

## DEVELOPMENT OF BILINGUAL WORKSHEET BASED ON MIND-MAPPING IN CHEMICAL EQUILIBRIUM TOPIC

Sofie Mellyani F. and Mitarlis

Jurusan Kimia FMIPA Universitas Negeri Surabaya

Hp: 085730347517, e-mail: [sofiemelly@gmail.com](mailto:sofiemelly@gmail.com)

### Abstrak

Telah dilakukan penelitian pengembangan Lembar Kerja Siswa (LKS) bilingual berbasis *mind-mapping* pada materi kesetimbangan kimia. Tujuan penelitian ini adalah untuk mengetahui kelayakan LKS bilingual berbasis *mind-mapping* pada materi kesetimbangan kimia yang dikembangkan ditinjau dari kriteria materi, kebahasaan, penyajian dan kesesuaian terhadap komponen *mind-mapping*. Selain itu juga untuk mengetahui hasil belajar pada uji coba terbatas terhadap media pembelajaran berupa LKS bilingual berbasis *mind-mapping* pada materi kesetimbangan kimia. Jenis penelitian merupakan penelitian pengembangan perangkat model 4-D dengan tahapannya yaitu, pendefinisian (*define*), perancangan (*design*), pengembangan (*develop*), dan penyebaran (*disseminate*), yang dibatasi hanya sampai pada tahap pengembangan (*develop*). Uji coba terbatas dilakukan terhadap 20 siswa kelas XI SMA Muhammadiyah 2 Surabaya dengan tujuan memperoleh data berupa hasil belajar siswa. Analisis data validasi dan hasil belajar dilakukan secara deskriptif kuantitatif. Hasil validasi diperoleh persentase untuk masing-masing kriteria kelayakan materi, kebahasaan, penyajian dan kesesuaian dengan komponen *mind-mapping* berturut-turut sebesar 85,19%, 82,22%, 87,2%, dan 85,33%. Hasil uji coba terbatas menunjukkan bahwa LKS yang dikembangkan mampu membantu siswa dalam ketuntasan hasil belajar, yang ditunjukkan oleh 95% ketuntasan pada penilaian *mind-mapping* siswa dan peningkatan ketuntasan sebesar 40%

**Kata Kunci:** LKS bilingual, *mind-mapping*, kesetimbangan kimia

### Abstract

*It has been conducted the research of development of bilingual worksheet based on mind-mapping in chemical equilibrium topic. The aims of this study were to evaluate the feasibility of developed bilingual worksheet based on mind-mapping in chemical equilibrium topic which was indicated by the criteria of content, language, presentation, and compliance with mind-mapping components. In this research, student's learning achievement after limited trial using the developed bilingual worksheet based on mind-mapping in chemical equilibrium topic were evaluated by test. The type of this research is development research 4-D model. The stages of 4-D model are define, design, develop, and disseminate. This research was confined only to the develop stage. Limited trial test was conducted to 20 students of XI grade in SMA Muhammadiyah 2 Surabaya in order to gather the students' learning achievement data. Data analysis of validation and students' learning achievement were analyzed by using quantitative description. The result of validation acquired for each criteria of feasibility such as language, presentation and compliance with mind-mapping components as followed 85,19%, 82,22%, 87,22%, and 85,33%. The limited trial results showed that the developed worksheet were able to assist students in improving learning achievement indicated by 95% mastery learning on the mind-mapping assessment and the improvement of 40% mastery learning on the multiple choice test.*

**Keywords :** *bilingual worksheet, mind-mapping, chemical equilibrium*

## INTRODUCTION

Globalization has led to the competition for educational institutions that are not only local or regional, but also

international. The global competition had an impact on the education sector. [1] One form of realizing the development of human resources (HR) is a global

competition with the excellent schools that implementing a bilingual learning.

Bilingual learning is defined as learning program that uses two languages as the instruction in the learning process. In the context of education, Christian and Genesee stated that students who master the dual, or multiple, language and culture have a better chance to take the chance of the opportunities offered by globalization [2]. Therefore, education experts have been trying to find ways to equip students with language skills other than their native language.

Bilingual learning can be applied in teaching chemistry. Chemical subjects classified as a subject that is quite difficult for most high school students. The causes of learning difficulties in chemistry are: many chemical concepts are abstract, also lack of teachers' competence in the use of interesting learning media [3]. Based on the pre-study questionnaire, 40% of students stated that chemical equilibrium topic is the most difficult topic and unpleasant.

In addition, teachers who teach the matters to students only verbally can lead to failure of communication or misconception between teachers and students [4]. Because of that, the subject matter or information can't be well understood by the students. To avoid that, teachers can implement learning media in their learning process.

One of the perceived learning media that can help students and teachers in the learning process is the student worksheet. Student worksheet is print media in the form of a book and contains visual matter [5]. Student worksheet is a learning media that can be developed by the teacher as a facilitator in the learning activities.

Learning process in curriculum 2013 requires teachers to conduct learning process based on scientific approach (observing, asking, collecting data, associating, and communicating), that in doing so, the teacher requires worksheets that have been adapted to the scientific approach to the curriculum in 2013.

As stated before, scientific approach provides opportunities for students to be

actively involved in learning, teachers are only as facilitators. This is in line with the theory of Piaget, Piaget stated "Cognitive development is based on two functions: organization and adaptation" [6]. Adaptation is done through a process of assimilation and accommodation. Assimilation is the process of adding new information to the existing schema. This process is subjective, because the person will tend to modify experience or information obtained in order to enter into a pre-existing schemes. Likewise with the theory of meaningful learning by David Ausubel. Meaningful learning is a process where new information is associated to relevant concepts in the person's cognitive structure. [6]

Learning strategies with mind-mapping is suitable to be used by teacher to deliver the matter or information to student. Mind-mapping will help students in learning, finding out and associating the concepts that are interconnected so that new concepts are more easily understood and remembered in a relatively long time.

According to Tony Buzan, mind-mapping is in the form of branches in which the chain contains matter that can be summarized systematically, there are keywords, variation of colors and images, so that the students are interested in following the learning process. [7]

In the system of the brain, when the brain is experiencing obstacles to describe and visualize what it gets from the cognitive experience, then the person's ability to acquire knowledge will be hampered. Mind-mapping is a system that helps the brain's performance by giving stimuli in the form of images, colors and words. Mind-mapping is nothing but a method of studying the concept. This concept is based on the workings of our brains store information. [7]

A research showed that the human brain does not store information in neatly lined nerve cells. But, collected in nerve cells that branch out, that if at first glance, it would seem like the branches of a tree [7]. From the facts it can be concluded, if we store information properly like how the brain do, the information is stored better.

The information is stored in branch-like map, where all information's connection is clearly visible. Finally, of course, the learning process becomes increasingly easy.

Moreover, according to the research *Development of Bilingual Worksheet By Using Mind Mapping Learning Strategy For Atomic Structure* by Yulianinda showed that there was an exaltation of student's learning achievement as much as 100% though limited trial using worksheet with mind-mapping learning strategy. [8]

Based on that reasons, developed the bilingual worksheet based on mind-mapping in chemical equilibrium topic which are interesting, facilitating the the students in understanding of the concept easily, and in accordance with globalization. The research was done by the following research question:

1. How are the feasibility of bilingual worksheet based on mind-mapping in chemical equilibrium topic in the criteria of content, language, presentation, and compliance with the mind-mapping component?
2. How is the feasibility of bilingual worksheet based on mind-mapping in chemical equilibrium topic reviewed from student learning achievement?

## METHOD

This research uses a the 4-D research development model proposed by Thiagarajan (1974). The development model consists of four stages: define, design, develop, disseminate [8]. This research is limited to develop stage only.

The objective of this research is the feasibility of the developed worksheet. The data sources of this research are the research data obtained from two chemistry lecturers, validation data obtained from two chemistry lecturers and one chemistry teacher, and limited trial data obtained from 20 high school students from SMA Muhammadiyah 2 Surabaya Grade XI.

### Research Instrument

#### Review Sheet

This sheet is conducted to provide opinions and advices from chemistry

lecturers as media, content, and language expert. The review sheet is an open questionnaire in terms of content, language, presentation, and compliance with the mind-mapping component. Based on the results of the review for worksheet draft I, the worksheet is then revised to produce worksheet draft II.

#### Validation Sheet

This validation sheet contains criteria for assessment of the content, language, presentation and compliance with the Mind-Mapping component. Validation is conducted to know the feasibility of worksheets based on defined criteria for worksheet draft II.

#### Mind-Mapping Assessment Sheet

Mind-Mapping assessment sheet is a summary of the chemical equilibrium topic to determine the students' ability to create Mind-Mapping after limited trials by using the developed worksheet. Students' mind-mapping then assessed based on rubric of Mind-Mapping component. Mind-mapping assessment sheet is used as students' learning achievement data and support the feasibility of the developed worksheet.

#### Student Test Sheet

Student test sheet given to students before and after limited trial using the worksheet. This tests consist of questions that represent learning indicators of chemical equilibrium topic. The test result is used as students' learning achievement data and support the feasibility of the developed worksheet.

#### Data analysis

##### Review sheet analysis

Review sheet results such as opinions and advices for improvement of the developed worksheet are analyzed for revision.

##### Validation sheet analysis

Validation data results of the developed worksheet are analyzed using quantitative descriptive method. This analysis is done on each of the criteria set out in the validation sheet. The percentage of this questionnaire data obtained by Likert scale calculations in Table 1.

Table 1 Likert Scale

Score Scale	Valuation
1	Very bad
2	Bad
3	Enough
4	Good
5	Very good

[10]

The formula used in the calculation to obtain the percentages are:

$$\text{Percentage}(\%) = \frac{\text{score of total data collection}}{\text{score criteria}} \times 100$$

Explanation:

Criteria score = the highest score x number of questions in the questionnaire x number of respondents

Percentage obtained interpreted into criteria that can be seen in the table 2 below:

Table 2 Criteria score

Percentage	Category
0.01 – 20.99	do not feasible
21.00 – 40.99	Less feasible
41.00 – 60.99	Enough feasible
61.00 – 80.99	Feasible
81.00 – 100.00	Very feasible

[10]

Based on the interpretation score criteria, the bilingual worksheet based on mind-mapping in chemical equilibrium topic is said to meet the feasibility of the content, language, presentation and compliance with the mind-mapping components if the percentage obtained from the results of the validation is  $\geq 61\%$ . So it can be worthy for use in teaching and learning process. [10]

#### Mind-Mapping Assessment sheet data

Students' learning achievement data in form of students' mind-mapping is obtained from mind-mapping assessment which is given to students' after limited trial using the developed worksheet. Students' mind-mapping results are assessed based on the total score obtained

from each of the Mind-Mapping components existing on the assessment rubric. Calculation of the final score using the formula:

$$\text{score} = \frac{\text{score of total data collection}}{\text{maximum score}} \times 4$$

The results are categorized according to the following table. Students are said to mastery the mind-mapping if the total score is  $\geq 2,80$ .

Table 3 Mind-mapping assessment category

Score Scale	Category
1,00-1,59	Very bad
1,60-2,19	Bad
2,20-2,79	Enough
2,80-3,39	Good
3,40-4,00	Excellent

[11]

#### Student test data analysis

Student test sheet consists of 10 multiple choice questions of chemical equilibrium topic. Data from that pre-test and post-test score that is used as students' learning achievement can be calculated using the following formula:

$$\text{score} = \frac{\text{total of correct answers}}{\text{maximum score}} \times 4$$

Based on the results of this analysis, according to the curriculum 2013 students mastery their learning if the total score obtained is  $\geq 2,80$  with predicate  $\geq B$ .

Table 4 Competence score scale based on curriculum 2013

Score	Predicate
3,85 – 4,00	A
3,51 – 3,84	A-
3,18 – 3,50	B+
2,80 – 3,17	B
2,51 – 2,79	B-
2,18 – 2,50	C+
1,85 – 2,17	C
1,51 – 1,84	C-
1,18 – 1,50	D+
1,00 – 1,17	D

[12]

Then calculated the percentage of students' mastery learning after a limited trial to strengthen the feasibility of the developed worksheet.

## RESULTS

### Stage I: Define

This stage was done to provide an overview a problem that was needed to develop the worksheet. At this stage were done some steps, such as. the front end analysis, students analysis, concept analysis, and tasks analysis.

#### Front end analysis

The curriculum applied in SMA Muhammadiyah 2 Surabaya is curriculum 2013 for grade XI students in the academic year 2014/2015. Due to the chosen subject was grade XI students, the curriculum 2013 was used as guidance in the preparation of the worksheets. Scientific approach in curriculum 2013 is in line with the constructivist theory of Piaget. Piaget found the teacher acts as a facilitator rather than a conduit of information [13]. Required appropriate media which is facilitating students in building his own understanding. bilingual worksheet based on mind-mapping is one of learning media which is intended students to have more motivation and to learn independently and fun.

#### Student analysis

High school student grade XI has an average age of 16-19 years. That age scale is the transition from adolescence to adulthood and at that age children are in the stage of formal operation. Students already received English language learning so that bilingual learning can be applied. As well, students already received a chemical topics that are quite difficult.

#### Task analysis

Learning unit contents such as learning objectives and indicators were specified. Steps of completion tasks by students were determined. Tasks to be carried out by students in each meeting were categorized, so, can be known the objectives that will be presentng in the meeting.

### Concept analysis

The main concepts of chemical equilibrium topic to be taught were identified systematically and in accordance with the curriculum 2013.

### Stage II: Design

Results from define stage was used to produce the worksheet draft 1 which will be reviewed by two chemistry lecturers

#### Worksheet Review

Based on worksheets review, the developed worksheet must be revised in some aspects, such as: illustration or images, font, and the grammar.

#### Worksheet Revision

Repair and revision were arranged based on the advices on the review sheet. Worksheet revision produced worksheet draft II which was ready to be validated.

### Stage III: Develop

#### Worksheet Validation

Validation was done by experts consisting of two chemistry lecturers and one chemistry teacher. Validation was conducted to determine the feasibility of the worksheet in criteria of the content, language, presentation and compliance with the mind-mapping component criteria. Feasibility is indicated if the feasibility assessment results got a percentage of  $\geq 61\%$  in accordance with a modified Likert scale [10]. The average results of the validation are presented in the following table 5:

Table 5 Worksheet validation result

Criteria	Percentage (%)	Category
Contents	85,19	very feasible
Language	82,22	very feasible
Presentation	87,22	very feasible
Compliance with mind-mapping component	85,33	very feasible

Based on validation results in Table 5 above, it can be seen that the developed worksheet got assessments from experts in the contents criteria with a percentage of 85.19% in the category of very feasible.

This indicated that the worksheets was in accordance with BNSP (2006) criteria: used a curriculum that was relevant to the learning indicators, contained truth content (facts, laws, concepts, principles), and in accordance with the structure of science. [14]

The worksheet also met the language criteria with the percentage of 82.22% in the category of very feasible. Bilingual language used in Worksheet were in accordance with the criteria according BSNP, such as: the language used in the worksheet was good and correct, also in accordance with the age of the students, and the terms used were easily understood. [14]

Presentation criteria were fulfilled by the percentage of 87.22% with a very feasible category. It showed that the worksheet met the criteria by BSNP: logical and systematic presentation, motivating students, encouraging students actively involved in learning activities, paying attention to the diversity of students, as well as interesting and fun. [14]

Compliance with mind-mapping component was fulfilled by 85.33% in the category of very feasible. This indicated that mind-mapping in the worksheet met the mind-mapping components by Buzan, including: the location of main idea was in the center, a variation of colors, variation of images, codes, symbols or dimensions, branches further away from the center is getting thinner, and the use of correct keywords.

The calculation of the four criteria above showed that the developed worksheet has been qualified with the percentage of  $\geq 81\%$  and in the very feasible category.

#### Limited trial of worksheet

After worksheet validation, limited trial using this worksheet was conducted in SMA Muhammadiyah 2 Surabaya. 20 students of grade XI were selected by chemistry teacher of SMA Muhammadiyah 2 Surabaya who had been familiar with the capabilities of each students. The limited trial used to know

the students' learning achievement by mind-mapping assessment and students' test.

#### Student Mind-Mapping Assessment

Students' mind-mapping assessment score in the chemical equilibrium topic after limited trial using bilingual worksheet based on mind-mapping can be seen in Table 6 below:

Table 6 Students' mind-mapping score

Student	Score	Category
1	2,31	Enough
2	3,44	Excellent
3	3,86	Excellent
4	3,48	Excellent
5	3,76	Excellent
6	3,44	Excellent
7	2,81	Good
8	3,11	Good
9	3,53	Excellent
10	3,58	Excellent
11	3,01	Good
12	3,25	Good
13	3,62	Excellent
14	3,62	Excellent
15	3,62	Excellent
16	3,62	Excellent
17	3,39	Good
18	3,11	Good
19	3,15	Good
20	3,39	Good

Based on Table 6 above, can be seen that 55% of students obtained excellent category, 40% of students obtained good category, and 5% of students obtained enough category. It showed that the students were able to compile the concepts of chemical equilibrium in a mind-mapping after trials with the developed worksheet. Based on data analysis, can be seen that 95% of students were mastery the mind-mapping assessment; these data support the feasibility of the worksheet.

Here are examples of the students' mind-mapping of excellent and good categories:

#### Excellent category

The following student's mind-mapping has met the mind-mapping component with excellent category. The details of

mind-mapping's assessment can be seen in table 7.

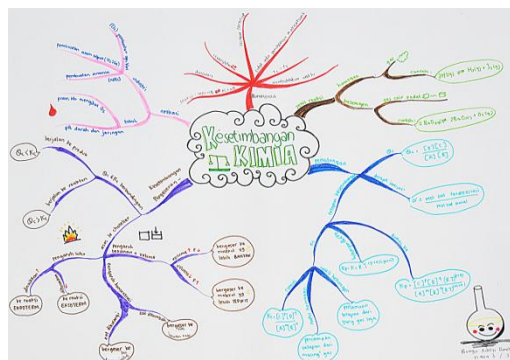


Figure 1 Example of student's mind-mapping with excellent category

Table 7 Example of student's mind-mapping assessment with excellent category

No	Assessment Criteria	Score
1.	The main topic is in the centre of the paper, use supported symbols or images	4
2.	The main branches' shape is a long curved line, color of each main branches is different one another, and there's main idea on the top of each branches	4
3.	Twigs / complementary ideas is smaller than the branch, complete with the keywords, its length suits the keywords/ picture, and there are some supported symbols /iamges	4
4.	The color of branch and twig is match each other, the writing is tidy	4
5.	Suitability of the material on the branches and twig	4
6.	All of material is related to chemical equilibrium	4
7.	The amount of correct keywords on branches/twigs	58
Final score		3,86

### Good category

The following student's mind-mapping has met the mind-mapping component with good category. The details of mind-

mapping's assessment can be seen in table 8.

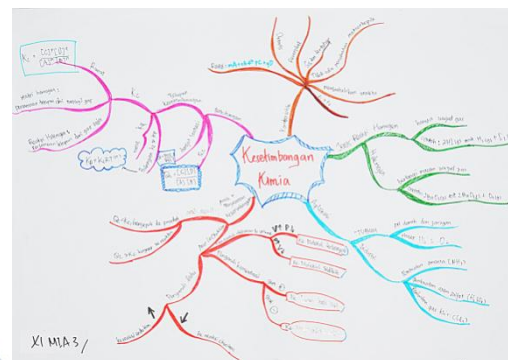


Figure 2 Example of student's mind-mapping with good category

Table 8 Example of student's mind-mapping assessment with good category

No	Assessment Criteria	Score
1.	The main topic is in the center of the paper, but it doesn't use capital font nor symbols and images that support the main idea	2
2.	The main branches' shape is a long curved line, color of each main branches is different one another, and there's main idea on the top of each branches	4
3.	Some of twigs/ complementary ideas is not smaller than the branch, complete with the keywords, its length suits the keywords/ picture, there is no supported symbols/images	3
4.	The color of branch and twig is match each other, the writing is not tidy	3
5.	Suitability of the material on the branches and twig	4
6.	All of material is related to chemical equilibrium	4
7.	The amount of correct keywords on branches/twigs	52
Final Score		3,39

### Student test sheet result

Student learning achievements were obtained from a test sheet consisting the pre-test and post-test. According to the

curriculum 2013 students are said to mastery the learning if the the score is  $\geq B$ . Student test results can be seen in Table 9 below.

Table 9 Students' *pre-test* and *post-test* results

Student	Pre-test Score	Post-test Score
1	B	B+
2	B	B+
3	B+	A
4	B-	A-
5	B+	A
6	B	A
7	B-	B+
8	B	B+
9	C-	B
10	A-	A
11	C	B
12	C-	B
13	B	A-
14	B+	A-
15	B-	A
16	B-	A-
17	B	A-
18	B+	A
19	C	B+
20	B	A-
Class' Mastery Learning	60%	100%

Pre-test results showed the mastery learning of students by 60%. After limited trial with the developed worksheet, learning achievement is obtained by 100% of mastery learning. Based on this result, it indicated that there was an improvement of student's mastery learning by 40%. Moreover, according to data from student learning achievement above, can be seen that all students' score were improving. It support the feasibility of the worksheet.

## CLOSING

### Conclusion

Based on the results can be concluded that:

1. The bilingual worksheet based on mind-mapping has been qualified to

be used in learning process indicated by the percentage of feasibility as follows: 85,19% in content criteria with a very feasible category; 82,22% in language criteria with a very feasible category; 87,22% in presentation criteria with a very feasible category, and 85,33% in compliance with mind-mapping component with a very feasible category.

2. The bilingual worksheet based on mind-mapping was able to assist students in improving learning achievement indicated by 95% mastery learning on the mind-mapping assessment and the improvement of 40% mastery learning on the multiple choice test.

### Suggestions

1. This research was done only to limited trial, therefore it is necessary for the application of the actual learning
2. Further research by applying this worksheet can also be used to train students' creative thinking

### BIBLIOGRAPHY

1. Triwianto, Teguh. 2007. *Globalisasi dan Perbaikan Pembiayaan Perguruan Tinggi*. (online). (<http://www.p2kp.org/wartadetil.asp?id=1637&catid=2&>, accessed on January 2015)
2. Rachmajati, Sri. 2008. *Pengembangan Model Pembelajaran MIPA Bilingual Berbasis Pendekatan Kontekstual Berbentuk Compact Disk (CD)*. Jurnal Penelitian Pendidikan 1(32)
3. Ashadi. 2009. *Kesulitan Belajar Kimia bagi siswa Sekolah Menengah Atas*. (Online). (<http://www.groups.yahoo.com/group/sains/files>, accessed on October 2014)
4. Suyanti, Retno dwi. 2010. *Strategi Pembelajaran Kimia*. Yogyakarta: Graha Ilmu.



5. Azhar Arsyad. 2004. *Media Pembelajaran*. Jakarta: PT. Raja Grafindo Persada.
6. Ratna, WilisDahar. 1989. *Teori-teori Belajar*. Jakarta: Erlangga.
7. Buzan, Tony. 2012. *Buku Pintar Mind Map*. Cetakan XI. Jakarta: PT Gramedia
8. Yulianinda, Yudit. 2013. *Development of Bilingual Worksheet By Using Mind Mapping Learning Strategy For Atomic Structure*. UNESA Journal of Chemical Education Vol. 3, No 1.
9. Ibrahim, Muslimin. 2001. *Model Pengembangan Perangkat Pembelajaran Menurut Jerold E. Kemp & Thiagarajan*. Surabaya: PSMS-PSS UNESA.
10. Riduwan, dkk. 2011. *Skala Pengukuran Variabel-variabel Penelitian*. Bandung: Alfabeta
11. Harnugrawan, Gebya O. 2012. *The Assessment Of Student's Mind Mapping Result On Limited Trial Towards Bilingual Interactive E-Book Media Through Mind Mapping Strategy On Chemical Bonding Matter For SMA RSBI*. UNESA Journal of Chemical Education Vol. 3, No 1.
12. Permendikbud. 2014. *Peraturan Menteri Pendidikan dan Kebudayaan Nomer 104 Tahun 2014 tentang Penilaian Hasil Belajar Oleh Pendidik pada Pendidikan Dasar dan Pendidikan*. Jakarta: Kementerian Pendidikan dan Kebudayaan.
13. Slavin, R. E. *Educational Psychology: Theory and Practice*. 4th Edition. Massachusetts: Allyn and Bacon
14. Badan Standar Nasional Pendidikan. 2006. *Panduan Penyusunan Kurikulum Tingkat Satuan Pendidikan Jenjang Pendidikan Dasar dan Menengah*. Jakarta: Badan Nasional Standar Pendidikan.