

# Experiments on the nature of how multiple images form in a plane mirror



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(Received 23 may 2010; accepted 10 September 2010)

## Abstract

This project will attempt to discover, by means of a series of experiments that explore the relationships between wholes, parts, planes and multiple images, the nature of how images are formed in a plane mirror. The aim of the activity is to give elementary school students the opportunity to accurately understand the definitions of a plane mirror as well as to make use of an everyday situation to make correct predictions about how many images a mirror can produce. The activity can be used as introductory experiments on the subject of images seen through a mirror which can be completed inside one classroom period.

**Keywords:** Plane mirror, Multiple images, Science activities.

## Resumen

Este proyecto se intentará descubrir, a través de una serie de experimentos que exploran las relaciones entre conjuntos, piezas, planos e imágenes múltiples, la naturaleza de cómo se forman las imágenes en un espejo plano. El objetivo de la actividad es dar a los alumnos de primaria la oportunidad de comprender con precisión las definiciones de un espejo plano, así como hacer uso de una situación cotidiana para hacer predicciones correctas sobre el número de imágenes de un espejo puede producir. La actividad se puede utilizar como experimentos de introducción sobre el tema de imágenes que se ven a través de un espejo que puede ser completado dentro de un período de clase.

**Palabras clave:** Espejo plano, imágenes múltiples, actividades de ciencia.

**PACS:** 01.50.My, 01.40.gb, 01.40.E-

**ISSN 1870-9095**

## I. INTRODUCTION

As we browse through a shopping center, looking at the decorative mirrors on the stands, made up of little pieces put together, we can sometimes see only one and sometimes more than one image of ourselves. Since characteristics of imaging in a plane mirror are always the same, how is this change explained?

Student understanding of image formation in plane mirrors and its properties have been studied extensively by the researchers [e.g., 1, 2, 3]. These studies revealed that instructed or not students from different grades have varying difficulties and misconceptions with image formation in plane mirrors and image properties. The studies conducted on students' understanding of image formation with plane mirrors utilized single mirror and cornered mirror systems. In addition, studies such as explaining the change in the number of images with angle in hinged mirror systems exist [4, 5, 6]. The current study investigates the number and properties of images in mirrors when they are coplanar sharing the same plane while they are being placed apart from each other.

A series of activities on imaging in coplanar mirrors designed and described below provides an answer to this question and clarifies this every-day perplexity. The activities also present an opportunity to explain the nature of the plane mirror and the reasons we sometimes see multiple images in a mirror.

## II. ACTIVITY 1

In the first activity (See Figure 1), the image of a doll placed in front of a mirror is observed. In this situation, only one image is seen in the plane mirror.

## III. ACTIVITY 2

The second activity is carried out in four stages. In the first stage, the same mirror used in Activity 1 is divided into four equal pieces with a blackboard marker (See Figure 2). In the second stage, the same mirror is now cut into four equal

pieces (See Figure 3) and in the third; these pieces are arranged on a plane, each 1 cm apart from each other (See Figure 4). In the fourth stage of the activity, the space between the mirrors is increased to 3 cm each (See Figure 5). There is only one image in the plane mirror in each of these stages. Dividing the mirror into 4 equal parts and changing the distance between the parts has not made a difference in the number of images seen.



**FIGURE 1.** The image of a doll placed in front of a mirror.



**FIGURE 2.** The mirror is divided into four equal pieces with a blackboard marker.



**FIGURE 3.** The mirror is cut into four equal pieces.



**FIGURE 4.** The pieces of the mirror are arranged on a plane, each 1cm apart from each other.



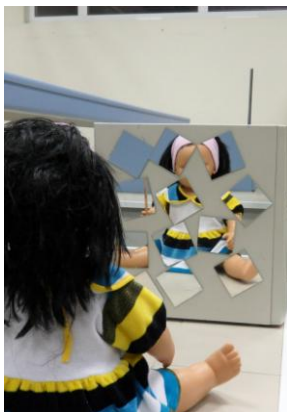
**FIGURE 5.** The space between the mirrors is increased to 3 cm each.

#### IV. ACTIVITY 3

In the third activity, the plane mirror used in Activity 1 and another plane mirror of the same dimension are now divided into 12 equal pieces. In the first part of this activity, the mirrors are arranged on the plane at a distance of 3 cm between each piece (See Figure 6). In the second stage, the pieces of mirror are now arranged in three different geometrical shapes (See Figures 7, 8 and 9). There is no difference in the number of images in both situations; only one image can be seen.



**FIGURE 6.** The mirror is cut into 12 equal pieces and arranged on a plane at a distance of 3 cm between each piece.



**FIGURE 7.** The pieces of mirror arranged in different geometrical shapes: geometrical shape 1.



**FIGURE 8.** The pieces of mirror arranged in different geometrical shapes: geometrical shape 2.



**FIGURE 9.** The pieces of mirror arranged in different geometrical shapes: geometrical shape 3.

## V. ACTIVITY 4

In the fourth stage of the experiment, the plane mirrors cut into 4 and 16 pieces in the second and third activities are used again. One of the 4 and 12 pieces of each mirror is then brought forward about 5 cm toward the doll, parallel to the

*Experiments on the nature of how multiple images form in a plane mirror other mirror pieces (See Figure 10, 11, 12 and 13). There is again no change in the number of images seen.*



**FIGURE 10.** One of the 4 pieces of mirror brought forward about 5cm toward the doll, parallel to the other pieces.



**FIGURE 11.** The image is seen when one of the 4 pieces of mirror brought forward about 5cm toward the doll, parallel to the other pieces.



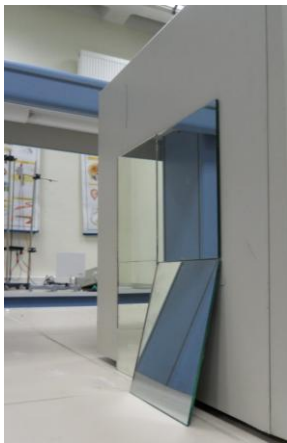
**FIGURE 12.** One of the 12 pieces of mirror brought forward about 5cm toward the doll, parallel to the other pieces.



**FIGURE 13.** The image is seen when one of the 12 pieces of mirror brought forward about 5cm toward the doll, parallel to the other pieces.

## VI. ACTIVITY 5

In the last activity, one of the 4 equal pieces of the mirror is set up at an angle to the others (See Figure 14). It is observed that the number of images seen is now two (See Figure 15).



**FIGURE 14.** One of the 4 equal pieces of the mirror is set up at an angle to the others.



**FIGURE 15.** The number of images when a piece of the mirror is set up at an angle to the others.

## VII. CONCLUSION

The experiments show us that, provided they are on the same plane, increasing the number of mirrors or changing the position of a mirror so that it remains at a parallel to other mirrors does not result in an increase in the number of images seen. On the other hand, when one of the plane mirrors is placed in front of the other mirrors at an angle of  $\alpha$  degrees (adding a new plane), this causes the number of images to double. With the observations that we have made in these experiments, then, the conclusion is reached that the number of images is related to the plane surface of the mirror. When the plane is changed, the mirror behaves as if it were another mirror.

With this experiment, which can be completed inside one classroom period, students can grasp the concept of the relationship between the whole and parts of a plane mirror and understand how a plane is related to images as well as how an image is formed in a plane mirror. The activity gives students the opportunity to accurately understand the definition of a plane mirror as well as to make use of an everyday situation to make correct predictions about how many images a mirror can produce.

## VII. IMPLICATION FOR INSTRUCTION

High school students and pre-service teachers participated in our study and did not have any difficulty with predicting the number of images when the mirrors are close to each other (as shown in Fig 1 and Fig 2). When the distances between the mirrors has been increased and are inclined with an angle, the students and the teachers were challenged with predicting the number of images. The series of plane mirror activities designed to eliminate the students and pre-service teachers' difficulties. In our study we first administered a test asking students questions in accord with the each activity on relating the mirror orientations with the number of images. Then each student was given opportunities to advance in the mirror system used in the activities. At the end, the test was administered again right after the activities and the changes in student understanding and therefore the affect of the activities were explored. It was observed that all the students and pre-service teachers involved in our study overcome the difficulties observed at the preinstruction.

The experiment might also be useful in enlightening adults who have insufficient knowledge and even misconceptions about the number of images that can be seen in a mirror. The activity can further be used as an introductory experiment on the subject of images seen through a mirror for elementary school children.

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