



Exemplar 11:

Applications of Transformation in Daily Life

Objective: To appreciate the application of transformation in daily life including the art-work of Escher

Key Stage: 3

Learning Unit: Transformation and Symmetry

Materials Required:

- (1) Pictures illustrating different patterns of transformation in the environment
- (2) Transparencies of tile designs and the corresponding basic units
- (3) Worksheets of the tile designs and cards of the basic units

Prerequisite Knowledge: Basic understanding of the idea of translation, reflection, rotation and enlargement

Description of the Activity:

1. The teacher shows pictures of tile design by repeating a pattern (or basic unit) to students and then asks students to
 - (a) identify the basic unit of the design;
 - (b) discuss in groups how these tile designs are formed from basic units;
 - (c) the transformation used in forming the pattern.



Fig. 1



Basic unit

2. The teacher shows the transparencies of other tile designs using the same basic unit (see Fig. 2) and the other basic units (Fig. 3 and Fig. 4).



Fig. 2



Fig. 3



Fig. 4

3. Students are divided into groups and each group is distributed with several tile designs above and different basic units. The teacher asks students to
 - (a) identify the basic unit of each tile design;
 - (b) name the transformations used in each tile design.

The teacher may also give the computer game TransGame.exe to students for them to construct the given pattern (Fig. 5).



Fig. 5

The teacher briefly explains the game including the following:

- (a) The left diagram is the given pattern that needed to be constructed.
- (b) Students select one of the top-right pattern as the basic unit to construct the pattern.

- (c) Students click and/or transform the basic unit and stick the units to the bottom-right box (Fig. 6).
- (d) Matching the constructed pattern with the given pattern. If the two match with each other, the students need to write the transformation procedures on the worksheet. If no, students can click the “help (?)” icon for hints or can reset the game and play again.



Fig. 6

(Further detailed instructions can be found in Appendix D).

4. Students may also design their own tile design if they click the “**Design your own pattern**” button.
5. Students are invited to present their solution. As to the non-uniqueness of answers in transforming the designs such as in Design ⑥, the teacher may further challenge students to explore some relationships among reflection and rotation. For example, consecutive reflections along two perpendicular axes results in a rotation of 180 degrees, etc.
6. The teacher may further show some wall charts of the work by M. C. Escher to illustrate how the idea of transformation can be used in designing tessellated pictures and art works in different cultures. For those who are interested in Escher’s work, they can visit the web-site related to Escher’s work.

Worksheet: Tile designs

1. Read the following tile designs.

(a) Circle the basic unit for the design.

(b) Name the transformation used in each design.

(a)



Transformation used:

(b)



Transformation used:

(c)



Transformation used:

(d)



Transformation used:

(e)



(f)



Transformation used:

Transformation used:

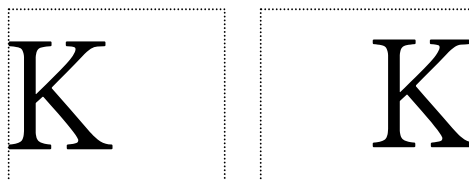
2. Create your own tile design from any one basic unit in Question 1.

Explain the transformation used:

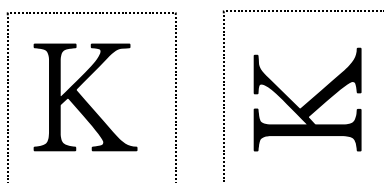
Notes for Teachers:

1. Students should be able to identify the meaning of the following types of transformation prior to this activity:

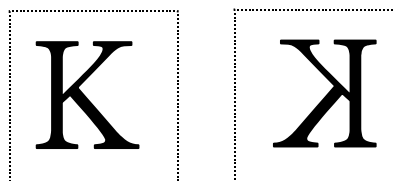
Translation: repeating the same object by shifting a constant distance



Rotation: repeating the same object by rotating an angle

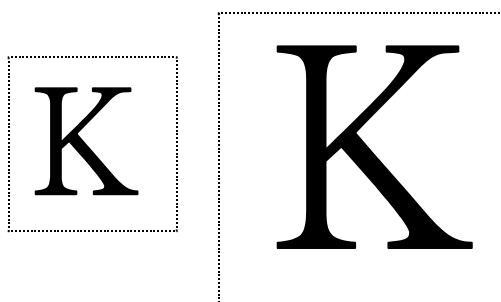


Reflection: repeating the same object by reflecting along a straight line



The above three transformations are called isometry as the shape of the object is unchanged. These transformations can be combined and the isometry nature is still preserved.

Enlargement/Contraction: a transformation that preserves angles but multiplies lengths by a constant factor k .



2. The teacher can assign students to design their own tile patterns with more than one basic unit as enrichment activities. Further designs can be found in the web-site <http://mathforum.org/geometry/rugs>.

3. Students have learnt simple ideas of tessellation in primary schools. Nevertheless, most of them may not come across the name of M. C. Escher. The teacher can introduce the story of Escher and his artworks for art appreciation activity:

M. C. Escher was born in Netherlands in 1898. He first visited Spain in 1922 and later in 1936. He was impressed with the structure of Alhambra, a 13th century palace with walls, floors, and ceilings built by the Moors and covered with beautiful mosaics of great variety. Escher spent days copying the patterns and he did not restrict himself to geometric tessellation but created tessellation figures that resemble fish, frogs, dogs, humans, lizards, and even creatures that he created from imagination.

Further details on M. C. Escher and his detailed work can be found in the web-site <http://www.worldofescher.com/>.

4. Further discussion on how polygons tessellate will be made on the learning unit “Angles Related with Lines and Rectilinear Figures”. Please refer to Exemplar 15 for the details.

Reference:

Books:

1. Brown, R. (1973). *Transformation Geometry*. Palo Alto, CA: Dale Seymour Publications.
2. Coxeter, H.S.M., Emmer, M., Penrose, R. & Teuber, L. (Eds). (1986). *M.C. Escher: Art and Science*. New York: North-Holland.
3. Dayoub, I. & Lott, J. (1977). *Geometry Constructions and Transformations*. Palo Alto, CA: Dale Seymour Publications.
4. Kenney, M. & Bezuska, S. (1987). *Tessellations Using Logo*. Palo Alto, CA: Dale Seymour Publications.
5. Ranucci, E. & Teeters, J. (1977). *Creating Escher-Type Drawings*. Oak Lawn, IL: Creative Publications.
6. Seymour, D. & Britton, J. (1989). *Introduction to Tessellations*. Palo Alto, CA: Dale Seymour Publications.
7. Yaglom, I. (1979). *Geometric Transformations*. Washington, D.C.: MAA.

Web-sites:

1. <http://mathforum.org/geometry/rugs/>
2. <http://www.worldofescher.com/>
3. <http://www.mathsonline.co.uk/nonmembers/gamesroom/transform/transform.html>

4. <http://www.bbc.co.uk/schools/gcsebitesize/maths/shape/transformationsrev1.shtml>
5. <http://www.numeracyresources.co.uk>