

## Analysis and Reconstruction of Laboratory Activity Design (DKL) on Alcohol Fermentation Material

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### Abstract

*The implementation of a practicum that is able to direct students to reconstruct knowledge and train their abilities requires a reference or guideline in carrying out practicum, namely in the form of laboratory activity design (DKL). This research aims to analyze the design of laboratory activities (DKL) on alcoholic fermentation respiration material used in SMA / MA to reconstruct it. This research method is descriptive qualitative, with sampling carried out by purposive sampling using as many as 3 LKS, which refers to the 2013 curriculum. The results showed that the design of laboratory activities (DKL) in terms of structural analysis is less encouraging for the emergence of phenomenal objects. Conceptual analysis as a whole has been relevant to the applicable curriculum. Then the analysis of aspects of knowledge construction as a whole shows that the process of knowledge construction has not been well developed.*

**Keywords:** Laboratory activity, Design, Practicum, Alcohol fermentation

### 1. Introduction

Education is a lifelong process, the manifestation of the formation of the whole self from the development of all potentials in order to fulfill all human commitments as individuals, social beings, and creations of God. Education also goes through a process of change, but the change and adoption of new transformational learning frameworks, is not as fast as the rapid development with digital information technology; So the change in education is said to have evolved. Although the change has been slow, there has been a labeling of changes in education to help understand the evolutionary stages in education. The industrial revolution has resulted in various changes, including in the world of education, including science education, including biology which must transform following the times (Zubaidah, 2019).

One of the 21st century life is marked by the rapid development of technology, information, and communication. The rapid development that occurs in the 21st century is the impact of science that is also growing. One of the things that plays a role in the development of science which affects 21st century life is

education (Zahra et al., 2021). The development of the world of global education in this century encourages many changes that must be guided by the Indonesian state. Education in the 21st century must be able to produce global graduates who have the ability, knowledge and motivation to deal with various problems that exist in the environment and are able to respect each other and be open in discussions (Witt and Orvis in as syiba et al., 2021). The education system requires a strategic plan to improve its practices to the best ability to meet the needs of the 21st century (as syiba et al., 2021).

In laboratory education, practicum is an integral part of teaching and learning activities, especially biology. This shows how important the role of laboratory activities to achieve educational goals. Biology is closely related to laboratory activities in the form of observation, research, experiments and practicum (Nurhaliza, 2022). Laboratory activities can be used as a choice of activities to explore and maximize student learning potential through the first bioscience activity, where students can develop themselves in learning biology as part of science, through laboratory-based activities (Croker in Darmawati et al., 2021). Learning biology requires practicum activities which are an important component in order to deepen understanding of the theories that have been studied. Practicum activities provide students with an

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understanding of biological sciences through observation and experimentation, developing coherent thinking (Assinder in Cahyani et al., 2021).

Procurement of a practicum guide used for academic circles. The principles of learning from the basic level to the upper level must be in accordance with the rules of the ideal principles of a practicum instrument. Practicum that must be considered are: demonstration principles, knowledge application, task-centered, activation of knowledge and experience, integration of knowledge in everyday life (Sofyan in As syiba et al., 2021), student center learning, learning by doing, developing social skills, curiosity, problem-solving skills, creativity and principled on the concept of lifelong learning (Sofyan in As syiba et al., 2021). Educators need to facilitate students in carrying out practicum activities that can apply the principles of practicum learning to achieve practicum learning objectives.

Practicum is an activity that combines the real domain and the domain of the mind (Novak & Gowin, 1984). Practice can be defined as a way of doing something or doing what is mentioned in theory (Rustaman in Ridwan et al 2020). Practicum is learning carried out in a certain place where students play an active role in adjusting the rubric/problem given through the use of certain tools, materials, and methods (Ridwan, 2022). Practicum is a learning strategy that allows students to practice/demonstrate/empirically simulate cognitive, psychomotor, and affective abilities simultaneously using laboratory facilities (Fauza et al., 2022).

Practicum in biology learning is an effective method to achieve learning objectives (Rustaman in Suryaningsih, 2017). Practicum is also a method of learning that invites students to make observations or direct observations to solve a problem (Arini et al., 2022). Learning with the practicum method is effective learning to develop students' science skills, so it is necessary to assess its implementation related to the emergence of students' science in the practicum (Rahmayani et al., 2019). Practicum activities are the main learning medium in training students' skills. This activity trains students to realize the theories in the book and visualize the workings in practicum manuals and research journals. This trains concentration and stimulates students' motor and analytical skills (Bellotti in Nugroho, 2021).

The implementation of a practicum that can direct students to reconstruct knowledge and train their abilities requires a reference or guideline in carrying out practicum, namely in the form of laboratory activity design (DKL). The design of laboratory activities is a learning tool used in carrying out practicum. There are two main principles in making DKL, (1) the purpose of

practicum must be in accordance with what students will learn, (2) the work steps compiled in DKL must be in accordance with the objectives of practicum so that students can understand the object or study of the material learned (Astika et al., 2020). However, in fact, DKL still often experiences obstacles, causing the DKL to not be able to direct students to be involved in practicum activities properly and correctly.

Research (Supriatno, 2018) explains that a teacher's ability to develop laboratory activities is only around 53%. Several factors cause this, (1) the purpose of practicum, which emphasizes more on cognitive aspects; (2) the material presented in DKL does not adjust to aspects of student abilities, (3) work procedures / steps contained in DKL are not structured in the end causing confusion to students (Supriatno, 2013). Therefore, the use of DKL is expected to make students more active in learning and increase the effectiveness and smoothness of the learning process so that learning objectives can be achieved.

One of the biological materials that has the potential to be developed through practicum activities is alcohol fermentation material. Alcohol fermentation material has a complexity that is quite complicated and abstract in understanding the material. Alcohol fermentation practicum is one of the basic competency achievements of the 2013 curriculum skill aspects at the KD 4.2 high school level, namely compiling experimental reports on the mechanism of action of enzymes, photosynthesis, and anaerobic respiration (Rahmawati et al., 2022). To observe fermented products in the form of ethanol and carbon dioxide in particular can be observed through alcohol fermentation practicum. The test can be applied in practicum activities in schools for the senior high school (SMA) level.

Practicum activities will be more effective if they have a match between what must be learned (goals), what must be done (student tasks), what is actually done (laboratory activities) and what is actually learned (student learning process) (Millar in Pratiwi et al., 2021). Therefore, it is necessary to reconstruct DKL, which, of course, is based on the results of the assessment analysis of several DKLs that have been carried out. This research analyzed structural aspects, conceptual aspects, and knowledge construction aspects based on vee diagram instruments. With regard to the problems described, researchers conducted research on the analysis and reconstruction of Laboratory Activity Design (DKL) on alcohol fermentation material.

## **2. Method**

The method used in this study is qualitative descriptive to describe the phenomena found. This research aims to analyze the design of laboratory

activities (DKL) on alcohol fermentation respiration material used in high school / MA to then reconstruct it and conduct trials on high school students. Sampling was carried out by purposive sampling with a total of 3 LKS referring to the 2013 curriculum.

The first step is to conduct practicum trials in accordance with the work directions at LKS without any manipulation of work steps. Then after the practicum trial, analysis was carried out using instruments consisting of conceptual aspects (relevance and competence), aspects of knowledge construction based on Vee diagrams and structural aspects. The data obtained from the instrument is then processed into the form of percentages (%). Based on the results of analysis and trials, the researchers then conducted LKS reconstruction and literature studies to then compile a new laboratory activity design based on the achievements of the independent curriculum.

### 3. Results and Discussion

The following are the results of the analysis conducted on three LKS based on structural analysis, conceptual analysis and knowledge construction analysis

#### a. Structural Aspect Analysis

Structural analysis is an aspect of development seen from the indicators of titles, objectives and work procedures that lead to the emergence of phenomenal objects. The results of structural aspect analysis can be seen in table 1.

**Table 1.** Results of Structural Aspect Analysis

Indicators	DKL			Result
	Class XII			
	I	II	III	
Heading	3	3	2	66,6%
Purpose	0	2	3	41,6%
Work procedure	0	2	3	41,6%

Based on table 1 on structural aspects, the title indicators for DKL 1 and 2 headings contain essential concepts and describe activities. While DKL 3 titles contain essential concepts but do not describe activities, so it shows results of 66.6%. The objective indicators in DKL 1 have no objectives, DKL 2 objectives are relevant to the curriculum (essential) and focus on activities that construct factual knowledge. While DKL 3 objectives are relevant to the curriculum (essential) and focus on activities that construct factual and conceptual knowledge, so that it shows results of 41.6%.

DKL 1 work procedure indicators procedures are irrelevant to goals, DKL 2 procedures are relevant to goals, structured and logical but do not give rise to objects and phenomena. While DKL 3 procedures are relevant to the goal, structured and logical, give rise to objects and phenomena but do not support the

construction of knowledge/competence, thus showing a percentage of 41.6%. The effectiveness of a practicum can be measured through activity procedures, which are related to everything done by students and the work of the practicum. The effectiveness of work procedures is by carrying out a work step in the design of laboratory activities that can produce data or facts that are in accordance with the objectives of the activity (Putri in Rahmawati et al., 2022).

#### b. Conceptual Aspect Analysis

DKL's conceptual analysis of conceptual aspects aims to analyze practicum activities with the applicable curriculum (Kurniasih in Maulana et al., 2021). In the conceptual aspect, there are two components analyzed, namely the relevance aspect (practicum activities and curriculum) and also the competency aspect (*hands on* and *minds on*). The results of conceptual analysis can be seen in table 2.

**Table 2.** Results of Conceptual Aspect Analysis

Indicators	DKL			Result
	Class XII			
	I	II	III	
DKL competence in accordance with KD demands	2	2	2	66,6%
Content on DKL complies with KD	2	2	2	66,6%
Observation ability	1	2	2	55,5%
Data transformation	1	2	2	55,5%
Data interpretation	1	1	2	44,4%
Level of cognitive ability	1	2	2	44,4%

Based on table 2 on the aspect of relevance, competency indicators in DKL with the suitability of basic competency demands (KD) in the curriculum show that 3 DKL have results of 66.6% because they have met the minimum competency standards of KD. Furthermore, the content indicators in DKL with basic competencies (KD) in the curriculum had a result of 66.6% because the 3 DKL analyzed had met the minimum KD standards. This indicates that the DKL analyzed is relevant to the curriculum. The content of the biology practicum instructions (DKL) analyzed is in accordance with the demands of basic competence (KD) of the 2013 Curriculum for grade XII high school level

(Rahmawati et al., 2022). In the competency aspect, there are *hands on* and *minds on*. Mind on activities can be interpreted as student activities in using their thinking skills during practicum activities which include data transformation obtained based on observations, the data from the transformation will later be analyzed and will eventually produce new knowledge (Supriatno in Maulana et al., 2021).

The observation ability indicator in the 3 DKL analyzed had a result of 55.5%, this shows that the analyzed DKL only directs students to observation activities of the general character of the object / phenomenon. For data transformation indicators, it has a result of 55.5%, this shows that the 3 DKL analyzed only lead students to present quantitative data that is still simple in the form of tabulations and frequencies. Furthermore, the data interpretation indicator has an average value of 44.4%, this shows that qualitative data is sufficiently represented in standard form only. For cognitive level indicators, an average value of 44.4% indicates that 2 DKL leads to the ability to analyze (C4) and 1 DKL only leads to the ability to apply basic skills regarding tabulation.

### c. Analysis of Knowledge Construction Aspects

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 in Zahra et al., 2021). Indicators analyzed in aspects of knowledge construction include (1) titles/objectives/focus questions, (2) object of phenomena, (3) theories/principles and concepts, (4) data recording and data transformation, (5) acquisition of knowledge (Maulana et al., 2021). The results of the knowledge construction analysis from 3 DKL can be seen in table 3.

**Table 3.** Results of Analysis of Knowledge Construction Aspects

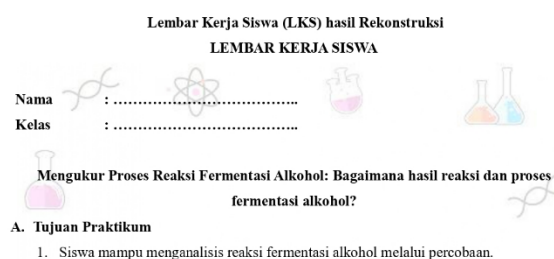
Indicators	DKL			Result
	Class XII			
	I	II	III	
<i>Foqus question</i>	0	1	2	33,3%
<i>Object/ Event</i>	1	2	1	44,4%
<i>Theories</i>	1	1	2	33,3%
<i>Records/ transforma tion</i>	1	2	3	50%
<i>Knowledge claim</i>	1	1	2	33,3%

Based on table 3 of the results of the analysis of aspects of knowledge construction in 3 DKL for the

*indicator foqus question DKL 1 no foqus question can be identified, DKL 2 questions (questions) can be identified, but do not focus on the main things related to objects and events (events) or do not contain conceptual parts, especially principles. While DKL 3 focus questions can be identified and contain conceptual parts but do not support the observation of the main object or event, so it shows a result of 33.3%. For DKL object/event indicators 1 and 3 the main event or object can be identified and is consistent with the focus question, or events and objects can be identified but not consistent with the focus question. While DKL 2 main events accompanied by objects can be identified and consistent with focus questions, so it shows a result of 44.4%. Indicators of DKL principles 1 and 2 have few identifiable concepts, but without principles and theories, or a written principle is knowledge gained from laboratory activities. However, DKL 3 has concepts and approximately one principle (conceptual or methodological) or relevant concepts and theories can be identified, thus showing a result of 33.3%.*

Indicators *Records/transformation DKL 1* Record keeping activities can be identified, but are not consistent with the main question or main activity. DKL 2 recording or transformation activities or events can be identified. While DKL 3 recording activities can be identified and correspond to the main events: transformation is inconsistent with *Focus Question*, thus showing a yield of 50%. For indicators *Knowledge Claim DKL 1 and 2 Knowledge Claim* does not correspond to the left half of the Vee Diagram. While DKL 3 *Knowledge Claim* is inconsistent with the data and/or events logged and transformed; or *Knowledge Claim* already pregnant *conceptual side*, So it shows a result of 33.3%.

### d. Reconstructed Student Worksheets (LKS)

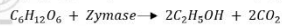
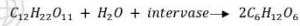


**Figure 1.** Title and purpose of practicum

**B. Landasan Teori**

Fermentasi etanol disebut juga fermentasi alkohol, merupakan proses biologi di mana gula seperti glukosa, fruktosa dan sukrosa diubah menjadi energi seluler dan juga menghasilkan energi etanol dan karbondioksida sebagai produk sampingan. Proses ini dilakukan oleh khamir/ragi tanpa membutuhkan oksigen, sehingga fermentasi etanol digolongkan sebagai respirasi anaerob. Respirasi anaerob adalah proses katabolisme yang tidak memerlukan oksigen untuk menghasilkan energi. Respirasi anaerob terjadi pada bakteri, ragi, dan organisme prokariotik ataupun makhluk hidup uniseluler yang berada pada lingkungan dengan kadar oksigen yang rendah.

Fermentasi etanol dapat digunakan pada pembuatan minuman beralkohol dan bahan bakar etanol, dan mengembangkan adonan roti. Reaksi kimia fermentasi alkohol glukosa adalah sebagai berikut. Dengan glukosa rumus kimianya  $C_6H_{12}O_6$ . Satu mol glukosa diubah menjadi 2 mol etanol dan 2 mol karbon dioksida:



$C_2H_5OH$  adalah rumus kimia untuk etanol.

Etanol merupakan salah satu produk hasil fermentasi dari bahan yang mengandung gula sederhana, pati, atau bahan berserat lainnya. Bioproses etanol dapat diawali dengan pemecahan gula atau pati menjadi bentuk sederhana yang berlangsung dengan hidrolisis atau reaksi enzimatis (Azizah dkk., 2012). Etanol memiliki rumus kimia  $C_2H_5OH$  dan dikenal juga sebagai alkohol. Etanol dipakai sejak ratusan tahun lalu untuk meragikan gula menjadi arak sebagai minuman keras. Etanol juga dapat dimanfaatkan dalam bidang pengobatan, pangan, pembuatan kosmetik, dan bahan bakar (Sebayang, 2006).

Produksi etanol awalnya dilakukan dalam produksi minuman beralkohol, seperti anggur (*wine*). Produksi alkohol dalam *wine* sendiri telah dilakukan sejak 6000 tahun sebelum masehi (Hawusiwa dkk., 2015). Produksi etanol saat ini banyak dikembangkan untuk bahan bakar pengganti bahan bakar fosil, karena lebih mudah terbakar dan sisa pembakarannya lebih bersih (Singh dan Sharma, 2015).

**C. Alat dan Bahan**

Tabel 1. Alat yang digunakan

No	Alat	Jumlah
1	Labu Erlenmeyer (100 ml)	3 unit
3	Timbangan	1 unit
4	Batang pengaduk	1 unit
5	Corong	1 unit
6	Pemanas air	1 unit
7	Termometer	3 unit
8	Gelas arloji	2 unit
9	Penggaris	1 unit
10	Cawan petri	6 unit
11	Tali rafia	30 cm

Tabel 2. Bahan yang digunakan

No	Bahan	Jumlah
1	Ragi roti	1 saset
2	Balon	3 buah
3	Gula	30 gram
4	Air	200 ml

**D. Langkah Kerja**

1. Siapkanlah 3 unit labu Erlenmeyer berukuran 100 ml.
2. Beri label pada setiap labu Erlenmeyer dengan tulisan "panas", "hangat", dan "dingin".
3. Nyalakan pemanas air, kemudian rebuslah air!
4. Siapkan labu Erlenmeyer yang sudah diberi label, kemudian masukkan ke dalam labu Erlenmeyer masing-masing:

- a) Air panas, yaitu air yang telah direbus mendidih (60 ml).
  - b) Air hangat, yaitu campuran  $\frac{3}{4}$  air dingin (40 ml) dan  $\frac{1}{4}$  air mendidih (20 ml).
  - c) Air dingin, yaitu air biasa bukan air es (60 ml).
5. Masukkan ke dalam setiap labu Erlenmeyer 10 gram gula pasir, dengan menggunakan corong.
  6. Kocok labu Erlenmeyer yang berisi gula hingga menjadi larut!
  7. Bagilah 1 saset ragi roti menjadi 3 bagian masing-masing 3,5 gram!
  8. Masukkan ragi yang telah dibagi 3 tersebut ke dalam masing-masing labu Erlenmeyer dengan menggunakan corong. Pada saat memasukkan ragi pada ketiga labu Erlenmeyer harus pada waktu yang sama dan corong harus benar-benar bersih.
  9. Aduk ragi yang ada di dalam masing-masing labu Erlenmeyer hingga larut!
  10. Tutup setiap mulut labu Erlenmeyer dengan balon yang berukuran sama dan waktu pemasangan harus bersamaan.
  11. Setelah 30 menit, amati perubahan yang terjadi pada balon saat mulai mengembang, membutuhkan berapa lama untuk mengembang, diameter balon, serta tinggi buih yang terbentuk di dalam masing-masing labu Erlenmeyer.
  12. Lepaskan balon dari labu Erlenmeyer lalu amati perubahan bau, dan suhunya.
  13. Catatlah data pengamatan ke dalam tabel.

**E. Tabel Pengamatan**

Tabel 3. Tabel hasil pengamatan

Pengamatan	Erlenmeyer air panas		Erlenmeyer air hangat		Erlenmeyer air dingin	
	Awal	30 menit	Awal	30 menit	Awal	30 menit
Balon mulai mengembang						
Balon mengembang						
Diameter balon						
Bau/aroma						
Suhu						
Ketinggian buih						

**F. Pertanyaan**

1. Apakah fungsi dari ragi dan gula dalam labu Erlenmeyer yang berisi air panas, hangat dan dingin?  
.....
2. Setelah 30 menit, apakah terjadi perubahan pada balon? Jelaskan jawabannya  
.....
3. Apakah terjadi perubahan suhu secara signifikan pada labu Erlenmeyer yang berisi air panas, hangat dan dingin? Jelaskan alasannya.  
.....
4. Apakah terdapat buih pada labu Erlenmeyer yang berisi air panas, hangat dan dingin? Manakah yang lebih banyak?  
.....
5. Bagaimanakah bau/aroma pada labu Erlenmeyer yang berisi air panas, hangat dan dingin?  
.....
6. Jika kalian membandingkan labu Erlenmeyer berisi air panas, hangat dan dingin. Faktor apakah yang dapat membuat reaksi fermentasi ragi berjalan dengan cepat?  
.....
7. Tuliskan kesimpulanmu berdasarkan percobaan yang telah dilakukan!  
.....

**Figure 3.** Table of observations and questions

**Figure 2.** Theoretical foundations, tools and materials and practical work steps

**4. Conclusion**

Based on trials and analysis of DKL with structural aspects, conceptual aspects and aspects of knowledge construction related to alcohol fermentation material, it was found that some did not encourage the emergence of phenomena objects, discrepancies and deficiencies in several indicators in these three aspects. So there is a need for reconstruction of the design of laboratory activities (DKL) so that the ethics of laboratory

activities for practicum are more effective and efficient. In addition, it is hoped that the reconstructed DKL can be an alternative that is relevant to the curriculum and representative, and can be a reference for students in practicum.

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