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Reconstruction of Senior High School Laboratory Activity Design on Motion System Materials

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Abstract: This study aims to provide an overview of the motion system practicum design used in senior high school. This research is a qualitative descriptive study. The samples in this study were 3 samples of motion systems in bone structure sub-material laboratory activity design, which were taken using a purposive sampling technique. This study uses an instrument developed based on the Vee Diagram component scoring table adapted from Novak and Gowin's book. The 3 things that underlie the research instruments used, namely: 1) the suitability of the LKS components, not yet by the demands of the 2013 Curriculum Basic Competence, 2) the title and objectives do not follow the work steps and are not relevant to the phenomena that appear, 3) the construction of knowledge has not led on emerging phenomena. Meanwhile, based on the results of the analysis of the Vee Diagram scoring instrument, shows that the components of focus questions, objects/ events, concepts/ theories/ principles, transformation notes, and knowledge claims have not yet reached the maximum score so the circulating practicum worksheets do not support the Vee Diagram by Novak & Gowin components optimally so it needs to be reconstructed.

***Keywords*:** *laboratory activity design, motion system, hard bone structure, vee diagram*

INTRODUCTION

Biology learning is related to the activity of systematically finding out about nature so learning biology is not only mastering a collection of knowledge in the form of facts, concepts, or principles but also a process of discovery. One of the activities that characterize biology learning is practical activities. Practicum activities are activities that facilitate students to observe an object or phenomenon in real terms that aim to help students find conceptual knowledge of the phenomenon (Hamidah et al., 2014, Dewi et al., 2021). Practicum activities will

be a key factor that can motivate and inspire students, thereby increasing student interest and learning outcomes (Handayanie et al., 2020).

Practicum activities have an important role in realizing effective Biology learning (Hamidah et al., 2014). However, this effectiveness must be supported by the design of good and appropriate practicum activities. Therefore, practicum activities in a biology lesson must be properly structured and implemented (Hamidah et al., 2014). The design of good practicum activities will produce good practicum activities. The design of practicum activities is considered good if it is made by adjusting the curriculum used so that the practicum activities carried out can help improve student learning outcomes as expected by the teacher.

The practicum activities that take place cannot be separated from the existence of the laboratory activity design. The laboratory activity design is made by the teacher to facilitate learning activities including practicum activities so that they run according to the procedure. The Laboratory activity design can be made according to the conditions and situations of learning activities that will be faced by students. The existence of the laboratory activity design has had a major influence on ongoing practicum activities (Dewi et al., 2021). If laboratory activity design is not prepared properly and correctly, practicum activities cannot run well and learning objectives cannot be achieved.

The laboratory activity design that is prepared must meet various requirements, namely didactic, construction, and technical requirements. The quality of the laboratory activity design can be measured first through several assessments and tests before later being used in learning. Determination of the quality of laboratory activity design can be seen from the value obtained from the assessment rubric, whether the value meets the standard or not. The laboratory activity design that is less than the standard is of course considered inappropriate and needs to be reconstructed according to the standards that have been made.

There are quite a lot of problems found in the laboratory activity design on Motion System Material in Hard Bone Structure Sub-material that is widely used in the field, such as mismatched titles and objectives, non-detailed descriptions of tools and materials, unclear procedures, questions that are not related to practicum, objects or phenomena. does not appear and many more. Various problems were found in each laboratory activity design that the researchers found. After conducting an assessment, the laboratory activity design used in the field is still not suitable for use and needs to be reconstructed. This reconstruction was carried out by looking at the errors that existed in the previous laboratory activity design. This laboratory activity design reconstruction needs to be carried out to get a laboratory activity design motion system material in hard bone structure sub-material that is suitable for use by teachers in learning.

Similar research has been carried out by several researchers on other biological materials such as material on how the catalase enzyme works (Setiawan et al., 2022), plant growth and development (Dewi et al., 2021), blood structure (Handayanie et al., 2020), the human respiratory system (Putri et al., 2020), blood group (Vikram et al., 2020) and biotechnology (Muzakki et al., 2021).

These studies carried out almost the same thing, namely in the form of laboratory activity design analysis and reconstruction, but no one has done this on bone structure material. The circulating bone structure's laboratory activity design is still not by the 2013 Curriculum and there are still several things that need to be improved. This research will focus on discussing the laboratory activity design analysis in practicum material for motion systems in hard bone structure sub-material, and the laboratory activity design reconstruction from the results of the researcher's analysis. This study aims to analyze errors in the laboratory activity design that have been circulating and present the laboratory activity design reconstructions by the 2013 Curriculum. This research is certainly useful for Biology teachers who will teach this material to their students. Appropriate laboratory activity design will make learning effective and meaningful.

METHOD

Research Design

The research design is a qualitative approach. Especially for qualitative research, the time and place of research need to be written down clearly (for quantitative research, it is also necessary). Research targets/subjects (for qualitative research) or sample population (for quantitative research) need to be explained clearly in this section. It is also necessary to write down the technique of obtaining subjects (qualitative research) and/or the sampling technique (quantitative research). This research is a qualitative descriptive study. The time for conducting the research is from March to May 2022 at the UPI Bandung Physiology Laboratory. The research targets were some laboratory activity design about motion systems in hard bone structure sub-materials that are used in senior high school right now. The samples in this research were taken using a purposive sampling technique.

Population and Sample

The samples in this study were 3 laboratory activity designs of senior high school Biology books that used the 2006 Curriculum and the 2013 Curriculum. The population in this study was laboratory activity design of senior high school in Biology books that used the 2006 Curriculum and the 2013 Curriculum about hard bone structure sub-material. In the first step, a practical trial was carried out on 3 laboratory activity designs samples without any work step manipulation. After that, followed by analysis using two instruments that have been prepared. Next, a laboratory activity design reconstruction is carried out which refers to the highest weight in the assessment rubric. The final step is to try out the results of the reconstruction by other people to find out whether the laboratory activity designs that have been reconstructed are feasible or not.

Research Instrument

The data collection techniques used in this study are observation and analysis based on trial activities. The instruments used in this study were

component conformity analysis in Laboratory Activity Designs and Vee Diagram knowledge construction analysis adapted by Novak & Gowin (2006). The results of these observations resulted in conclusions and assessments related to the design of laboratory activities that had been tested with several assessment aspects. The instrument for component conformity analysis in Laboratory Activity Designs used the scoring rubric in Table 1 below.

Table 1. Scoring Rubric The Instrument of Component Conformity Analysis in Laboratory Activity Designs

Num.	Indicator	Score
	Title	
1.	Has no title	0
2.	The title does not contain an essential concept	1
3.	The title contains the essential concept but does not describe the activity	2
4.	The title contains the essential concept and describes the activity	3
5.	The title contains essential concepts, describes activities and is in the form of 4 interrogative sentences	4
	Goals	
6.	Has no purpose	0
7.	Objectives relevant to the curriculum (essential)	1
8.	Objectives are relevant to the curriculum (essential) and focus on activities that construct factual knowledge	2
9.	Objectives are relevant to the curriculum (essential) and focus on activities that construct factual and conceptual knowledge	3
10.	Objectives are relevant to the curriculum (essential) and focus on activities that construct factual, conceptual and procedural knowledge	4
	Procedures	
11.	Procedures are irrelevant to goals	0
12.	Procedures are relevant to objectives, structured and logical	1
13.	Procedures are relevant to objectives, structured and logical, elicit objects and phenomena but do not support knowledge/competence construction	2
14.	Procedures are relevant to objectives, structured and logical, elicit objects and phenomena but do not support knowledge/competence construction	3
15.	Procedures are relevant to objectives, structured and logical, eliciting objects and phenomena that support knowledge/competence construction	4
	Maximum Score	**12**

RESULT AND DISCUSSION

Result of Research Procedure

The results of the analysis carried out on the 3 Laboratory Activity Design (LAD) based on suitability analysis on conceptual, practical, and knowledge

construction aspects as well as knowledge construction based on the Vee Novak & Gowin Diagram can be seen in Table 2 below.

Table 2. Component Conformity Analysis Results in Laboratory Activity Design (LAD)

Indicator	Maximum Score	LAD 1	LAD 2	LAD 3	Average Score
The title contains essential concepts, describes activities, and is in the form of interrogative sentences	4	1	2	3	**2**
Objectives are relevant to the curriculum (essential) and focus on activities that construct factual, conceptual, and procedural knowledge	4	2	0	2	**1,3**
Procedures are relevant to the objectives, structured and logical, and also generate objects or phenomena that support the construction of knowledge or competence	4	2	0	2	**1,3**

Based on Table 2, the title of the 1st LAD does not contain essential concepts, the title of the 2nd LAD contains essential concepts but does not describe activities, while the title of the 3rd LAD already contains essential concepts and describes activities. The objectives in the 1st and 3rd LAD are relevant to the (essential) curriculum and focus on activities that construct factual knowledge, while the 2nd LAD does not include objectives. Procedures in LAD 2 are not relevant to the objective. Procedures in the 2nd LAD are relevant to goals, structured and logical but do not raise objects and phenomena, while the 1st LAD procedures are also relevant to goals, structured and logical but do not raise the expected objects and phenomena. In this practicum, the expected object and phenomenon is the change in the characteristics of hard bones to become soft after being immersed in an HCl solution. Irregular work procedures in practicum activities will hinder the sustainability of practicum activities and the achievement of learning objectives. Therefore, a proper LAD must have the correct work procedures to provide students with an understanding of the concepts being studied (Huda et al., 2020). Furthermore, the results of the analysis of knowledge construction based on the Vee Diagram adapted from Novak & Gowin can be seen in Table 3 below.

The data in Table 3 shows that the construction of knowledge based on the Vee Novak and Gowin Diagrams in LAD has not yet reached a maximum score. The 1st LAD has a title and purpose but does not focus on the main things related to objects and events or does not contain a conceptual section, especially principles. While the titles in the 2nd and 3rd LAD can be identified and contain conceptual parts, they do not support the observation of the main object or event. The main events or objects in 1st and 3rd LAD can be identified and are consistent with the focus question. However, there is no identifiable object or event in the 2nd LAD. In 1st and 3rd LAD, there is an identifiable concept, but without

principles or theory. Whereas in the 2nd LAD, there is no identifiable conceptual part. The 1st and 3rd LAD contain recording or transformation activities or events that can be identified, but Knowledge claims are not consistent with the data. The 2nd LAD has no identifiable recording or transformation activities and no identifiable knowledge claims. The disadvantages between 1st DKL and other DKL are almost the same. But the 3rd DKL seems slightly superior in terms of questions. Questions are made quite well and can help in constructing students' knowledge.

Table 3. The Results of Vee Diagram Knowledge Construction Analysis

Rated Aspect	Maximum Score	LAD			Average Score
		1	2	3	
Focus question	4	1	2	2	**1,7**
Object or phenomenon	4	1	0	1	**0,7**
Theory, principles and concepts	4	1	0	1	**0,7**
Recording or transformation activities	4	2	0	2	**1,3**
Knowledge claim	4	2	0	2	**1,3**

Discussion

Based on data from Tables 2 and 3, it can be concluded that the 3 LAD that have been tried out have not yet achieved the maximum score from several aspects assessed. But among the 3, 1st and 3rd LAD can be considered better because several aspects are quite suitable. Weaknesses in 1st LAD include, the title of the activity does not describe the activities to be carried out and does not yet in the form of a representative question sentence; a less detailed description of tools and materials; the soaking time is less long so that the phenomenon of softening of the bones cannot be observed; the question related to calcium is not quite right, the observation table should provide a column related to the state of the solution before and after immersion to bridge the phenomena obtained with the questions given; the words "hardness" and "flexibility" are not appropriate to use, so they can be replaced with "bone characteristics"; and there are several questions that are not related to visible phenomena but only ask about written concepts that can be answered by students without practical activities. But behind the drawbacks, there are also advantages to 1st LAD, which include a warning or safety lab to be careful with HCl solutions.

In 2nd LAD there are quite a lot of things that are not appropriate, the title is written incorrectly; procedures are written in one paragraph and not numbered, making it difficult for students to digest; no description of tools and materials at all, making it difficult to execute; no observation table; the time required for soaking is very short, so you can be sure that the phenomenon of softening of the bones will not be seen; no clear information about the required concentration of HCl solution; questions related to the function of calcium are not appropriate. Furthermore, the deficiencies in 3rd LAD include: the title is enough to describe the activity, but not in the form of an interrogative sentence;

the beaker and HCl solution used was too large to submerge a bone, wasting too much material; the time used for soaking is still not long enough, so the phenomenon of softening of the bones is not visible. The advantage of this LAD is that there is a theoretical basis at the beginning of the LAD which can be a starting point for students in carrying out practicums and questions much better than the other two LAD.

The concept of the Vee Diagram was adapted into an assessment rubric because the Vee Diagram can be used as an instructional strategy or structure that can develop students' metacognitive abilities (Dewi et al, 2016). Research conducted by (Alvarez & Rizko, 2007 in Dewi et al, 2016) regarding the effectiveness of using Vee diagrams to help students with science concepts and learning, significantly shows that Vee Diagrams are a feasible tool for studying the structure of knowledge and the process of obtaining knowledge including metacognitive student. Based on the results of the researchers' observations and trials regarding the 3 LADs that were used as this sample, the title of the LADs needs to be corrected. A good title is a title that can describe how the activity will be carried out (Arifin, 2000). Therefore, the title must be made specific. The title must also be essential. A good practicum title is a title that is relevant to the objectives and work steps of the practicum. Practicum objectives must be relevant to the curriculum (essential) and focus on activities that construct factual, conceptual, and procedural knowledge. Practicum objectives must also be in line with practicum work steps.

The practicum work steps listed in the LAD must be relevant to the objectives, structured, and logical. In addition, practicum work steps must bring up objects or phenomena that support the construction of knowledge or competence. If the object or phenomenon does not appear, then the practicum activities carried out are of no value at all, because the emergence of this object or phenomenon is important which will help students construct their knowledge of a material. In addition, tools and materials must also be explained in detail including the amount and dosage. Tools and materials that are not specified can make students confused, as well as unclear and unstructured work steps can also lead to multiple interpretations. Therefore, if the work steps are quite complicated, it would be better if they were supplemented with pictures or illustrations (Supriatno, 2018).

Focus questions or focus questions are prepared to focus inquiry about the events and/or objects being studied. Focus questions are very important to make a practicum activity more focused and focused on an object. Events and/or objects are descriptions of events and/or objects to be studied to answer focus questions. A good LAD will lead students to bring up expected events and/or objects. The expected transformation here is in the form of tables, graphs, concept maps, statistics, or other forms of organizing the notes made (Novak & Gowin, 2006). A good LAD will not forget the data recording activities from the practicum carried out. The observation table is one of the components that must exist in LAD to support this.

Theories, principles, and concepts are on the conceptual side of the Vee Diagram. Theories are general principles that guide inquiry that explain why events or objects are the way they are observed. Therefore, the existence of a theoretical basis in a LAD is also important and must exist. Principles are statements about the relationships between concepts that explain how objects or events are expected to occur or act. Meanwhile, the concept is the definite regularity of an event or object (a record of an event or object) which is stated by a label. These principles, theories, and concepts must be identifiable. Furthermore, knowledge claims are statements that answer focus questions and are based on the interpretation of records and the transformation of observed records or data (Novak & Gowin, 2006). This knowledge claim must contain concepts that are appropriate to the focus question and match the results of recording and transformation and lead to the formation of a new focus question.

In addition to these matters, in determining whether LAD is good or not, it can also be assessed from its practical analysis, whether this practical activity can be carried out in schools or can only be carried out in special laboratories. The problem that is often encountered in schools related to difficulties in carrying out practicum activities is that the tools and materials listed in the LAD are not available in schools, some schools do not have a special laboratory for practicum, and practicum instructions in schools are not clear so that teachers have difficulty implementing them on learning (Simatupang et al., 2018, Dewi et al., 2014). However, the 3 LAD that have been analyzed have good scores in assessing this aspect. The 3 LADs require tools and materials that are easy to find and available in schools.

Based on the results of trials of the 3 LADs used by teachers in the field and the results of an analysis of suitability, the researchers carried out a constructive reconstruction of the bone structure sub-material LAD to produce an alternative LAD that could be used in schools. LAD as a result of this reconstruction has also been tried out by other partners. This LAD has been proven to be able to be implemented properly without any obstacles and it is very possible to implement it in schools. Based on comments from other colleagues, the researcher changed and added several questions that aim to further clarify the expected knowledge construction in this practicum activity. This LAD has been reconstructed by adjusting the standards contained in the assessment rubric and obtaining the maximum score for each indicator. The following is the LAD resulting from the reconstruction.

What are the Characteristics of Hard Bones?

A. Basic Theory

Bones have a fairly unique structure. Based on its structure, bones are filled with threads made of a strong, slightly branched substance called collagen. Bones also have hard minerals like calcium. Calcium makes bones strong and stiff. This strong and hard structure is used by bones as a support for the body. Bones also have blood vessels that transport food and nerves to feel pressure and nerves. In addition, bones contain a substance that resembles jelly and is commonly known

as bone marrow. On the outside of the bone, there is a layer that becomes the skin of the bone, the periosteum. According to its constituent substances, bones are divided into two groups, namely cartilage, and osteon. Cartilage is more flexible and light in color. Meanwhile, hard bones or true bones are not flexible and have a more cloudy color. Cartilage is more flexible because it is not composed of calcium. This flexible structure makes cartilage more flexible and does not function to support the body.

B. Activity Goals

- To analyze the characteristics of hard bones
- To analyze the main substances that make up hard bones
- To conclude the difference between bone and cartilage

C. Tools and Materials

1. Tools Needed
   - A beaker glass 400ml
   - A pair of gloves
   - A tweezers
   - A petri dish

2. Materials Needed
   - 200 ml of 15% HCl solution
   - A piece of chicken thigh bone
   - Aluminum foil to taste

D. Procedures

1. Use gloves
2. Prepare the tools and materials needed
3. Observe the color and characteristics of the bones
4. Soak the bones in a beaker containing 200 ml of 15% HCl solution for 9 hours
5. Cover the mouth of the beaker with aluminum foil
6. Take the bone using tweezers and place it on the petri dish
7. Observe the color and characteristics of the bones
8. Record the results of observations in the observation table

Table 4. The Results of Observation of Osteon Structure

Num.	Observed Characteristics	Photos and Observations Before Soaking in HCl	Photos and Observations After Soaking in HCl
1.	Bone Characteristic		
2.	Bone Color		
3.	Solution Color		

E. Questions

1. What is the purpose of immersing bones in HCl solution?
2. What causes changes in bone characteristics before and after soaking in HCl solution?
3. Why is the bone observed in practicum activities referred to as hard bone?
4. Why does the color of the HCl solution change before and after it is used to soak the bones? Does it have something to do with the bone?
5. What is the difference between bone and cartilage from the phenomena you observe? And what are the characteristics of cartilage?
6. Based on the phenomena you observed, can hard bones that have changed their characteristics still be called hard bones? Can hard bones with these characteristics still be used as supports for the body?

The design of practicum activities based on the 2013 Curriculum has a good level of interpretation. The interpretation process already uses several data components, such as qualitative descriptions and pictures of observations as well as practical activities involving Higher Order Thinking Skills (HOTS). In addition, the 2013 curriculum requires students to observe the specific characteristics of objects or phenomena. Meanwhile, the design of the 2006 Curriculum practicum activities does not yet have a good level of interpretation, in which the interpretation process does not use varied data and does not involve HOTS too much. The abilities involved are still about the ability to know, understand and observe. Practical activities also only observe the general characteristics of objects or phenomena (Darmawati et al., 2021).

This reconstructed LAD has been repaired based on an analysis of the 3 LAD that have been used in the field. The practicum activities have been adjusted to the 2013 Curriculum KD 3.2 class 11 which reads, "Analyzing the relationship between the structure of the organ-composing tissue in the locomotion system about bioprocesses and functional disturbances that can occur in the human locomotor system." In the practical activity entitled "What are the characteristics of hard bones?" students will observe the characteristics of hard bones before and after immersion in HCl solution, the phenomena that occur later are associated with the main substance that makes up hard bones, namely calcium. At the end of the activity, students are expected to be able to analyze the characteristics of bone and the main substances that make up bone and to conclude the differences between bone and cartilage more meaningfully. Apart from that, it is certain that this alternative LAD can be implemented in schools without any obstacles because the tools and materials are not complicated and are readily available in schools. This practicum also does not have to be carried out in the school laboratory but can be inside or outside the classroom.

CONCLUSION

The results of the component suitability analysis and knowledge construction on the 3 LADs circulating in the field show results not by several aspects of the assessment. The title and purpose of the LAD are irrelevant. The objectives presented are also not by the practicum work steps. Tools and

materials are not described clearly and in detail, thus allowing for multiple interpretations by students. After carrying out several trials by researchers and analyzing the deficiencies found in the circulating LAD, a constructive reconstruction of the LAD carried out. The results of this reconstruction have also been tested by other parties to find out the views and reality in practice on the ground. After revising the practicum questions, this LAD has been reconstructed and is ready to be used as an alternative LAD in schools.

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