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TECHNOLOGICAL CONTENT KNOWLEDGE (TCK) ANALYSIS IN ONLINE LEARNING ASSISTED BY C-MAP TOOLS ON STATIC ELECTRICITY

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Abstract. The problem in this research is utilization of technology in learning which is used to make students creative in accordance with the skills in the 2013 curriculum. The aims of the study were to determine students' abilities about Technological Content Knowledge (TCK) assisted by C-Map Tools on static electricity material. The method uses assignments and filling out questionnaires. The sample used in this research is class XII IPA 1. The sampling technique used was *purposive cluster random sampling* where each individual in the class had a known opportunity to be clarified as an option in a study. Data were collected by average score of student response questionnaire and average of students six group for rubric assessment C-Map Tools. Data analysis using descriptive analysis with the average score of the student response questionnaire and the average score rubric assessment C-Map Tools. Students' abilities regarding TCK was obtained from the results of a student response questionnaire which contained three aspects, namely display, material, and advantage. The average of these three aspects is a good category. Students' skills in making concept mapping on static electricity material through the C-Map Tools application are in good category. Students are able to connect concepts with each other by using the C-Map Tools application. There is also a limitation in this study, namely that many students did not include focus questions in their C-Map tools.

Keywords: TCK, C-map Tools, Learning, Static Electricity, Skills.

INTRODUCTION

One of the national standards in the education system in Indonesia is developing a curriculum. The curriculum is included in the learning tools used as an educational program provided by an institution. The curriculum in Indonesia has undergone 10 changes, including: RPP 1947; RPP 1952; RPP 1964, Curriculum 1968, Curriculum 1975, Curriculum 1984, Curriculum 1994, KBK (Competency-Based Curriculum) 2004, KTSP 2006, and Curriculum 2013.

The Curriculum that is considered closest to the nation's goals is the 2013 curriculum. (Permendikbud, 2013) explain that authentic assessment is an assessment carried out comprehensively to assess starting from input, process, and output. (output) learning which includes the domains of attitudes, knowledge, and skills. The 2013 curriculum has 3 aspects of assessment, namely aspects of knowledge, aspects of skills, and aspects of attitudes and behavior. The assessment aspect of the 2013 curriculum makes a significant difference when compared to other curricula, namely the difference in the skills aspect. There are four skills students must master in the 21st century: 1) 21st century core subjects and themes; 2) learning and innovative skills; 3) information, media and technology skills; and 4) life and career skills (Adamson & Darling-Hammond, 2015; *Anna Rosesvky*, n.d.). One example of learning and innovative skills is the activeness of students in the classroom which is considered capable of developing character education in accordance with national education standards in Indonesia. In addition to developing character education, the 2013 Curriculum can also develop the creativity of

teachers and students in creating a good learning atmosphere. Teachers must be able to utilize the facilities and infrastructure as much as possible to make students active in the classroom. Students are also expected to be able to express their creativity in the learning process in the classroom.

One way for teachers to express students' creativity in the learning process in the classroom is by doing learning innovative and creative. According to (*Nurdyansyah 2019*, n.d.) An innovation is a new idea that is different from an existing one and consists of an idea, method or product. In addition, according to (*Sunandar*, n.d.) creativity is a process of fluency, originality, and flexibility in thinking. The existence of innovative and creative learning is expected that students will more easily understand the material provided by the teacher.

In addition to learning and innovative skills, there are also information, media, and technology skills that students must master in the 21st century. Information, media, and technology skills are very helpful for building innovative and creative learning. This means that technology can become much needed in today's learning era. According to (*Anglin Gary*, n.d.) technology is a science that systematically applies behavior, traits and other knowledge to solve problems. So technology is a medium to be able to take full advantage of the surrounding conditions systematically or sequentially. The idea to use technology as a learning tool, developed a new learning model called *Technological Pedagogical Content Knowledge (TPACK)*.

Technological Pedagogical Content Knowledge (TPACK) combines several important content in school learning, namely technology and pedagogical skills. TPACK itself is a learning model that requires teachers to use technology in delivering material (Mar'atus Sholihah & Yuliati, n.d.). *TPACK* consists of six knowledge components. The constituent components are *Knowledge Technology* (TK), *Content Knowledge* (CK), *Pedagogical Knowledge* (PK), *Pedagogical Content Knowledge* (PCK), *Technology Pedagogical Knowledge* (TPK), *and Technology Content Knowledge* (TCK). One component of TPACK is called *Technological Content Knowledge* (TCK) and TCK itself is a balance between technological knowledge and material content (Koehler et al., 2013).

TCK knowledge can be seen through the teacher's ability to use technology when delivering material and utilize technology to map students' conceptions in solving a problem. Several ways can be used to improve students' understanding of a material, one of which is by using a concept map (Gourlay, 2017). Solving a problem using the TCK model in learning will be more efficient if the teacher uses a concept map in conveying material, especially Static Electricity which is known to have many concepts in it so that the delivery of Static Electricity material in learning becomes more concise and easily understood by students. Concept maps are made to develop students' cognitive knowledge about concepts in subjects (Novak, 1995). According to (Sari & Ardianti, 2021) a concept map is a visual tool that becomes a pattern of organizing or planning original ideas into a more concise concept. Concept maps can have a positive impact on increasing student learning scores as a learning tool (Lestari et al., 2018). Previous research showed that students' understanding of thinking skills in physics subjects was still low (N. Suprapto et al., 2018). In general, concept maps consist of concepts written on circles or squares or other shapes, and the relationships between these concepts are shown by lines. The application of concept maps to technology can use the C-Map Tools application.

C-Map Tools is an application to help the process of making concept maps with various forms, where it is expected that students are more interested in studying physics in Static Electricity material based on C-Map Tools. It is also hoped that teachers can teach static electricity material in a practical and easier way for students to understand. C-Map Tools are used in delivering material in the form of concept maps to make it more concise. Therefore, in the learning process, students and teachers can use the C-Map Tools application to create concept maps.

C-Map Tools is also open source software so that it can be used by everyone without the need to buy this tool. Software it was developed by the *Institute for Human and Machine Cognition* and can be downloaded for free at the address http://cmap. ihmc.us. The website has provided various information about *software* this, including how to install and use it.

The existence of technology development through the Technological Content Knowledge learning model and C-Map Tools is a means to utilize existing technology so that this article aims to determine student knowledge about technology content knowledge based on C-Map tools on Static Electricity material.

RESEARCH METHOD

Research Design

The method in this research uses assignments and filling out questionnaires. The sample used in this research is class XII IPA 1. The assessment in this research used a student response

questionnaire and an assessment on the C-Map Tools group of students.

The assignment method is a way of learning by giving assignments from the teacher to do by students at school or at home individually or in groups. In addition, according to (Sagala, 2013) the assignment method is a way of delivering material that is characterized by certain tasks so that students can take responsibility for their learning activities. The assignment in this research is to create a concept map on static electricity using C-Map Tools and work in groups. Questionnaire is a technique of collecting data in the form of questions given in writing to a group of people to find out the responses and information needed by researchers. In this study, the method of filling out questionnaires was in the form of responses from class XII IPA 1 students about learning using new technology (C-Map Tools).

Procedure

In this reseacrh, researchers observed the ability of Technological Content Knowledge (TCK) in high school students studying Static Electricity using the C-Map Tools application. Learning begins with developing existing learning tools such as syllabus, lesson plans, handouts, worksheets, and assessment sheets. The first lesson uses power point static electricity material which is explained by discourse method by the teacher. When finished with learning using power points, the teacher continues learning using C-Map Tools as a learning tool. The teacher gives an introduction to the C-Map Tools and also shows the application. The teacher gives an example of making a concept map using the C-Map Tools application. Next, the teacher explains the static electricity material in the form of a concept map using C-Map Tools. The teacher also guides students to make concept maps by utilizing the C-Map Tools application using the same material which will later be assessed based on the assessment rubric given by the teacher. After finishing learning using C-Map Tools, the teacher provides a post-test as a teacher evaluation in this lesson. TCK assessment in students can be seen based on indicators. The implementation of the C-Map application starting by the example by the teacher that is illustrated in Figure 2 (Nadi Suprapto et al., 2020)

Table 1. TCK Indicator in students by (Chai et al., 2011)

Number	Variable	Indicator	Label
1.	Technological Content Knowledge (TCK)	Can take advantage of existing technology	TCK 1
		Can choose the material according to the technology used	TCK 2
		In the learning process using existing technology (Laptops and the C-Map Tools application)	TCK 3
		Can find out learning materials that require technological facilities to make it easier for students to understand the material	TCK 4

Table 1 explain about TCK indicator. In this research, students are expected to be able to take advantage of technology in accordance with the indicators above. There are 4 labels that describe indicators of technological content knowledge. Label 1 explains the advantages of existing technology. Label 2 explains materials according to the technology used. Label 3 explains the learning process using existing technology. Label 4 explains learning materials that require technological facilities

Instrument

The instruments needed in this research were the student response questionnaire, the C-Map Tools assessment rubric by (N. Suprapto et al., 2018). Student response questionnaires were made based on the existing grid. The C-Map Tools assessment rubric is based on the scoring rubric developed by (N. Suprapto et al., 2018). Table 2 explains the response questionnaire grid based on the items.

The indicators in table 2 are used as guidelines for teachers in compiling student response questionnaires. It is also used to indicate a change during learning. As a guide in planning and making good student response questionnaires

Table 2. Student Response Questionnaire Grid

Aspect	Indicator	Number
Display	Utilization of technology	1
	Presentation of material	2, 3, 7, 8
	Presentation of image	6
	Presentation of the assessment rubric	9
Material	Retention of material	5, 10, 11
	Image and material suitability	4
	Comprehension of rubric based assessment	12
Advantage	Ease of learning	13
	Increased learning creativity	14
	Increased motivation to learn	15

Table 3 is the content of the response questionnaire based on the items. table 3 describes the student response questionnaire that has been prepared according to the aspects and indicators in table 2. There are 3 answer choices for students to assess learning by utilizing technology and the application of C-Map Tools.

Table 3. Student Response Questionnaire

Number	Questionnaire Questions	Answer Choice		
		VG	G	NG
1.	The teacher's tools for utilizing existing technology (laptops and the Cmap Tools application) really helped me in accepting learning well			
2.	The presentation of static electricity material on ppt makes me interested			
3.	The teacher's explanation of static electricity material made me understand			
4.	Giving examples of static electricity images makes me understand more about the material			
5.	Students happy to receive the teacher's explanation of static electricity material from ppt			
6.	The introduction of Cmap Tools in the form of images made me interested			
7.	Presentation of concept maps regarding static electricity makes me more interested			
8.	The teacher's explanation using concept maps using Cmap Tools makes it easier for me to learn			
9.	The teacher's explanation of the Cmap Tools assessment made me more enthusiastic in learning			
10.	Students accept the teacher's explanation of static electricity material from Cmap Tools well			
11.	Students create concept maps using Cmap Tools easily			
12.	Students give Cmap Tools an assessment based on the rubric			
13.	Students get a good evaluation of learning from the teacher			
14.	The technology used by teachers in learning can increase student creativity			
15.	The technology used by teachers in learning can increase students' learning motivation			

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Tables 4 explain the scoring of each item in the student response questionnaire. There are 3 criteria, namely very good, good, and not good which are used by students as a reference to assess the learning process by utilizing technology and application C-Map tools.

Table 4. Scoring Scale

Scoring Scale	Criteria
3	Very Good
2	Good
1	Not Good

After knowing the results of student responses through a questionnaire, the results can be calculated according to the formula below. Then it can be seen that the value of the results of the questionnaire is included in the criteria determined based on the percentage described in Table 5.
Table 5 explain the percentage about scoring student response based on a questionnaire.

Percentage of Student Responses = $\frac{total\ skor}{total\ skor\ max}\ x\ 1$ (1)

Table 5. Student Response Criteria Based on a Questionnaire (*Akbar*, n.d.)

Percentage (%)	Categori
81,25 < x < 100	Very Good
62,5 < x < 81,25	Good
43,75 < x < 62,5	Not Good

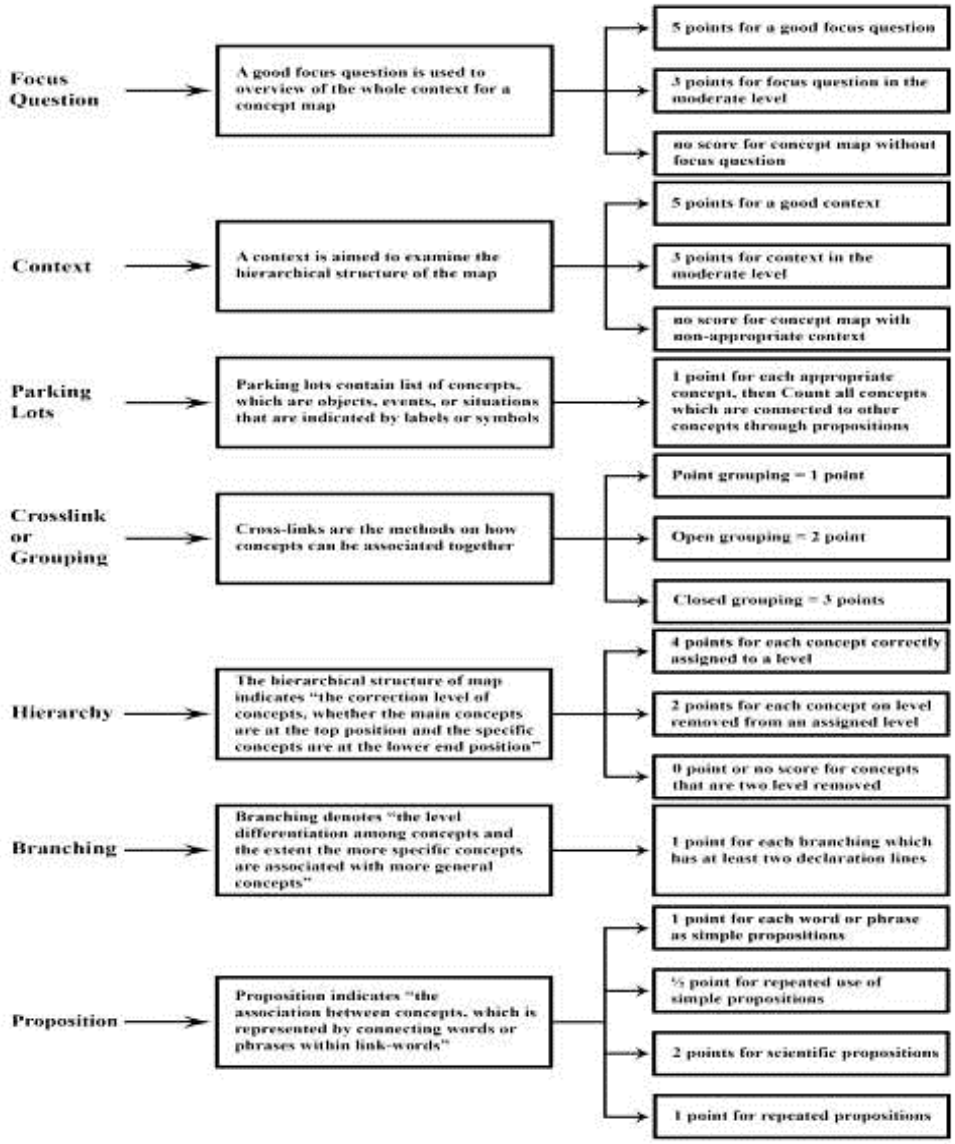

Figure 1. Explanation of the C-Map Tools assessment rubric

Figure 1 explains the rubric for the assessment of C-Map Tools according to (N. Suprapto et al., 2018) for each aspect then for an explanation of the score for each aspect can be seen in Table 6. There are seven aspects that can be used as a reference for assessing the results of student cmap tools. It is also explained about the points that will be obtained by students.

Data Analysis

In analyzing the student response questionnaire data using the average score obtained. The results of the concept maps done by students were assessed based on an assessment rubric.

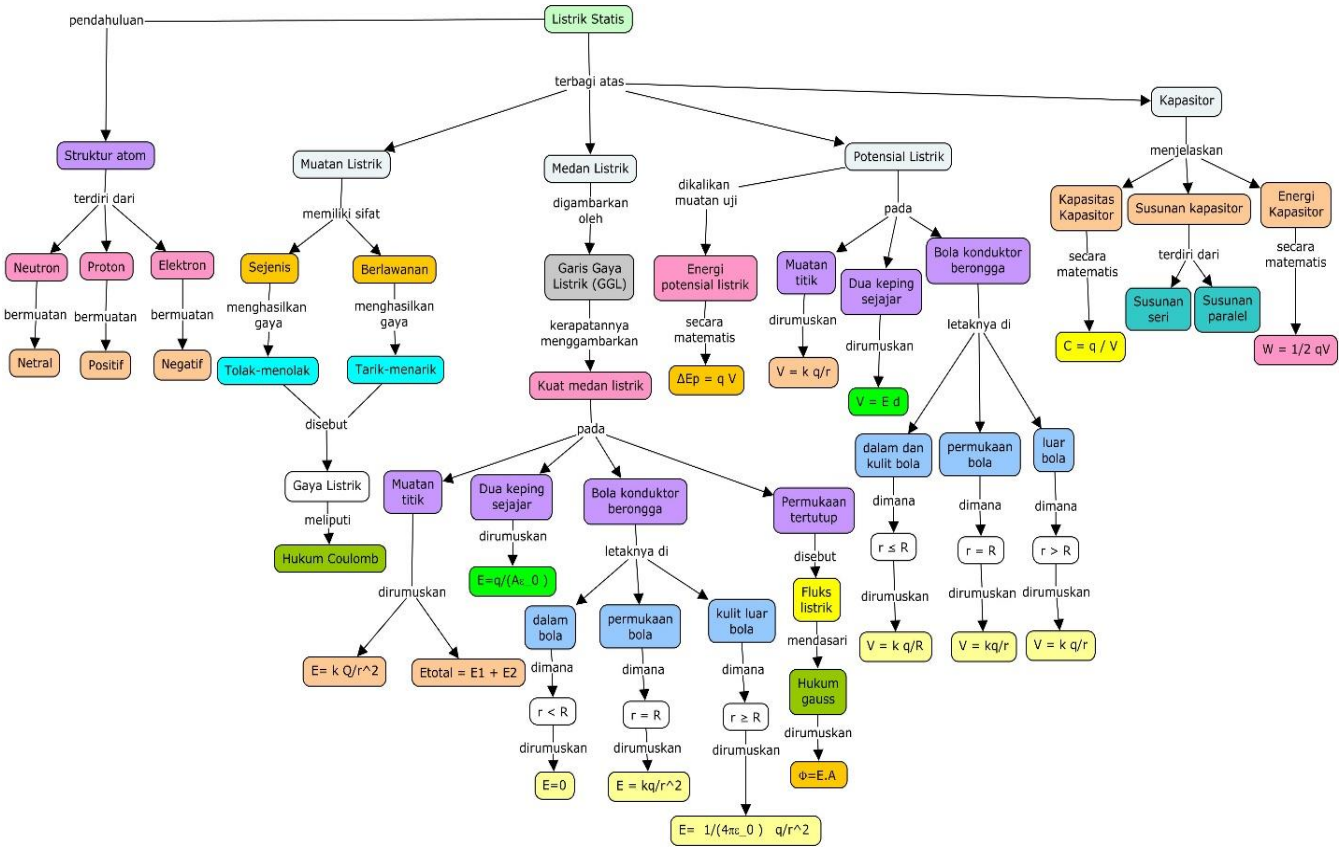

Figure 2. Example of C-Map Tools static electricity material

Figure 2 is an example of C-Map Tools static electricity material for to be used as learning in class. Teaching with the cmap tools application is expected that students can understand the concept of static electricity more easily. For Table 6 explain about C-Map Tools Assesment Rubric which is used to assess the results of the cmap tools students. The results of the cmap tools assessment will later be analyzed. It is also explained about the points that will be obtained by students and the total value of students is obtained from the sum of all aspects that have been given point.

Table 6. C-Map Tools assessment rubric by (N. Suprapto et al., 2018)

No	Aspect	Symbol	Point
1	Focus of the question	a	5
2	Context	b	5
3	Parking lots	c	1
4	Cross Links (Point Grouping)	d	1
5	Cross Links (Open Grouping)	d	2
6	Cross Links (Closed Grouping)	d	3
7	Hierarchy (True concept at the same level)	e	4
8	Hierarchy (There is one concept that is omitted at the concept map level)	e	2
9	Hierarchy (There are two or more concepts that are omitted at the concept map level)	e	0
10	Branching	f	1
11	Simple Proposition	g	1
12	Repeated Proposition	g	1/2
	Total		

RESULT AND DISCUSSION

Result

Technological Content Knowledge Student's Analysis

Technological Content Knowledge Analysis into three parts, such as Display, Material, and Advantage. Each part has several indicators. The parts were obtained from the results of the student response questionnaire. The result of Technological Content Knowledge Analysis can be seen in Table 7.

Table 7. The Result of Technological Content Knowledge Analysis

Student Response Questionnaire		
Aspect	Indicator	Percentage (%)
Display	Utilization of technology	78
	Presentation of material	79,2
	Presentation of image	78
	Presentation of the assessment rubric	74,3
Material	Retention of material	80
	Image and material suitability	76
	Comprehension of rubric based assessment	72
Advantage	Ease of learning	80
	Increased learning creativity	81
	Increased motivation to learn	78
	Average	77,4

Technological Content Knowledge consists of several aspects, namely display, material and advantage. Each aspect consists of several indicators. Display aspect consists of utilization of technology, presentation of material, presentation of images, and presentation of the assessment rubric. Utilization of technology in terms of the teacher's ability to utilize existing technology in laptops and C-Map Tools because this research was conducted online. Presentation of material in terms of the teacher's ability to display material from ppt. Presentation of images in terms of the teacher's ability to display examples of C-Map Tools in the form of images. Presentation of the assessment rubric in terms of the teacher's ability to display the C-Map Tools assessment rubric from (N. Suprapto et al., 2018).

Material aspect consists of retention of material, image and material suitability, and comprehension of rubric based assessment. Retention of material in terms of the student's ability to understand the material presented by the teacher. Image and material suitability in terms of the teacher's ability to present examples of C-Map Tools in the form of images that are suitable with Static Electricity material. Comprehension of rubric based assessment in terms of students' ability to understand the assessment of C-Map Tools that are suitable with the assessment rubric by (N. Suprapto et al., 2018).

Advantage aspect consist of ease of learning, increased learning creativity, increased motivation to learn. Ease of learning in terms of the student's ability to understand learning at the meeting. Increased learning creativity in terms of students' ability to be creative in learning. Increased motivation to learn in terms of the student's ability to increase learning motivation. From the results obtained, the average number is not good in accordance with the results of (Suryawati & Dan Yosua Hernandez, n.d.) research which states that students' abilities related to learning with technology still need to be developed again.

Students' Skill to Make Concept Map through C-Map Application

Students' skills to make a concept map were assessed by Suprapto's rubric. There were six students' groups (SG) in a group. Every group made a concept map in static electricity matter through C-Map application. The score students' skill to make a concept map is shown in Table 8.

Table 8. The result of students' skill to make concept map

Student's Group	Score
SG 1	66,5
SG 2	53,5
SG 3	79
SG 4	58,5
SG 5	77
SG 6	116
Average	75,08

Table 8 is a result of student's skill to make concept map. Based on Table 8, we can see the average of students' skill score to make concept map

was 75,08 in good category. An example of C-Map Tools with the best score was made by students' in Static electricity matter was showed in Figure 2.

Figure 3 is an example of C-Map Tools with the best score was made by student's in Static Electricity material. Based on Figure 3, a simple analysis could be dedicated to the simple concept map created by a student as follow:

a. Concept map starting from electrical material in general, but the concept maps presented are less variety and less colorful.
b. Concept maps are quite complete and student has been able to work on map components such as: context, parking lots, proposition, grouping, branching, and hierarchy of concepts.
c. Student has been able to make the specificity of the developed concept map starting with questions and answers.
d. Student classify the discussion of static electricity matter into several parts. Example: electrical charge, example of static electricity, electric field.

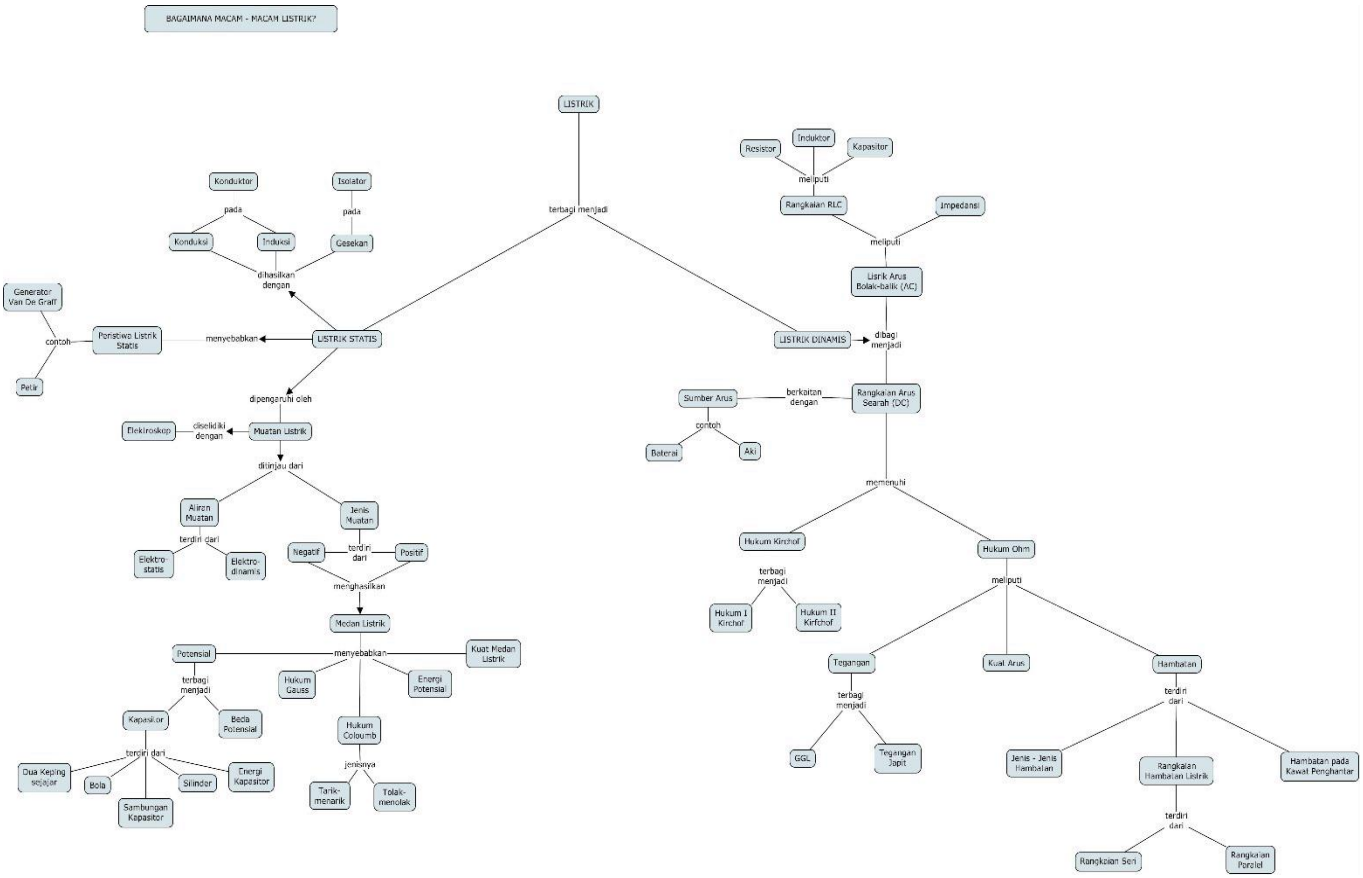

Figure 3. An example of C-Map Tools with the best score was made by students' in Static Electricity material

Discussion

This study aims to determine students' abilities about Technological Content Knowledge assisted by C-Map Tools on static electricity material. Student response questionnaires were made to determine students' ability to use technology in static electricity learning. The sample in this study was 30 students of class XII Science 1. Student response questionnaires were seen from 3 aspects, namely appearance, material, and excellence. The display aspect consists of the use of technology, presentation of material, presentation of images, and presentation of the C-Map Tools assessment rubric. In this aspect the teacher hopes to know the students' ability to use technology in the form of laptops and C-Map Tools because this learning is done online. The material aspect consists of material retention, images and material suitability, as well as an understanding of the assessment based on the C-Map Tools rubric. In this aspect of the material, the teacher hopes to know the students' ability to understand the suitability between technology and the material presented by the teacher.

Aspects of excellence consist of ease of learning, increased learning creativity, and increased motivation to learn. In this aspect of excellence, the teacher hopes that students will get new learning innovations that can increase student learning motivation.

Based on table 7, it can be seen that the average percentage obtained based on these three aspects is 77.4% with a good category where the good category is in accordance with the Student Response Criteria Based on a Questionnaire (*Akbar*, n.d.). Based on the aspect of appearance, the largest percentage is the presentation of the material (79.2%), which means the teacher is able to explain the static electricity material in ppt form well so that students feel enjoy learning. Based on the material aspect, the largest percentage is material retention (80%) which means the teacher is able to make students understand the static electricity material explained by the teacher. Based on the aspect of excellence, the largest percentage is an increase in learning creativity (81%), meaning that teachers are able to increase students' learning creativity by introducing and teaching the use of the C-Map Tools application.

In addition to discussing Technological Content Knowledge, this research also discusses C-Map Tools. Students are expected to be able to create concept maps using the C-Map Tools application and assessed based on the assessment rubric of (N. Suprapto et al., 2018). Based on Table 8, it can be seen that the average skill of making concept maps through the C-map application is 75.08% with a good category. This finding confirms the study of Suprapto et al. (2018), which underlines that "making concept maps through C-Map Tools can investigate the level of understanding of the material and concept maps of one understanding of physics indicators". In addition, these findings also support the premise: "The application of concept maps as a consolidation phase can improve students' conceptual understanding of environmental pollution" (Nugroho et al., 2017)).

The application of C-Map Tools on static electricity provides a new experience and impression for students. Students make concept maps in groups about static electricity using the C-Map Tools application. The teacher has guided and trained how to create a concept map using the C-Map Tools application. Concept maps can help students learn by knowing the hierarchy of a concept from connecting concepts to one another. Concept maps are innovations that map students' thoughts into concepts that are correlated with each other so as to minimize misconceptions in students (Nair & Narayanasamy, 2017).

The teacher also explains the indicators used as an assessment rubric. on concept maps and teach how to assess concept maps according to the rubric described by (N. Suprapto et al., 2018). Concept map indicators consist of "focus questions, context, parking lots, cross-links or groupings, hierarchies, branching, and propositions" (N. Suprapto et al., 2018). In the training concept map, the teacher explains and also provides examples of concept map assessments based on the assessment rubric by (N. Suprapto et al., 2018). In addition, students' skills in developing static electricity concept maps using the C-Map application optimize their multiple intelligences, especially visual, logical mathematics, linguistic intelligence (N. Suprapto et al., 2017)

Each concept map has a focus question that is used in formulating the problem to be worked on. Next, create a concept map that contains context, parking lots, cross-links, hierarchies, ramifications, and propositions. However, this study also found limitations, in the preparation of concept maps there were still many students who did not provide a focus on questions so it was difficult to describe concepts. So that in this study students still need to do some exercises in making concept maps whose assessment rubrics are in accordance with (N. Suprapto et al., 2018).

CONCLUSION

Determine students' abilities about Technological Content Knowledge assisted by C-Map Tools on Static Electricity. Students' abilities regarding Technological Content Knowledge were obtained from the results of student response questionnaires which contained 3 aspects, namely display, material, and advantage. The results of the student response questionnaire for each aspect were in the form of a percentage. The display aspect is to see student responses to the display of the material presented by the teacher. The greatest percentage was on the ppt display during the presentation (79.2%). The material aspect is to see the response of students' understanding to the static electricity material and C-Map Tools presented by the teacher. The greatest percentage is understanding the material (80%). The advantage aspect is to see the benefits of learning presented by the teacher. The greatest percentage is increasing learning creativity (81%). The average of these three aspects is 77.4%. Students' skills in making concept maps using the C-Map Tools application on statistical electricity material reached 75.08% in the good category. Students are able to connect concepts to one another by using the C-Map Tools application. There is also a limitation in this research, that many students did not include focus questions on their C-Map tools. So, in this study

students still need to do several exercises in making concept maps whose assessments rubric according to (N. Suprapto et al., 2018).

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