Study on the Coloring of Specific Elements and Regions in Geometer's Sketchpad

Zhaohui Ming, Bo Chen

School of Mathematics and Information Technology, Jiangsu Second Normal University, Nanjing, Jiangsu Province, China

ABSTRACT. *The Geometer's Sketchpad is a software widely used in mathematics teaching in primary and secondary schools of China. This paper studies the methods of coloring graphics images through this software. Through examples, three methods of coloring basic graphs are analyzed, including the "internal" coloring through construction, the "indirect" coloring through construction and coloring with "functions".*

KEYWORDS: *The geometer's sketchpad, Line, Circle, Structure, Coloring*

1. Introduction

The Geometer's Sketchpad software takes points, lines and circles as basic elements, and helps students explore mathematical problems through the animation, transformation, measurement, calculation, construction, track and other functions of these basic elements. The software is powerful and easy to operate, and can demonstrate objective mathematical conclusions. It can be used to solve problems, complete the "mathematical experiment" and get mathematical experience in that process. Therefore, it can make abstract knowledge more concrete and get mathematical conclusion. It is a teaching software suitable for teachers and students to carry out mathematical exploration and research.

2. Problems of Coloring in the Process of Mathematical Discovery and Creation in Geometer's Sketchpad

Mathematics educator George Polya pointed out that, "mathematics has two sides. On the one hand, it is a rigorous, Euclidean science subject. From this point of view, mathematics looks like a systematic deductive science. On the other hand, mathematics in the process of creation looks like an experimental inductive science." In order to improve students' mathematics quality, we must fully embody the two sides in mathematics teaching, focusing on the formalization and abstraction of contents, as well as the concretization of mathematics discovery and creation process. Under the current situation, to stimulate students' interest in mathematics learning, improve students' ability, and concretize the process of mathematics

discovery and creation are particularly important for the basic mathematics education.

In traditional mathematics teaching, teachers usually use auxiliary tools such as chalks, rulers, triangular rules and compasses to draw pictures. The pictures are fixed on the blackboard, which are static and cannot be changed in shape and size. In the process of teaching, if teachers ignore the creation of intuitive background and its development process of inquiry, students' interest in learning will not be stimulated effectively. It will lead to low learning interest, poor understanding ability and weak inquiry ability of students; there will be some difficulties for students to acquire abstract knowledge, which will bring some difficulties in learning. The use of *Geometer's Sketchpad* in teaching can realize the creation of intuitive background and reflect the process of exploration and development. The graphics and images are dynamic, and can keep the internal geometry unchanged in motion.

In order to clearly mark a geometric element, *the Geometer's Sketchpad* software often uses color to represent specific graphic and image elements, or mark different elements with different colors. The operation of coloring in *Geometer's Sketchpad* is to use color to express specific graphic and image elements, which is a skill that mathematics teachers must master when using. However, compared with some large-scale software, the coloring ability of *Geometer's Sketchpad* is relatively weak; it does not have the function of coloring at will. There are few literatures about the coloring operation of this software, for example, in literature [1], courseware such as "Pentagram" involves "color and parameter control"; in literature [2], courseware such as "six petal flower" involves the problem of graphic coloring; in literature [3], only the problem of "dynamic control of object color" is discussed; in papers [4] - [8], the same situation exists.

In this paper, we adopt the V5.06 version of *Geometer's Sketchpad* to discuss some cases that need coloring, hoping to summarize and share experiences with other teachers.

3. "Internal" Coloring through Construction in Geometer's Sketchpad

3.1 Coloring the Edges of a Equilateral Triangle

First, create a new sketchpad, and directly draw a line segment AB by using the line formation tool;

Second, click the line AB; rotate point B 60 degrees with A as the center, and rotate point A 300 degrees with B as the center; the lines intersect at point C;

Third, construct the midpoint of CA, AB and BC respectively, intersect at D, E and F, and then construct the small equilateral triangle DEF;

Fourth, select DEF to construct the internal color;

Fifth, right click to change internal color and line color, and hidden points
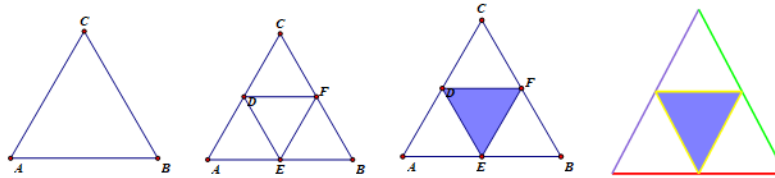
according to personal preference

Fig.1 -1 Coloring the Edges of a Equilateral Triangle.

3.2 Coloring the Five Angles of a Pentagram

First, create a new sketchpad, and draw a circle c1 directly with the tool of making circle IN the *Geometer's Sketchpad*;

Second, find a point A on the circle; take the center of circle, O as the center of rotation, repeat the transformation and rotation of point A for 72 degrees for 5 times, and get A, A', A", A'" and A"";

Third, select AA", A A'", A' A"", A" A"" and A'A'" to construct line segments and get a pentagram star. Take their focuses as B, C, D, E, and F;

Fourth, select points FAB, BA'C, CA"D, DA'"E and EA""F to construct the interior of the triangle;

Fifth, right click to change the color according to personal preference, and then hide redundant line segments and points to get the figure
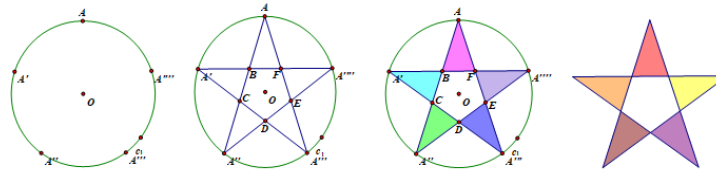

Fig.1 -2 Coloring the Five Angles of a Pentagram.

3.3 Coloring a "Flower"

First, create a new sketchpad, and draw a line segment AB directly using the line formation tool;

Second, click line AB, rotate it 90 degrees with A as the center to get L1, and rotate the line 270 degrees with B as the center to get L2;

Third, click L1, measure its length, and then click to realize

the translation transformation of the lengths of AB and L1, which respectively intersect with L1 and L2 at C and D;

Fourth, select the edge of CA, AB, BD and DC to construct centers E, F, G and H respectively, and then select EA, FA, GD and HD to construct two points; draw a circle at a point O;

Fifth, select COA, AOB, BOD and DOC at a time to construct the arc of three points, and then construct the area of the inner sector of the arc;

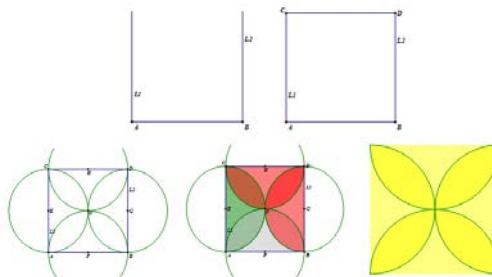Sixth, unify the color, and then hide the redundant line segments and points.

Fig.1 -3 Coloring a "Flower".

4. "Indirect" Coloring through Construction in Geometer's Sketchpad

4.1 Coloring a ring

First, create a new sketchpad. Draw two concentric circles C1 and C2 with O as the center through the sketchpad tool;

Second, select C1 and C2 respectively to construct the inner part of the circle;

Third, select C1, right-click other colors, and pull the "◀" label on the rightmost side of the prompt bar to the top, which is white;

Fourth, select C1, right-click the attribute, and adjust the transparency degree to 100% opaque;

Fifth, hide redundant points and modify internal colors as required.

Fig.2 -1 Coloring a ring.

4.2 Coloring Two Arcs

First, create a new sketchpad, and draw line segment AB directly using the line formation tool;

Second, click line AB; rotate it 90 degrees with A as the center to get L1, and rotate it 270 degrees with B as the center to get L2;

Third, click L1, measure the length, and then click to realize the translation transformation of AB with the length of L1; intersect the line with L1 and L2 at C and D;

Fourth, select CA and DB to construct midpoint E and F; construct line segment EF and construct midpoint G; connect CGA and DGB respectively to make a three-point arc;

Fifth, connect ABCD in turn to color it, and then color two arcs respectively and select the white color;

Sixth, set the attribute transparency of the two arcs to 100% opaque;
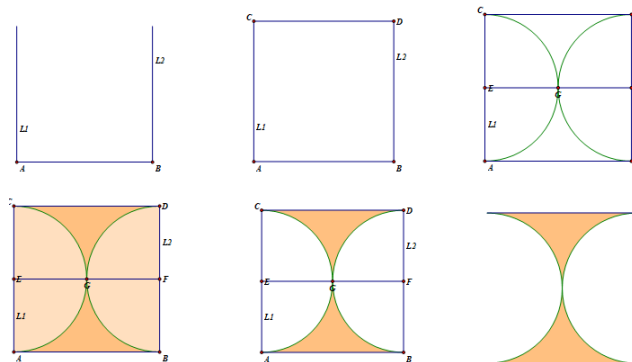
Seventh, hide redundant line segments and points

Fig.2 -2 Coloring Two Arcs.

4.3 Coloring "Tai Chi"

First, create a new sketchpad, and draw circle C1 with O as the center directly with the tool in the *Geometer's Sketchpad*;

Second, find any point A on the circle; take O as the center, transform and rotate point A 180 degrees to obtain A', and construct line segments AA', AO and A'O;

Third, select AO and A'O, construct midpoints B and C; construct circles C2 and C3 with BO and CO, and select any point D, E and F on C1, C2 and C3;

Fourth, connect ADA', AEO and OFA' respectively to construct the arc of three

points, and color them uniformly;

Fifth, right click to make the OFA' color white; set the attribute of transparency as 100% opaque; hide redundant lines and points
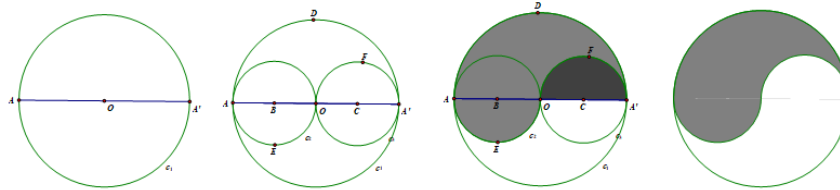

Fig.2 -3 Coloring "Tai Chi".

5. Coloring Function Graphics and Images in Geometer's Sketchpad

5.1 Composition between the Dye Function Image and Coordinate Axes

First, create a new sketchpad, and draw a new function $f(x) = (x/2)^2-2$, so that the function intersects X axis at A and B points;

Second, construct line AB; select any point P on the function below line AB, and make P perpendicular to AB and intersect at point Q;

Third, connect PQ to get a line segment; hide the vertical line, and select P and PQ to construct the track;

Fourth, select any point S on the function above line AB, and make S perpendicular to X axis and intersect at point T;

Fifth, construct segment ST, hide vertical line, select S and ST to construct the track.
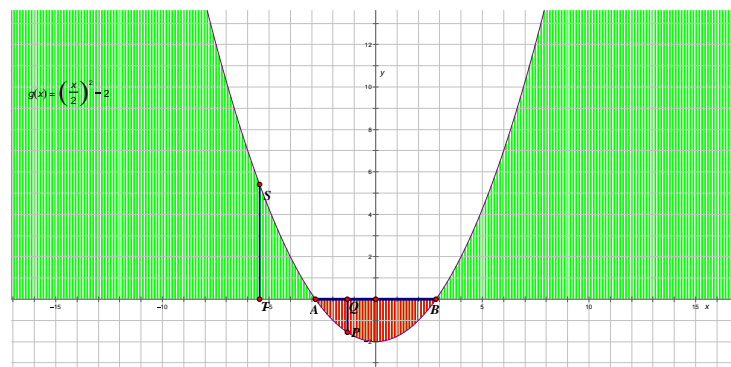

Fig.3 -1 Composition between the Dye Function Image and Coordinate Axises

5.2 Composition of Dye Function Image and Line Segment

First, create a new sketchpad; draw new functions f (x)=-4／x, and f (x) = - x;

Second, make the function f (x) = - 4 / x and f (x) = - x intersect at A and B;

Third, draw point C (3,0) and point D (- 3,0) on the function;

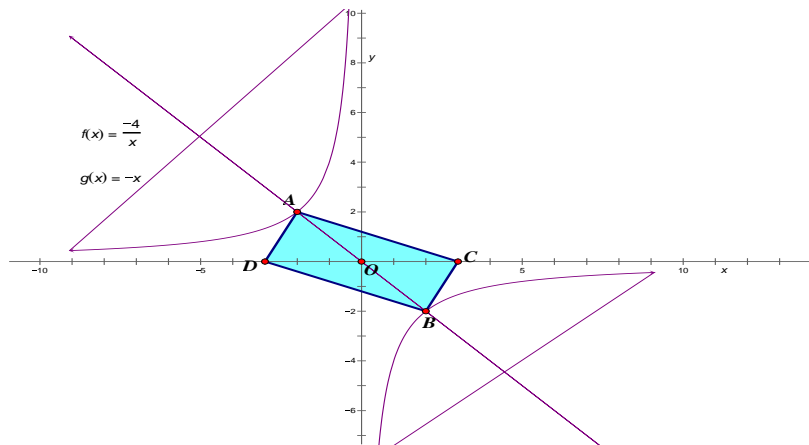Fourth, connect points A, C, B and D successively to form a quadrilateral ACBD.

Fig.3 -2 Composition of Dye Function Image and Line Segment

5.3 Composition of Dye Function Image and Intersection Point

First, create a new sketchpad and draw new functions f (x) = 4 / x and f (x) = - x + 5;

Second, make f(x)=4／x and f(x)=-x+5 intersect at points A and B; f (x) = - x + 5 intersect X axis at point D, and intersect Y axis as point C;

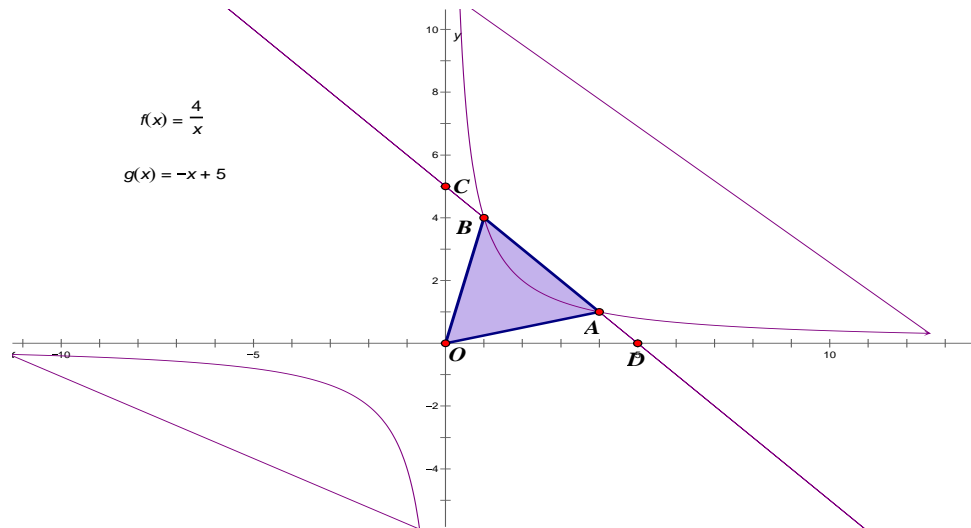Third, connect points A, B and O successively to form a triangle ABO

Fig.3 -3 Composition of Dye Function Image and Intersection Point.

6. Conclusion

The Geometer's Sketchpad can make abstract mathematical knowledge more vivid, concrete, intuitive and easy to understand. Using the *Geometer's Sketchpad* as an auxiliary teaching tool in mathematics courses can not only change the mathematics class from a single class to a variety of classes, but also increase students' interests and exploration consciousness in autonomous learning. As an auxiliary tool of mathematics teaching, *Geometer's Sketchpad* can change mathematics classroom from static state to dynamic state, and shorten the distance between mathematics learning and real life.

This paper mainly discusses the coloring of special elements and regions in *the Geometer's Sketchpad*, and explores the three coloring problems of "internal coloring", "indirect coloring" and "functional coloring". It is hoped that the teaching through *Geometer's Sketchpad* can become more convenient and colorful, and that students can love mathematics, enjoy learning mathematics and become masters of learning.

Acknowledgement

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