Development of Teaching Modules with Mind Mapping Strategy to Improve Creative Thinking Skills on Chemical Bonding Material

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DOI: https://doi.org/10.33369/pendipa.7.3.362-372

ABSTRACT

This study aimed to describe the feasibility of teaching modules with mind mapping strategies to improve creative thinking skills in chemical bonding material. The research method used was the 4-D model (define, design, develop and disseminate) which is limited to the development stage. The trial was conducted on 34 students of class XII IPA 4 at one of state senior high school in Surabaya. The teaching module was said to be feasible in terms of validity, practicality and effectiveness. The results showed the feasibility of teaching modules in terms of content validity getting mode 5 on very good category and construct validity getting mode 4 on good category so that overall the teaching module gets mode ≥4 and is declared valid. The practicality of teaching modules in terms of learning implementation gets a percentage of 93.63%, student activities get a percentage of 97.35% and student responses with a percentage of 92.12% with very practical criteria. The effectiveness of the teaching modules is seen from the improvement of students' creative thinking skills through pretest and posttest mind mapping as well as questions on the description of creative thinking skills on chemical bonding material with an N-Gain value obtained respectively of 0.73 and 0.72 in the high category. Based on the results of validity, practicality and effectiveness can be concluded that teaching modules with mind mapping strategies are appropriate to be used in learning to improve creative thinking skills in chemical bonding material.

Keywords: *Teaching modules, mind mapping, creative thinking skills, chemical bonds.*

INTRODUCTION

Education as the main forum for humans to acquire knowledge is faced with great challenges in the midst of the development of science and technology in the 21st century. Changes that occur in various aspects of life require a person to be able to adapt, face challenges and be able to compete globally in terms of thinking, expertise and skills (Wulandari & Sholihin, 2016).

As an effort to follow up on existing needs and challenges, the ministry of education and culture proposed the concept of "Independent Learning Education" which is included in the independent curriculum. The implementation of the independent curriculum is considered as an alternative to the Indonesian education system in equipping students with various skills needed in the 21st century, one of which is creative thinking skills (Ningrum, 2022).

Creative thinking is a skill to create something new, diverse and original. Individuals must be able to think about, create new techniques or develop existing old ways to produce something useful to solve a problem which is expressed through aspects of fluency, flexibility, originality and elaboration (Ahmar, 2016). Individual creativity can be reflected in various ways, including thinking patterns, attitudes, personality and problem-solving skills (Febrianti dkk., 2016).

This shows that creative thinking can broaden thinking power, so that to produce quality thoughts requires the development of good ways of thinking (Febrianti dkk., 2016). In this case the teacher's role is very important in the learning process, the teacher must be able to design and create learning tools that can not only help students in participating in learning but can also improve students' creative thinking skills. One of the learning tools that is very essential and must be prepared properly by the teacher is the teaching module.

The teaching module is a new mention in the independent curriculum as a substitute for lesson plans, but there are significant differences in the content contained in both. One of the differences lies in the content of Pancasila student profiles in

teaching modules that are tailored to the needs of students. One indicator of the Pancasila student profile is creative reasoning. So that by compiling a series of learning activities in teaching modules it is possible to foster students' inventive reasoning (creativity thinking) in dealing with various problems in everyday life (Maulida, 2022).

The teaching module designed by the teacher will become a guide for implementation during learning and assist students in achieving predetermined competency criteria. The availability of teaching modules with interesting and structured learning activities is expected to make it easier for students to absorb the content of the subject matter and do the assignments given. This is directly related to the learning strategy used. The learning strategy is the most important aspect in improving the quality of learning implementation and the skills of students, therefore the teacher must provide the right strategy, well planned and easy to apply (Fatimah & Kartikasari, 2018).

Ainurrohmah and Mitarlis (2019) said that learning using a mind mapping strategy that applies visual and sensory reminders with patterns of connected ideas can improve students' creative thinking skills. Teachers can practice creative thinking skills by using mind mapping strategies, because when students make mind maps, they will develop something different from the others with varied forms and produce unlimited ideas. In addition, students are trained to be able to associate the concepts of subject matter with their own thoughts so as to encourage students to think creatively.

Based on data obtained from a pre-research questionnaire distributed to 33 students of class XI IPA at one of state senior high school in Surabaya, as many as 72.72% of students consider chemistry subjects difficult to understand and as many as 90.9% of students find it difficult to understand chemical bonding material. Learners stated that chemical bonding material is abstract and contains many concepts making it difficult to remember the material in the long term. Instead of actively trying to develop their own understanding of these chemical concepts, students generally tend to learn chemistry by rote. In fact, most of the chemical materials are interconnected or in other words, one material becomes the basis that needs to be mastered before studying the next material, for example, chemical bonding material (Sabrina, 2018).

As stated by Widarti et al., (2018), chemical bond material is the basis for understanding other material such as chemical equilibrium, thermodynamics, molecular structure and chemical reactions, even though the topic of chemical bonds is very important in chemistry learning, it is difficult for curriculum designers, teachers and students to learn and apply it because the concept of chemical bonds is abstract. Chemical bonds are divided into several subtopics, including ionic bonds, covalent bonds, coordinate covalent bonds and metallic bonds. Apart from that, chemical bonding also involves many concepts such as molecules, atoms, protons, neutrons, electrons, cations, anions, repulsion of like charges and attraction of opposite charges (Rahayu & Fitriza, 2021).

In studying the chemical bonding material, students must be able to construct their own knowledge by using higher-order thinking skills, one of the thinking skills is creative thinking skills. Based on the results of the pre-research questionnaire, it was found that 96.96% of students stated that they needed various learning strategies, 63.63% said they had never applied the note-taking method using mind mapping and 81.81% of students said they were more interested and understood the material better. when learning is done by drawing and coloring. Based on the description above, the purpose of this research is to produce and describe the feasibility of teaching modules with a mind mapping strategy to improve creative thinking skills in chemical bonding material in terms of validity, practicality and effectiveness.

RESEARCH METHODS

Research Design

The 4-D model is the research methodology used in this development study. The 4-D development paradigm's four main steps are define, design, develop, and disseminate. This study is just concerned with the development stage.

Date and Place of the Research

Research on the development of teaching modules with a mind mapping strategy, namely the review and validation stages, was carried out in May-June, while trials for teaching modules with a mind mapping strategy were carried out on 25 July-1 August 2023.

The trial implementation of teaching modules with a mind mapping strategy was carried out at one of state senior high school in Surabaya.

Reseach Subject

This research involved 34 students of class XII IPA 4 at one of state senior high school in Surabaya as research subjects and the target of this research was a learning tool in the form of mind mapping strategy teaching modules to improve creative thinking skills in chemical bonding material.

Trial Design

One Group Pretest Posttest Design was used for trials in this study. The following is an overview of the research design that was carried out:

O_1 – X – O_2

Information:

O_1 : Pretest, namely a test of creative thinking skills before being given treatment

X : Treatment, namely testing of teaching modules with a mind mapping strategy on chemical bonding material to research subjects in the learning process

O_2 : Posttest, namely a test of creative thinking skills after being given treatment

Data Collecting Methods

To describe the feasibility of teaching modules with a mind mapping strategy, an appropriate data collection method is needed. This study included a variety of data collection techniques, including questionnaire, observations, and tests.

Research Instruments

The feasibility of teaching modules with a mind mapping strategy developed in terms of the aspects of validity, practicality and effectiveness. This study used several instruments including validation sheets, observation sheets on the implementation of learning, observation sheets on student activities and test sheets for creative thinking skills. An expert assessment of the content criteria and construct criteria for the created training modules is obtained using the instrument in the form of a validation sheet. Instruments in the form of student response questionnaires supported by observation sheets of learning implementation and observation of student activities used to evaluate the practical aspects of the teaching modules. Meanwhile, the creative thinking skills test sheet instrument was used to obtain data on the effectiveness of using teaching modules to enhance creative thinking skills in the form of pretest posttest mind mapping questions and pretest posttest questions on chemical bonding material.

Data Analysis

The data collected was then carried out a quantitative descriptive analysis. In this research, validation data analysis, practicality data analysis, and effectiveness data analysis were carried out.

1. Validation Data Analysis

The assessment obtained for each aspect contained in the validation sheet refers to the Likert scale as follows:

Table 1. Likert Scale Categories

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

The validation data obtained is then determined by the mode gain for each aspect being assessed. The mode on each aspect with criteria can be used to assess data validation findings in the form of ordinal data. Aspects are declared valid if the aspects assessed by the validator have mode ≥4. Aspects are declared invalid if the aspects assessed by the validator have a score mode <4. Aspects that don't fulfill the requirements must be updated and revalidated until they do in order to meet the requirements (Lutfi, 2021).

2. Practicality Data Analysis

The practicality of the teaching modules developed in this study were obtained through instruments in the form of student response questionnaires, observation sheets of learning implementation and observation sheets of student activities which will be used as supporting data to find out the activities carried out by teachers and students during the learning process.

The results of student response questionnaires which are practical data are analyzed using the Guttman scale with the following conditions:

Table 2. Guttman Scale Category

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

The practicality score of the teaching modules obtained is then calculated using the following formula:

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

Keterangan:

P : Presentation of student answers

F : The number of answers "Yes" or "No" from students

N : Number of students

The results of the percentage of student response data obtained were then interpreted into criteria which can be seen in the table below:

Table 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

Teaching modules are deemed practical according to the criteria in the table above if students respond positively to them by at least 61% of the time (Riduwan, 2015).

The results of observations of students' activities were analyzed by calculating the percentage of activities carried out by students throughout the learning process using the following formula.

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

Student activities are considered to have been carried out well and the mind mapping strategy teaching modules developed are declared practical if the percentage of relevant activities exceeds the percentage of irrelevant activities (Riduwan, 2015).

The results of observing the implementation of learning are used to determine the management of learning by the teacher in each learning phase. Observers give a score to the management of learning carried out by the teacher according to the assessment rubric. The percentage of learning implementation can be calculated using the following formula:

$$\%Learning\ management = \frac{\sum observed\ aspect\ scorei}{\sum highest\ score} \times 100$$

Furthermore, the average percentage of learning implementation in each phase is calculated, then the results are interpreted according to the learning management category as follows:

Table 4. Learning Management Category

Precentage (%)	Category
81-100	Very good
61-80	Good
41-60	Good Enough
21-40	Not good enough
0-20	Bad

3. Effectiveness Data Analysis

The effectiveness of the developed teaching modules can be seen from the results of the pretest and posttest of creative thinking skills. The increase in pre-test and post-test results can be analyzed using N-gain score calculation, with the formula.

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

Keterangan :

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

$S_{posttest}$ = Posttest score

$S_{pretest}$ = Pretest score

S_{maks} = Maximum score

The following table presents the interpretation of the results of calculating the N-gain value or increasing students' creative thinking skills.

Table 5. 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 DISSCUSSION

This research was carried out according to the stages in the 4-D research model with four main stages which were limited to the development stage.

Define

The purpose of the defining stage is to collect various information regarding the suitability of learning needs with the applicable independent curriculum, the characteristics and abilities of students and the conditions of the school. This information and facts were obtained by distributing pre-research questionnaires to class XI students at one of state senior high school in Surabaya regarding chemical bonding material, learning implementation, learning strategies and teaching materials used.

There are five steps in the define stage, the first step is front end analysis which is carried out to find and identify the fundamental issues in the learning

process faced by both students and teachers. The facts obtained included 90.9% of students stating that chemistry subjects, especially on chemical bonding material, included material that was difficult to understand; 87.87% of students stated that it was difficult to remember the material and connect the concepts presented in the textbook; 96.96% of students stated that they needed various learning strategies to make the material simpler to comprehend; and as many as 63.63% of students stated that they had never done chemistry learning using mind mapping (creative and colorful note-taking). In addition, students stated that they often found it difficult when they had to give more than one answer, answered questions in various ways, gave answers that were different from what they were used to and found it difficult when asked to answer questions in detail. This shows the lack of students' skills to think creatively. According to the description of these facts, a learning strategy is needed that can help students understand chemical bonding material better while at the same time increasing students' creative thinking skills.

The learning strategy is closely related to the process of learning, a series of learning activities in the independent curriculum are contained in a learning tool, namely the teaching module. Through the preparation of teaching modules teachers can help students understand the material and increase creativity by using mind mapping strategy. Mind map provides an opportunity for students to make notes based on ideas poured from their own thoughts so that it is useful for understanding the material by making the material being studied into a pattern visually and graphically (Casmini, 2022).

The second step is the analysis of students which includes academic ability, age and cognitive development. The level of students' academic abilities is in the medium category and based on data obtained from chemistry teacher interviews, creative thinking skills have not been specifically trained and are still relatively lacking. Chemical bonding material in the independent curriculum is taught to students in class XI SMA, where the average age of students ranges from 16-17 years which, if related to Piaget's theory, is at the formal operational stage. At the formal operational stage, students aged 16-17 years are able to think abstractly. Based on this theory students at this age can reason logically, process information and understand the interrelationships between existing materials.

The ability to organize and understand information varies with age and learning style. To help organize information and understand the interrelationships of the information, a strategy is needed. Learning with a mind mapping strategy is one strategy that can be used.

The third step is task analysis, assignments are presented in Student Activity Sheets (SAS/LAPD) and adapted to a series of learning activities with mind mapping strategy developed to foster the development of creative thinking skills.

The fourth step is concept analysis, the concepts that have been summarized on the concept map are used to help plan the sequence of learning and mastery of concepts that must be achieved by students. Through concept maps and chemical bonding materials that have been mastered, students will be able to map the understanding gained into a mind map.

The fifth step is the analysis of learning objectives, by writing down learning objectives, researchers can find out what studies will be displayed in the teaching module, determine the grid of questions, and finally determine how much the learning objectives will be achieved.

Based on the series of analyzes that have been carried out at the definition stage above, the researcher developed a mind mapping strategy teaching module which can be an alternative to improve creative thinking skills in chemical bonding material.

Design

Based on the steps that have been passed in the design stage, including choosing media that is appropriate to the characteristics of the material and learning objectives, selecting the format and initial design, a product is produced in the form of an initial design of teaching modules with a mind mapping strategy on chemical bonding material which is shown in the following figure 1.

The initial appearance of the developed mind mapping strategy teaching module cover consists of a title, a mind map image accompanied by the description "with a mind mapping strategy", an image that represents the content of chemical bonding material and the identity of the teaching module constituents.

The developed teaching module contains an attachment in the form of Student Activity Sheets (SAS/LAPD) which consists of 3 LAPDs which

contain 3 subject matter namely: Elemental Stability (LAPD 1), Types of Chemical Bonds (LAPD 2), Intermolecular Forces (LAPD 3). Figure 2 shows the initial view of the Student Activity Sheet.

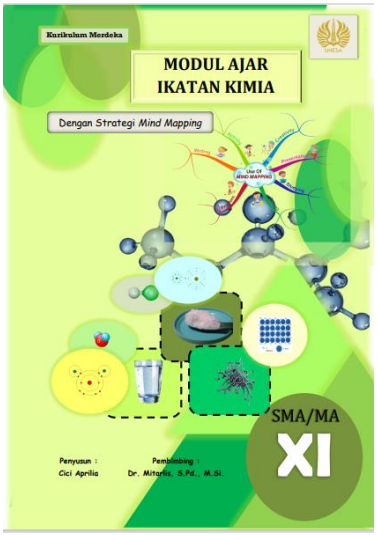
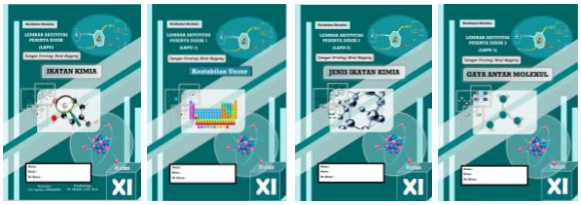


Figure 1. Cover the Teaching Module with the Mind Mapping strategy



(a) (b) (c) (d)

Figure 2. Student Activity Sheet cover view (a) Main Cover (b) Cover LAPD 1 (c) Cover LAPD 2 (d) Cover LAPD 3

Student Activity Sheets contain assignments in the form of mind mapping with the scaffolding technique shown in the following figure.

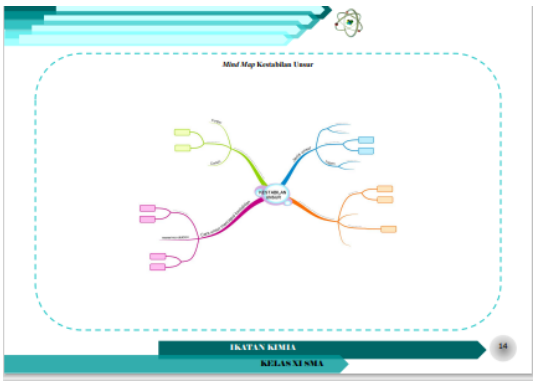


Figure 3. Assignment of Mind Mapping in LAPD

Develop

1. Validity

The validity of the developed mind mapping strategy teaching modules is viewed from content validity and construct validity. The content criteria cover three aspects, namely the suitability of the teaching modules with the independent curriculum, the completeness of the teaching module components and the suitability of the Student Activity Sheet (LAPD). While the construct criteria reviewed include linguistic, presentation and graphic aspects.

Content criteria related to the suitability of teaching modules with the independent curriculum include conformity of learning objectives with learning outcomes (LO/CP), the compatibility of the lesson's content with its learning objectives, Pancasila student profiles' compatibility with the course's content, suitability of the flow of learning activities with syntax and learning phases and suitability assessment with criteria on learning objectives. Content criteria related to conformity with the independent curriculum obtain mode 5 with very good category.

The content criteria related to the completeness of the teaching module components consist of 3 main components including elements of general information, essential elements, and attachments (Maulida, 2022). The elemment of general information include the identity of the module author, the institution of origin, school level, class and time allocation, Pancasila student profiles, facilities and infrastructure, target students, models, learning methods and strategies. The essential elements of the teaching module include learning objectives, meaningful comprehension, triggering questions, learning activities, assessment and remedial and enrichment. The last aspect of the completeness of the teaching module component is the attachment, the attachment includes the entire assessment sheet that will be used (diagnostic, formative and summative assessments), SAS/LAPD, teacher and student reading materials, glossaries and bibliography. Content criteria related to the completeness of the teaching module components obtain mode 5 with very good category.

The content criteria related to the suitability of LAPD consist of several components, the first of which is the suitability of the content or lesson content on LAPD with learning objectives. Second, LAPD contain facts, concepts and pictures that are

in accordance with the content of the lesson. Third, the suitability of learning activities in LAPD with the content of the lesson. Fourth, the suitability of LAPD with mind mapping strategies and fifth, namely the suitability of LAPD with creative thinking skills that are measured include fluency, flexibility, elaboration and originality. Content criteria related to the suitability of LAPD get mode 5 with very good category.

The results of validation related to content criteria as a whole obtained mode 4 with a valid category of 4 aspects and mode 5 with a very valid category of 24 aspects. So that based on the content criteria, the teaching module with the mind mapping strategy developed was declared valid because it obtained a mode ≥4 (Lutfi, 2021).

The construct criteria related to the language of the teaching modules developed are categorized as valid with the acquisition of modes 4 and 5. The linguistic aspect includes writing teaching modules using good and correct Indonesian, using communicative language, using precise and easy-to-understand terms, using effective and efficient language and clear instructions or directions on Student Activity Sheets (LAPD). Communicative language is straightforward language that makes it easier for the reader to understand the author's message or information (Sidiq & Najuah, 2020). Students can better comprehend the material in LAPD by using clear language.

The construct criteria related to the presentation of the developed teaching modules are categorized as valid with the acquisition of modes 4 and 5 in each aspect. The presentation aspect includes the information presented in complete and systematically arranged teaching modules, the sequence of material on LAPD contained in the teaching module is arranged systematically, presentation of pictures on the LAPD which is contained in the teaching module according to the material, the presentation of the LAPD contained in the teaching module arouses the motivation and curiosity of students and the presentation of the material encourages students to be actively involved. Motivation is a psychological impulse to someone so that it influences the person to take action aimed at achieving certain goals both consciously and unconsciously (Hae dkk., 2021). By providing LAPD during the learning process, it can make it easier for teachers to convey and provide direction to students in carrying out learning activities and doing assignments.

The construct criteria related to the graphics of the developed teaching modules are categorized as valid with the acquisition of modes 4 and 5 in each aspect. The graphical aspect includes an attractive cover display and represents the contents of the teaching module, the use of the type of font and text size used makes it easier for readers to use the teaching module, the harmony of the layout of the text and images in the teaching module as well as illustrations, graphics, pictures and photos help in understanding the concept. An attractive student activity sheet cover design can increase student interest in the learning process. According to (Khoiruddin et al., 2016) a book with an attractive cover equipped with pictures that represent the contents can foster a person's interest in reading or studying it. Image illustrations can be a learning tool for conveying material to students which aims to make it simpler for students to comprehend the information, remember the contents of the material, clarify abstract concepts, enhance the level of student interest in learning, and facilitate student activities during the learning process (Utami, 2020).

The results of the validation related to the overall construct criteria obtained mode 4 with a valid category of 10 aspects and mode 5 with a very valid category of 5 aspects. So based on the construct criteria, the teaching module with the mind mapping strategy developed is declared valid because it obtains mode ≥4 (Lutfi, 2021).

Table 6. Student Response Results

Response	Precentage	Category
Implementation of learning	92,65%	Very good
Student Activity Sheet (LAPD)	92,01%	Very good

2. Practicality

Data on the practicality of teaching modules with the mind mapping strategy developed were obtained from student responses which were supported by the implementation of learning and student activities.

Student responses to the development of teaching modules with a mind mapping strategy are responses related to the implementation of learning and responses related to LAPD used during the learning process. Table 6 is the result of student

response data. Based on the data in table 6, it is known that students' responses to the implementation of learning obtained a percentage of 92.65% and Student Activity Sheets (LAPD) obtained a percentage of 92.01% with a very practical category.

The implementation of learning in this study is the result of observing teacher activities during the learning process using the developed teaching modules. Observations were made in detail on each syntax of the TPS (Think, Pair, Share) cooperative learning model with the mind mapping strategy contained in the teaching module.

Table 7. Implementation of Learning

No	Syntax Component	Average (%)		
		First Meeting	Second Meeting	Third Meeting
1	Introduction	94,5	100	94,5
2	Phase 1: Communicate objectives and motivate learners	94,5	97,25	91,75
3	Phase 2: Delivering information	89,75	95,25	91,75
4	Phase 3: Organizing students into study groups	87,5	100	95,75
5	Phase 4: Guiding work and study groups	91,75	94,5	97,25
6	Phase 5: Evaluation	89,5	93,75	91,75
7	Phase 6: Provide rewards	83,25	100	83,25
8	Closing	98,25	98,25	93,25
	Average	**91,12**	**97,37**	**92,40**

Based on the results obtained related to the observation of the implementation of each learning syntax using teaching modules with a mind mapping strategy consisting of three meetings, it was obtained that the average percentage of learning implementation in the first, second and third meetings respectively was 91.12%, 97.37% , 92.4% with very good category.

Apart from being based on the data from the questionnaire responses of students and observations of the implementation of learning, the practicality of the teaching modules is also seen from the activities of the students during the teaching module trials. The results of observing student activities during the implementation of learning using teaching modules are presented in table 8.

Table 8. Student Activity Observation Data

Meetings	Precentage (%)	Category
1	97,62	Excellent
2	97,37	Excellent
3	97,07	Excellent
Average	**97,35**	**Excellent**

According to the observed data on student activities, the first meeting's student activity received a percentage of 97.62%, the second meeting's student activity received a percentage of 97.37%, and the third meeting's student activity received a percentage of 97.07% with a very good category.

So based on the implementation of learning, student activities and student responses with the acquisition of sequential percentages of 93.63%, 97.35% and 92.12% it can be concluded that teaching modules with a mind mapping strategy are declared practical to be used as learning tools because the percentages obtained ≥61%.

3. Effectiveness

Data on the effectiveness of the developed mind mapping strategy module were obtained from the pretest and posttest of creative thinking skills. Analysis of students' creative thinking skills was obtained from the results of the pretest and posttest mind mapping as well as the results of the pretest and posttest 8 questions about chemical bonding material which were adjusted to indicators of creative thinking skills. The results of the pretest and posttest data obtained were used to measure the increase in students' creative thinking skills after trying out the mind mapping strategy teaching module on chemical bonding material. Aspects of creative thinking skills that are measured are fluency, flexibility, elaboration and originality.

The teaching module developed contains a series of learning activities with mind mapping strategies and assignments related to making mind maps in the provided Student Activity Sheets (LAPD). Based on the trial implementation of learning using teaching modules, it is known that there is an increase in students' creative thinking skills. This can be seen from the results of the pretest and posttest mind mapping which was carried out before and after the implementation of learning

using the mind mapping strategy teaching module. This is in accordance with previous research where through making mind maps one can develop brain function to the fullest and be able to produce ideas that are new, original and different in accordance with aspects of creative thinking (Pramunita, 2021). In the following, the results of the mind mapping of students in the very good category are presented.

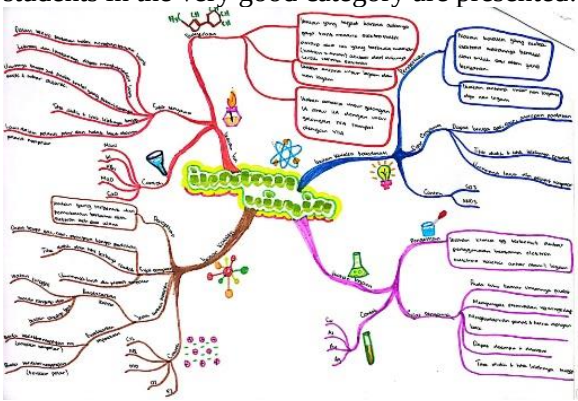


Figure 4. Student Mind Mapping Results with Very Good Category

The picture is the result of the student's mind mapping which reflects the four aspects of creative thinking skills, namely fluency, flexibility, elaboration and originality so that it can be categorized as very good. Aspects of fluency in the mind map made by students can be seen from students being able to determine as many keywords as possible and can determine keywords which are themes, sub-themes, branches and sub-branches correctly.

The aspect of flexibility in the mind map images made by students is reflected through the choice of different colors for each branch, the curved shape of the branches, the thickness of the branches made and the size of the branches which are getting smaller towards the branches. The aspect of flexibility can also be seen from students who add pictures or symbols to most of the branches that represent each keyword. Aspects of creative thinking skills namely elaboration are reflected by students through the ability to describe (specify) each keyword in great detail or many branches totaling ≥4 in most of the existing keywords.

The originality aspect of the mind map images made by students has also been fulfilled, this is indicated by the mind map design which is the result of their own work and imagination and is something new with unique combinations with images of their own work, not copying friends or other sources and according to the concept. In the following, the results of the mind mapping of students in the good category are presented.

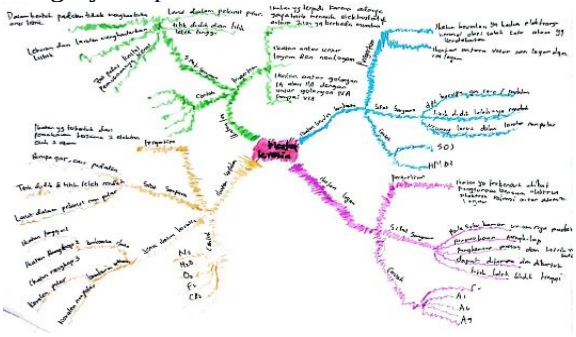


Figure 5. Student Mind Mapping Results with Good Category

The image is a mind mapping with a good category made by students. The mind map has fulfilled the aspects of fluency, elaboration and originality, but the aspects of flexibility have not been fulfilled. The use of different colors for each branch and the shape of the branch which is curved and narrows towards the branch already reflects some aspects of flexibility, but the aspect of flexibility in mind mapping is still not fulfilled because students still do not include pictures or symbols in keywords.

Students are able to find and write down as many keywords as possible and determine the keywords which are themes, sub-themes, branches and sub-branches correctly so that the fluency aspect in the mind mapping that is made is fulfilled properly. Furthermore, the elaboration aspect of mind mapping has also been reflected with students being able to describe (specify) each keyword in great detail or many branches totaling ≥4 in most of the existing keywords. The aspect of originality in the mind map images made by students has also been fulfilled, this is indicated by the mind map designs that are made which are the result of their own work and imagination and are different from the others. In the following Figure 6, the results of the mind mapping of students in the pretty good category are presented.

The image is a mind mapping with a pretty good category made by students. In the mind map, the aspects of fluency, elaboration and flexibility are still not met. The use of different colors for each branch and the shape of the branch which is curved and narrows towards the branch already reflects

some aspects of flexibility, but the aspect of flexibility in mind mapping is still not fulfilled because students still do not include pictures or symbols in keywords.

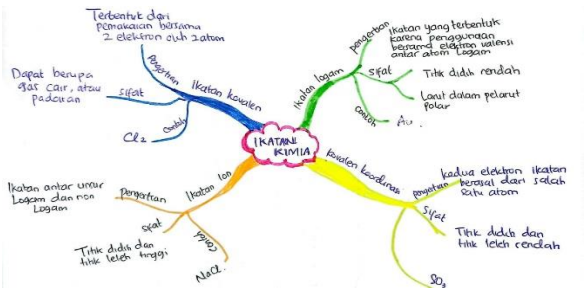


Figure 6. The results of the Mind Mapping of Students with the Enough Category

The fluency aspect of the mind map has also not been fulfilled because students have not been able to find and write down as many keywords as possible even though they have been able to determine the keywords which are themes, sub-themes, branches and sub-branches correctly. Furthermore, the elaboration aspect of mind mapping has not been reflected because students have not been able to describe (break down) each keyword in detail, where the number of branches for each keyword is still relatively small. The originality aspect of the mind map image made by students has been fulfilled, this is indicated by the mind map design which is the result of their own work and imagination and is different from the others even though it is not accompanied by pictures or symbols.

According to the results of the pretest and posttest mind mapping, there is an improvement in the four components of creative thinking skills, which are reflected in the mind map images created. According to the assessment of the four components of creative thinking, including fluency, flexibility, elaboration, and originality, the results of the pretest and posttest mind mapping show a considerable improvement. This increase is strengthened by calculating the N-gain score. The results of the N-gain score analysis on the results of the pretest and posttest mind mapping were 0.73 in the high category.

After being given a mind mapping posttest, students are then given 8 questions describing creative thinking skills on chemical bonding material. Giving a posttest in the form of a description of chemical bonding material adapted to creative thinking indicators aims to strengthen and support students' creative thinking skills data after participating in learning with a mind mapping strategy and working on Student Activity Sheets which are contained in the teaching module. Based on the assessment of the four aspects of creative thinking skills which include fluency, flexibility, elaboration and originality, it is known that there is a significant increase in the results of the pretest and posttest. This increase is strengthened by calculating the N-gain score. The results of the analysis of the N-gain score on the results of the pretest and posttest on the description of creative thinking on chemical bonding material is 0.72 in the high category.

CONCLUSIONS

Based on the results of the research and discussion, it can be concluded that the teaching module with mind mapping strategy to improve creative thinking skills on chemical bonding material developed was suitable for use as a learning tool because it has met the eligibility criteria in terms of validity, practicality and effectiveness.

Referring to the research results and conclusions that have been explained, teaching modules with mind mapping strategy can be applied and used by teachers as an alternative to improve students' creative thinking skills in chemistry learning, especially in chemical bonding material and can be used as a reference for researchers in further studies related to development of learning tools in the form of better teaching modules.

DAFTAR PUSTAKA

Ahmar, D. S. (2016). The relationship between Self Regulation with Creative Thinking Ability of Students in Chemistry Class XI IPA at Takalar. *Jurnal Sainsmat*, *5*(1), 7–23.

Ainurrohmah, A. (2019). Pengembangan Lembar Kerja Peserta Didik (LKPD) Dengan Strategi Mind Mapping Untuk Meningkatkan Berpikir Kreatif Peserta Didik Pada Materi Koloid. *UNESA Journal of Chemical Education*, *8*(1), 67–74.

Casmini, N. L. (2022). Penerapan Metode Mind Mapping Untuk Meningkatkan Motivasi dan Hasil Belajar Kimia Siswa Kelas XII MIPA 1 SMAN 2 Busungbiu. *Jurnal Ilmiah Pendidikan Profesi Guru*, *3*(1), 193–201.

Fatimah, F., & Kartikasari, R. D. (2018). Strategi Belajar Dan Pembelajaran Dalam Meningkatkan

Keterampilan Bahasa. *Pena Literasi*, *1*(2), 108.

Febrianti, Y., Djahir, Y., & Fatimah, S. (2016). Analisis Kemampuan Berpikir Kreatif Peserta Didik dengan Memanfaatkan Lingkungan pada Mata Pelajaran Ekonomi di SMA Negeri 6 Palembang. *Jurnal Profit*, *3*(1), 121–127.

Hae, Y., Tantu, Y. R. P., & Widiastuti, W. (2021). Penerapan Media Pembelajaran Visual Dalam Membangun Motivasi Belajar Siswa Sekolah Dasar. *Edukatif : Jurnal Ilmu Pendidikan*, *3*(4), 1177–1184.

Khoiruddin, M. A., Taulabi, I., & Imron, A. (2016). Menumbuhkan Minat Baca Sejak Dini di Taman Baca Masyarakat. *Journal An-Nafs: Kajian Penelitian Psikologi*, *1*(2), 291–319.

Lutfi, Achmad. (2021). Research and Development (R&D): Implikasi dalam Pendidikan Kimia. Surabaya: Universitas Negeri Surabaya.

Maulida, U. (2022). Pengembangan Modul Ajar Berbasis Kurikulum Merdeka. *Tarbawi*, *5*(2), 130–138.

Ningrum, A. S. (2022). Pengembangan Perangkat Pembelajaran Kurikulum Merdeka Belajar (Metode Belajar). *Prosiding Pendidikan Dasar*, *1*, 166–177.

Rahayu, D. S., & Fitriza, Z. (2021). Identifikasi Miskonsepsi Peserta Didik Pada Materi Ikatan Kimia : Sebuah Studi Literatur. *Edukatif : Jurnal Ilmu Pendidikan*, *3*(3), 1084–1091.

Rian Ningsih Pramunita. (2021). Pengembangan Buku Ajar IPA Berbasis Peta Pikiran untuk Melatih Berpikir Kreatif Peserta Didik di Sekolah Dasar. *Jurnal Riset Madrasah Ibtidaiyah (JURMIA)*, *1*(1), 40–47.

Ricu Sidiq, & Najuah. (2020). Pengembangan E-Modul Interaktif Berbasis Android pada Mata Kuliah Strategi Belajar Mengajar. *Jurnal Pendidikan Sejarah*, *9*(1), 1–14.

Riduwan. 2015. Skala Pengukuran Variabel-variabel Penelitian. Bandung: Alfabeta.

Sabrina, R. (2018). Identifikasi Kesulitan Siswa pada Materi Ikatan Kimia di SMAS Muslimat Samalanga Bireuen. *Angewandte Chemie International Edition, 6(11), 951–952.*, 5–24.

Utami, Y. S. (2020). Penggunaan Media Gambar Untuk Meningkatkan Hasil Belajar Siswa Dalam Pembelajaran Ipa. *Jurnal Pendidikan Dan Konseling (JPDK)*, *2*(1), 104–109.

Widarti, H. R., Safitri, A. F., & Sukarianingsih, D. (2018). Identifikasi Pemahaman Konsep Ikatan Kimia. *J-PEK (Jurnal Pembelajaran Kimia)*, *3*(1), 41–50.

Wulandari, N., & Sholihin, H. (2016). Analisis Kemampuan Literasi Sains pada Aspek Pengetahuan dan Kompetensi Sains Siswa SMP pada Materi Kalor. *Jurnal Edusains UIN Syarif Hidayatullah*, *8*(1), 66–73.