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DEVELOPMENT OF STUDENT ACTIVITY SHEETS (LAPD) WITH MIND MAPPING STRATEGY TO TRAIN CREATIVE THINKING SKILLS ON CHEMICAL EQUILIBRIUM MATERIAL

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Abstract

This study was conducted to determine the feasibility of Student Activity Sheets or LAPD designed with a mind mapping strategy to improve students' creative thinking skills in the topic of chemical equilibrium. The research applied the 4D development model consisting of the define, design, develop, and disseminate stages, but its implementation was limited to the develop stage. The product was tested on 35 eleventh grade students at a public senior high school. The feasibility evaluation covered three aspects, namely validity, practicality, and effectiveness. The results showed that the LAPD fulfilled the validity criteria, as all components of content and construct validity achieved a mode score equal to or greater than 4. Practicality was reflected in the high percentage of relevant student activities at 97,10 percent and positive student responses at 88,54 percent, both categorized as very practical. Effectiveness was indicated by the improvement in students' creative thinking skills based on the comparison of pretest and posttest results from mind mapping assessments and Cognitive test on chemical equilibrium topic, which obtained N gain scores average of 0,76 and 0,72, respectively, both classified in the high category. Therefore, the mind mapping based LAPD can be considered feasible and effective in enhancing students' creative thinking skills in chemical equilibrium learning.
Keywords: student activity sheets, mind mapping, creative thinking skills, chemical equilibrium

INTRODUCTION

The Industrial Revolution 4.0 era has produced rapid advances in science and technology across various aspects of life, one of which is education, which has been significantly impacted. Education, as an institution that develops knowledge and human resources, requires highly adaptable, competitive, and 21st-century skills. In this global change, students are required not only to understand the material in general but also to develop high-level skills, one of which is critical and creative thinking skills, as well as effective communication and collaboration [1].

One of the skills included in the independence curriculum is creative thinking skills, which are included in the Pancasila student profile [2].

Creative thinking skills in this case refer to the skills to produce original, diverse, detailed or detailed ideas in solving problems. [3] states that creative thinking skills consist of four aspects: fluency, flexibility, originality, and elaboration. However, based on the results of a pre-research questionnaire conducted with 35 eleventh-grade students, most students experienced difficulty providing more than one answer, providing diverse ideas, generating ideas that differed from those of their peers, and explaining their answers in detail. This indicates that students' creative thinking skills still need systematic and in-depth training through appropriate learning strategies.

One One learning material that can be developed to train students' creative thinking skills is the Student Activity Sheet (LAPD). In the Independent Curriculum, the LAPD is a crucial component of the learning module, designed to encourage active student involvement in independently constructing their knowledge [4]. The development of LAPD should be accompanied by instructional strategies that are able to optimize

students' thinking potential. [5] This confirms that learning strategies are important things or factors in improving the quality of learning and developing students' skills, especially creative thinking skills.

The use of mind mapping strategies in the Learning Assessment and Processing Department (LAPD) is an alternative way to train students' creative thinking skills. Mind mapping is a creative note-taking technique that organizes keywords, symbols, colors, and relationships between concepts, helping students construct information visually and systematically based on their own thinking [6]. Research conducted [7] this shows that implementing a mind mapping strategy can train students' creative thinking skills. This is because the mind mapping strategy encourages diverse and original ideas to emerge from students' thinking.

Chemical equilibrium was selected as the subject matter in this study because it is abstract in nature and involves many interrelated concepts, such as dynamic equilibrium, the equilibrium constant, and Le Chatelier's principle. Based on the results of the pre-research questionnaire, 74,29% of students stated that they experienced difficulties in understanding chemical equilibrium material. These difficulties are caused by the complexity of the concepts and students' tendency to memorize without understanding the relationships between concepts [8]. Therefore, an instructional tool is needed that can help students visualize and connect these concepts creatively.

Based on the background described above, the aims of this study are: (1) to determine the validity of the mind map based LAPD strategy for practicing creative thinking skills on chemical equilibrium, based on content validity and construct validity; and (2) to determine the practicality of the mind map based LAPD for practicing creative thinking skills on chemical equilibrium, based on student responses and activities; (3) to determine the effectiveness of the mind map based LAPD for practicing creative thinking skills on chemical equilibrium, based on pretest and posttest creative thinking skills.

This research is intended to produce and evaluate the suitability of a Student Activity Sheet (LAPD) designed with a mind mapping strategy to enhance students' creative thinking skills in learning chemical equilibrium, as assessed based on its validity, practicality, and effectiveness. Therefore, the development of this LAPD is expected to serve as an innovative alternative instructional tool that supports the implementation of the *Merdeka Curriculum* in improving the quality of chemistry learning.

METHOD

This study adopted a research and development approach utilizing the 4-D model. The model encompasses four sequential phases, namely define, design, develop, and disseminate. Nevertheless, the execution of this research was confined to the develop phase only.

Time and Research Location

The development of the LAPD using the mind mapping strategy, particularly during the review and validation stages, was conducted in May–June. Furthermore, the trial implementation of the LAPD with the mind mapping strategy was carried out from January 12–24, 2026. The trial of the LAPD using the mind mapping strategy was conducted at SMA YPM 2 Sukodono.

Research Subjects

This study was conducted with 35 students of class XI F2 at SMA YPM 2 Sukodono. The focus of this study was the development of learning instruments, specifically Student Activity Sheets (LAPD) with a mind mapping strategy to train creative thinking skills in chemical equilibrium material.

Trial Design

The research procedure in this study uses a One Group Pretest–Posttest Design. Below is a description of the research framework implemented during the trial phase:

O1 - X - O2

O_1 : Pretest, namely the creative thinking skills test administered before students received the treatment.

X : Treatment, namely the implementation or trial of the instructional tool using the mind mapping strategy on the selected material

for the research subjects during the learning process.

O_2 : Posttest, namely the creative thinking skills test administered after students received the treatment.

Data Collection Methods

To describe the feasibility of the LAPD using a mind mapping strategy, appropriate data collection methods are required. In this study, several data collection techniques were employed, namely questionnaires, observations, and tests.

Research Instruments

The feasibility of the LAPD using a mind mapping strategy developed in this study was assessed in terms of validity, practicality, and effectiveness. Several instruments were used, including a validation sheet, an observation sheet for student activities, and a creative thinking skills test sheet. Expert assessment of the LAPD's content and construct criteria was obtained through the validation sheet. The practicality level of the LAPD was assessed through a student response questionnaire, which was reinforced by observations of student learning activities. In addition, the effectiveness of the LAPD in enhancing creative thinking skills was determined using a creative thinking skills test instrument, administered through pretest and posttest items related to mind mapping and the chemical equilibrium topic.

Data Analysis

The data collected were then analyzed using quantitative descriptive analysis techniques. In this study, the analysis was conducted on validity, practicality, and effectiveness data to describe the level of feasibility of the Student Activity Sheet (LAPD) using a mind mapping strategy that was developed.

Validity Data Analysis

The scores assigned to each criterion included in the validation instrument were determined based on the Likert scale presented in Table 1.

Table 1. Likert Scale Categories

Assessment	Scale Value
Very good	5
Good	4
Good enough	3
Not good enough	2
Bad	1

The validation data obtained were then analyzed by determining the mode for each assessed aspect. The mode value for each aspect, along with its criteria, was used to interpret the validation findings, which were in the form of ordinal data. An aspect was considered valid if the validator's assessment showed a mode value of ≥ 4. Conversely, an aspect was considered invalid if the mode value was < 4. Aspects that did not meet this criterion were revised and revalidated until they fulfilled the feasibility requirements [11].

Practicality Data Analysis

The level of practicality of the LAPD produced in this research was determined using multiple instruments, including a student response questionnaire and an observation sheet of student activities. These tools functioned as complementary data sources to capture and analyze the learning activities conducted by both the teacher and the students throughout the instructional process.

The data derived from the student response questionnaire, reflecting the practicality aspect, were examined using the Guttman scale according to the criteria outlined in Table 2.

Table 2. Guttman Scale Categories

Question	Answer	Score
Positive	Yes	1
	No	0
Negative	Yes	0
	No	1

The practicality value for LAPD is calculated using the calculation formula presented below:

$$P(\%) = \frac{F}{N} \times 100\%$$

Explanation:

P : Percentage of student responses

F : Number of "Yes" or "No" responses

from students

N : Total number of students

The percentages obtained from student response data were then analyzed and grouped based on predetermined criteria, which are shown in the Table 3.

Tabel 3. Interpretation of Student Responses

Interval (%)	Criteria
81-100	Very practical
61-81	Practical
41-60	Quite practical
21-40	Less practical
0-20	Impractical

Based on the criteria shown in the table, LAPD is categorized as practical if it receives a positive response from students with a minimum percentage score of 61% [9].

The data gathered from observations of student activities were processed by determining the percentage of activity execution throughout the instructional sessions, calculated using the formula provided below.

$$\%\text{activity} = \frac{\sum \text{relevant activity frequency}}{\sum \text{overall activity}} \times 100$$

Student engagement is regarded as effectively carried out, and the LAPD incorporating a mind mapping strategy is deemed practical when the proportion of relevant activities exceeds the percentage of irrelevant activities observed during the learning process [9].

Effectiveness Data Analysis

The effectiveness of the developed LAPD was evaluated based on the outcomes of the pretest and posttest measuring creative thinking skills. The increase in scores between the two assessments was examined by calculating the N-gain value using the formula provided below.

$$< g >= \frac{S_{postest} - S_{pretest}}{S_{max} - S_{pretest}}$$

Explanation :

$< g >$ = N-gain score or increase in creative thinking skills

$S_{postest}$ = Posttest score

$S_{pretest}$ = Pretest score

S_{max} = Maximum score

The table below illustrates the criteria for interpreting the N-gain calculation results, which reflect the extent of enhancement in students' creative thinking abilities.

Table 4. N-gain Score Category

Skor $< g >$	Category
$< g \geq 0{,}7$	High
$0{,}7 > < g > \geq 0{,}3$	Medium
$< g >< 0{,}3$	Low

RESULT AND DISCUSSION

This research was carried out following the phases of the 4-D development model, which includes four principal steps; nevertheless, the actual execution of the study was confined only to the develop stage.

Define

The purpose of the definition phase in this development research is to obtain information about the needs of students in the field related to the independent curriculum, student abilities, student characteristics, and school conditions. Data collected were obtained from a pre-research questionnaire administered to 35 eleventh-grade science students at SMA YPM 2 Sukodono. Data were also obtained from interviews with the school's chemistry teacher regarding chemical equilibrium material, the classroom learning process, learning strategies used, and teaching materials used in class.

This definition stage consists of five steps or procedures. The initial stage is identifying the problems faced by students and teachers in the classroom learning process. The questionnaire results showed that 74,29% of students experienced difficulties in understanding chemical equilibrium material. A total of 94,29% of students reported difficulty in recalling the material and connecting the concepts presented in the textbook. All students (100%) expressed the need for varied instructional strategies to make the material easier to understand. In addition, 85,72% of students had never used the mind mapping note-taking technique. Furthermore, 94,29% of students reported difficulties when asked to provide more than one answer, solve problems in various ways, give answers different from their usual responses, and explain their answers in detail. These results suggest that the level of students' creative thinking abilities remains comparatively limited. Based on

these results, a learning strategy is needed that can help students understand chemical equilibrium material more effectively while simultaneously enhancing their creative thinking skills.

Instructional strategies are closely related to the learning process, and in the Merdeka Curriculum, the sequence of learning activities is outlined in instructional tools, one of which is the Student Activity Sheet (LAPD). Through the development of LAPD, teachers can facilitate students in understanding the material while also enhancing creativity through the implementation of the mind mapping strategy. This strategy provides students with the opportunity to express ideas based on their own thinking in a structured visual form, thereby aiding material comprehension through graphic concept representation [10]. Therefore, it is necessary to develop LAPD with a mind mapping strategy to solve existing or identified problems.

The second stage is analyzing students' academic abilities, age, and cognitive development. Based on a pre-research questionnaire conducted previously, students' academic abilities or grades are categorized as moderate. This is indicated by several students whose scores do not meet the Minimum Competency (KKM). Interviews with chemistry teachers revealed that students' creative thinking skills have not been optimally or maximally developed. The chemical equilibrium material in the independent curriculum is included in the eleventh grade, with an average age of 16-17 years. According to Piaget's cognitive development theory, at this age, students are in the formal operational stage, where students are able to think abstractly, reason logically, process information, and connect understanding between variables. However, the ability to organize and understand material varies according to individual learning styles. Therefore, appropriate learning strategies are needed to help students practice creative thinking skills to link relationships between concepts with mind mapping strategies that align with this objective.

The third stage is task analysis. The tasks in the Student Activity Sheet (LAPD) are tailored to a series of guided inquiry learning activities and utilize mind mapping strategies. Learning activities include formulating problems, hypotheses, collecting data, analyzing data through practical activities, identifying keywords or concepts, grouping, and creating mind maps independently or individually. These learning activities are designed to encourage active student involvement in learning activities and train students' creative thinking skills in chemical equilibrium material, especially factors that influence shifts in chemical equilibrium (concentration, temperature, volume, and pressure).

The fourth step is the concept analysis. The chemical equilibrium concepts were identified and systematically organized into a concept map to assist in planning the sequence of learning activities and determining the conceptual mastery that students are expected to achieve. The concept map serves as a framework for presenting the material in a logical and structured manner. Through mastering the concepts summarized in the concept map, students can subsequently map their understanding into a mind map as a visual representation of the relationships between concepts.

The fifth step is the learning objectives analysis. By formulating clear learning objectives, the researcher can determine the scope of the material to be included in the LAPD, develop an evaluation question grid, and assess the level of achievement of the learning objectives. Formulating learning objectives ensures that the developed instructional tool aligns with the learning outcomes specified in the Merdeka Curriculum.

Based on the series of analyses conducted in the define stage, a Student Activity Sheet (LAPD) using a mind mapping strategy was developed as an alternative instructional tool to improve learners' creative thinking abilities in the topic of chemical equilibrium.

Design

Based on the stages completed in the design phase, which included selecting media appropriate to the characteristics of chemical equilibrium material and learning objectives, determining the

instructional tool format, and preparing the initial draft, an initial product was produced in the form of a Student Activity Sheet (LAPD) using a mind mapping strategy for chemical equilibrium material. This initial product was developed based on the analysis that had been carried out previously, namely at the definition stage, this ensures that all components are adapted to the needs of students and the characteristics of the material being discussed.

The initial placement of the LAPD using the mind mapping strategy begins with the creation of a cover, which contains the title, a mind mapping image and the addition of the caption "using the mind mapping strategy" and is given an image representing the chemical equilibrium material, and the author's identity. This cover is designed to show an initial overview of the material by emphasizing the use of the teaching strategy used. This LAPD includes four types of covers: the main cover and covers for each subtopic, namely the concentration factor, the temperature factor, and the pressure and volume factors. Figure 1 presents the initial appearance of the Student Sheet.

Figure 1. Cover LAPD

The LAPD currently being developed is equipped with a foreword and a list. The foreword aims to provide a brief explanation of the LAPD, which consists of three LAPDs corresponding to the subtopics of chemical equilibrium. A table of contents is provided to assist students in locating the material and to facilitate the use of the LAPD. In addition, the LAPD also includes a concept map that aims to help students understand the overview of the material to be discussed and the relationships between concepts in chemical equilibrium before engaging in the main learning activities.

To support practice in mind mapping strategies, the LAPD also includes instructions for creating mind maps and examples that students can use as references. These guidelines and examples serve as an initial framework, helping students understand the steps involved in creating mind maps while still providing room for creativity. The Student Activity Sheets include tasks presented as mind maps using the scaffolding technique, as illustrated in the Figure 2.

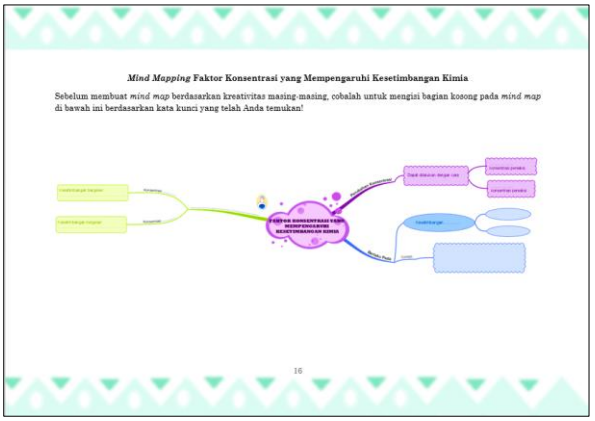

Figure 2. Scaffolding Mind Mapping

The instructional tasks presented in the LAPD are organized in alignment with the stages of the Inquiry learning model. In the introduction and orientation phase, students are introduced to the subtopics, learning outcomes, and learning objectives, and are provided with initial motivation. The next phase is problem formulation, in which students are guided to identify issues related to the chemical equilibrium material. Following this, in the hypothesis formulation phase, students develop preliminary assumptions based on their prior knowledge.

In the data collection phase, students explore various learning resources to obtain relevant information. The information gathered is then identified in the form of keywords, which serve as the basis for constructing the mind map. This activity is followed by laboratory work or experiments to test the hypothesis, particularly regarding the effect of concentration changes on shifts in chemical equilibrium in accordance with Le Chatelier's principle. The observations are

recorded and analyzed as part of the scientific verification process.

The next stage is to test the hypothesis and draw conclusions. At this stage, students are asked to analyze the data obtained previously from the practicum activities, and discuss their findings with their groups, and conclude the effect of changes in concentration on chemical equilibrium. To deepen the concept, students are first asked to fill in the gaps in the mind map as a form of practice or assistance, and then individually or independently create a complete mind map as a final summary of the learning. This activity is designed to strengthen conceptual understanding and practice creative thinking skills through organizing information visually and systematically.

During the development phase, the initial draft of the LAPD (draft I) was assessed by experts in the relevant fields to obtain feedback and suggestions for improvement. The assessment results indicated that several aspects needed revision, including the graphics on the cover, the sentences in the foreword, and the completeness of the references. Based on these results, improvements were made, resulting in draft II, which was more systematic and met academic standards for teaching materials. This revision demonstrated that the developed LAPD had been refined before proceeding to the validation and trial phase.

Overall, the results of the design and development phase indicate that the mind-mapping LAPD on chemical equilibrium material has been systematically structured, visually appealing, and in accordance with the syntax of inquiry learning. This product is expected to be able to serve as an alternative learning tool that can train students' active involvement in supporting the development of creative thinking skills in chemistry learning.

Develop

1. Validity

   In this study, the validity of the Student Activity Sheet (LAPD) using the mind mapping strategy was assessed using two criteria, namely content validity and construct validity. Content validity includes the alignment of the LAPD with the Merdeka Curriculum, the alignment of instructional activities with the targeted learning outcomes and objectives, as well as the incorporation of the Pancasila Student Profile, the suitability of the mind mapping strategy and the instructional model applied, as well as its relevance to the indicators of creative thinking skills. Meanwhile, construct validity encompasses aspects of language, presentation, and graphical design that support readability and facilitate students' use of the LAPD. The validation procedure was carried out to confirm the appropriateness of the LAPD prior to its application in classroom instruction.

   During the validation phase, Draft II of the LAPD revised in accordance with prior review feedback was evaluated by three validators, namely two lecturers from the Chemistry Education Department of Universitas Negeri Surabaya and one chemistry teacher from SMA YPM 2 Sukodono. The LAPD was considered feasible if each aspect obtained a mode score of ≥ 4, categorized as valid (mode = 4) or very valid (mode = 5) according to the established criteria [11].

   According to the validation findings for the content component, the compatibility between the stated learning objectives and the expected learning outcomes within the Merdeka Curriculum achieved a mode score of 4, categorized as good. This finding implies that the learning objectives formulated in the LAPD are consistent with the Grade XI learning outcomes for the topic of chemical equilibrium.

   The aspect of alignment between the content of learning activities and the learning objectives also obtained a mode score of 4 (good), indicating that the activities presented systematically support the achievement of the intended objectives.

   Furthermore, the aspect of alignment between the content and the Pancasila Student Profile obtained a mode score of 4 (good), demonstrating that the activities in the LAPD

have integrated the dimensions of critical thinking, creativity, independence, and collaboration through discussions, mind map construction, and problem-solving tasks.

The aspect of alignment between the LAPD and the mind mapping strategy obtained a mode score of 5 (very good). This confirms that the implementation of mind mapping has been optimally integrated into each stage of the learning activities, supported by clear instructions, examples, and scaffolding in the form of partially completed mind maps to assist students in organizing concepts.

The aspect of alignment with creative thinking skills (fluency, flexibility, originality, and elaboration) obtained a mode score of 4 (good), indicating that the activities in the LAPD were systematically designed to train the indicators of creativity in a structured manner.

In addition, the conformity of the LAPD with the stages of the guided inquiry learning model achieved a mode score of 5, which falls into the very good category, as the stages of the activities consistently followed the sequence of orientation, problem formulation, hypothesis development, data collection and analysis, and conclusion drawing in a coherent and systematic manner.

Overall, for the content criteria, a mode score of 4 was obtained for four aspects and a mode score of 5 for two aspects. Therefore, in terms of content criteria, the mind mapping-based LAPD is declared valid, as all aspects achieved a score of ≥ 4.

In terms of construct criteria, the linguistic aspect showed that the use of proper and correct Indonesian, communicative language, appropriate terminology, effective and efficient wording, and clarity of instructions each obtained a mode score of 4 (good). This indicates that the language used in the LAPD complies with linguistic standards and facilitates students' understanding of the instructions and learning materials [12].

In the presentation aspect, the completeness and systematic organization of information, as well as the appropriateness of images in relation to the material, each obtained a mode score of 4 (good). Meanwhile, the presentation of mind mapping that was able to stimulate students' motivation obtained a mode score of 5 (very good), indicating that this strategy is effective in enhancing students' interest and engagement in learning [13].

In terms of graphics, including cover design, font selection and size, and the harmony between text and image layout, each of these points received a rating of 4 (good). Attractive and proportional visuals can increase students' learning interest and reading comfort during the learning process [14].

Overall, in construct validity, a mode value of 4 was obtained for 10 aspects and a mode value of 5 for 1 aspect. This frequent occurrence of a mode value of 4 indicates that the developed LAPD has met construct validity in this case, namely language, presentation, and graphic design.

Because each aspect assessed received a mode value of 4 or more, it can be concluded that the LAPD with the mind mapping strategy developed meets validity standards and is suitable for use as a learning instrument. These results confirm that both the content and construct criteria have been fulfilled in accordance with the predetermined feasibility standards [11].

2. Practicality

The practicality data of the developed mind mapping-based Student Activity Sheet (LAPD) were obtained from students' responses, supported by the implementation of learning activities and students' engagement during the instructional process. Students' responses to the development of the mind mapping-based LAPD included their responses to the implementation of the learning process and their responses to the use of the LAPD during learning activities.

The analysis of the questionnaire data revealed that students' responses toward the implementation of the learning process achieved a percentage of 90,71%, while their responses to the use of the LAPD reached 88,54%, both categorized as very practical.

The result of observations of student activities during the implementation of learning using LAPD with mind mapping strategy are presented in the following Table 5.

Table 5. Student Activity Observation Data

Meeting	Precentage	Category
1	96,25	Excellent
2	97,42	Excellent
3	97,64	Excellent
Average	97,10	Excellent

According to the results of the student activity observations, the percentage obtained in the first meeting was 96,25%, 97,42% in the second meeting, and 97,64% in the third meeting, all categorized as very good. The average percentage of students' activities across the three meetings was 97,10%.

Therefore, based on the implementation of learning (90,71%), students' activities (97,10%), and students' responses (88,54%), the mind mapping-based Student Activity Sheet (LAPD) is declared practical for use as a learning tool. This is because all obtained percentages are ≥ 61%, meeting the predetermined practicality criteria.

3. Effectiveness

Information regarding the effectiveness of the mind mapping-oriented Student Activity Sheet (LAPD) was derived from students' pretest and posttest scores measuring creative thinking skills. The evaluation of these skills was carried out by examining the outcomes of the pretest and posttest mind mapping tasks, along with the pretest and posttest essay responses on chemical equilibrium content, which were designed in accordance with the established indicators of creative thinking ability.

The pretest and posttest data were used to measure the improvement in students' creative thinking skills after the implementation of learning using the mind mapping-based LAPD. The aspects of creative thinking skills assessed included fluency, flexibility, elaboration, and originality.

The developed LAPD contains a sequence of learning activities incorporating the syntax of mind mapping integrated into each student activity, including assignments to create mind maps in every meeting. The findings from the implementation of learning activities utilizing the LAPD demonstrated an enhancement in students' creative thinking abilities. This improvement is reflected in the marked difference between the pretest and posttest mind mapping outcomes administered prior to and following the instructional process.

The improvement indicates that the mind mapping strategy is capable of facilitating students in developing ideas in a more structured and creative manner, in line with previous studies stating that constructing mind maps can optimize brain function and encourage the emergence of new and original ideas. The following presents examples of students' mind maps categorized as very good.

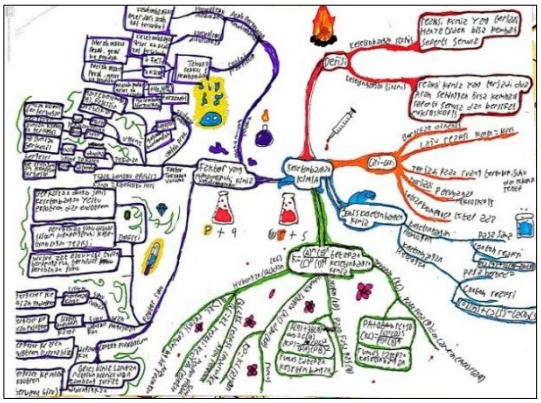

Figure 3. Student Mind Mapping Results on Very Good Category

The results of students' mind maps in the very good category demonstrate the fulfilment of all four aspects of creative thinking skills. The aspect of fluency is seen in the ability of students to determine keywords and determine which keywords are

the main theme, subtheme, branch, and sub-branch. The flexibility aspect can be seen from the use of various colors, curved branches that gradually taper outward, and the addition of symbols or images that represent the concept. The elaboration aspect can be seen in the ability of students to detail each keyword into several detailed and relevant branches (≥ 4 branches). In addition, the originality aspect can be seen from the mind mapping design as a product of the ideas and creativity of each student who does not copy the work of peers, and is in accordance with the concept of chemical equilibrium material. The following are the results of students' mind mapping that are categorized as good.

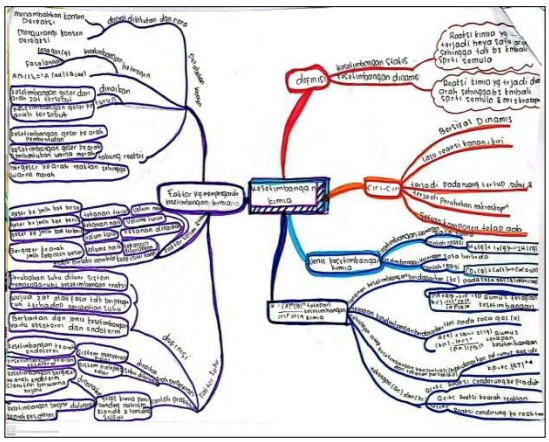

Figure 4. Student Mind Map Results on Good Category

In the good category, the mind map met the fluency, elaboration, and originality criteria. However, the flexibility aspect was not fully optimized or maximized. This was because students consistently provided symbols or images to visualize each branch or keyword.

Furthermore, in the "fairly good" category, several aspects, including fluency and elaboration, were not yet optimally developed. This is because the number of keywords and the level of detail in the branches are still quite limited. However, in terms of originality, distinctive or original designs are visible, reflecting the students' own work.

Based on quantitative calculations, the data shows that the increase in students' creative thinking abilities as shown by the comparison of pre-test and post-test mind mapping scores, obtained an N-gain value of 0.76 and is included in the high category.

Furthermore, calculations were also obtained from an analysis of six essay questions on chemical balance given before and after the exam, designed to align with creative thinking indicators. This analysis yielded an N-gain score of 0.72, also considered high.

The results of this study indicate that the use of LAPD with a mind mapping strategy effectively trains students' creative thinking skills on chemical equilibrium material, both through visual depictions of mind mapping and through students' abilities in writing written results according to indicators of fluency, flexibility, elaboration, and originality.

CONCLUSION

Based on the data obtained and the analysis presented, it was concluded that the Student Activity Sheet (LAPD) using a mind mapping strategy, developed to train creative thinking skills in chemical equilibrium, is suitable and can be used as a teaching material. This is demonstrated by the results of validity, practicality, and effectiveness obtained.

Based on its validity, the LAPD received a mode score of ≥ 4 in all assessment aspects, both in content validity and construct validity. Therefore, the LAPD was declared valid and suitable for use in the classroom learning process.

Based on its practicality, the results of the observations that have been carried out obtained the percentage of relevant student activities of 97,10% and student responses of 88,54%, and both are categorized as very practical. This indicates that the developed LAPD is easy to use and effectively supports active student engagement in classroom learning.

Furthermore, based on its effectiveness, the increase in students' creative thinking skills as shown by the results of the N-gain analysis received a score of 0.76 for the mind mapping

assessment and 0.72 for the essay test, and both were in the high category.

Based on these results and conclusions, LAPD with a mind mapping strategy can be used by teachers or educators as teaching materials to train students' creative thinking skills in chemical equilibrium material. Furthermore, the findings of this study may serve as a reference for future researchers in developing more innovative and effective learning materials.

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