Grade 11 student’s mental model of the Nature of Light

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Abstract. This study aims to explore Grade 11 Student’s Mental model of the Nature of Light with the integration of learning about light. The participants were 50 students in Ban Tha Muang School, Buriram, Thailand, Province Thailand. The methodology is in the respect of interpretive paradigm by opened question about Nature of light and interview. The results were student could to explain primary light sources more than secondary light sources because they could students easily find primary light sources in everyday life. Student could to model of understanding mental model about moving light. They could to explain light travels straight out of the light source and travel because its intermediaries because light was electric wave including understanding Mental Model. They could to draw and explain light travels straight from the sun through the vacuum and the atmosphere of the earth and there are some students who paint a wave of light by drawing a wave like a wave in a rope. They could to explain mental model of visibility as see with our eyes, however, there are only some students who associate the impact and reflection to explain the vision. This paper also discusses teaching science about the student's mental model of Nature of Light in physics as a guideline for those who are involved in the development of learning, focusing on learners who learn to light.

1. Introduction
Today, national is expected to be a scientifically literate person by means of being able to understand real life events, having the happiness of knowledge about the natural world, applying scientific processes in personal life, asking and suggesting reasonable solutions for questions, make decisions, able to use technology, and be good at social communication. Physics is such a branch that any event in real life may be explained with the help of real life, which can also encourage student curiosity and make sense why they learn about chemistry. Students encounter many real-life events from an early age and they relate to what they already know and construct coherent understanding of these events. During in physics learning process, students often experience difficulties and lack conceptual understanding of basic concepts [1], [5], [6], [9]. Students usually tend to learn factual knowledge presented and tries to grasp the knowledge that they just need for exams, without making any meaningful connections to what they already know or constructing an understanding of the underlying concepts, they only hold their own coherent understanding based on their prior knowledge and
experience [6], [10]. In the case of Thailand high school students, students are mostly focused on the university entrance examination and performance rather than learning, the important points for them to take high grades in exams, make good memorization to answer the questions rather than inquiring for scientific facts.

In the current study, Mental model of the Nature of Light were investigated, which is one of the fundamental topics in physics and easily influenced by daily life and experiences [3]. Students’ understanding of learning usually is assessed by traditional assessment techniques such as multiple-choice questions, which are often more preferable in science classes since they are easy to apply. Even students are successful in conventional tests, this success does not reveal that the students’ understandings of given concepts. A student could get a high score by chance and luck factor; which does not reveal meaning learning. In order to assess students’ ideas on nature of light, one of alternative assessment techniques, was used, which included daily life events that students might find interesting to learn.

Norman also speaks of conceptual models. In the article "Some Observations on Mental Models Norman [7] distinguishes between mental models and conceptual models: Conceptual models are devised as tools for the understanding or teaching of physical systems. Mental models are what people really have in their heads and what guides their use of things." In other words, the designer designs a conceptual model into the system in order for it to appear graspable and coherent to the user. If she manages to get the conceptual model right, the correct mental model (in the mind of the user) will follow. At least in theory. Norman's account is of course an over-simplification, but it captures some central dilemmas of interaction design by using mental models as a vehicle for explanation and illustration. The study ideas of existing student’s exploration, which is between 10-7 years old, about the light source. Light and vision Found that small students [8]. They can tell their original ideas about many primary sources such as the sun, the light, the flashlight, the light, the TV, but the secondary light source. And may be told secondary light sources in the manner of windows, ceiling, doors, sky, moon, students can relate to the origin. Primary and secondary lighting is very rare. The idea of light travel is related to the idea of a light source if we see light. This idea is hard to understand because it is not visible. The visionary has few students who can understand the scientific explanation of the sight that light must leave the object in our eyes, that could see the object. The reports on the third year of a three-year longitudinal investigation into six secondary students' understanding of optics at a secondary school level [4]. In the third year of this investigation the students, who by now were in Year 12, underwent a teaching sequence that centered on the teaching and learning of physical optics and quantum ideas. The students' mental models of the nature of light were explored prior to, and following this teaching sequence. The researcher took on the dual roles of teacher and researcher. This paper will outline the findings of the third year of this study and the implications they have for the teaching and learning of optics at secondary school level. Concepts related to events students directly or indirectly experience vary according to their structures and the way they occur. In this process, while it is always possible for some concepts to be experienced in daily life, for some it is impossible to understand without having prior knowledge on the subject. This paper also discusses teaching science about the student's mental model of Nature of Light in physics as a guideline for those who are involved in the development of learning, focusing on learners who learn to light in Thailand [12], [13].

2. Methodology
The research regarded interpretive paradigm. Grade 11 student’s mental model of the Nature of Light which has been taught by the first author for 16 periods in a month. The participant questionnaire observation and interview, students’ discussion and questions, worksheets, and unstructured interview were interpreted to examine mental model of the Nature of Light [3], [12], [13].
2.1 Target Group
The participants were 50 Grade 11 students in in Ban Tha Muang School, Buriram, Thailand

2.2 Research Focus
To this point, studies on light have been conducted on students’ mental models and conceptual difficulties concerning such phenomena. The motivation behind this study is to disperse the lack of studies on different physical phenomena related to light. The other phenomena mentioned above are explained by the particle model of light. Enchanting its cue from these ideas, the purpose of this study is to understand primarily the students’ mental models of light to explain generation light source, motion of light and visibility of light. Also, the aim was also to show how students use light-related models in explaining physical phenomena. To this end, questions used as data gathering tools were prepared for each context in accordance with the nature of the study. As such, this study puts forth in detail the different forms of models used by students related to physical phenomena. Thus, this study attempted to answer resulting questions: What mental models do students have about the nature of light to explain various phenomena?

2.3 Data Analysis
The data obtained from the question were analyzed by questionnaire to quantitatively by the researcher. As the aim in this study was to determine Student’s mental model of the Nature of Light, during the analysis process different contexts were analyzed among themselves, and no generalization was made in students’ reasoning with other contexts. Therefore, students’ mental models for each context were determined and as such whether models are context-dependent. First of all, frequently used drawings and descriptions were gathered under three different mental models to explain generation light source, motion of light and visibility of light.

3. Findings

3.1 Students’ mental models about the concept of generation light source
As a result of the questionnaire, most students have a Mental Model about the light source, rather than drawing or drawing only. And most students know the source of light in daily life. They could tell more than seven light sources. They would to tell of primary sources light and able to tell the Mental Model about a large number of primary sources such as sun, light, flashlight, candle light, etc. However, only a small number of students could describe secondary light sources. Which students usually tell the secondary light source in the manner of the earth, moon, window, etc., as shown in Figure 1.
Student could explain the primary source of light rather than the secondary source of light. They observe the light directly from the source and it can be seen from the drawing or drawing a lecture. They could draw lines out of the light source for a short time. Especially the sun and light bulb, etc. When asked the reason for the interview, students will say "It was painted this way". Students may have seen examples from comic books or from the imagination of students who think that if the bulb goes out, there will be no line from the lamp to differentiate from the light bulb.

They could tell about source of the light emitted by the heat. Incandescence was more than the light source emitted by fluorescence. And why students could tell the light source caused because these light sources can be easily found in everyday life. They were knowing familiar with this source of light example in Figure 2. They could to tell the sun, candles, fire, matches, etc., most students can lift up to five examples of this kind of light source, especially the sun. All students can say that the light source caused by the light emitting heat. However, there are some people who can give examples of light sources emitted by glow such as fireflies, fluorescent lights, etc.
Most students are unable to link the relationship between primary light sources and secondary light sources. Teachers prepare to provide the correct main ideas about the different types of light sources about primary light sources and secondary light sources. This provided light by reflecting light from one primary light source for students to take advantage of the study of physics in the geometric light in the next order.

3.2 Students’ mental models about the concept of motion of light
With the first question given below, students’ mental models of light were determined for Question. First question: How were you having an idea about the journey of light? Student thought are related to the idea of light source, if They would see the light. This idea is difficult for students to understand because they do not see it. The answer to that question. Second question: How does sunlight come to the world? Some students answer the question by drawing a drawing or drawing a lecture. The answer of the students has the correct understanding and know that light is electromagnetic, so light does not need to rely on moving medium. Some students respond that the sun shines through the atmosphere through the atmosphere. The light moves from the sun to the Earth as shown in Figure 3 (a). There are some students who describe the earth's light through the world without moving media, linked to reflection and refraction. Students explain that the sunlight is pushing the air down. If the object or object is subjected to collision, refraction and refraction will take place.

![Figure 3. Mental model of light way](image)

(a) The sun will shine as go down to the Earth.  
(b) Light form the sun pass environment

![Figure 4. Light was wave](image)
In addition, some students use their own understanding patterns to convey the wave of light by drawing. As the wave in the rope, shown in figure 4. Student's caption illustrates did the direction of the arrow. The light of the sun could write lines that were not straight lines instead of light waves. It was important to know that the student knows that light travels straight but arrows. But it was not straight lines, because the light is wave. Also known as light waves.

Interesting points from this study, some students will not understand where the beam is coming from. They did not understand the origin of the sound but students say that the beam is from the sun. According to scientists, the beam was sent down [8], [10], [11] describes the issue. In this way, perhaps the scientist might have been thinking about the journey of light from childhood as well.

From Figure 5 (a), most students visualized the passage of light in a straight line, and the arrowhead indicates the direction of light. To indicate that the directional light ejected from the light source. However, only a small percentage of students draw the path of light in a straight line without the direction of the arrow. The direction of light was shown in Figure 5 (b). The idea of the scientist was that light travels straight out of the light source in all directions.

Some students could understand the scientific explanation of light. Students see the light must be reflection from the object and it could saw the object. In research the questionnaire: How do students see the book? And how did students see candles? They were describing, write, or draw, their own free speech. Based on data analysis. The results show that students had shown model of vision as that can be divided into 2 subjects, which corresponds to research [8] Details were as follows:

- Students present ideas as images but didn’t explain the meaning of the image.

**Figure 5.** Light travels in a straight line.

**Figure 6.** Mental model of vision, which wasn't explain image.
Analyzing data from questionnaire that the visualization of secondary light source was related to the reflection of light. It was difficult for some students because they couldn’t explain objects that need to reflect light from the light source. Another eye to saw the object for some students who cannot explain, write, lecture or draw a picture. They would simply explain that when we look at any object. They explain saw that the object was unconnected, that the reflection of light of the visible part. Then draw a picture showing how the student sees the book. What does the candle look like? No explanation or rationale. Details were as follows:

Students present ideas as images but didn’t unconnected the meaning of the image.

![Figure 7](image1.png)

**Figure 7.** Mental model to see the object was unconnected.

Conduction form figure would represent knowledge about light of some student. They represent model of light as necessary went they saw object. They would to draw object or sources of light as show concept of student represent as light help to saw object.

### 3.3 Students’ mental models about the concept of visibility of light.

The finding of research has student’ mental models about the concept of visibility of light. First, several students could show mental model as who draw line connect between eyes and object to one step. But model wasn’t complete because who didn’t draw arrow of line of light. Also, example in figure 8(a) and some student could to connect line of light between object and eyes show in figure 8(b). The finding of research, several students would to draw model of light as line direct and had some student draw model of light as point.

![Figure 8](image2.png)

**Figure 8.** Mental model’s student about seeing the objects as connected.

Second, several students could show mental model as who draw line connect between eyes and object to two steps. Show in figure 9(b) were concept about in line of light help to saw object because the light reflects form object and light move to eyes. And some time, we saw the misconception of student for example show in figure 9(a) by mean of student draw direction of light go away form eye onto sources of light. They gave respond as eyes will be staring at an object. Actually, mentioning the light, it must leave the light source. However, we found that most students have the ability to write a light path in a straight line. There was a direction from the object to the eye which was described by correct concept.
Third, the finding of research explained to connect way of light 2 step. All most student could to draw line of light connect between object source of light and eyes. They claim understanding as “Light must use help to see” and “We need to use eyes to see.” The sentence interpretive understand of student to connect in several as mental models involve light. Student explained understanding about to see of object were to without the direction of light from the light source but can tell that light was needed for vision. For example, in figure 10(a)

![Figure 9](image9.png)

**Figure 9.** Mental model direct of light.

![Figure 10](image10.png)

**Figure 10.** Mental model of student about to see object as show connect two steps.

Form figure 10(b), represent mental model of student connection thinking and knowledge explain light moving to object and light leave go to eyes by draw line of light. We had understanding some student form mental model about view same scientist as property of light. We can see it because the light struck the object and reflected go to our eyes for example in figure 11.
The results of the student's explanation of the vision follow were most of the students explained the sight of the book different from seeing the flame from the candle. They thought that the candles sent light directly into the eyes in fact, the book couldn’t have sent light to eyes. They used light distribution features to explain their vision which makes the description of the vision deep to the point of seeing of various objects. For example, light white in the nature take on object appear reflection of light, absorption of light, and transmission of light. If object could reflection of light all wavelength in equal then it’s would to white light. The object absorbs all the light, we would see that the object is black because there was no light from that object reflect out to our eyes. If the object didn’t absorb the not equal light in each wavelength when the white light hits, the object would appear as that color. For example; Apple had rad color if when light impact to it could to absorb blue color and green color, then it could to reflection red color out to our eyes.

4. Concluding and Discussion
The result of questionnaire and interview regarding nature of light were study to grade 11 student’s mental model of the nature of light to detail follow in below. Frist, student could to explain five primary sources of light and secondary sources of light. Students’ mental models about the concept of generation light source. Students know the source of light in daily life involve primary source of light and secondary source of light. They allude to incandescence, luminescence and incandescence. Second, mental models of student about the concept of motion of light who describe the earth light through without moving media, linked to reflection and refraction. They would to tell way of light source to direct to electromagnetic wave it can pass atmosphere of world by draw picture and write to explain understanding. And third, mental model of the vision follow was light help to see object. They thought that the candles sent light directly into the eyes in fact, the book couldn’t have sent light to eyes. They used light distribution features to explain their vision which makes the description of the vision deep to the point of seeing of various objects. They could to explain light moving to object and reflect to our eyes by draw picture to understanding.
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