International Journal of Eurasia Social Sciences
Vol: 10, Issue: 37, pp. (890-898).

Research Article

Received: 27.05.2019 *Accepted: 21.09.2019*

ap

DETERMINATION OF SCIENCE TEACHER CANDIDATES' KNOWLEDGE AND SKILL LEVELS ABOUT COLOR ALGEBRA AND COLORED SHADOWS[1]

Süleyman AYDIN
Asst. Prof. Dr, Agri Ibrahim Cecen University, *yupul@hotmail.com*
ORCID:0000-0002-1759-0567

Havva HAFIZOĞLU
Agri Ibrahim Cecen University, *havva.hafizoglu@gmail.com*
ORCID: 0000-0002-6322-2503

ABSTRACT

The aim of this study was to determine the knowledge and skill levels of science teacher candidates on the colored shadow formation and algebra of colors. The sample of the study consisted of randomly selected 10 undergraduate sophomore students registered in the Department of Science Education at the Department of Mathematics and Science Education of Ağrı İbrahim Çeçen University in 2018-2019 academic year. For this purpose, semi-structured interview questions created by the researcher were used to collect data and to determine the knowledge and skill levels of prospective teachers about the formation of colors and colored shadows. The teacher candidates were first asked the semi-structured interview questions about the colour algebra and colored shadows, then they were asked to make experiments about their answers to the questions and finally to make consistent explanations between the answers they gave in the first step and their experiments. The data obtained from this study were analyzed by separating according to the steps of primitive, synthesis and scientific knowledge. According to the results obtained from the research, it was understood that pre-service science teachers have prior knowledge about colors but their knowledge and skill levels related to color algebra and colored shadows were not sufficient. It was determined that the level of knowledge of teacher candidates about the colors was in the synthesis step, but their knowledge about color shadows and color algebra was in the primitive stage. In addition, it was understood that the science teacher candidates' color algebra and color shadows skills were in primitive level. In order to better understand the colors of teachers and academics, students and pre-service teachers, it is recommended to design experiments related to color arithmetic and colored shadows to share these experiments in the classroom, environment, science festivals and various social networks. At the same time, it is recommended to include colored shadows and algebra of colors in the science curriculum.

Keywords: Colour algebra, coloured shadows, science education

[1] This study has been presented as an oral presantation in 3rd International Congress Of Eurasian Social Sciences, 18 - 21 April 2019 Muğla TURKEY.

INTRODUCTION

The fact that science is the basis of all aspects of science and that science applications are the basis of engineering practices have been one of the main reasons that affect the developments of the nations and construct their educational programs according to these developments. The parallelism of developing program paradigms to the developing technology in this respect is an inevitable necessity to lead the development and research discussions (Turkoguz, 2008).

Nearly perfect methods and techniques used by science are common methods and techniques used by developing technology (Çepni, and Ayvacı, 2006). The physics involved in science teaching is the most comprehensive and pioneering discipline that examines and investigates everything that exists in the universe, from the smallest building blocks of the universe to the greatest celestial bodies, systems and all systems, including the formation of the universe. Physics is the most important subject where scientific knowledge can be provided and applied to developing technology with its aspect which includes observational, experimental, conceptual, operational and theoretical steps as equal.

The role of physics education in the development of countries is almost as important as the objectives of achieving the level of civilization of the countries.

Individuals who are educated in physics can contribute much more to the development of their countries and all technological developments in the world than individuals who have received education from other disciplines. Because physics has observational, experimental, conceptual, operational and theoretical steps as cascading or equal, and because of the abstract nature of the concepts (Karakuyu, 2006), understanding of physics courses is more difficult than other subjects.

Classical physics, modern physics, relativity and quantum physics are the main sub-branches of physics in our age, and the geometric optical unit is one of the main sub-branches of classical physics. While the arithmetic of colors and colors within the geometric optics unit is usually a subject that is taught from secondary school, the subject of colored shadows is included in the curriculum of high school and university level in the spiral of physics curriculum (MEB, 2013, 2017).

Besides, the ability to understand, interpret, and create visual information is vital in our era (Avgerinou,2009).The ability to understand, interpret and create visual images is a learned ability, and it is known as visual literacy (VL); (Yeh & Cheng, 2010).

Colour phenomena are usually fascinating. However, it is frequently quite challenging for students to explain such phenomena based on adequate scientific concepts (Haagen-Schützenhöfer, C. (2017a).

Optical phenomena are usually fascinating. At the same time, most learners do not have adequate ideas about the characteristics of the light we are usually surrounded by. Consequently, it is difficult to understand the mechanism underlying colour phenomena (Haagen-Schützenhöfer, C. 2017b).

Understanding of light requires an understanding of the mechanism of vision, which necessarily involves knowledge from other disciplines, such as, biology and chemistry. Moreover, many optical phenomena from everyday life cannot be analyzed without taking into account the medium in which light travels.

A high percentage of students, even at the university level, have however a lot of alternative conceptions about the formation of a shadow and its characteristics, like, its color, shape, orientation and size. In addition, the colored shadows discussed by Hawkins in 1983 (Olivieri, Torosantucci, & Vicentini,1988), appear as a fantasy scenario in the eyes of those who ignore their existence and formation. Research on colored shadows (Feher & Rice, 1992; Olivieri, Torosantucci, & Vicentini, 1988) identified a number of alternative mental models and several alternative conceptions. Similar phenomena do not usually appear in everyday life, and, when students come into contact with them, a kind of cognitive disequilibrium can be induced.

Arithmetic of colors and colored shadows are often used in today's technology and even in social areas. Therefore, in this study, it is aimed to determine the knowledge and skill levels of science teacher candidates about the arithmetic of colors and color shadows.

Theoretical Information

Color according to Newton; the amount of light in the dark (Finlay, 2007). Although this definition is more compatible with the particle structure of light, it is the physical phenomenon that all objects in our environment reflect to us and formed in our minds by the wave structure of light.

The light in some cases shows the wave and in some cases a particle characteristic (Serway, & Beichner, 2011, p.1108). The wave model of electricity and magnetism can explain other properties of light that are known except for the particle property. The quantification model proposed by Einstein acknowledges that the energy of the light wave is contained in energy packets called photons. Thus, energy is said to be quantized (Serway, & Beichner, 2011, p.1107). From these definitions, light can be said to be an electromagnetic wave composed of very small energy packets called photons whose energy is E = hf.

All the objects we see around us are visible because they reflect the light they receive. The rays from the sun are first perceived as white. Some light beams appear when they are absorbed, while others are reflected in color. The color of everything around us varies depending on the absorption and reflection of the color lights. The color differences that come to our eyes from the objects around us are also due to this. The three main light colors we see in all objects are blue, red and green.

Some objects reflect all the light they receive and are perceived as the sum of the three colors, as white. Some objects absorb the entire light and the object without light is perceived as black. Some objects reflect a part of the three light colors and are perceived in color. The three primary colors of the light colors, when combined with two pairs, are lighter, and the other three colors are more bright and with the intermingling of the three, they reproduce the white color, ie the light itself (Feher & Rice, 1992; Polat, 2012).

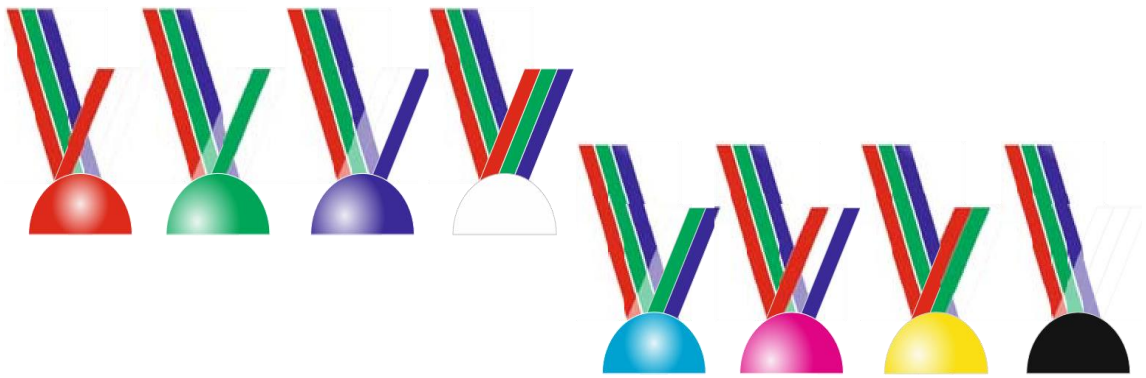

Figure 1: Absorption and reflection of light

In the theory of Yong-Helmholtz, all colors are experimentally composed of three different colors. Today, working principles of all imaging systems from television to computer technology are based on light color theory, also known as RGB (Red, Green, Blue). When the red, green and dark blue light sources are overlaid by reflection; The mixture of blue and green rays make up the cyan blue, the mixture of red and dark blue rays make up the magenta, the mixture of red and green rays creates a yellow color, a mixture of all three colors creates white light (Seylan, 2005).

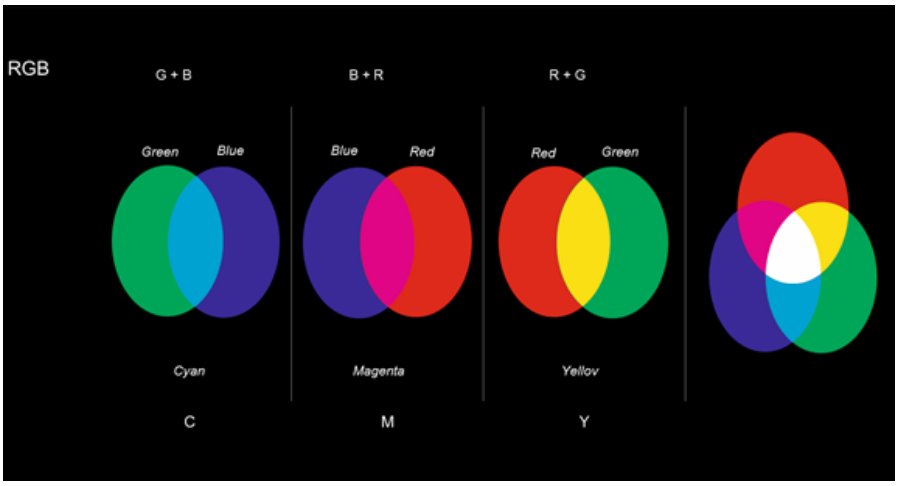

Figure 2: Additive color mixture (Parker, 2012)

Primary colors are colors that cannot be produced with a mixture of other colors.

Intermediate colors are the colors that come up with a mixture of primary colors.

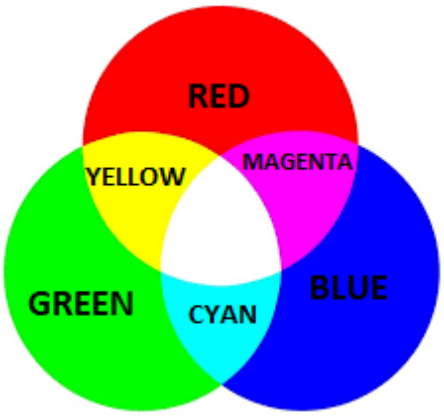

Figure 3*:* Main and intermediate colors

Shadow, Shadow Formation and Colorful Shadows

The light generates shadow when it is blocked by an object (Feher, & Rice, 1988). When colored lights are dropped over colored and translucent objects, they create colored shadows (Olivieri, et al, 1988).

METHOD

Qualitative research method was used in this study, which was designed to determine the knowledge and skill levels of prospective science teachers about arithmetic of colors and colored shadows.

It is possible to define qualitative research as a research which uses qualitative information collection methods such as observation, interview and document analysis, and a qualitative process for realizing perceptions and events in a realistic and holistic way in the natural environment (Yıldırım, 1999).

Sample

The sample of the study was consisted of 10 undergraduate students randomly selected from sophomore students of the Department of Mathematics and Science Education of Ağrı İbrahim Çeçen University in 2018-2019 academic year.

Data Collection Tool

In this study, which was designed to determine teacher candidates' knowledge and skill levels about the formation of colors and colored shadows, semi-structured interview questions created by the researcher were used to collect data.

The semi-structured interview questions consisting of five questions have been examined by academicians who were experts in both physics and science education and thus, the reliability and validity of the test is ensured.

Data Analysis

Teacher candidates were first asked about semi-structured interview questions about the arithmetic of colors and colored shadows, then they were asked to make experiments about their answers to the questions and finally to make consistent explanations between the answers given in the first step and their experiments.

The knowledge and skill levels of those who could not answer correctly, could not make the experiment and could not make a consistent explanations were evaluated as primitive steps. The level of knowledge of the science Teacher candidates who answered the question correctly but could not make the experiment and had a consistent explanation was evaluated as the synthesis step and the skill level was evaluated as a primitive step. The level of knowledge and skill of those who answered correctly, did the experiment but could not make a consistent explanation was evaluated as the synthesis step. The level of knowledge and skill of those who gave the correct answer, who made the experiment and who made a consistent explanation between the answer and the experiment were evaluated as scientific steps.

FINDINGS

1. What are the main colors? Describe by showing.

All teacher candidates were able to rank the primary colors green, red and blue. They were able to correctly focus the spotlights with the main color to the same point and were able to explain that the primary colors were colors that could not be produced with a mixture of other colors.

2. What are intermediate colors? Describe the result by designing an experiment to obtain intermediate colors.

Five of the pre-service science teachers could not answer the intermediate colors correctly, but they could design the intermediate colors and create intermediate colors however, they were able to partially express the correct explanation of the formation of intermediate colors as " Intermediate colors are the colors that emerge with the mixture of primary colors. ".

The remaining five of the sample of science teacher candidates were not able to define the intermediate colors and could not design the experiment related to the formation of intermediate colors andthey could not explain the formation of intermediate colors correctly.

3. What is shadow? Can a colored shadow be created? Design the experiment of colored shadow and describe the formationof colored shadow scientifically.

Six of the pre-service science teachers were able to make the right definition of shadow and only one Teacher candidate could give the correct answer about the colored shadow, but this teacher candidate could not design the experiment related to this answer and could not explain the formation scientifically.

4. Can the colored shadows be formed by sunlight? Design an experiment and explain the result.

Six of the pre-service science teachers were able to indicate that they could not create a colored shadow with sunlight, they succeeded in doing experiments on it however, they could not make a consistent explanation between the answer and the experiment. The answers of the four other prospective teachers and their experiments are already inconsistent and far from scientific knowledge.

5. If a red and a green light are reflected to the same spot under white light, what color will occur at the point where they overlap? Explain by experiment.

Nine of the prospective science teachers were able to give the right answer to this question related to the formation of intermediate colors with primary colors, they could design the experiment but could not make a consistent explanation between them.

RESULTS AND DISCUSSIONS

There are researches implicate that the students have misconceptions on colur and vision or colored shadows. (Mota, & dos Santos, 2018; Naranjo Correa et al., 2016; Martinez-Borreguero, et al., 2013). The main idea was to create a learning environment that makes students familiar with the experience of observing “differently coloured objects” illuminated by differently coloured light (Haagen-Schützenhöfer, 2017).

From the results of the research it was understood that pre-service science teachers had prior knowledge about colors however, tehir knowledge and skill levels related to color arithmetic and color shadows are not sufficient. It was determined that the level of knowledge of science teacher candidates about the colors was in the synthesis level, but their knowledge about color shadows and color arithmetic was in the primitive stage. In addition, it was understood that science teacher candidates' skills related to color arithmetic and colored shadows were at a primitive level.

Most colleges and universities in the United States expect undergraduate students to take science courses at the introductory level where the mathematical rigor is kept to a minimum. Sometimes, these courses are specifically designed for non-science students (Mian, Marx, & Pagonis, 2008). In Turkey we have also tought the same. Students should take the courses, espacially physics courses with minimum mathematics. So they have many misconceptions and can not count the result color of the object without taking into account the formulation or precedural learning.

It is suggested that teachers and academics, students and prospective teachers should design experiments on color arithmetic and colored shadows in order to better understand the colors, share these experiments in the classroom environment, science festivals and various social networks. At the same time, it is suggested that colored shadows and arithmetic of colors should be given in science curriculum starting from the elementary school.

REFERENCES

Avgerinou, M. D. (2009). Re-viewing visual literacy in the “bain d’images” era. *TechTrends*, *53*(2), 28-34.

Chen, M. S. (2009). Shadows: Young Taiwanese children’s views and understanding. *International Journal of Science Education, 32(3)*, 59-79.

Çepni, S. ve Ayvacı, H.Ş. (2006). *Laboratuvar destekli fen ve teknoloji öğretimi*. S. Çepni (Ed.). Kuramdan uygulamaya fen ve teknoloji öğretimi içinde (s:158- 188). Ankara: Pegema yayıncılık, 5. Baskı.

Feher, E., & Rice, K. (1988). Shadows and anti-images: Children’s’ conceptions of light and vision II. *Science Education, 72(5)*, 637-649.

Feher, E., & Rice, K. (1992). Children’s conceptions of color. *Journal of Research in Science Education*, *29(5)*, 505-520.

Finlay, V. (2007). *Renkler*. Çev., Kudret Emiroğlu. Ankara: Dost Yayınevi.

Haagen-Schützenhöfer, C. (2017a). A Hands-on to Teach Colour Perception: The Colour Vision Tube. *Scientia in Educatione*, *8*. p. 191–198.

Haagen-Schützenhöfer, C. (2017b). Students’ conceptions on white light and implications for teaching and learning about colour. *Physics Education*, *52*(4), 044003.

Karakuyu, Y. (2006). *Lise ve dengi okul öğrencilerinin ısı ve sıcaklık öğreniminde karşılaştığı kavram yanılgıları*. Doctoral dissertation, Süleyman Demirel Üniversitesi Fen Bilimleri Enstitüsü.

Martinez-Borreguero, G., Pérez-Rodríguez, Á. L., Suero-López, M. I., & Pardo-Fernández, P. J. (2013). Detection of misconceptions about colour and an experimentally tested proposal to combat them. *International Journal of Science Education*, *35*(8), 1299-1324.

MoNE. (2013). Fen Bilimleri Dersi Öğretim Programı (İlkokul ve Ortaokul 3, 4, 5, 6, 7 ve 8. Sınıflar). Ankara. Milli Eğitim Bakanlığı.

MoNE. (2017). Fen Bilimleri Dersi Öğretim Programı (İlkokul ve Ortaokul 3, 4, 5, 6, 7 ve 8. Sınıflar). Ankara. Milli Eğitim Bakanlığı.

Mian, S. M., Marx, J. D., & Pagonis, V. (2008). Bringing the" Two Cultures" Together through" A World of Light and Color". In *Forum on Public Policy Online* (Vol. 2008, No. 2, p. n2). Oxford Round Table. 406 West Florida Avenue, Urbana, IL 61801.

Mota, A. R. L., & dos Santos, J. B. L. (2018). Investigating Students' Conceptual Change About Colour in an Innovative Research-Based Teaching Sequence. *Investigações em Ensino de Ciências*, *23*(1).

Naranjo Correa, F. L., Martinez Borreguero, G., Perez Rodriguez, A. L., Suero Lopez, M. I., & Pardo Fernandez, P. J. (2016). A new online tool to detect color misconceptions. *Color Research & Application*, *41*(3), 325-329.

Newton, I. (1966). Opticks, or a Treatise of the Reflexions, Refractions, Inflexions and (Colours of Light. London 1704); Opera quae exstant omnis, Tom IV, London 1782; Optics. *Reprint Bruxells*.

Olivieri, G., Torosantucci, G., & Vicentini∗, M. (1988). Coloured shadows. *International Journal of Science Education*, *10*(5), 561-569.

Polat, H. H. (2012). Renk Teorisi ve Temel Yanılgılar. *Selçuk Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, (28), 165-173.

Serway, R. A., & Beichner, R. J. (2011). Fen ve Mühendislik İçin Fizik-2, Beşinci Baskıdan Çeviri, Çev. Ed. *Kemal Çolakoğlu. Ankara: Palme Yayıncılık*.

Seylan, Ali (2005). *Temel Tasarım.* Ankara: M-Kitap Yayınevi.

Türkoğuz, S. (2008). *Görsel sanat etkinlikleriyle bütünleştirilmiş ilköğretim fen ve teknoloji öğretimi* (Doctoral dissertation, DEÜ Eğitim Bilimleri Enstitüsü).

Yeh, H. T., & Cheng, Y. C. (2010). The influence of the instruction of visual design principles on improving pre-service teachers' visual literacy. *Computers & Education*, *54*(1), 244-252.

Yıldırım, A. (1999). Nitel araştırma yöntemlerinin temel özellikleri ve eğitim araştırmalarındaki yeri ve önemi. *Education and Science*, *23*(112).