

# Investigation of the Cognitive Structures of Prospective Preschool Teachers on the Concepts of Circle, Disk and Annulus with the Word Association Test\*

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## Abstract

This study aimed to investigate the cognitive structures of prospective preschool teachers and to identify their misconceptions about the concepts of circle, disk and annulus. In the study, the Word Association Test was used as the data collection instrument. The study was conducted in the fall semester of the 2014-2015 academic year with the participation of 120 prospective preschool teachers. The prospective teachers were presented with three basic geometrical concepts frequently used in preschool education and were requested to write down the words each key concept evoked in order of significance within 30 seconds. Their replies were matched with the key concepts and converted into a frequency table and concept maps that represent the cognitive structures of the prospective preschool teachers were constructed based on this frequency table. The cutoff point method was used in the construction of the concept maps. The cutoff point is designated as a value three-five lower than the number of answers for each key concept and is determined by reducing this value by designated intervals until all key concepts are revealed. The first part is constructed by recording the key concepts and the answers above the cutoff point. In the concept map generated through this method, all the parts were constructed by determining all the answers given by the prospective teachers for the key concepts. Data analysis showed that the prospective preschool teachers associated the geometrical concepts of circle, disk and annulus mostly with examples from daily life, had misconceptions about the key concepts and had difficulty in differentiating between these concepts.

**Keywords:** misconception, word association test, circle, disk, annulus

## 1. Introduction

The need for qualified workforce progressively increases. Seferoğlu (2004) and Tuğluk (2013) advocate that “A qualified workforce can only be achieved through qualified educational institutions,” further emphasizing the importance of teachers’ role for the formation of high quality educational institutions. Therefore, the significance of preschool teachers for preschool educational institutions is an indisputable fact. In order to ensure implementability for the general objectives of the Ministry of National Education’s Preschool Education Program (2013), preschool teachers should have high domain and professional knowledge, and set a model for the qualifications pursuant to the general objectives. Inadequacy in one these qualities would constitute an obstacle in children’s acquisition of basic concepts (Uyanık & Kandir, 2010).

Misconceptions are considered to be one of the deficiencies in domain knowledge in preschool teachers. Before discussing misconceptions in preschool teachers, the subjects of concept and misconception should be mentioned. “A concept is a one-word knowledge structure that represents the common characteristics of difference objects and phenomena that gain meaning in the human mind” (Ülgen, 2004, p.107) while a misconception can be defined as a significant discrepancy between a person’s current understanding and the scientific consensus of a particular concept (Marioni, 1989; Tery, Jones and Hurford, 1985; Riche, 2000; Stepan, 1996 as cited in Aydoğan, Gülçiçek and Güneş, 2003; Bahar, 2003). This definition would imply that the possible misconceptions of preschool teachers who guide children in exploring basic concepts might expose children to misconceptions at the beginning of their education. Therefore, researchers believe that it is imperative to identify the misconceptions of prospective teachers regarding basic concepts.

A research of literature yields many studies in various fields particularly in science and mathematics education (Aydoğan et al., 2003; Frede, 2006; Köse and Uşak, 2006). However, notwithstanding the existence of studies on misconceptions in the field of geometry (Küçükaydın and Gökbulut, 2013; Öksüz, 2010; Ubuz, 1999; Yenilmez and Yaşa, 2008), an important sub-branch of mathematics, there are no studies investigating Turkish preschool teachers’ geometrical misconceptions. This raises the questions given below for prospective preschool teachers who are required to be adequately knowledgeable in every field: Do they have existing misconceptions about the basic concepts of geometry? If so, what are these misconceptions? This study aims to identify the misconceptions of prospective preschool teachers regarding basic geometrical concepts (i.e. circle, disk and annulus) by investigating their cognitive structures.

## 2. Method

### 2.1 Participant Characteristics

The study population comprised 141 prospective teachers who attended the first, second and third years of the Preschool Education Program at a state university in İstanbul in the fall semester of the 2014-2015 academic year. The study sample consisted of the 120 prospective teachers who voluntarily participated in the study to represent the study population. The distribution of the prospective teachers by the years they attended are given in Table 1.

Table 1. Distribution of Participants by Year at University

Year	F	%
First year	37	30.83
Second year	45	37.51
Third year	38	31.66
<b>Total</b>	<b>120</b>	<b>100</b>

The percentages of the prospective teachers who attended the first, second and third years of the Preschool Education Program were 30.83%, 37.51% and 31.66%, respectively. Table 1 reveals that the number of prospective teachers attending different years at university have approximate numbers.

### 2.2 Data Collection Instrument

This study employed the Word Association Test to identify the cognitive structures of prospective preschool teachers. The Word Association Test was based on the basic concepts cited in the Ministry of National Education's Preschool Education Program (2013). After an investigation of these basic concepts and specialist consultation with three professors of preschool education, three preschool teachers and three mathematics teachers, the researchers decided on the concepts of circle, disk and annulus as potential sources of misconception. In the test forms, one page was allocated for each key concept (Figure 1).

Dear Prospective Teacher,  
 Please write the words that comes to your mind  
 for the keyword given below in 30 seconds.

Circle .....

Circle .....

Circle .....

Figure 1. Word Association Test Sample Page

### 2.3 Data Collection

The Word Association Test was administered to the participants on November 17-21, 2014 in the fall semester of the 2014-2015 academic year after an examination of their course schedules and with the permission of the professors giving the respective lectures. Prior to administration, the researchers provided the necessary instructions, explanations and examples to the participants. Consulting relevant past studies, the researchers chose to allocate a 30-second period for each key concept (Bahar and Özatlı, 2003; Çardak, 2009, Ercan, Taşdere and Ercan, 2010). The prospective teachers were requested to write the words that the given key concept evoked on the page allocated for the respective concept in order of importance within 30 seconds. The total test duration for the Word Association Test developed for the three key concepts used in the study is 90 seconds. For the analysis of the results of the Word Association Test developed for the key concepts of circle, disk and annulus, the words the prospective teachers gave in reply were analyzed in depth and converted into a detailed frequency table (Appendix 1). The detailed frequency table was constructed by the number of times the replies for the key concepts were iterated. The Detailed Frequency Table was used in the construction of the concept maps with the Cutoff Point Method employed by Özatlı and Bahar (2010). In the Cutoff Point Method, the total numbers of words given in reply to the key concepts are grouped by specific intervals and grouping intervals are used as cutoff points.

## 3. Results

Results presented “Result and Discussion on the Number of Total Replies to the Key Concepts and Results and Discussion on the Concept Maps Constructed for the Words Given in Reply to the Key Concepts” two different parts.

### 3.1 Result and Discussion on the Number of Total Replies to the Key Concepts

The number of total words given in reply to each key concept in the Word Association Test is presented in Table 2.

Table 2. Number of Total Words Given in Reply to the Key Concepts

Key Concepts	Number of Words
Circle	580
Disk (i.e. Closed Disk)	829
Annulus	456
Total	1865

The total number of words given in reply to the key concepts by the participants is 1865. Disk and annulus are the key concepts with the highest (829 words) and the lowest (456 words) number of replies, respectively. The data revealed that the prospective preschool teachers produced a greater number of associations for the key concept of disk but associated the key concepts of circle and annulus with fewer words. The distribution of the number of words given in reply to the key concepts in the Word Association Test by the year the prospective preschool teachers attended is presented in Table 3.

Table 3. Distribution of the Number of Words Given in Reply to the Key Concepts by Year at University

Key Concept	First Year	Second Year	Third Year
Circle	192	210	178
Disk	416	300	113
Annulus	162	164	130
Total	710	674	421

Table 3 shows that the first-year prospective preschool teachers had the highest total frequency with respect to year at university while the third-year prospective preschool teachers had the lowest.

The data demonstrate that first-year prospective preschool teachers who had recently completed university preparation produced a greater number of words in reply to the key concepts. The lower number of replies by the third-year prospective preschool teachers could be attributed to the decreased focus on basic geometrical concepts since university preparation.

### 3.2 Results and Discussion on the Concept Maps Constructed for the Words Given in Reply to the Key Concepts

After the participants' replies were converted into a detailed frequency table, concept maps were constructed with the Cutoff Point Method. The concept map constructed with a cutoff point of 35 and over is given in Figure 2.

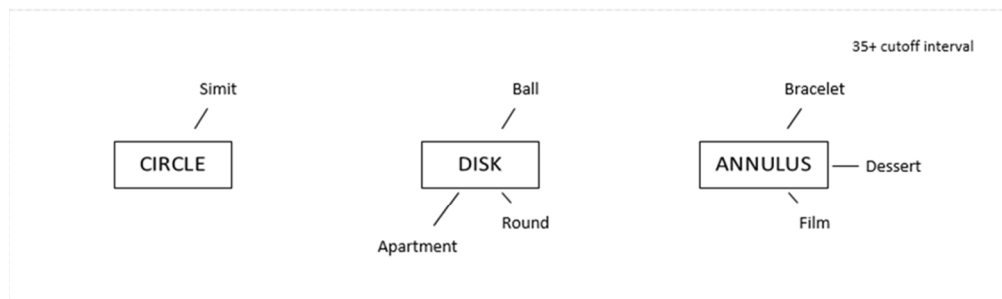


Figure 2. Concept Map with a Cutoff Point of 35 and over

The prospective preschool teachers associated circle with *simit* (a local circular bread generally encrusted with sesame seeds); disk with apartment, ball and round; and annulus with bracelet, film (i.e. the horror movie named *The Ring*) and dessert (i.e. *halka tatlısı*, a ring-shaped Turkish desert). The concepts on this map with a cutoff point of 35 and over are detached and non-associated.

The prospective preschool teachers associated the geometrical concepts of circle, disk and annulus with objects used in daily life. *Simit* (n=35) associated with the key concept of circle does not visually represent a circle as an object. This indicates a discrepancy between the real and the perceived dimensions of objects.

Among the replies for the key concept of disk, apartment (n=49) stands out. The participants made this association based on the homonymous property of the Turkish word *daire*, which is the translation for both disk and apartment. In addition, ball (n=63), another association made for the key concept of disk, fails to satisfy the concept by any means. The fact that the participants produced their replies according to the visuals in their own cognitive structures could indicate a difficulty in spatial thinking. Furthermore, round, another reply for the key concept of disk, is an adjective that does not meet the scientific concept of disk. Every disk (or circle/annulus) has a round shape but it is not accurate to refer to every round object as a disk (or circle/annulus). On the other hand, the statement that “The inside of a circle is empty and the circle is only the outer boundary of the round area,” given in Cognitive Developmental Achievement – 12 in the Ministry of National Education’s Preschool Education Program (2013) would easily lead prospective preschool teachers into a misconception.

The associations the prospective preschool teachers produced for the key concept of annulus were *halka tatlısı* (n=39) and film (n=36). Although bracelet could be considered an accurate reply when regarded in two

dimensions (picture), it indicates the existence of a misconception when regarded as three-dimensional. The concept map constructed with a cutoff interval of 25-34 replies is given in Figure 3.

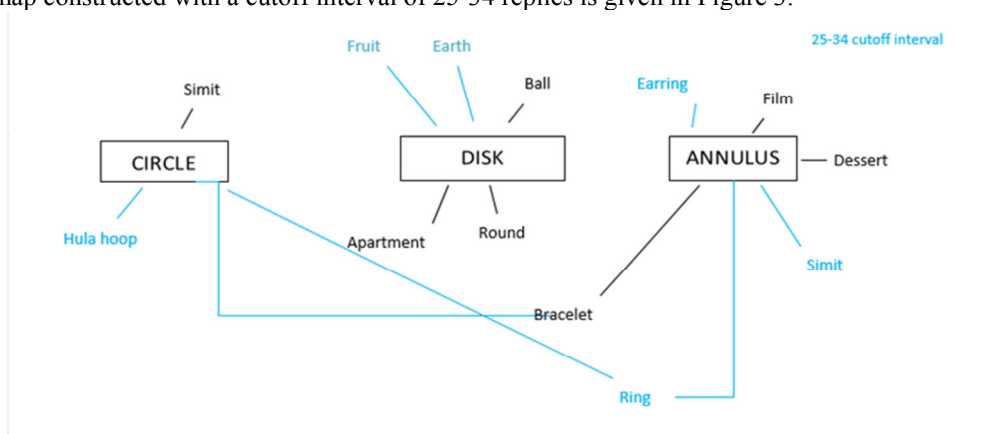


Figure 3. Concept Map with a Cutoff Interval of 25-34

The prospective preschool teachers associated circle with bracelet, ring and hula hoop; disk with fruit and the Earth; and annulus with ring, earring and simit. Within this cutoff interval, ring was associated with both annulus and circle.

In view of these findings, bracelet, ring and hula hoop replies for the key concept of circle do not satisfy the concept of circle when regarded as real objects. This indicates the existence of a misconception in the prospective preschool teachers for the concepts of annulus and circle. The concept map constructed with a cutoff interval of 15-24 replies is given in Figure 4.

15-24 cutoff interval

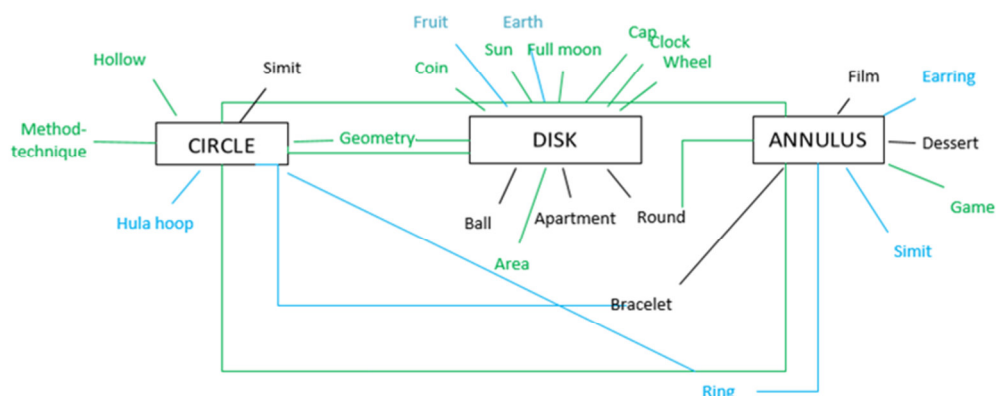


Figure 4. Concept Map with a Cutoff Interval of 15-24

Figure 4 shows an increase in the number of associations for the concepts of circle, disk and annulus, however, it also shows that the concept of circle was erroneously used in place of annulus (n=27) and disk (n=24). This indicates the existence of a misconception in the prospective preschool teachers. In addition, the participants associated the key concept of circle with hollow (n=18), round (n=23), geometry (n=20), technical (n=19; first-year=0, second-year=11, third-year=8). Albeit the fact that hollow and geometry are concepts related to the concept of circle, 11 prospective preschool teachers associated the key concept of circle with the word technical. This can be explained by the circle (ring) technique taught as a part of the Teaching Principles and Methods course in the fall semester of the second year of the Preschool Education

Program. The fact that first-year prospective preschool teachers did not make this association between circle and technical supports this possibility.

In addition, the participants associated full moon (n=24), sun (n=23), coin (n=19), lid/cap (n=16), clock (n=21) and wheel (n=19) with the key concept of disk. This indicates a discrepancy between the real and the perceived dimensions of objects, suggesting the existence of a misconception in the prospective preschool teachers. The key concept of disk was associated with the term area for the first time in this cutoff interval and the key concept of annulus was associated with game. The concept map constructed with a cutoff interval of 5-14 replies is given in Figure 5.

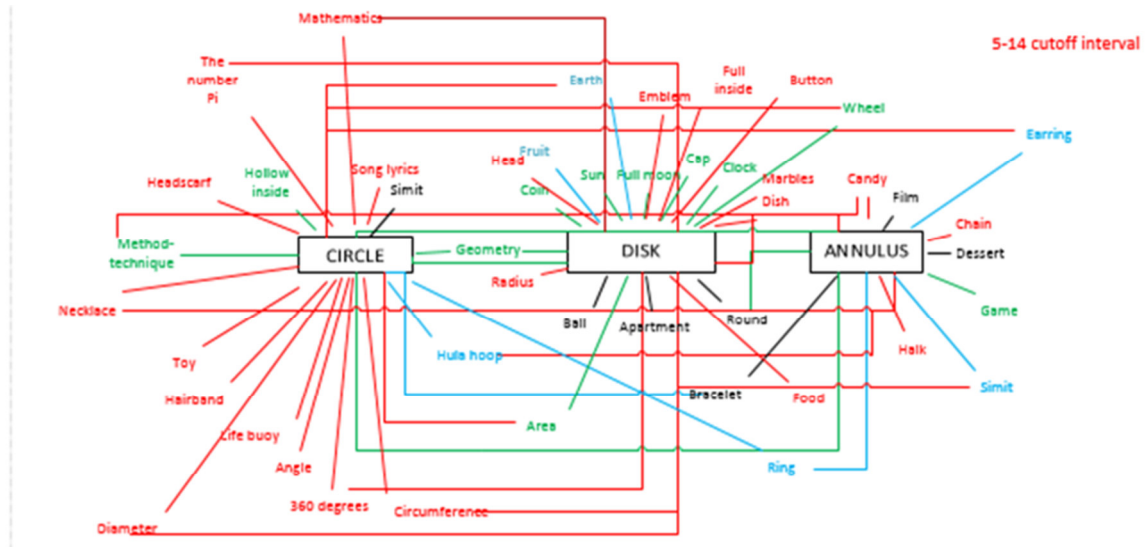


Figure 5. Concept Map with a Cutoff Interval of 5-14

Figure 5 shows that the replies to the key concepts included mathematical terms such as diameter, radius,  $\pi$ , angle, 360 degrees, dimension, area and polygon. However, replies like life buoy, hairband, toy, earring and the Earth indicate the existence of a misconception for the key concept of circle. Furthermore, the association of the concept of circle with the word area demonstrates the need to question the prospective preschool teachers' knowledge of basic geometrical concepts.

#### 4. Conclusion and Recommendations

This study employed the Word Association Test (WAT) to investigate the associations between concepts in the cognitive structures of prospective preschool teachers and to identify their misconceptions regarding the concepts of circle, disk and annulus. Data analysis showed that the prospective preschool teachers associated the geometrical concepts of circle, disk and annulus mostly with examples from daily life. However, their failure to make associations that satisfy the key concepts could be interpreted as a difficulty in matching objects with respective concepts. Furthermore, the study results revealed that the prospective preschool teachers had misconceptions about the key concepts and had difficulty in denominating the differences between these concepts.

In view of the Word Association Test results, the researchers would like to make the following recommendations:

- This study adopted a survey research design and aimed to describe the existing structure. Therefore, empirical studies that employ the Word Association Test with a pretest-posttest design can be conducted to identify conceptual changes in prospective preschool teachers.
- The study results yielded various misconceptions in the prospective preschool teachers for the concepts of circle, disk and annulus. An educational process for identifying, preventing and eliminating misconceptions should be designed and implemented.

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#### Notes

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