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Analyzing students'conceptualization through their drawings

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Abstract

The aim of this study is to propose a categorization of concept drawings that permits the analysis of preservice primary teachers' conceptualization. Students were asked to draw a rectangle in the course of a mathematics lesson and a flower in that of science. The sample included 50 students from the primary education department at Uludag University, Bursa, Turkey. Their responses were analyzed using the same grid. Two main categories were distinguished: the drawing of a concept's structure (conceptual, iconic, redundant/missing drawing) and labeling/coding of the concept's parts (comprehensive, partial, incorrect labeling). The first finding shows that students who produced a response categorized as conceptual and iconic drawings were identified as in the comprehensive labeling category. Thus, there may be a relationship between conceptual and iconic drawings and conceptual comprehension. Another finding concerns the similarities in the categorization of responses for both maths and science questions. Students who made *iconic* and *conceptual* drawings were able to label more correctly than students who drew a *redundant/missing* drawing. In addition, it can also be said that for the biology drawing the whole flower was observed whereas in geometry an abstract subject which is not generally observed was made physical by the drawing.

Keywords: Primary teachers; biological drawing; geometric drawing; science education; mathematics education.

1. Introduction

One of many research methods used to explore students' understanding is that of students' drawings. Several studies have shown drawings to be of help in understanding students' thoughts. (Stein and McNair, 2002; Prokop and Fancovicova 2006; Hoase and Casem, 2006; Köse, 2008; Tapan and Arslan 2009). McNair and Stein (2001) emphasize that a picture drawn by a student can reveal how he or she perceives an object, and the degree to which a student observes details and presents them. They can serve as a "window" to a student's conceptual knowledge. Moreover, instructors can gather large amounts of data on the mental models that students have about scientific concepts using simple drawings and thus improve the teaching and learning process. There has been much research related to drawings enabling the gathering of information about adult students' understanding of scientific perceptions (Stein &McNair 2002; Prokop& Fancovicova 2006; Hoese & Casem 2007; Köse 2008).

A study by Dempsey and Betz (2001) stated that biology, the study of life, requires careful observation and description. An excellent way to describe an object is to draw it, with plants being particularly good subjects for careful observation because they are stationary. Many studies indicate that in general students have some

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misconceptions about flowers or flowering plants (Jewell 2002; McHellden, 2004; Lin 2004; Gatt et al. 2007, İlkörücü-Göçmençelebi 2009) as the flower is an integral organ of the flowering plant. Another difference is that as the concept of a flower is associated with other concepts, it is as necessary for it to be taught correctly as it is to be learned.

As well as drawings being of benefit in mathematics lessons in many ways (function, derivations), geometric shapes are frequently encountered in daily life. Geometry is often used as a tool for understanding and interpreting science. The shapes or areas of objects and organisms are sometimes described using geometry. (Synder 1999; Hartvigsen 2000). Laborde (2005) mentioned that diagrams in two dimensional geometry play an ambiguous role: on the one hand they refer to theoretical geometrical properties, while on the other, they offer spatio-graphical properties that can give rise to a students perceptual activity.

Thus, using drawings to understand the level of pre-service teachers' concepts could be a valuable contribution to teacher training. It is just as important for the teacher to have the correct concept as it is for the student to learn it.

The aim of this study is to propose a categorization of concept drawings that permit the analysis of preservice primary teachers' conceptualization from their drawings.This study focuses on whether scientific and mathematical drawings of students can be evaluated in the same way to establish their level of understanding.

2. Method

The sample included 50 students from the Primary Education Department at Uludag University in Bursa, Turkey. The data was collected from students within 2 weeks of the information having been taught in a lesson. For the science question, the students were firstly asked to draw a flower and then to label the component parts. For the mathematics question, the students were asked to draw a rectangle and label it appropriately.

Data analysis: The students drawings in this study were evaluated under 2 main headings of drawing of the concept and labelling, as it was hypothesized that the actual drawing and defining the drawing were not the same.

For the science question the evaluation of the labeling was made according to the parts which had been taught.

Examining *the labelling/coding* of the parts of the concept, three categories were defined as based on previous studies (Hoase and Kasem; 2007; Kara et al. 2008; Tapan, 2009; İlkörücü-Göçmençelebi 2009) as given below;

Comprehensive labelling/coding: All the parts labelled correctly.

Partial labelling/coding: Some parts labelled incorrectly.

Incorrect labelling/coding: All parts labelled incorrectly or not labelled.

Examining *the drawings* of the structure of concept, three categories were defined as based on previous studies (Hoase and Kasem; 2007; Kara et al. 2008; Tapan, 2009; İlkörücü-Göçmençelebi 2009) as given below;

Visual-iconic drawing: The structure of the concept was visually drawn correctly as had been taught in the lesson. For science drawings, the internal structure of the flower was not considered.

*Conceptual drawing:*The structure of the concept was correctly drawn but not in the way that had been taught.

Redundant/ Missing drawing: The drawing was not related to the concept and had either missing or extra parts. Data were analysed using SPSS (Version 17). The student frequency was calculated using descriptive analysis.

3. Results

The results for the science drawing are shown in Table 1. An iconic drawing was made by 14 students (28.6 %), of which 1 (2.0%) was labelled incorrectly. A conceptual drawing was made by 20 students (40.8%) and a redundant/missing drawing by 15 students (30.6%). 22 students (44.9%) were not able to label the flower correctly.

Figure 1 illustrates clearly that students who made *iconic* and *conceptual* drawings were able to label more correctly than students who drew a *redundant/missing* drawing. Most students drew iconic and conceptual drawings.

The results for the mathematics drawing are shown in Table 2. An iconic drawing with comprehensive labeling was made by 14 students (31.1%). Of 24 total iconic drawings, 1 (2.2%) was labelled incorrectly. A conceptual drawing with comprehensive labeling was made by 2 students (4.4%). 9 (20.0%) of the students were not able to draw a rectangle correctly and 29 students (64.5%) were not able to label a rectangle correctly.

Figure 2 shows that students who made *iconic* and *conceptual* drawings were able to label more correctly than students who drew a *redundant/missing* drawing. Most students drew iconic drawings.

Table 1 Percentages of science drawing groups according to labelling categories

Grups	comprehensive labeling	partial correct labelling	incorrect labelling	Total
iconic drawing	22.4% (*n* =11)	4.1% (*n* =2)	2.0% (*n* =1)	28.6% (*n* =14)
conceptual drawing	30.6% (*n* =15)	8.2% (*n* =4)	2.0% (*n* =1)	40.8% (*n* =20)
redundant/missing drawing	2.0% (*n* =1)	20.4% (*n* =10)	8.2% (*n* =4)	30.6% (*n* =15)
Total	55.1% (*n* =27)	32.7 % (*n* = 16)	12.2 % (*n* = 6)	100 % (*n* = 49)

Table 2 Percentages of related mathematics drawing groups according to labelling categories

Grups	comprehensive labelling	partial correct labelling	incorrect labelling	Total
iconic drawing	31.1% (*n* =14)	20.0% (*n* =9)	2.2% (*n* =1)	53.3% (*n* =24)
conceptual drawing	4.4% (*n* =2)	17.8% (*n* =8)	4.4% (*n* =2)	26.7% (*n* =12)
redundant/missing drawing	0% (*n* =0)	11.1% (*n* =5)	8.9% (*n* =4)	20.0% (*n* =9)
Total	35.6% (*n* =16)	48.9 % (*n* = 22)	15.6 % (*n* = 7)	100 % (*n* = 45)

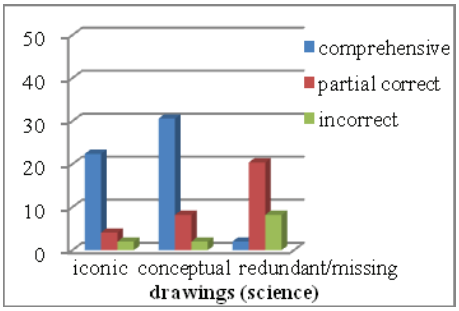

Figure 1

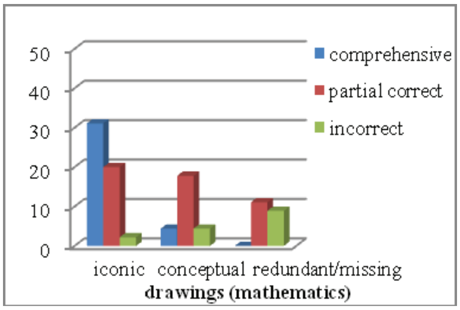

Figure 2

4. Discussion

A significant difference was seen in the science and the mathematics drawings of the relationship between comprehensive labeling and iconic drawing (Figure 1, 2). This may be firstly because a 3-dimensional subject (spatial) was used for science and a 2-dimensional (geometric) one for mathematics.

A second reason may be that in biology the drawing on paper represented something from real life whereas in geometry an abstract mental image had to be drawn. It can also be said that for the biology drawing the whole flower was observed whereas in geometry an abstract subject which is not generally observed was made physical by the drawing. In this respect the roles were completely reversed for biology and geometry. According to Çakıcı (2005) the students' social and cultural background are likely to affect their ability to fully comprehend scientific concepts and their interpretation or construction of meaning. Tapan and Arslan (2009) indicated that the most frequently encountered difficulty in the learning of geometrical reasoning is to leave out the concrete drawing. In addition they mentioned that it becomes important to throw light on the concrete drawing's role for the teachers and visual elements' usage while realizing a geometrical construction. According to our study results, it was seen that in the science drawings, those which were more accurately drawn were comprehensively labeled. However, it was seen that approximately half of the students were lacking in knowledge about the flower. These results conform with the results of İlkörücü-Göçmençelebi (2009). The perception is understood to be correct if there is a true physical representation correctly labelled. Kara et al (2008) stated that students have difficulty in drawing concepts about which they have no knowledge. In this situation a student may give a correct or a false answer, but in the case of drawings, it has been shown that if a drawing is not made, an answer is not given.

A study by Mifsud (2009) stated that children match what they see with their existing related mental models. Some children drew added features so as to compose a more complete picture of the scene. According to Gavin & Boyd (1990) drawings are normally labelled and have appended explanatory notes or annotations. Moreover, careful and accurate labelling is just as important as actual drawing and should be done neatly and clearly.

In conclusion, drawings can improve conceptual understanding. It was thought that the drawing would correspond to the student's observation and the labelling to what the student had learned. We need to understand whether the students have fully understood or only memorized. For this reason, drawing activities should be used in conjunction with interviews to explore students' ideas about their daily world and academic concepts.

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