



## TEACHING OPTICS PERSPECTIVES: 10-11 YEAR OLD PUPILS' REPRESENTATIONS OF LIGHT

Alyona Grigorovitch

Primary School Teacher-Researcher, Moscow, Russia

### ABSTRACT

The light is a distinct entity in the area, independent sources that produce it and the effects it causes during its spread. In a number of researches focused on mental representations of light that are children from 5 to 16 years found that these representations are often incompatible with the scientific model. 96 children (46 boys and 50 girls) participated in this research where we studied representations of children 10-11 years on the light. As a technique of research we chose the directive individual interview. The results of the research show that children of 10-11 years, use different categories of representations for the light

**Key words:** light representations, 10-11 year old children, primary education.

### INTRODUCTION AND THEORETICAL FRAMEWORK

The question of children's mental representations in science and especially in the field of physics has been reported in number of concept areas such as mechanics, heat, electricity etc. A large part of contemporary research focuses on the study of spontaneous representations or alternative ideas of students of different ages for various concepts and phenomena (Driver, Guesne & Tiberghien, 1985; Driver et al., 1994). During the last thirty years, in several researches we can see that, children are approaching the physical world, formulate and reformulate certain ideas, solve problems and gradually acquire knowledge of physical world. Based on the assumption that each individual in a given situation mobilizes personal explanatory systems, it is often noted that their own representation can be an obstacle to the appropriation of scientific concepts. This underlines the need for organizing suitable teaching for achieving overshooting of obstacles (Dumas Carré, Weil-Barais, Ravanis & Shourchah, 2003; Ravanis, Christidou & Hatzinikita, 2013).

As often demonstrated through descriptive research focused on mental representations of light that are children from 5 to 16 years, amid a series of difficulties on the propagation and interaction of the physical entity with different objects, the main obstacle to the recognition of light as being a separate and autonomous, independent entity from sources that produce it and the effects it causes exist in a certain region of space. According to the authors who have studied this subject, this difficulty stems from the tendency of the subjects to associate the light exclusively to its source or visible effects it causes (Tiberghien et al., 1980; Stead & Osborne, 1980; Andersson & Kärrqvist, 1983; Guesne, 1984, 1985; Osborn et al., 1993; Ravanis, Papamichael & Koulaidis, 2002; Castro, 2013). It is in this perspective that we studied children's representations of light.

"The model of school science geometrical optics provides the framework for discussing these representations. The main characteristic of this model, are the hypothesis of the point light sources, the straight propagation of the light rays and the light as an entity in space that is independent from sources and its respective results" (Castro & Rodriguez, 2014).

A starting point of our study is the research results about light representations of 5-16 year-old students. Indeed, understanding light as an entity in space has previously been identified in a series of studies. Research based on various experimental procedures had ruled out the possibility of children comprehending the concept of light in space. For the children's thought light may be conceived as something static and is not connected with movement and transition of an entity. Thus it seems that pupils' thought concentrates more on light sources or bright areas where light bounces (Rice & Feher, 1987; Feher & Rice, 1988; Ravanis & Papamichael, 1995; Selley, 1996; Langley, Ronen & Eylon, 1997; Galili & Hazan, 2000; Ravanis & Boilevin, 2009). Our study was set out 10-11 years old children's representations on

the concept of light. From the results we are trying to develop and schematise the principal axes of a model educational intervention aimed at exceeding of the cognitive obstacles created by the own representations of students

### METHODOLOGY

The identification of the representations of children was also conducted through interviews. Each interview lasted approximately ten minutes. Four situations have been proposed to the children. The questions concern the recognition of light as a separate entity in space. The conversation took place in a dimly-lit room specially prepared to that procedure in a special site of the schools. We present tasks, devices and features excerpts from responses of children. We also propose a categorization of answers and present the frequencies of the responses of subjects (Table).

96 children (46 boys and 50 girls) 10-11 years of age coming from 4 different school classes, took part in this study. The students were in the fifth grade of a primary school. None of the children had yet received any formal or informal instruction concerning the light. Each socio-economic level (low, moderate, high) and all levels of students' performance (low, moderate, high) are represented equivalently in the sample.

### RESULTS

Four types of tasks were used to obtain different kinds of information. Task 1. At every child, we ask the question: "What is the light for you?". With this question we seek to know if children spontaneously distinguish light as a separate entity of the light sources. This first question we got the answers that we have classified into three categories:

- Responses that recognize the existence of light like entity in space. For example, "*Light is like the air ..... in the air..... are all over the place ....*", "*...light fills the whole space*".
- Responses focused on the visible effects produced by light. E.g. "*The light ..... brighten the apartment ..... all things .....*", "*Is a white thing on the floor, on the wall.....*".
- Responses focused on light sources. E.g. "*Is the stars... and the sun*" "*Is an object that enlightens us...*", "*Is a lamp..... a torch.....*".

Task 2. We ask every child the question: "What does the light?". With this question we want to know if the children focus on light sources, their operating characteristics, and some directly sensitive phenomena such as heating and lighting or if they recognize other more general phenomena like life, the development of the plants etc. The responses to this question were classified into four categories:

- Responses that recognize more general effects caused by light as entity. For example, "*... warms and dries clothes*", "*... it makes the*

day".

- b) Responses focused on the sensitive effects produced by light. E.g., "Lights the world... the towns and everything around...", "Light enlightens people ..... houses .....".
- c) Responses focused on the presence and function of light sources. E.g., "... we turn on the lamp and it lights up the room...", "Light is in the candles, in the lamps, on TV...".

Task 3. We ask children to show us a few locations in the room "where there are light". When children show us exclusively light sources in operation and/or illuminated or strongly illuminated surfaces we ask them to show other places to check if they can evoke the light in the space. The responses of children have been categorized as follows:

- a) Recognition of light as an autonomous entity in space or in the dimly lit surfaces. For example, "The light is everywhere all around and... fills the air...", "... it is also on the wall..." "Here where we are sitting...almost in the whole room....".
- b) Focus on strongly illuminated surfaces. E.g. "I can see the light on the window, on the floor...", "Light is everywhere... on the ground... on the table...".
- c) Focus exclusively on light sources. E.g. "It's the Sun and incandescent electric lamps", "As we light this electric lamp... it has light (touch the lamp)...".

Task 4. Turning on a flashlight we produce on the wall a bright spot and we ask each child: "Where there - it of the light from the flashlight?". If the children recognize the existence of the light in the lamp and on the wall we ask them, pointing to the somewhere between the lamp and the wall: "what is there between the lamp and the wall light?". This situation gives the opportunity to the children recognize the light outside sources, on a bright spot or in space, in a familiar situation. The responses were classified into three categories:

- a) Recognition of light in space. E.g. "There is in the air... to the wall... could not always see".
- b) Focus on the bright spot on the wall. E.g. "The round mark made on the wall", "There... on the white wall".
- c) Focus exclusively on the light sources. E.g. "The light is the torch you hold".

The table shows the frequencies of responses of children to four tasks

**Table. The frequencies of responses.**

	Task 1	Task 2	Task 3	Task 4
Light as entity in space	7	10	15	19
Light as sensitive effects	43	56	35	50
Focus on the light sources	46	30	46	27

**DISCUSSION**

The analysis of the responses of the children showed the difficulties of 10-11 years old students. Based on these difficulties we formulate categories of representations of subjects on the concept of light. The results obtained in the first three tasks indicate that light is associated with light sources. This corresponds to a common social understanding centered on perceptual aspects. The focus on light sources and/or effects is an obstacle to a design of light as entity in the space between a source and a reflective surface.

The results obtained in the fourth tasks confirm the results obtained in the previous research (Ravanis, 2012; Grigorovitch, 2014). The light remains, for children, strictly linked to the light sources with the exception of the circumstances where it produces intense bright spots, as for example, in the situation where we used a powerful flashlight. The essential obstacle to the age of 10-11 relates to the difficulty of that light and light sources are entities not having the same status. This raises several important issues for the teaching plan of

optical phenomena in the primary school, since the change of primitive conceptions of the student may occur spontaneously. But the clear knowledge of different types of mental representations allows the construction of didactic procedures which would facilitate the transition to the new representations, compatible with the scientific model of the school geometric optics.

Indeed, if light is strictly attached to the light sources, it is impossible to understand any problem pertaining to phenomena involving spread straight light in all directions like, for example, the formation of shadows, the phenomena of diffusion, the formation of images by mirrors or lenses (Rice & Feher, 1987; Resta-Schweitzer & Weil-Barais, 2007; Gallegos-Cázares, Flores-Camacho & Calderón-Canales, 2009). Therefore, the recognition of the light as a separate entity from the source is a prerequisite for any educational activity for teaching about the concept of light. So, the questions raised by the researchers are related to the possibility of developing innovative teaching interventions based at the representations that students form regarding the light concept.

**REFERENCES**

1. Andersson, B., & Kärrqvist, C. (1983). How Swedish pupils aged 12-15 years understand light and its properties. *European Journal of Science Education*, 5(4), 387-402.
2. Castro, D. (2013). Light mental representations of 11-12 year old students. *Journal of Social Science Research*, 1(2), 35-39.
3. Castro, D., & Rodriguez, J. (2014). 8-9 year old pupils' mental representations of light: teaching perspectives. *Journal of Advances in Natural Sciences*, 2(1), 40-44.
4. Driver, R., Guesne, E., & Tiberghien, A. (1985). *Children's ideas in science*. Philadelphia: Open University Press.
5. Driver, R., Squires, A., Rushworth, P., & Wood-Robinson, V. (1994). *Making sense of secondary science research into children's ideas*. London & New York: Routledge.
6. Dumas Carré, A. Weil-Barais, A. Ravanis, K., & Shourcheg, F. (2003). Interactions maître-élèves en cours d'activités scientifiques à l'école maternelle : approche comparative. *Bulletin de Psychologie*, 56(4), 493-508.
7. Feher, E. & Rice, K. (1988). Shadows and anti - images: children's conceptions of light and vision II. *Science Education*, 72(5), 637-649.
8. Gallegos-Cázares, L., Flores-Camacho, F., & Calderón-Canales, E. (2009). Preschool science learning: The construction of representations and explanations about color, shadows, light and images. *Review of Science, Mathematics and ICT Education*. 3(1), 49-73.
9. Galili, I., & Hazan, A. (2000). Learners' knowledge in optics: interpretation, structure and analysis. *International Journal of Science Education*, 22(1), 57-88.
10. Grigorovitch, A. (2014). 8-9 year old pupils' mental representations of light: teaching perspectives. *Journal of Advances in Natural Sciences*, 1(1), 34-39.
11. Guesne, E. (1984). Children's ideas about light. In E. J. Wenham (ed.), *New Trends in Physics Teaching*. Paris: UNESCO, Vol. IV, 179-192.
12. Guesne, E. (1985). Light. In R. Driver, E. Guesne & A. Tiberghien (eds), *Children's ideas in science*. Philadelphia: Open University Press, 10-32.
13. Langley, D., Ronen, M., & Eylon, B. (1997). Light propagation and visual patterns: preinstruction learners' conceptions, *Journal of Research in Science Teaching*, 34(4), 399-424.
14. Osborne, J., Black, P., Meadows, J., & Smith, M. (1993). Young children's ideas about light and their development. *International Journal of Science Education*, 15(1), 83-93.

15. Ravanis, K. (2012). Représentations des enfants de 10 ans sur le concept de lumière: perspectives piagétienes. Schème - Revista Eletrônica de Psicologia e Epistemologia Genéticas, 4(1), 70-84.
16. Ravanis, K., & Papamichaël, Y. (1995). Procédures didactiques de déstabilisation du système de représentation spontanée des élèves pour la propagation de la lumière. Didaskalia, 7, 43-61.
17. Ravanis, K. Papamichaël, Y., & Koulaidis, V. (2002). Social marking and conceptual change: the conception of light for ten-year old children. Journal of Science Education, 3(1), 15-18.
18. Ravanis, K. Christidou, V., & Hatzinikita, V. (2013). Enhancing conceptual change in preschool children's representations of light: a socio-cognitive approach. Research in Science Education, 43(6), 2257-2276.
19. Ravanis, K., & Boilevin, J.-M. (2009). A comparative approach to the representation of light for five-, eight- and ten-year-old children: educational perspectives. Journal of Baltic Science Education, 8(3), 182-190.
20. Resta-Schweitzer, M., & Weil-Barais, A. (2007). Éducation scientifique et développement intellectuel du jeune enfant. Review of Science, Mathematics & ICT Education, 1(1), 63-82.
21. Rice, K. & Feher, E. (1987). Pinholes and images: Children's conceptions of light and vision. Science Education, 7, 629-639.
22. Selley, N. J. (1996) Children's ideas on light and vision. International Journal of Science Education, 18, 713-723.
23. Stead, B., & Osborne, R. (1980). Exploring student's concepts of light. Australian Science Teacher Journal, 26(3), 84-90.
24. Tiberghien, A., Delacote, G., Ghiglione, R., & Matalon, B. (1980). Conceptions de la lumière chez l'enfant de 10 - 12 ans. Revue Française de Pédagogie, 50, 24-41.