Chapter 22
Effectiveness of GSP-Aided Instruction

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ABSTRACT

The objective of this study was to determine the effectiveness of the Geometer's Sketchpad (GSP) in teaching the area of triangles to elementary students. The authors adopted a pretest-posttest research design with 2 equivalent groups. The subjects of the experiment comprised fifth-grade students from an elementary school in Pingtung County, divided into an experimental group of 26 students and a control group of 25 students. Both groups attended six 40-min lessons over a month, with the experimental group receiving GSP-aided instruction and the control group receiving traditional lecture instruction. The authors revised the test instrument based on Tan (1998), and the instrument was further reviewed and revised by experts. They conducted a third revision of the contents after performing a pilot test. The difficulty index of the test ranged between 0.18 and 1, and the discrimination index ranged between 0.13 and 0.88. The split-half reliability of the test was 0.8723. The results revealed the following: (a) in learning the area of triangles, the experimental group performed significantly better than the control group; (b) the results of the formative assessments indicated a superior performance in the experimental group compared with the control group in all of the lessons, with the exception of the second lesson; and (c) the male and female students in the experimental group and the control group exhibited no significant differences. Based on these results, the authors suggest that students be offered the opportunity to use concrete teaching aids or computer simulations when learning the area of triangles.

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INTRODUCTION

Research Questions and Background

Elementary school students typically do not have too much difficulty understanding the geometry of circles, squares, and rectangles. The majority, however, recognize only equilateral and isosceles triangles as triangles. The shapes of triangles are diverse, and include obtuse triangles, acute triangles, and right-angled triangles. Although most students can recite area formulas, they cannot explain the origins of these formulas clearly, which shows that their perception of the area involves merely rote memory, rather than an understanding of the derivation process. This often results in students using formulas incorrectly when solving problems (Tan, 1998). Furthermore, in traditional lecture instruction, the student is often considered a passive receiver of knowledge; with such unidirectional communication, it is difficult to achieve real learning progress. By contrast, constructivism emphasizes the active role of the student. Education is currently inclined toward free constructivist learning approaches, in which new information is linked to existing knowledge, thereby corresponding to developed archetypes (Resnick, 1983). Therefore, students must actively participate in activities geared toward different learning modes to stimulate and strengthen cognitive growth (Larkin & Chabay, 1989). The microcosm of the physical world that can be represented on computers enables students to explore, experiment, and operate artificial systems or models with actual scientific effects (Dede, 1987).

In the IT Whitepaper in K-12 Education, the Ministry of Education (MOE, 2008) stated that schools must develop diverse digital teaching resources, and enhance the IT equipment and network services in classrooms, so that in the future, the incorporation of IT into the teaching field will no longer be restricted to computer laboratories. Software associated with mathematics includes SAS for statistics, Maple and Mathematica for algebra, and Excel for numerical computations. However, it is difficult for math teachers to master these programs and apply them to teaching (Kaput, 1992). Numerous researchers and teachers are currently studying dynamic geometry, but the majority are focusing on problem-solving. Rarely have they concentrated on the process of cognitive psychology. Jackiw (1991) created the Geometer's Sketchpad (GSP), a tool that enables users to construct and manipulate basic geometric shapes. Phonguttha, Tayraukhamh, and Nuangchalerm (2009) compared the effectiveness of GSP as a teaching medium against traditional textbook teaching. Their results revealed that the GSP can improve mathematics achievements and the analytical thinking of students effectively. The GSP allows the teaching of mathematics to begin from dynamic shapes, enabling students to follow an intuitive process of learning. It provides a geometric construction, continuous dynamic transformation, structure retention, a view of the specific as general, and the recording of the geometric construction process. These functions provide a simple teaching environment in which to discuss the properties of different geometrical shapes. Students can thus observe, experiment, conjecture, and generalize the constant properties of continuously changing dynamic shapes. Kurz, Middleton, and Yanik (2005) stated that the GSP enables students to test their hypotheses regarding geometrical shapes, relations, and transformations, and other researchers have agreed that using dynamic visual teaching methods helps deepen students' understanding of mathematical concepts (Fallstrom & Walter, 2009; Teoh & Fong, 2005).

Van Hiele and van Hiele-Geldof (1958) divided the development of geometric thought into five levels: (a) visualization, (b) analysis, (c) informal deduction, (d) formal deduction, and (e) rigor. These