Structure analysis of student worksheet for junior high school science subject using the Vee diagram

I Permana¹* and E Nuraeni²

¹ Program Studi Pendidikan IPA Universitas Pakuan, Jl. Pakuan No.1, Bogor 16143, Indonesia
² Departemen Pendidikan Biologi, FPMIPA, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia

*irvanpermana@unpak.ac.id

Abstract. The purpose of this study was to analyze the student worksheet structure of science subject of junior high school grade 8 based on the Vee diagram framework. The analysis was conducted on 39 worksheets from the 3 most widely used source textbooks in Bandung, West Java, Indonesia. The worksheet analysis is performed using a checklist of completeness and whether the worksheet components are presence or not based on Diagram Vee components, namely focus questions, object/events, theory/concepts/principles, notes/transformations, and knowledge claims. The quality measurement of the student worksheet structure for each component is carried out using the presence rubric of Diagram Vee components and the scoring rubric to the presence of the Diagram Vee components. The results showed that almost all worksheets had the components of focus questions and objects/events. However, several Diagram Vee components are found with poor quality in all worksheets, with the lowest component is in the theory/concept/principle.

1. Introduction
Learning is the process of forming schemes of knowledge and experience through the interaction of students with learning resources. The formation of cognitive schemes can be integrated and meaningful through first-hand activities that involve students in the acquisition and processing of the data based on experience [1]. The process of forming knowledge through the formation process of understanding can be done by students themselves [2], where students must be taught how to increase personal self-awareness of the ability to construct their knowledge, so that with the emergence of that awareness, students are able to evaluate their minds by designing and assessing what they learned. The learning process of students in learning science subject is not only limited in making observations about the universe, but also the presence of opportunities to inquire about it [3]. This is in accordance with Minister of Education Regulation No. 26 concerning Content Standards for Junior High Schools. To facilitate inquiry learning, the 2013 curriculum student textbooks are equipped with Student Worksheets.

As one of the learning resources, Student Worksheets are used to create learning conditions that are in accordance with the standard processes in the 2013 curriculum. Student Worksheets can help students learn in a directed and oriented manner [4], as well as to facilitate students to play an active role in the
learning process [5], and as a guide in hands-on activities through practicum as a process of providing knowledge and learning experiences for students.

Most of Indonesian students were not able to associate their science knowledge with phenomenon that occur in the world [6]. According to the analysis conducted by Supriatno, it was found that only several student worksheets with the demands from the School Based Curriculum (SBC) that could be carried out and could show relevant objects or phenomena, with unclear work steps or procedures [7]. These findings showed that worksheets do not guide students to link the phenomenon or object they observed with the science concept.

Student worksheets with high quality helps students to build their knowledge in a guided and controlled manner. Novak and Gowin developed a heuristic (thinking framework) that implements metacognitive strategies to direct activities to be structured, so that students are able to understand the process of forming knowledge within themselves [8]. This heuristic is known as Diagram Vee. This heuristic is a procedure for achieving an understanding of complex objects/events [9]. Diagram Vee involves the dimension of knowledge (conceptual) that is already known by students on the left side, and the dimension of experience/activities (methodological) on the right side. Both sides interact to build knowledge when practicum activities are carried out. The focus question is used as the starting point of the process located in the middle of the diagram. The focus question is an active dynamic bridge between prior/known knowledge and the estimates placed on the right side of the diagram. When students conduct practicum activities to answer focus questions, they record data during the activity and turn it into a table, graph, etc. Then students write their knowledge and experimental claims from the results of the activity [10]. Student worksheets that are arranged based on the framework of Diagram Vee (developing metacognitive abilities) will help students to understand the relationship between known and necessary objects/events with known concepts to find out and understand new concepts through these objects/events. This is done so as to know what is already known and what is not yet known in order to maximize the process of forming new knowledge that occurs in the students themselves [11]. This statement relevant with research result that found by Safdar et al., [12]. They stated that implementing Vee diagram in laboratory work improve the secondary school science students’ understanding of concepts in the physical science laboratories and make the learning more meaningful.

Based on the importance of Vee diagram to build knowledge through laboratory activities, it is necessary to analyze the structure of the student worksheets in the textbooks according to the Diagram Vee framework.

2. Methods
The population of this research is the student worksheets of grade VIII junior high school science textbooks used by students in Bandung, West Java, Indonesia. The research sample was 30% of all student worksheets in the textbook (39 student worksheets) taken from the 3 most widely used science textbooks for students. The worksheet analysis is performed using a checklist of completeness and whether the worksheet components are presence or not based on Diagram Vee components, namely focus questions, objects/events, theory/concepts/principles, notes/transformations, and knowledge claims. The quality measurement of the student worksheet structure for each component is carried out using the presence rubric of Diagram Vee components and the scoring rubric to the presence of the Diagram Vee components [10]. The data obtained is then presented and described.

3. Results and discussion
The results of the study are findings about the presence of Vee diagram components, namely Focus questions, Objects/Events, Theories/Concepts/Principles, Notes/Transformations, and Knowledge claims. Figure 1 presents the percentage of the presence of Diagram Vee components in all student worksheets.

Figure 1 shows that all student worksheet presents science objects/events that students can observe. Almost all student worksheets (94.88%) are equipped with focus questions as the aim of practicum activities. Only a few student worksheets are equipped with basic conceptual theory as a component of
the theory/principle/concept (12.82%) which underlies the practicum. Of all the student worksheets, only half can help students construct new knowledge through practicum activities. From these findings, the absence of several components in student worksheets makes these student worksheets not optimal to guide the course of the practicum, do not facilitate the process of knowledge formation, and add less meaningful learning experiences through the formation of concepts for students.

![Figure 1. Percentage of presence diagram Vee component in students worksheets of junior high school science subject.](image)

Student worksheets were analyzed for the quality of their structure based on the rubric scoring component of Diagram Vee. The quality of each component of Diagram Vee on the student worksheet are shown as follow:

3.1. Focus questions
Focus questions contain the purpose of the activities carried out. Figure 2 is a recapitulation of the percentage of the focus questions quality on the student worksheets of junior high school science subject. Four types of focus questions in the student worksheet are found (Table 1).

| Student Worksheet Components | Found in          | %     | Example                                |
|------------------------------|-------------------|-------|----------------------------------------|
| No focus questions (0 score) | Nowhere           | 5.12  | None                                   |
| Focus questions can be identified, but do not focus on the main objects and events or conceptual side of Vee. (1 score) | In the title     | 46.15 | Archimedes Law                        |
| Focus questions can be identified; including concepts, but does not support observation of formed main objects or events. (2 score) | In the title and/or aims of the practicum | 17.94 | Measuring the frequency of breathing “Investigating Factors that Affect Heart Rate Frequency”. |
| Focus questions can be clearly identified; including the concepts to be used and showing the main objects/events that accompany them. (3 score) | In the aims of the practicum | 30.76 |                                         |
Based on the description, it was concluded that most of the focus questions on the student worksheets had not been able to focus on the main things related to objects/events. Only a few student worksheets already contain a clear conceptual part and support objects/events.

3.2. Objects/Events
Objects/events are facts that students find during practicum activities that are guided by student worksheets. Findings on this component are presented in Table 2. Table 2 shows that current student worksheets are still dominated by student worksheets with low structural quality based on the scoring rubric of Diagram Vee.

| Student Worksheet Components | %   |
|------------------------------|-----|
| No observed Objects / Events (score 0) | 5.12 |
| The facts found are not consistent with the focus question (title or aim) (score 1) | 64.10 |
| The object / event component is consistent with the focus question although it does not yet support the other components (the note / transformation and knowledge claims component) (score 2) | 33.33 |
| Objects / events that are consistent with the focus question and are able to support what is written (score 3) | 2.5 |

Based on Figure 1 and Table 2, it is concluded that all student worksheet is capable of presenting objects or events that illustrate the concept, but only a small portion is consistent with the purpose of the practicum.

3.3. Theory/Principle/Concept
On the left side of the Diagram Vee heuristic, there is a conceptual side to both the theory/principle/concept that will be linked to the method side which are the objects/events and notes/transformations, so as to form knowledge claims in response to the focus question [10]. Figure 2 shows a recapitulation of the percentage of the conceptual components quality on the student worksheets.

![Figure 2. Percentage of the conceptual components quality on the student worksheets of Junior High School.](image-url)

The analysis result of the conceptual component quality in Figure 2 shows that most student worksheets do not have a conceptual component in the form of a theory/principle/concept. This finding shows that student worksheets integrated in student textbooks do not contain theory/principle/concept needed for practicum activities. It was also concluded that the conceptual components that appeared on the student
worksheet was still low and could not strengthen the other Diagram Vee components on the student worksheets in an effort to guide the formation of knowledge claims.

3.4. Notes/Transformations
Notes can be identified through the command to record/take a note, or the availability of columns/pictures that are presented on the student worksheet for students to record data/results of activities. The results of this recording / note-taking are very helpful for students in recording the facts found which are then transformed into mathematical form (bar charts, diagrams, pictures, etc.) so that they can pattern facts. The analysis result of the notes/transformations quality on the students worksheet of junior high school science subject was done through scoring, and a recapitulation of the percentage of the notes/transformations components quality is shown in Figure 3.

![Figure 3. Percentage of the notes / transformations components quality on the student worksheets of Junior High School.](image)

Based on Figure 1 and Figure 3, very few student worksheets can train students to take notes and transform data. Of the total, 30.76% of the student worksheets had a transformation component with a score of 1, meaning that the note-taking activities were not consistent with the main questions. Based on the description, the quality of the notes/transformations component on the student worksheet decreases in percentage as the score increases in the rubric of the quality of the notes/transformations component.

3.5. Knowledge claim
Knowledge claims can be formed through a metacognitive process that has been structurally designed in activities based on the Diagram Vee heuristics. Figure 4 is a recapitulation of the percentage of the knowledge claims quality that students can achieve through the Student Worksheet.
Figure 4. Percentage of the knowledge claims components quality on the student worksheets of Junior High School.

Based on Figure 1 and Figure 4 of all the student worksheets analyzed, 41% of it cannot guide the formation of knowledge claims. This shows that only small portion of student worksheets that can guide students to form knowledge (15.38%). Whereas, 35.89% of student worksheets can guide the formation of knowledge claims, even though they are not consistent with the data and events recorded and transformed.

Student worksheets (practicum guidance) largely determines the quality of practical work done by students [13]. Learning activities in the laboratory are more meaningful if students are given the opportunity to manipulate appropriate tools and materials to construct knowledge from relevant scientific phenomena and concepts [14]. According to this study result, most of worksheet for Junior High School Science Subject fail to helps student to learn science meaningful. This indicates that the location, as well as the form of component presentation, plays a role in the process of forming meaningful learning activities. The findings of this study indicate that student worksheets in the textbooks have not been able to guide students to find concepts through practicum activities conducted by students. This finding is relevant to the findings of Supriatno [7] for student worksheets based on the School Based Curriculum.

4. Conclusion
Most student worksheets are of low quality according to the framework of Diagram Vee. Many components of Diagram Vee are not displayed in the student worksheet, and the Diagram Vee components that are present in the worksheet are of low qualities based on the scoring rubric of Diagram Vee components. Components that include focus questions, objects/events, theories/concepts/principles, notes/transformations, and knowledge claims on student worksheets (practicum guides) are still far less than ideal. Student worksheets have not shown the interrelation between the focus questions and the phenomena observed during the practicum, the data obtained and recorded by students, and the knowledge that can be deduced from the observed phenomena. Student worksheets are not able to facilitate the development of metacognition to foster awareness in forming new knowledge.

References
[1] Nuraeni E and Rahmat A 2018 Connecting qualitative observation and quantitative measurement for enhancing quantitative literacy in plant anatomy course Journal of Physics: Conf. Series 1013 1-8
[2] Mochammad Y, Muslimin I, Widodo W and Wahono W 2015 Pengembangan Perangkat Pembelajaran Biologi Berbasis Metakognitif untuk Melatihkan Keterampilan Berpikir Reflektif Siswa SMA Jurnal Pengajaran MIPA 20 2 163-17
[3] Nillar R and Osborne J F 1998 Beyond 2000: Science Education for the Future (London: King's College London)

[4] Sumarni 2004 Pengembangan Bahan Ajar (Jakarta: PT Elek Media Komputer)

[5] Anggraini R, Wahyuni S and Lesmono A D 2016 Pengembangan Lembar Kerja Siswa (LKS) Berbasis Keterampilan Proses di SMAN 4 Jember Jurnal Pembelajaran Fisika 4 4 350-356

[6] Rubini B, Ardianto D, Pursitasari I D and Permana I 2017 Professional development model for science teachers based on scientific literacy IOP Conf. Series: Materials Science and Engineering 166 1-8

[7] Supriatno 2013 Pengembangan Program Perkuliahan Praktikum Biologi Sekolah Berbasis ANCORB untuk Mengembangkan Kemampuan Merancang dan Mengembangkan Desain Kegiatan Laboratorium (Bandung: Sekolah Pascasarjana, Universitas Pendidikan Indonesia)

[8] Novak J D and Gowin D B 1984 Learning how to learn (Cambridge, UK: Cambridge)

[9] Alvarez M C and Risko V J 2007 The Use of Vee Diagrams with Third Graders as A Metacognitive Tool for Learning Science Concepts [Online] Retrieved from: http://www.bepress.com/pres/5

[10] Novak J D 1990 Concept maps and Vee diagrams: two metacognitive tools to facilitate meaningful learning Instructional Science 19 29-52

[11] Afamasaga-Fuata’I 2004 Concept Maps & Vee Diagrams As Tools for Learning New Mathematics Topics Proceeding of The First International Conference on Concept Mapping, Pamplona, Spain

[12] Safdar M, Hussain A, Shah I and Tasnim M H 2013 Make the laboratory work meaningful through Concept maps and V Diagram IOSR Journal of Research & Method in Education (IOSR-JRME) 3 2 55-60

[13] Woodley R 1993 Practical Work in School Science- Why is it important School Science Review (SSR) 91 339

[14] Hofdeine A and Lunetta V 2004 The laboratory in science education: Foundations for the twenty-first century Science education 88 1 28-54