigh the potatoes then record them in the table provided
8. Calculate the percentage change in weight and length using the formula below:

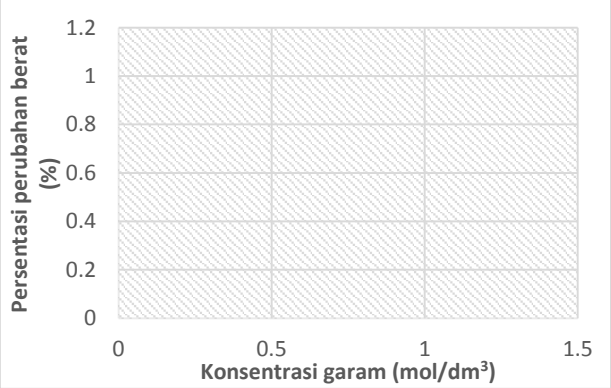
$$\text{Percentage change in mass (\%)} = \frac{\text{Final Weight (g)} - \text{Initial Weight (g)}}{\text{Initial Weight (g)}} x\ 100\%$$

9. Graph the percentage change in weight (vertical axis) against salt concentration (horizontal axis)

Observation Table

Concentration of mol / dm3 salt solution	Initial Weight (g)	Final Weight (g)	Change in weight (g)	Percentage change in mass (%)
0				
0.25				
0.50				
0.75				
1.0				

Observation chart



Question

a. What happened after the potato slices were immersed at different concentrations during experiment I (first 45 minutes) and experiment II (second 45 minutes)? What is the essence of the increase or decrease in weight? (Explain scientifically!)
b. After the experiment, which concentration shows the osmotic potential of potatoes?
c. The change in weight of the potato strips is the increase or decrease in weight? After knowing this, then which solution is hypertonic, hypotonic and isotonic? (Explain one by one!)
d. Based on the graph that has been made, how is the relationship between the difference in the concentration of the salt solution and the weight change in potatoes?
e. Based on the results of the experiment, what will happen if you water the plants using salt water? Will the water leave or enter the plant cell if it has a higher water potential than the surrounding environment?
f. Give a conclusion from the results of the experiments that have been carried out!

Student worksheet osmosis circulating and used in schools has not contained content and trains students' skills in accordance with the demands of the applicable curriculum. Based on the results of practical analysis, knowledge construction and the relevance of curriculum and content, the student worksheet used does not yet fully fulfill the complete student worksheet components and can build student skills. In fact, practicum and laboratory activities are very important in learning biology. After analyzing and testing the work steps, reconstruction is generated as a solution to the existing problems. The results of the reconstruction have been judged by experts in their fields.

REFERENCES

Allard, D. W., & Granberry, R. L. (2017). Osmosis Revisited. *The American Biology Teacher*, *54*(8), 456–457.

Eka Astika, Sri Anggraeni, & Bambang Supriatno. (2020). Analisis Komponen Penyusun Desain Kegiatan Laboratorium Enzim Katalase. *Biodik*, *6*(3), 343–356. https://doi.org/10.22437/bio.v6i3.9469

Emriyuni, S., Ardi, A., & Rahmi, Y. L. (2018). Identification Misconception of Transport Substance on A Freshman Used Technique Certainty of Response Index (CRI) in the Study Biology UNP Education. *Bioeducation Journal*, *2*(1), 41–50. https://doi.org/10.24036/bioedu.v2i1.71

Erwinsyah, R., Riandi, R., & Nurjhani, M. (2016). Relevansi praktikum dan perkuliahan teori pada mata kuliah genetika. *Proceeding Biology Education Conference: Biology, Science, Enviromental, and Learning*, *13*(1), 546.

Handayanie, Y., Anggraeni, S., & Supriatno, B. (2020). *Analisis Lembar Kerja Siswa Praktikum Struktur Darah berbasis Diagram Vee (Analysis of Blood Structure Student ' s Practical Worksheet based on Diagram Vee)*. *6*, 361–371.

Kurniasih, W., Sri Anggraeni, & Bambang Supriatno. (2020). Alternatif Lembar Kerja Peserta Didik Materi Osmosis Berbasis ANCORB. *Biodik*, *6*(3), 266–276. https://doi.org/10.22437/bio.v6i3.9451

Laelasari, I., & Supriatno, B. (2018). Analisis komponen penyusun desain kegiatan laboratorium bioteknologi. *Jurnal Bioedukatika*, *6*(2), 84. https://doi.org/10.26555/bioedukatika.v6i2.10592

Meirin Dwiningtyas Putri, Sri Anggraeni, & Bambang Supriatno. (2020). Analisis Kegiatan Praktikum Biologi SMA Materi Sistem Pernapasan Manusia. *Biodik*, *6*(3), 288–298. https://doi.org/10.22437/bio.v6i3.9454

Millar, R. (2004). *The Role of Practical Work in The Teaching and Learning of Science*. National Academi of Science.

Nadia, N., Supriatno, B., & Anggraeni, S. (2020). Analisis dan Rekonstruksi Komponen Penyusun Lembar Kerja Peserta Didik Struktur dan Fungsi Jaringan Tumbuhan. *Biodik*, *6*(2), 82–94. https://doi.org/10.22437/bio.v6i2.9439

Novak, & Gowin. (1984). *Learning How to Learn*. Cambridge Univeristy Press.

P, Suparno. (2000). *Teori Perkembangan Kognitif Jean Piaget*. Kanisisus.

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, A., & Wulan, A. R. (2007). Kegiatan laboratorium dalam pembelajaran biologi. In *Universitas Terbuka*.

Shana, Z., & Abulibdeh, E. S. (2020). Science practical work and its impact on students' science achievement. *Journal of Technology and Science Education*, *10*(2), 199–215. https://doi.org/10.3926/JOTSE.888

Supriatno, B. (2009). Uji langkah kerja laboratorium biologi sekolah. *Proseding Seminar Nasional Jurusan Pendidikan Biologi*, *Univeritas*(Bandung).

Supriatno, B. (2013). *Pengembangan Program Perkuliahan Pengembangan Praktikum Biologi Sekolah Berbasis ANCORB untuk Mengembangkan Kemampuan Merancang dan Mengembangkan Desain Kegiatan Laboratorium.*

Swami, & Shields. (2006). *Gowin's Knowledge Vee: Using To Improve Preservice Teachers Ability for Conducting and Directing Science.*

Vikram, M., Supriatno, B., & Anggraeni, S. (2020). Analisis Komponen Penyusun Lembar Kerja Peserta Didik Uji Golongan Darah Sistem ABO. *Biodik : Jurnal Ilmiah Pendidikan Biologi*, *6*(4), 562–569. https://online-journal.unja.ac.id/biodik

Wahidah, S. N., Supriatno, B., & Kusumastuti, N. M. (2018). Analisis Struktur dan Kemunculan Tingkat Kognitif pada Desain Kegiatan Laboratorium. *Assimilation: Indonesian Journal of Biology Education ISSN*, *7260*(2), 70–76.

Zubaidah, S. (2019). Pendidikan Biologi dalam Perkembangan Revolusi Industri. *Seminar Nasional Pendidikan Biologi Dengan Tema "Biologi Di Era Revolusi Industri 4.0: Riset Dan Pembelajaran" Di FKIP Univesitas Negeri Jakarta*, *December*, 1–22.