DOG*eometry* - Game Concept

Simone Kriglstein*
University of Vienna

Guenter Wallner†
University of Applied Arts Vienna

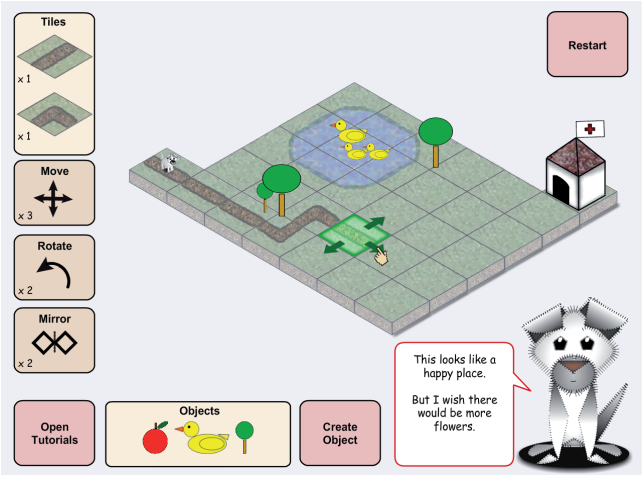

Figure 1: *The playing field of the game with an almost completed puzzle. On the left is a list of available tiles and geometric transformations. At the bottom is a list of objects which have been already created by the child and which can be placed individually in the virtual world. From time to time the dog gives hints and expresses the wish for certain objects.*

1 Motivation

Following [von Hiele 1999] we believe that *for children, geometry begins with play* and motivated to design a learning concept for children to understand geometric transformations by creating and reflecting on visual arts, we propose an educational game called DOG*eometry*. Games allow children to actively participate in the learning process rather than just being passive observers. Moreover, games have *the ability to position the player deeply in the center of a situation* [Isbister et al. 2010] and therefore have the potential to increase the engagement of the child with the matter at hand.

2 Concept

The idea behind the game is to combine problem-solving tasks with artistic expression. On the one hand the child has to build a path for a dog to get to a veterinarian by using a set of tiles and arranging them with a limited number of geometric transformations like translation, rotation or reflection. On the other hand the dog will, from time to time, request new things from the child which, once created, can be freely placed in the world to make the world more enjoyable for him (going to the doctor is usually an unpleasant thing to do as many children know from their own experience and therefore it should be easy for them to put themselves into the dog's position). Figure 1 illustrates this concept which we will explain in the following in more detail.

2.1 Path Creation

The above mentioned dog acts as teacher which will explain geometric transformations by the way of animations to the child (see additional Figure 2). After the transformation has been explained the child can apply the gained knowledge in a puzzle which requires the construction of a path between the dog and the veterinarian (additional Figure 3). However, the number of tiles which can be placed is limited as well as the number of geometric transformations. For example, once the concept of reflection has been explained to the child, a puzzle is presented to the child which has to be solved without rotations. This allows players to solve problems in different ways. According to the suggested learning principles of [Gee 2005] the puzzles will increase in difficulty to *lead players to form hypotheses that work well for later, harder problems*.

2.2 Object Creation

The objects which are requested by the dog can be found in the natural world around us. We have several reasons why we have chosen objects from nature. First, geometric concepts can be found throughout nature and therefore children can play around with and reflect upon objects they are familiar with from their own environment not just with abstract figures as often used in geometry education. Furthermore, nature is a true treasure trove when it comes to symmetry and repetitive patterning (e.g., the hexagonal pattern of a honeycomb). With the help of these objects children will therefore learn that many things in nature which look complicated at first sight, can be made with simple shapes by using geometric transformations, like rotation or reflection.

At the beginning the program will show the child with the help of an animation how the object can be constructed, e.g., a daisy can be made with a circle and an ellipse which is rotated multiple times around the center of the circle (see additional Figure 4) or a duck can be drawn with differently scaled ellipses. Afterward, the child has to create the object with the help of a constrained set of simple geometric shapes and transformations (e.g., the ellipse can only be placed once so that the child has to rotate it; later on, only reflections are allowed and so on). Learned concepts have to be applied to construct more complicated objects later in the game (e.g., a windmill can be constructed by applying the knowledge gained in creating the daisy). This way children will learn that new objects can be constructed by combining two or multiple objects (e.g., an apple tree can be made with a broad-leafed tree and multiple apples, see additional Figure 5). To foster the creativity of children they can also create their own objects in a *free-style* mode where they can combine objects to their liking which will encourage them to think about relationships, not isolated objects.

References

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*e-mail: simone.kriglstein@univie.ac.at
†e-mail:wallner.guenter@uni-ak.ac.at