

# Discovering the Properties of Light through the Ray of Light Learning in the Reggio Emilia Approach in Early Childhood Education

Sherin Maudri Asy'ari<sup>1</sup>, Yeni Rachmawati<sup>2</sup>

<sup>1</sup> Early Childhood Education, School of Postgraduate, Indonesia University of Education

<sup>2</sup> Early Childhood Education, School of Postgraduate, Indonesia University of Education  
Email: [maudrisherin@upi.edu](mailto:maudrisherin@upi.edu)

## ABSTRACT

This research is driven by teachers' understanding that optics learning is a difficult subject to be introduced to early childhood students. The reasons why it has not been delivered in early childhood education are the limited sources of teaching materials, the lack of understanding in the importance of learning the subject, and the lack of knowledge about how to orient learning activities according to children's ages. Other factors causing the learning of the subject has not been well-implemented are the lack of supporting facilities and infrastructures, limited innovation, motivation, and creativity of teachers in implementing learning that utilizes light and the surrounding environment. The purpose of this study is to find out learning activities that can be carried out to investigate the properties of light through the ray of light atelier in the Reggio Emilia approach in early childhood education. This study employed a qualitative research model that produces information in the form of descriptive data records by providing clear and systematic descriptions. The data collection techniques used were literature studies and structured interviews. The results indicated that learning the properties of light is not a difficult material for children if carried out appropriate to the children's developmental stage by providing new, interesting and fun learning experiences for children.

**Keywords:** *The Properties of Light, the Ray of Light Learning, the Reggio Emilia approach*

## 1. INTRODUCTION

Reggio Emilia is a small town in northern Italy. The figure who plays the role in expressing ideas regarding the Reggio Emilia learning approach is Loris Malaguzzi [1]. The Reggio Emilia Approach (REA) develops learning design methods and principles that focus on children's development [2]. This approach believes that every child has great potential. Children like to explore, actively work, adapt easily and enjoy interacting with friends, parents, teachers and surrounding environments. The Reggio Emilia approach understands that every child is an active, expressive, communicative learner, and has his/her own characteristics of "hundred languages" [2]. The term "hundred languages" means that children are gifts from God who have potential and have their own way of learning, expressing opinions, socializing, and playing, influenced by the social and cultural diversity backgrounds of the children [3], [4].

The Reggio Emilia approach is developed as an education system that helps improve children's problem-solving skills by offering various learning opportunities through project-based education systems [5]. Children are encouraged and stimulated to be able to explore the environments and express themselves [2]. The environments, teachers and parents are the main pillars in the implementation of the learning process. The importance of creating learning conditions that encourage and facilitate children makes the Reggio Emilia approach-based activities that can optimize children's participation in exploring the surrounding environment as the main learning resource. The term "the environment as the third teacher" means that environments hold a lot of knowledge values that can support the learning process to form knowledge in children [6], [7].

As we all know that the environment closest to children is the natural environment, such as the sun which is the main light source that plays important roles

in the life of all living things. In the field of education, sunlight provides various learning concepts that can be developed to be introduced to children from an early age [8]. Learning the properties of light can certainly provide new, interesting and fun learning experiences for children, including the nature of light that can propagate, can penetrate clear objects, can be reflected, can be refracted, and can be dispersed [9]. However, utilizing sunlight as learning materials is considered a difficult lesson to be introduced to children from an early age. In fact, through appropriate and fun delivery, as well as by learning in accordance with the understanding of children's developmental stage, they will be able to understand the concept of light properly according to their stage of development. The learning of optics about the properties of light has been widely conducted. However, it is not for early-age children, but for primary and secondary school children [10], [11], [9], [12], [13], [14], [15], [16], [17]. The reasons why the learning of optics has not been conducted in early childhood education are due to the limited sources of teaching materials, the lack of understanding in the importance of learning the subject, and the limited knowledge about how to orient learning activities according to the ages of children [18]. Other factors related to that are the facilities and infrastructures that are less supportive and the limited innovation, motivation, and creativity of teachers in implementing learning that utilizes light and surrounding environments [19].

Loriz Malagzzi introduced the ray of light learning center which is one of his ideas in the Reggio Emilia approach [3]. The ray of light atelier is a place designed to facilitate children to be able to explore, experiment, and play using light as a learning resource. Media that can be used in the ray of light activities include table lamps, mirrors tables, used bottles, OHPs, candles, LCD projectors, white screens, black screens, glasses, magnifying glasses, flashlights, computers, and CDs [20].

The Ray of light learning activities can be carried out indoors outdoors. The spaces for the ray of light indoor activities are arranged with minimal lighting and dark walls, it is done in order to stimulate children's imagination when using various media. While the activities in the outdoor spaces require bright sunlight and sunny weather so that children can start learning activities well.

This paper will discuss optics learning activities that can be done to introduce the concept of the properties of light to early childhood education through the ray of light atelier in the Reggio Emilia approach.

## **2. THEORETICAL FRAMEWORK**

### ***2.1. The Reggio Emilia Approach***

The Reggio Emilia approach develops several methods and learning design principles focusing on child

development through providing encouragement and stimulation to children to be able to explore the environments and express themselves [2]. The education is focused on cooperation between each child and his/her family, environment, school, and community [21]. The term "the environment as the third teacher" means that the environment has an important role in building knowledge, where children can explore, experiment, play, and learn [6], [7].

In the arrangement of classrooms, indoor and outdoor classes are designed to be interconnected to support learning activities in schools that can encourage and foster choice, independence, curiosity, and problem solving. The classroom is also arranged in detail by taking into account the aesthetic dimension providing an optimal and multi-sensory learning environment with the purpose that children can gain understanding of themselves regarding to their environment [7]. The classroom also serves as a meeting place between children and the teacher to plan and discuss learning activities to be carried out. It is a place where children have the right to be able to express their ideas in making decisions in working on projects [3].

Study rooms in the Reggio Emilia approach are known as ateliers or art studios. Atelier provides various resources and tools to support project work and research during learning activities [7]. The atelierista is a teacher who is trained in the field of visual arts as a guide for discussion and collaboration with teachers and children [22].

Teachers acts as study partners, guides and facilitators. Teachers also have three main functions namely having roles and responsibilities in providing visual recordings of children's work, assisting in developing or expanding project ideas, and providing reports to parents about the results of children's development and learning with the aim that parents can actively participate in the project activities [7].

### ***2.2. Theory of Light***

Light is energy in the form of electromagnetic waves that can be seen by eyes. With light, living things can see objects around them [9]. Light is an important form of energy for the needs of all living things, without light it is certain that life on earth will be destroyed [23]. The objects that can produce light include the sun, lamps, fire, and candles [24].

### ***2.3. Properties of Light***

Light has the following properties:

#### ***a. Light Propagates in Straight Lines***

Light can travel in straight lines when it passes through an intermediate medium. Examples in everyday

life that show that light can propagate in straight lines include the entry of sunlight into the room through narrow cracks in the walls and through a dark room making straight white lines appear, the light beam of a flashlight that goes straight, the light beam of a projector that shines to the screen, the red light of a laser that can travel long distances, and the light from car headlights at night [25].

*b. Light Passes through Transparent Objects*

Light can pass through transparent objects. The examples of transparent objects are glass, plastic, crystal, and water. Transparent objects can transmit light through the objects making it like light passes through the objects. However, light cannot pass through dark objects because light will be absorbed by the objects. The examples of dark objects include walls, wood, black objects, and dark cloth [26].

*c. Light Can be Reflected*

Reflection of light is the process of re-emitting light from the surface of an object. "*Reflect means catching the light and making a reflection come out, catching the energy and reflecting it, like mirrors making light rebound.*" [20]. The direction of reflected light rays can be divided into two, called regular reflection and diffuse reflection. Light can be reflected regularly when it hits an object that has a flat or even and shiny surface, so the resulting light reflection will be parallel and regular. For example, if light hits a flat mirror, the light will be reflected by having the same angle between the angle of incidence and the angle of reflection. As for the direction of diffuse or diffuse reflection, light hitting objects with uneven, rough and wavy surfaces will produce diffuse or irregular light reflections such as when light strikes the surface of a convex mirror and a concave mirror.

*d. Light Can be Refracted*

Refraction is the bending of a beam of light that propagates through a medium with a different density [27]. As an example, the refraction of light can be seen when a piece of wood is placed in a glass cup filled with water, the wood looks like broken, but it is actually not. Other examples are a swimming pool that looks shallow, and an asphalt road that looks watery during the day, known as mirage.

*e. Light Can be Dispersed*

Dispersion is a phenomenon of the separation of white light into its spectrum of colours. These lights have different wavelengths. An example of light dispersion is in the process of a rainbow, when white

light splits into various colors that are red, orange, yellow, green, blue, indigo and purple [24].

**2.4. *The Ray of Light Atelier in the Reggio Emilia Approach***

The Ray of Light atelier or light art studio is a room that provides various media and tools to support children's project and research learning activities, where children can play and experiment using light [7]. Children are given the freedom to determine and choose the tools and materials to be used in exploration and experiment activities. The Ray of Light activities can be done indoors and outdoors. The spaces for indoor activities are arranged with minimal lighting and dark walls, it is done in order to stimulate children's imagination when using various media. While the use of outdoor spaces requires bright sunlight and favorable weather in order that children can start learning activities well [20].

**2.5. *The use of the Ray of Light Media***

Media that can be used in the Ray of Light activities include plain cloth, blackboards, mirror tables, table lamps, OHPs (Overhead Projectors), LCD projectors, flashlights, computers, white and black screens, shooting lamps, light screens, and used bottles [20], [28], [29].

**3. RESEARCH METHOD**

This study used a qualitative research model. Qualitative research produces information in the form of descriptive data records by providing clear, systematic, critical, objective, and analytical descriptions and explanations [30], [31]. Qualitative research is also designed to provide an overview based on existing data and supported by real experience [32].

The data collection technique was done by conducting literature studies and structured interviews. In research, literature studies are used to provide an overview of things that have not been known and are known about a certain phenomenon. Search and review of literature can be done during the process of data collection and data analysis [33]. Literature review is carried out by collecting data such as books, journals, reports, notes, literatures, newspapers, etc according to the research topic [34], [35]. Speaking about data, the data used in this paper are more than 50 literatures. The steps taken in the literature study include preparing data, compiling data, collecting data, classifying data and describing data [36], [33].

In obtaining qualitative data, researchers use interview techniques to explore thorough information from diverse sources in order to collect data from various activities carried out in optics learning [37]. Interviews are conducted with the aim of obtaining

information, perceptions, conceptions, ideas, hopes, demands and concerns from the interviewees with reference to the research topic [38]. In addition, the type of interview conducted by the researcher was structured interviews. In managing the interview, the researcher first prepares and make detailed interview-guidelines. The researcher makes a list of questions, and the questions are asked when the interview begin [39]. The Interviews were done by inquiring 11 teachers from several kindergartens in West Java in February 2021.

The data analysis technique included three parts that are carried out at the same time covering data reduction, data presentation, and drawing conclusions. The data reduction was carried out as a process of collecting data, making summaries, as well as directing and selecting data, in order to produce verifiable conclusions. The triangulation of data presentation is a technique used to enrich and check the validity of the data including comparing the data that have been obtained from the results of interviews with the data obtained from the review of literature [40], [41]. The next part was to draw conclusions and verifications. The conclusion was obtained from the results of the data that has been obtained by the researcher and has undergone several processes of selecting and checking the validity of the data.

#### **4. DISCUSSION**

Environments provide a vast array of values that can support the learning process in order to form children' knowledge [6]. In the field of education, sunlight presents various learning concepts that can be developed to be introduced to children from an early age [8]. Learning the properties of light can certainly provide new, interesting and fun learning experiences for children, such as the properties of light that can propagate in straight lines, can penetrate transparent objects, can be reflected, can be refracted, and can be dispersed [9]. Through relevant and fun delivery and by learning in accordance with the understanding of children's development, children will be satisfactorily able to understand the concept of light according to their stage of development.

The Ray of Light is one of learning activities in the Reggio Emilia approach [3]. The Ray of Light atelier or light art studio is a room that provides various media and tools to support children's project and research learning activities, where they can play and experiment using light [7]. Children are given the freedom to determine and choose the tools and materials to be used in exploration and experiment activities. Some games that utilize light are also obtained from the results of interviews with teachers.

Furthermore, the examples of games that can be carried out in the Ray of Light atelier to figure out the properties of light are as follows:

##### **4.1. Light Propagates in Straight Lines**

- a. Flashlight game, this game can be done to introduce the characteristic of light that can propagate in straight lines. The game is carried out by using a flashlight or a laser. Children experiment by emitting beams of a flashlight or a laser onto a blackboard or other object by recognizing the concept of near and far distances, also straight, vertical, horizontal, and diagonal positions [42].
- b. Catch the light game, this game is a game of capturing light emitted from a flashlight or a laser. Some children who are inside the cloth try to catch the light emitted by the teacher from outside the cloth [20].
- c. Tricks of the light game, this game uses OHP (Over Head Projector). Several colored plastic bottles placed on an OHP produce beams of light projected onto the screen. This game can explain the concepts of shapes, shadows, colors and numbers to children [20].
- d. Game of light riddles, this game can use bottle caps or various shapes of objects placed on an OHP. These objects produce a variety of different shapes of shadows. Through this activity, children can imagine and explore the shape of shadows [20].
- e. Symmetry game, this game can introduce the concept of balance between elements (symmetrical) to children. The children can make bridges from light reflections of objects arranged on an OHP [20].
- f. Shadow detective game, this game was obtained from the results of interviews at Al-Ishlah Kindergarten, Majalaya. The child measures the image of him/herself and draws the image of the object. The activity of measuring self-image is done by one of the children standing in the sun and another child observing the shadow, measuring, and comparing the height of the image with the child's actual height. The next activity is drawing a shadow, the child is asked to place one of the objects in the sun, then put a paper under the shadow and the child traces the shadow on the paper [43].
- g. Game using LCD projector and computer. The first activity is painting on walls. This game requires an LCD projector, computer, paint, large paper or cloth, brushes, and markers. The image from the computer is transmitted using the LCD projector onto the paper wall and the child paints freely. The second activity is painting on clothes, the image projected from the LCD projector will be directed to the clothes worn by the child, and the child paints on his clothes using the equipment provided [42].

#### **4.2. Light Can Pass through Transparent Objects**

- a. Table light game, the use of table lamps can introduce the property of light that can pass through transparent objects. In the use of a table lamp, the bottom of the table is mounted with a flat lamp and then layered with glass. The flat lamp can penetrate glass which is a transparent object. Through the use of a table lamp, children can observe the patterns of silhouettes and shadows produced from various forms of objects [42].
- b. Window art games, children are given the opportunity to be creative in painting windows with various colors according to their wishes. Then during the day, sunlight that enters through the window emits a variety of interesting colors, just like the paintings made by the children. Through this game, children will learn the aesthetics of colors [3].
- c. A dance of reflection game, sunlight that enters the room through the window can be used as a medium for children to be creative. The children move their hands and other body parts such as butterflies, birds, and dragonflies. The light from the window hitting the children's body produces unique and interesting shadow shapes [20].
- d. Magnifying glass game, this learning activity was conducted at Al-Ishlah Kindergarten, Majalaya. Based on the results of the interview, the game is played by using a magnifying glass. The child together with the teacher put a piece of paper and a magnifying glass in the sun, then they together observe the paper until it produces sparks that gradually burn the paper [44].

#### **4.3. Light Can be Reflected**

- a. Mirror table game, light that hit by the mirror experiences reflection. The mirror table is used to introduce the concept of reflection and counting. Activities that can be done include tracing, drawing, and other writing exercises [42].
- b. Path of light game, this game can be done outdoors by utilizing sunlight and mirrors. The light is reflected on the mirror held by a child and is transmitted to an object the child wants. The child then pinpoints light identity, such as horizontal light lines, light intensity, and light paths formed [20].
- c. The tower of light game, it is a project-based learning activity in which children make a light tower equipped with wheels at the bottom of the tower, the wheels function as propulsion in order that the tower can move from place to place to get the right and appropriate light intensity. In the light tower section, several objects that can capture and reflect light are arranged, such as glass, mirrors,

CDs and colored transparent plastics. The objects are arranged in order that children can learn the concept of reflection of light from one object to another. The trajectory of the reflected light beam encourages children to know the accuracy of elements such as the angle and the light intensity related to the reflection phenomenon [20].

#### **4.4. Light Can be Refracted**

- a. Refraction candle experiment, it can be done by preparing a glass tube filled with water and a small candle that has been lit, placing the candle behind the glass tube that has been filled with water until it is full, then observing from the front of the tube with a position from below. From the observation, the candle reflection will seem like above the water surface in an inverted position [45].
- b. Bent pencil experiment, this experiment can be carried out by using a transparent glass filled with water and a pencil, placing the pencil in the glass that has been filled with water, then observing from the front of the glass. From the observation, it will appear that the pencil shadow seems bent and looks larger [45].

#### **4.5. Light Can be Dispersed**

- a. Colorful light of rainbow, this experiment is done by employing plastics that have a variety of colors, then the plastics are arranged and stacked on top of each other. The reflection of light that touches the colors of the plastic will mix and produce a variety of colors. "*rainbow is the colour of light*" [20].
- b. Rainbow cup experiment, it is a simple experiment by making a rainbow from the refraction of light that occurs between sunlight and water in a transparent plastic cup. A glass containing three-fourths of water and a piece of white paper is placed in a position exposed to sunlight. The glass is directly positioned on the paper in order that sunlight can pass through the water in the glass. Later, light waves are formed with a set of colors that are visible on the paper [46].
- c. Rainbow experiment, this experiment of making rainbows uses a flat mirror, a container filled with water, and a piece of white paper. The mirror is placed in a container filled with water and faces the direction of the sun's rays. Then, the dispersion of light is directed from the mirror reflection to the white paper that has been provided [46].

### **5. CONCLUSION**

Light plays an important role in the life of all living things. Light holds many learning concepts that can be delivered in early childhood education. Learning the

properties of light is not a difficult material for children to learn if the delivery method is carried out according to the children's developmental stage by providing new, interesting and fun learning experiences for children. The environment where children can explore, experiment, play, and learn has an important role in building knowledge. The ray of light atelier is a place that provides various media and tools to support children's project learning and research activities, where they can play and experiment with light. In that place, they are given the freedom to determine and choose the tools and materials that will be used in exploration and experiment activities to perceive the properties of light. The media used include materials that are easily available, for example, used bottles, mirrors, glasses, flashlights, lamps, water, leaves, lasers, projectors, cloth, paper, color paints, CDs, and so on. Through fun learning and concern with children's development, the subject related to the properties of light can be conveyed easily to early-age children.

### ACKNOWLEDGMENT

The researcher would like to express the greatest gratitude to all those who have assisted and supported the research writing process, the postgraduate lecturers of Early Childhood Education and Indonesia University of Education.

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