Optimizing Senior High School Students Creative Thinking Skills of Optical Devices through Inductive Learning Models Assisted by e-Mind Map

IOP Conf. Series: Journal of Physics: Conf. Series **1233** (2019) 012029 doi:10.1088/1742-6596/1233/1/012029

Optimizing Senior High School Students Creative Thinking Skills of Optical Devices through Inductive Learning Models Assisted by e-Mind Map

Dian Aulia Lazuardini*, Insih Wilujeng and Heru Kuswanto
Yogyakarta State University, Indonesia

*Email: dianaulilazuardini@gmail.com

Abstract: This study aims to determine the inductive learning model assisted e-mind map in optimizing creative thinking skills students. This study uses a quasi-experimental design of one group pretest post-test design. This study involved 33 students of class XI Science 1 from SMA Negeri 6 Yogyakarta. The inductive model assisted by e-mind map consists of several stages of syntax namely, 1) data collection and presentation, 2) data testing and calculation, 3) classification, 4) formulation and testing of hypotheses, and 5) application. Learning tools are arranged based on an inductive learning model assisted by e-mind map to determine the effect on students' creative thinking skills. The indicators of creative thinking skills consist of fluency, flexibility, originality, and elaboration. Before being given treatment, the research class was given a pretest to find out the students' initial abilities. Then the class was given treatment using an inductive model with a mind map assisted and then given a post-test. The results showed that there was an increase in the mean value of creative thinking skills. Before treatment (pretest), the average value of students' creative thinking skills in class XI IPA 1 was 72.73 while (post-test) was 93.18 after using inductive learning model assisted by e-Mind Map. The N-gain test results show a value of 0.75 so that it shows creative thinking skills in the high category. The results show students' creative thinking skills can be optimized by using an inductive learning model assisted by e-mind maps.

Keywords: Creative thinking skills; Inductive learning model; E-mind map.

1. Introduction

Education is an important key in the development of human quality. Addiin, *et al*. stated that education as one of the levels of quality of human resources is in line with the formulation of educational goals [1]. National education in accordance with Permendikbud RI No. 20 has a function as a developer of "ability and form the insight of a dignified nation in the framework of educating the life of the nation" [2]. The purpose of education is fully realized and quality, so a curriculum is needed. The curriculum is a set of plans and setting goals, content and learning materials to the method used as a reference for the implementation of learning [2]. The current curriculum in Indonesia is the K-13 curriculum. K-13 is designed for student-centered learning.

Physics as learning in class is an effort to teach physics, namely theories, principles, concepts, laws and equations of physics. Physics learning can use several strategies, approaches, models or methods of learning that are effective and efficient [3]. Physics learning needs to be a careful concern with the aim of preparing students to face globalization of the 21st century today [4]. In its implementation, physics learning is expected not to directly burden students with complicated calculation tasks, but the

guidance to be able to interpret the data then translates in the form of mathematical equations or thought charts [2]. In its implementation, physics learning is expected not to directly burden students with complicated calculation tasks, but the guidance to be able to interpret the data then translates in the form of mathematical equations or thought charts [2]. All physics learning activities are still expected to aim at achieving the physics learning objectives found in basic competencies.

Learning constraints in SMA Negeri 6 Yogyakarta were found in the results of the pre-study. One of them is the observation that students have creative thinking skills that are still relatively low. Learners are only limited to the teacher's explanation and formula recapitulation. Students also show the difficulty of solving physical problems related to everyday life. Based on the results of teacher interviews also showed that the teacher had not found the right strategy to optimize students' creative thinking skills. Physical learning taught to students is expected to be in accordance with the characteristics and standards of the learning process in accordance with the K-13. The characteristics of physics learning as part of natural science are not only limited to the way of working, thinking, and seeing [5]. Physics learning to be a part of science is considered as "a way of knowing" where a process that includes attitudes / actions, habits of thinking, curiosity and procedures related to forming students' understanding [6]. Learning physics is not just memorizing the theory or formula in it, but it is a process of discovery by students.

Learning models have an important role in achieving high-quality learning. One learning model is an inductive learning model. An inductive learning model which is the result of Hilda Taba's findings has the advantage of being able to improve concept development, thought processes, analytical skills, and the freedom of learning content used. Inductive teaching and learning is like an umbrella that houses several methods of learning physics [7]. Inductive learning method is known have some forms include inquiry learning model, case-based teaching and discovery learning [7]. Inductive discussion and problem solving can be expressed as a form of inductive learning [8].

The link between active learning and inductive learning can also be found with students becoming more responsible for their understanding. Active learning has 2 basic foundations. The foundation of active learning is the existence of individual control over their learning and is based on constructivist theory [9]. Inductive learning is considered capable of facilitate individuals to experiment and explore and end conclusions in the form of rules or principles. Inductive learning model is identical to the process of direct observation of various natural phenomena to look for laws of order. The inductive learning model consists of activities including information processing, concept formation, data interpretation, and the application of physical principles [10, 4].

Inductive learning models are oriented towards understanding, learning independently and opposing methods of memorizing like physicists and technicians [7]. Another advantage of the inductive learning model is problem solving [11], student-centered [11], and able to create learning interest [12]. In addition, this model can increase the level of understanding of concepts (Joyce, 1986), can be applied to various types of physics material [4], and can also increase the expert's critical and creative thinking [9]. The inductive model syntax is described in Table 1 below.

Table 1. Inductive Model Syntax

Step	Syntax	Student Activities
1.	Data Collection and Presentation of Data	Collecting data uses a set of data from the substantive domain that is shown for academic purposes. The spheres / fields of field are quite diverse and arbitrary for a field.
2.	Test and Calculation of Data	Testing data carefully, whether the data is in the form of skirt music, or poetry or philosophy (for example), the data needs to be labeled so that we can identify it when we move the data. Suppose skirt music has a different number or color label.
3.	Classify Data	Making students really productive, we usually classify data.
4.	Formulation and testing	Developing hypotheses based on existing theories or correct

	of hypotheses	principles. Next test the hypothesis. The hypothesis can be accepted or rejected. If it turns out right, the hypothesis is accepted.
5.	Application	Applying generalizations testing hypotheses on data or other data as well as to measure creative thinking skills (application of understanding). At the same time solve problem problems to know creative thinking skills and learners.

The hypothesize that inductive learning model assisted by E-Mind Map can optimize creative thinking skills. The ability that is important to be owned by students like scientists is creative thinking skills. Mukin in [3] explains that creative thinking skills are seen as activities to get new things when solving problems. Creative thinking skills are one of several components of a high-level thinking process that produces new and different ideas [3]. Criteria for creative thinking skills consist of bag of fluency, flexibility, originality, and elaboration while developing ideas or ideas [10, 7, 6]. The indicators of creative thinking skills are listed in Table 2.

Table 2. Indicators of Creative Thinking Skills

No.	Type	Indicators
1.	*Fluency*	a. Express various questions smoothly b. Propose various ways or suggestions c. Show lots of ideas
2.	*Flexibility*	a. Produce varied questions, ideas, or answers b. Look at it from various points of view problems
3.	*Originality*	a. Develop new and unique expressions b. Have an unusual way of expressing something c. Combine unusual things from several parts d. Generate ideas in ways that are genuine and rarely given by most people.
4.	*Elaboration*	a. Develop and enrich ideas or ideas b. Analyze in detail an object, idea, idea, or situation around them in the form of tables, graphs, images, models or words

One way to provide scaffolding in physics learning is the right media. The media is an electronic mindmap (e-mindmap) that can be arranged using a laptop without the need to be compiled manually. E-mindmap is expected to make students better understand the concept of physics and be able to solve problems properly. Based on these descriptions, this study aims to determine the effect of inductive learning models in optimizing students' creative thinking skills.

The rest of this paper is organized as follow: Section 2 describes the proposed research method. Section 3 presents the obtained results and following by discussion. Finally Section 4 concludes this work.

2. Research Method

This study used an experimental design with the design of one group pretest post-test. The subjects of this study were students of class XI in SMA Negeri 6 Yogyakarta academic year 2017/2018 consisting of 33 students. The research was carried out by providing care in the form of an inductive learning model assisted by e-mindmap in a research class. The appearance of this research design is opened in Table 3.

Table 3. Research Design Scheme

Group	Pre-Test	Treatment	Post-Test
Experiment	O_i	X	O_f

This research is specifically to determine the use of inductive learning models assisted by e-mindmap to optimize students' creative thinking skills. As for some devices prepared to carry out research. Includes learning tools such as syllabus, RPP (Learning Implementation Plan), LKPD, and test of creative thinking skills. Before being used in learning, the entire device is validated by an expert validator. The syllabus of physics learning on the material of optical devices using an inductive learning model is shown in Figure 1.

SILABUS FISIKA MODEL PEMBELAJARAN INDUKTIF

Satuan Pendidikan : SMA Negeri 6 Yogyakarta

Mata Pelajaarn : Fisika

Kelas/Semester : XI/ Genap

Kompetensi Inti

KI. 1 Menghayati dan mengamalkan ajaran agama yang dianutnya.

KI. 2 Menghayati dan mengamalkan perilaku jujur, disiplin, tanggung jawab, peduli (gotong royong, kerjasama, toleran, damai), santun, responsif dan pro-aktif dan menunjukkan sikap sebagai bagian dari solusi atas berbagai permasalahan dalam berinteraksi secara efektif dengan lingkungan sosial dan alam serta dalam menempatkan diri sebagai cerminan bangsa dalam pergaulan dunia.

KI. 3 Memahami, menerapkan, dan menganalisis pengetahuan faktual, konseptual, prosedural, dan metakognitif berdasarkan rasa ingin tahunya tentang ilmu pengetahuan, teknologi, seni, budaya, dan humaniora dengan wawasan kemanusiaan, kebangsaan, kenegaraan, dan peradaban terkait penyebab fenomena dan kejadian, serta menerapkan pengetahuan prosedural pada bidang kajian yang spesifik sesuai dengan bakat dan minatnya untuk memecahkan masalah.

KI. 4 Mengolah, menalar, dan menyaji dalam ranah konkret dan ranah abstrak terkait dengan pengembangan dari yang dipelajarinya di sekolah secara mandiri, bertindak secara efektif dan kreatif, serta mampu menggunakan metoda sesuai kaidah keilmuan

Kompetensi Dasar	Materi Pokok	Pembelajaran	Penilaian	Alokasi Waktu	Sumber Belajar
3.11 Menganalisis cara kerja alat optik menggunakan sifat pemantulan dan pembiasan cahaya oleh cermin dan lensa	Alat Optik	**Tahap 1.** *Pengumpulan dan penyajian data* **1. Mengamati** ▪ Siswa mengamati gambar bagian-bagian mata beserta fungsinya yang dijelaskan oleh guru. ▪ Guru menampilkan video tentang *eye defect* (cacat mata) ▪ Guru meminta siswa untuk mencatat semua hal dari video tersebut untuk dijadikan data awal dalam memberikan gambaran cacat mata kepada siswa ▪ Guru kemudian bertanya siswa yang menderita cacat mata seperti pada video tersebut. **2. Menanya** ▪ Guru memberikan kesempatan siswa untuk bertanya berkaitan video cacat mata tersebut. ▪ Guru mencatat semua pertanyaan di papan tulis untuk selanjutnya dipilih sesuai tujuan pembelajaran. **3. Mengasosiasi** **Tahap 2.** *Pengujian dan penghitungan data* ▪ Siswa berdiskusi dalam kelompok untuk mengidentifikasi jenis cacat mata yang tertera pada data di LKPD 1. ▪ Satu kelompok terdiri atas 3-4 siswa. **Tahap 3.** *Klasifikasi* ▪ Kelompok siswa membagi data-data kasus cacat mata tersebut menggunakan *MindJet MindManager 2017* yang telah diinstal sebelumnya. ▪ Kelompok siswa menuliskan kasus cacat mata pada LKPD 1. sesuai dengan cacat mata miopi,	**Tes** (terlampir)	**1 x 2 JP (90 menit)**	▪ *Handout Model Induktif* tentang optik ▪ Buku pegangan siswa ▪ Video pembelajaran yang diunduh dari youtube yakni *eye defect* ▪ Phet Colorado tentang optik ▪ PPT materi pembelajaran

Figure 1. The Optical Devices Syllabus of the Inductive Learning Model

The optical syllabus is prepared with reference to K-13. The syllabus consists of core competencies, basic competencies, subject matter, learning activities, time allocation and assessment systems. The design of the syllabus takes into account the syntax of the inductive learning model and the use of E-mindmap. The explanation of learning activities using an inductive learning model and E-mindmap is found in learning implementation plan (lesson plan). The part of learning implementation plan is shown in Figure 2.

J. Langkah-Langkah Pembelajaran

Alokasi Waktu 2 x 45 menit

Kegiatan	Proses Pembelajaran		Waktu
	Guru	Siswa	
Pendahuluan	1. Membuka pembelajaran dengan memberikan salam 2. Memberi motivasi tentang kaitan cahaya dalam teknologi dan alat optik dalam kehidupan sehari-hari. "Benda apakah yang kalian lihat ini?" "Mengapa kalian dapat melihat bahwa benda ini adalah spidol?" "Dapatkah kita melihat benda tersebut dalam keadaan gelap?" 3. Menyampaikan tujuan pembelajaran. 4. Me*review* materi secara tentang sinar istimewa pada lensa cekung dan cembung pada materi optik fisis di SMP. 5. Memberikan pengarahan proses pembelajaran dan memastikan siswa telah menginstal *MindJet MindManager 2017*. 6. Guru memberikan demonstrasi singkat penggunaan	1. Membuka pembelajaran dengan memberikan salam 2. Memperhatikan penyampaian guru dan memberikan jawaban pertanyaan guru, misalkan: "Itu adalah spidol?" "Karena ada **cahaya** pantulan spidol yang masuk kedalam **mata**, sehingga yang terlihat adalah spidol" "Tentu tidak" 3. Memperhatikan penjelasan guru. 4. Me*review* materi pembentukan bayangan pada lensa cekkung dan cembung berdasarkan jalannya sinar istimewa. 5. Memperhatikan pengarahan guru. 6. Memastikan bahwa laptop terlah terinstal *MindJet MindManager 2017*. 7. Memperhatikan demonstrasi guru berkaitan	10 Menit

Figure 2. Optical Devices Learning Implementation Plan

Physics learning on the material of optical devices using handouts. This handout is arranged in full color so it attracts students to learn it. As for the display of the handout can be seen in Figure 3.

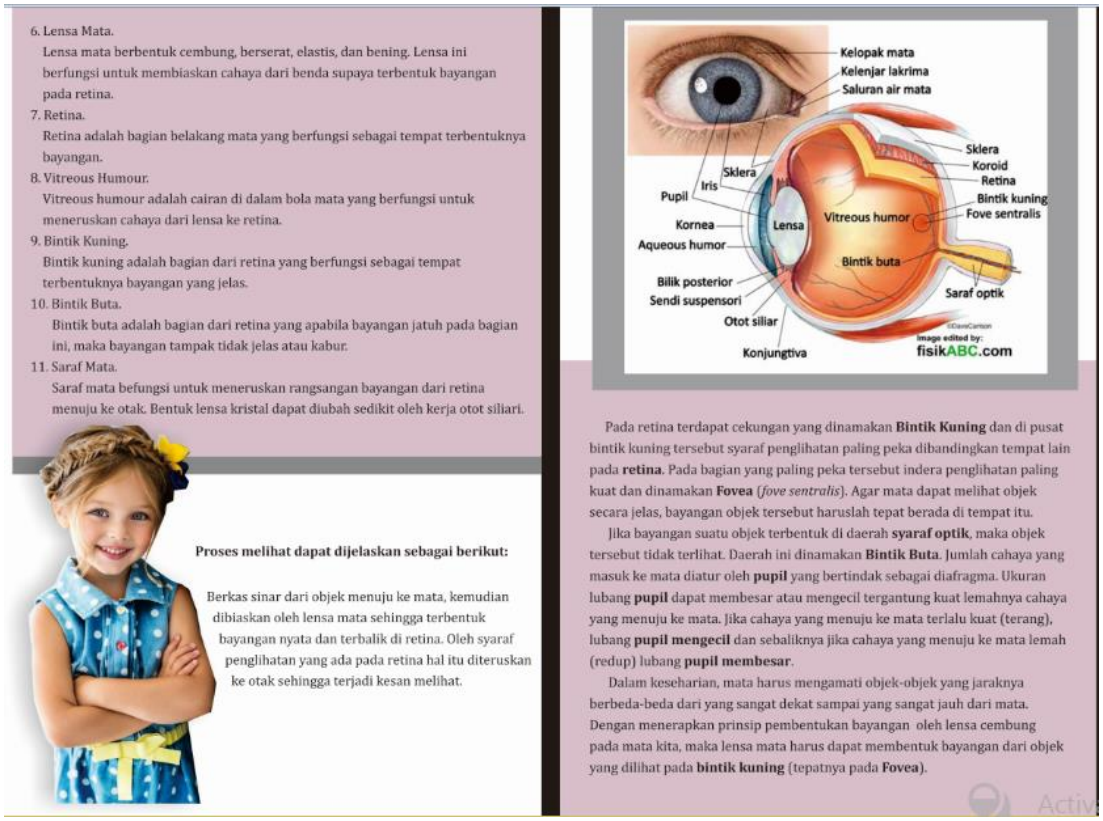


Figure 3. Handout of Optical Devices in Physics Learning

This handout is used to add information that students need to determine conclusions. Handouts are arranged as interesting as possible to eliminate students' saturation.
Before being given a treatment, students are given a pretest question to find out the initial abilities related to physics material. The treatment is carried out using a device that has been developed and validated. The e-mindmap assignment is given to the LKPD that is distributed during learning. The last stage after learning, students were given post-test questions to determine the effectiveness of inductive learning models assisted by e-mindmap in optimizing creative thinking skills. As for the previously validated creative thinking skills that are used are multiple choice questions.
Validity analysis of test questions by material experts. Validators of test questions for material experts give a score for each item with very appropriate answers (4), according to (3), quite appropriate (2), inappropriate (1), and not suitable (0) (see Table 4), then add the total score for each validator and look for average validity with the following formula.

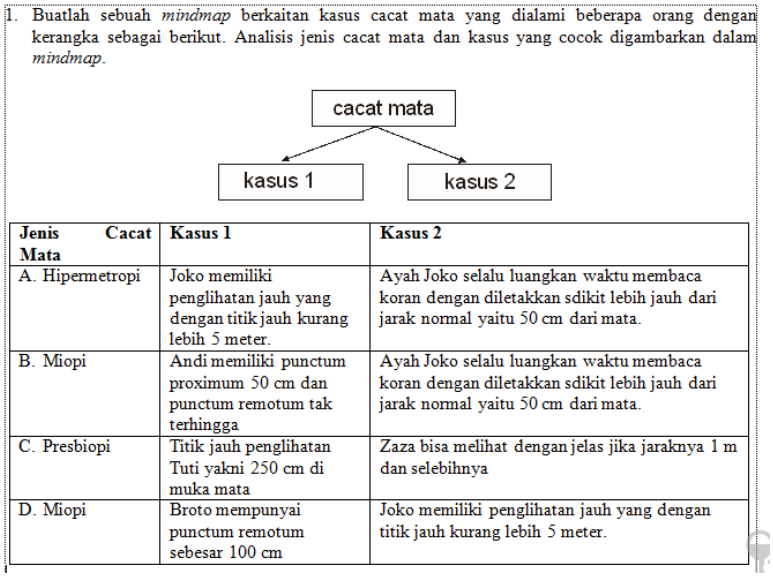
$$VR = \frac{\sum_{1=1}^{n} \bar{V}_l}{n}$$

Description:
VR: average validity
$V\ l$: average score of each validator
n: many validators

Table 4. Criteria For Categorizing The Validity of Questions By Material Experts

Scor Interval	Validity category
$3 \leq VR \leq 4$	Very Valid
$2 \leq VR \leq 3$	Valid
$1 \leq VR \leq 2$	Less Valid
$0 \leq VR \leq 1$	Invalid

The multiple choice questions with validity reached 3.75. So that the question criteria are very valid to be used to measure students' creative thinking skills. One example of the results of validating the test of creative thinking skills is shown in Figure 4.


1. Buatlah sebuah *mindmap* berkaitan kasus cacat mata yang dialami beberapa orang dengan kerangka sebagai berikut. Analisis jenis cacat mata dan kasus yang cocok digambarkan dalam *mindmap*.

Jenis Cacat Mata	Kasus 1	Kasus 2
A. Hipermetropi	Joko memiliki penglihatan jauh yang dengan titik jauh kurang lebih 5 meter.	Ayah Joko selalu luangkan waktu membaca koran dengan diletakkan sdikit lebih jauh dari jarak normal yaitu 50 cm dari mata.
B. Miopi	Andi memiliki punctum proximum 50 cm dan punctum remotum tak terhingga	Ayah Joko selalu luangkan waktu membaca koran dengan diletakkan sdikit lebih jauh dari jarak normal yaitu 50 cm dari mata.
C. Presbiopi	Titik jauh penglihatan Tuti yakni 250 cm di muka mata	Zaza bisa melihat dengan jelas jika jaraknya 1 m dan selebihnya
D. Miopi	Broto mempunyai punctum remotum sebesar 100 cm	Joko memiliki penglihatan jauh yang dengan titik jauh kurang lebih 5 meter.

Figure 4. Example of Creative Thinking Skills Test in This Study

After the research data is obtained then data processing is done on students' creative thinking skills. Data is processed to be tested for normality, statistical tests, and n-gain tests to see differences before and after physics learning.

3. Result and Discussion

Evaluation is carried out before (pretest) and after learning (post-test). The questions used to measure previous thinking skills were also validated by expert validators, namely 2 UNY postgraduate lecturers. The critical thinking questions that are prepared are multiple choice questions with the number of questions, namely 4 questions. Based on the results of validation, the results obtained 3.75 valid by 2 expert validators. Thus, the questions are declared valid to measure creative thinking skills in optical instrument material. The results of the average value from the evaluation of creative thinking skills before (pretest) and after (post-test) are shown in Figure 5 as follows..

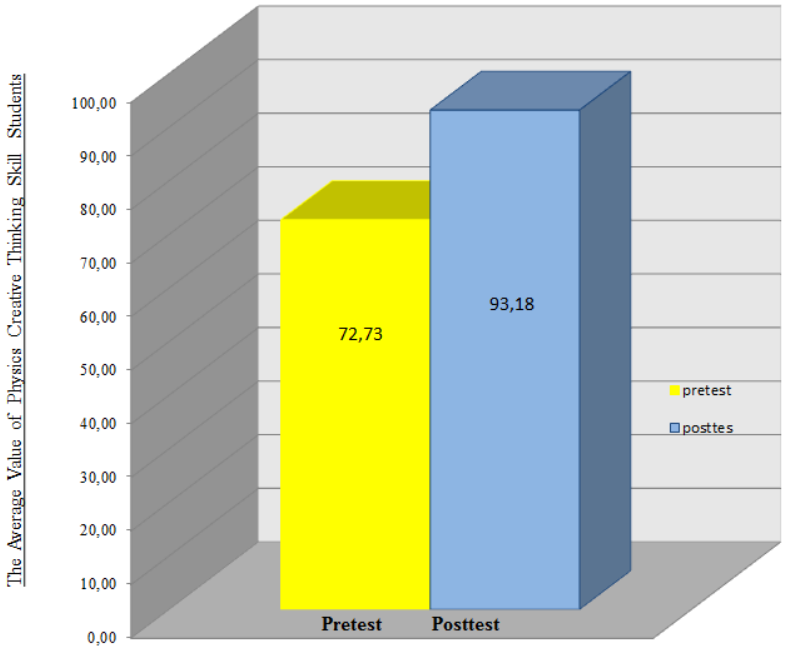


Figure 5. Average Value of Creative Thinking Skills

Figure 5 shows that the average value of the results of evaluating creative thinking skills before and after learning using an inductive model assisted by e-Mind Map increases. The mean value of creative thinking skills test show the result before learning innovation (pretest) was 72,73 and after (post-test) was 93,18 from maximum scores is 100. The mean calculation shows that there are differences before and after. This score shows that student's creative thinking skills are increased after using the inductive learning assisted by an e-Mind Map. Furthermore information to know statistically, statistical tests are used.

The normality test is used to determine whether the data from the pretest and post-test differences in creative thinking skills have been normally distributed. If the data is normally distributed, parametric statistical tests can be carried out. Conversely, if the result of the normality test is known that the data is not normally distributed, then a non-parametric test is needed. The normality test hypothesis is as follows.

Ho: data on creative thinking skills is normally distributed,
Hi: data on creative thinking skills is not normally distributed.
The decision making as follows:

- If Sig. (P)> 0.05 then Ho is accepted,
- If Sig. (P) <0.05, Ho is rejected.

Following are the results of the normality test of creative thinking skills in Figure 6 below.

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Diff	.332	33	.000	.811	33	.000

Figure 6. Normality Test Results for Creative Thinking Skills Data

The results of the significance value in the Kolmogrov-Smirnov and Shapiro-Wilk tests showed the sig value. equal to 0.000. So that the p-value is < 0.05 or Ho is rejected, accepted Hi. Thus, it is known that the results of the normality test, data on creative thinking skills is data not normally distributed. Therefore, non-parametric analysis is needed on statistical tests In non-parametric analysis, the test hypothesis is determined as Figure 6 below. As for the hypothesis testing of non-parametric data as follows.

Ho: there is no optimization of creative thinking skills by using an inductive model assisted by e-Mind map.

Hi: there is an optimization of creative thinking skills using an inductive model assisted by e-Mind map.

- If Sig. (P)> 0.05 then Ho is accepted,
- If Sig. (P) <0.05, Ho is rejected and Hi accepted.

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Pretest	33	72.73	13.056	25	100
Posttest	33	93.18	11.307	75	100

Wilcoxon Signed Ranks Test

Ranks

		N	Mean Rank	Sum of Ranks
Posttest - Pretest	Negative Ranks	1[a]	11.50	11.50
	Positive Ranks	24[b]	13.06	313.50
	Ties	8[c]		
	Total	33		

a. Posttest < Pretest

b. Posttest > Pretest

c. Posttest = Pretest

Test Statistics[b]

	Posttest - Pretest
Z	-4.434[a]
Asymp. Sig. (2-tailed)	.000

a. Based on negative ranks.

b. Wilcoxon Signed Ranks Test

Figure 7. Non-Parametric Test Results Creative Thinking Skills

The statistical tests used to measure creative thinking skills are non-parametric tests. This is because the questions used are multiple choice questions with the data generated is nominal data. In addition, due to the small number of respondents. So the data generated is not normally distributed. Therefore, to measure creative thinking skills non-parametric analysis is used. Based on the results of Wilcoxon's analysis obtained the value of Z is -4.396 and the p value is 0.000. The value of Z is known to be less than the critical limit of 0.05 so the hypothesis Hi is accepted so that there is there is an optimization of creative thinking skills using an inductive model assisted by e-Mind map.
Furthermore, to measure the category of value differences between pretest and post-test, an N-gain test is performed. The N-gain measurement uses the Hake formula [13] [14] as follows.

$$Ngain = \frac{S_{posttest} - S_{pretest}}{S_{max} - S_{pretest}}$$

Furthermore, the N-gain value is included in the category of change in N-gain score, which is listed in Table 5.

Table 5. N-Gain Score Acquisition Category

Limitation	Category
g > 0,7	High
0,3 < g ≤ 0,7	Medium
g ≤ 0,3	Low

The results of N-gain calculation of creative thinking skills are shown in Figure 8 as follows.

Skor_Rerata_Pretest	Skor_Rerata_Posttest	Skor_Max	N_gain
72.73	93.18	100	0.75

Figure 8. Changes in N-gain Creative Thinking Skills

The N-gain in creative thinking skills is equal to 0.75. Based on the results of the N-gain value, it is known that N-gain creative thinking skills are in the high category. Thus the inductive learning model assisted by e-Mindmap can effectively optimize students' creative thinking skills. It is known that N-gain in creative thinking skills is equal to 0.75. Based on the results of the N-gain value, it is known that N-gain creative thinking skills are in the high category. Thus the inductive learning model assisted by e-Mindmap can effectively optimize students' creative thinking skills.
The skill aspects of creative thinking are increased in learning activities using an inductive model assisted by e-Mindmap. Creative thinking skills include being able to express various questions smoothly. This is proven by actively asking students questions to the teacher regarding the material of optical equipment. This shows an indicator of creative thinking skills namely fluency has been achieved with this learning innovation. In addition, students are also able to show various ideas in making tamplate from their mind maps. This can be seen from the varying mind map results shown in Figures 9 and 10 below.

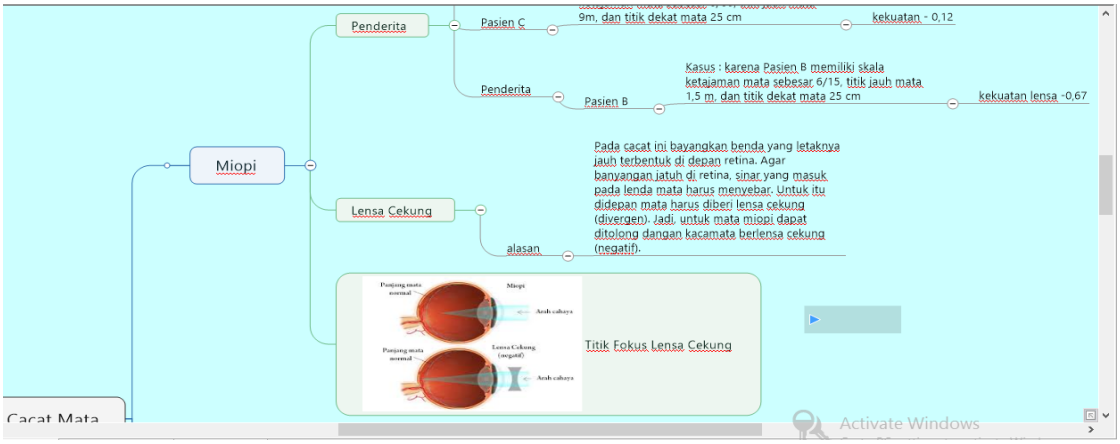


Figure 9. Results of e-Mindmap Students

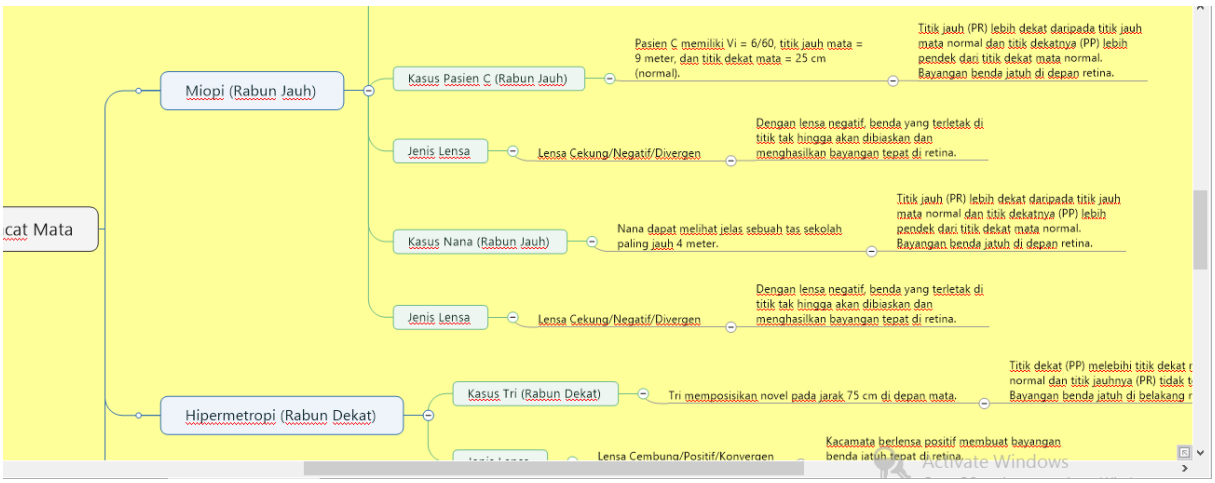


Figure 10. Examples of Variations in e-Mindmap Students

In addition, indicators of creative thinking skills are also seen when students express the purpose of their discussion in the e-Mind map. Some students write down all the reasons for a long time, while the students briefly explain. The thing is the authenticity of the mindset of students in solving problems like the case listed. While for flexibility, it also appears when students reveal the answers to the discussion of LKPD 1 & LKPD 2. Participants are not able to generate questions by raising the formulation of problems in LKPD. In addition, students also managed to look at cases of eye defects with various points of view based on available information. So that students actively discuss with group friends to get definite results in solving cases.

In addition, indicators of Elaboration ability of students appear by using this e-Mind Map-assisted inductive model. This is proven by the students being able to solve post-test problems well. The increase in pretest and post-test mean scores also shows that there are positive differences between pre-treatment and after. Based on the results of statistical tests and N-gain shows a high category, the inductive model assisted by e-Mind map is able to optimize creative thinking skills and is very good to be applied in physics learning.

4. Conclusion

This study has determined the inductive learning model assisted e-mind map in optimizing creative thinking skills students. Physical learning using inductive assisted e-Mind Map influences changes in creative thinking skills with sig values. (2-tailed) of 0.000 <α = 5%, then reject Ho. The P-value shows that the values before and after learning use an inductive model assisted by e-Mind Map significantly

different at the level of 5%. It is also known that N-gain in creative thinking skills is equal to 0.75. Based on the results of the N-gain value, it is known that N-gain creative thinking skills are in the high category. Thus this study proves that optimizing creative thinking skills can be done using an inductive learning model assisted by e-mind maps.

References

[1] Addin, I., Redjeki, T., dan Ariani, Sri, R.D. 2014. Penerapan Model Pembelajaran Project Based Learning (PjBL) Pada Materi Pokok Larutan Asam dan Basa di Kelas XI IPA 1 SMA Negeri 2 Karanganyar Tahun Ajaran 2013/2014. *Jurnal Pendidikan Kimia*. 3(4):125-129.
[2] Republik Indonesia. 2003. *Undang-Undang RI Nomor 20 Tahun 2003, tentang Sistem Pendidikan Nasional*.
[3] Mukin, M.U.J. 2016. Pengembangan perangkat pembelajaran fisika berbasis proyek untuk meningkatkan pemahaman konsep dan keterampilan berpikir kreatif peserta didik SMA. Tesis. UNY.
[4] Inyuan Guo. 2014. Preparing Teachers to Educate for 21st Century Global Citizenship: Envisioning and Enacting. *Journal of Global Citizenship & Equity Education*. 4(1).
[5] Iaccarino, M. 2003. Science and culture. EMBO Reports, 4(3), 220–223. doi:10.1038/sj.embor.embor781
[6] Richard A. Duschl, Heidi A. Schweingruber, and Andrew W. Shouse. 2007. TAKING SCIENCE TO SCHOOL Learning and Teaching Science in Grades K-8. http://www.nap.edu/catalog/11625.html, Date: 2018-08-18.
[7] Prince, M.J. & Felder, R.M. (2006). Inductive teaching and learning methods: definitions, comparisons, and research base. Journal of Engineering and Education, 95, 123- 138.
[8] OECD. 2017. The OECD Handbook for Innovative Learning Environments. OECD, Publishing. Paris.
[9] Moyer, J.C., Cai, J., Wang, N., & Nie, B. 2011. Impact of curriculum reform: Evidence of change in classroom practice in the United States. *International Journal of Educational Research, 50, 87-99.*
[10] Sejpal, K. 2013. Models of teaching: the way of learning. *International Journal of Research in Humanities & Social Sciences, 2, 18-24.*
[11] Narjaikaew, P., Emerat, N., Arayathanitkul, K., & Cowie, B. (2010). Magnetism teaching sequences based on an inductive approach for first-year thai university science students. *International Journal of Science and Mathematics Education, 8, 891-910.*
[12] Renninger, K.A. 2009. Interest and identity development in instruction: an inductive model. *Educational Psychologist, 44(2), 105–118.*
[13] Meltzer, D. E. (2002). The relationship between mathematics preparation and conceptual learning gains in physics: A possible "hidden variable" in diagnostic pretest scores. *American journal of physics*, *70*(12), 1259-1268.
[14] Ling, C. C., Zhang, P., Archambault, Y., Bocanek, J., Tang, G., & LoSasso, T. (2008). Commissioning and quality assurance of RapidArc radiotherapy delivery system. *International Journal of Radiation Oncology* Biology* Physics*, *72*(2), 575-581.