COMMENCEMENT

Standards & Performance Indicators

EXPLORING TRANSFORMATIONS:

On The Computer And Using Transformations On The Computer To Create A Unique Design

Generally, the students learn the material faster and better than the traditional way using graph paper and ruler.

Teacher

MST 3

- ▲ transformations
- ▲ learning technologies
- ▲ investigate transformations
- ▲ graphing utilities
- ▲ transformations to functions

MST 7

- ▲ analyze problems/issues
- ▲ design solutions
- ▲ work effectively
- ▲ gather/process information
- ▲ present results

Geometer's Sketchpad 3.0, Key Curriculum Press, Berkeley, CA

This experience was created to integrate computers into the regular Sequential 2 math program and to combine ideas from two disciplines, math and art. All participants were ninth-graders taking Sequential 2 and none of them had previous experience with the software.

Despite the extra work, I have continued to employ the self-teaching concept because I feel strongly that it is the best way for students to learn.

Teacher

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Grade 9

1 Phase One—Exploration

In the first part, students explore what happens when geometric figures are transformed on the coordinate plane. The teacher uses the first day to review the basic transformations that students learned in *Sequential Math 1*. During the next four class sessions in the computer lab, the students work together in pairs, moving geometric shapes in the plane, measuring the coordinates of the original and image figures, making conjectures regarding rules for each transformation, and testing their hypotheses. They then formalize their rules as functions. Throughout the activity, the students direct their own learning using only their knowledge of the program learned earlier in the year and the tutorial provided by the teacher.

The class was given 2 to 3 successive days in the lab during the first activity, and then a discussion of the results obtained to date was held in the regular classroom. Thus, all students were able to get feedback regarding their work; those who were successful would know that they were, and those who were in error could be steered back in the right direction. In the lab itself, the teacher serves as a facilitator, observing each 2-person team and making suggestions and answering questions, thus keeping the lessons focused.

2 Phase Two—Design

In the second part, students use their new-found knowledge of transformations to create an original artistic design, such as a tessellation, according to a suggested real-life situation. Students must work together effectively, process information, observe common themes, and present their results. It also serves to acquaint them with an assignment such as they might reasonably expect to encounter in the world of work.

By far the greatest amount of time must be devoted to the teacher's own self-preparation.

Teacher

Students working in teams of two are given the following scenario and instructed to use the computer to create an original drawing which satisfies the criteria.

Imagine the following situation: You are employed by a design firm which creates designs for vendors who manufacture wallpaper, wrapping paper, tile, and fabric. Your supervisor has assigned you to develop a new design which may be sold to one of these vendors.

The design must contain the following elements:

- It must employ at least two types of transformations: line reflections, point reflections, rotations, dilations, and/or translations.
- It must use at least two colors.
- It can be extended to cover at least 75% of the piece of paper.
- It must be relatively easy to reproduce.

In addition, you must write an explanation of how you created your design. This explanation must be clear and easy to read, typed on a word processor, and illustrate your knowledge of transformations. It should be easy to understand so that anyone who reads it can duplicate your design from the instructions.

ASSESSMENT

Phase One—Exploration

Evidence of students' progress is provided in a number of ways. While they are working in the computer lab, the teacher observes their work, answers questions, and asks other questions,which can point them to further discoveries. The tutorial worksheet requires student responses, and students can also record their discoveries in a script box on the sketchpad workpage. Two or three times during the unit the students report to their regular classroom to discuss, compare, and analyze their findings. Homework from the text is assigned as students complete each of their explorations in each type of transformation. At the conclusion of the unit, each student submits a set of four problems using composition of transformations. These are done using a ruler and graph paper (not the computer) and are scored on a scale of 1 to 10 points, exactly as they are on the Sequential Regents' exams. This assignment assesses individual learning. Each student does the work on his/her own, and is given a separate rating.

Phase Two—Design

Assess whether the students understand how to apply transformations to achieve artistic effects.

Design Rubric

Projects are evaluated according to the following criteria:

THE DESIGN:

• was created using at least two different transformations.	10
• can be duplicated repeatedly to cover the surface.	5
• uses at least two colors.	5
• is adaptable to a commercial use.	5
• is fairly simple to reproduce.	5
• is pleasing to the eye.	5
Total:	**35 points**

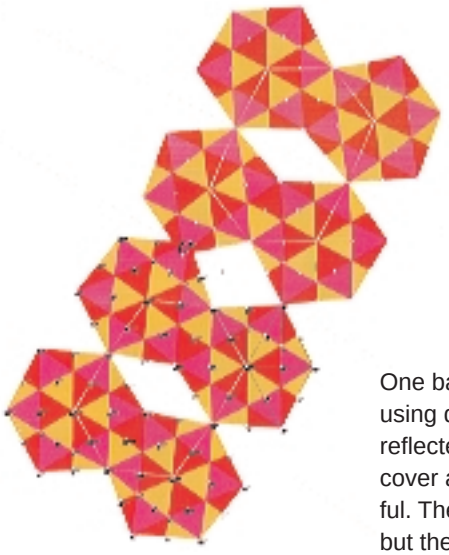
THE DESIGN DESCRIPTION:

• can be easily duplicated by the anyone who reads it.	7
• is clear and easy-to-read, with no run-on sentences and no spelling errors.	5
• is typed on a word processor.	3
Total:	**15 points**
Project Total:	**50 points**

Each team of two people is given the same project score. Individuals are assessed according to the assignment described above, and on subsequent tests.

APPENDIX

If you are using *Geometer's Sketchpad 3.0* the following **Course 2 Transformations** worksheet is a guide created for this learning experience.



One basic shape has been divided using dilations, then rotated and reflected. It is easily reproduced to cover a surface and commercially useful. The three colors are eye-catching, but the repetitive triangles render it less appealing to the eye.

The design uses both rotations and dilations; yellow and green are the colors. The design can easily be translated across the page, and it would make a pleasant tile or textile sample. In addition, the students have incorporated the extra element of curved lines (arcs).

The design is very pleasing to the eye and has nice color contrast. The student has used rotation well, but the translations were done using different directions and distances, resulting in a picture which is not symmetrical. This was probably not intentional, but the unequal white spaces are not only disturbing to view, but render the design difficult to duplicate on the page and therefore not commercially usable. Some minor adjustments, particularly the use of one translation vector, would correct the problems.

This design is deceptively simplistic. The two colored figures are not in fact congruent, but were created by adding and subtracting pieces from congruent squares in the manner of M. C. Escher, then rotated and translated to produce a tessellation. This design is both simple to recreate and infinitely extendible. It is adaptable to many color combinations, making it a useful design for any number fabric items, although a different set of colors would have had more personal appeal, I think.

Two shapes have been created from one basic trapezoid through the use of reflections and translations. The minimal use of two colors keeps the design from looking too cluttered, rendering it pleasant to look at, and useful as a wall tile design. It is easy to recreate and duplicate across the page.

Following is a students' written explanation of how this design was created.

Create an isosceles trapezoid (shorter base = 4.5cm./10nger base = 7cm./ sides = 2.5)

- Keep reflecting the trapezoids until you have the desired length.
- Reflect the trapezoid over the longer base...then the shorter base...then the longer...
- Reflect the column of trapezoids to create to columns...then three...until you have reached the desired length.
- Delete the longer base of each of the trapezoids. Now you should have overlapping hexagons.
- Color in the diamonds created by the overlapping hexagons. All colors are allowable, but we used yellow and green.

This written description received a score of 15 according to the following criteria:

- easily duplicated by the reader 7
- clear and easy-to-read instructions, with no run-on sentences or spelling errors 5
- typed on a word processor. 3

Total: 15 points