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Creativity and Insight in Problem Solving

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ABSTRACT This paper analyzes the thought process involved in problem solving and its categorization as creative thinking as defined by psychologist R. Weisberg (2006). Additionally, the notion of insight, sometimes present in unconscious creative thinking and often leading to creative ideas, is discussed in the context of geometry problem solving. In particular, it is argued that solving insight problems used by psychologists to measure creativity and solving certain geometry problems share similar thought processes.

KEYWORDS *problem solving, creativity, creative thinking, insight, geometry*

Problem Solving as a Creative Process

"Virtually every major twentieth-century psychologist (e.g., Freud, Piaget, Rogers, Skinner) has taken creativity seriously and explored what it means to be creative, and at present the field can be described only as explosive" (Kaufman & Sternberg, 2010, p.4). Psychologists have always been interested in creativity, but it wasn't until recently that the definition of creativity has been explored and broadened enough to lend itself to the interdisciplinary connections being made today. As a result, today's psychologists offer many perspectives on creativity, and even mathematics education scholars have begun to explore the concept.

What is "creativity?" Current definitions disagree in greater or lesser ways. In the case of problem solving, the notion of value in a creative product is most relevant since one might question the value of a student's solution in the field of mathematics. According to theorist R. Weisberg (2006), "creative thinking occurs when a person intentionally produces a novel product while working on some task" (p.70). He emphasizes that, "sometimes those intentional novel products are valued highly by society, and sometimes they are not, but all of them are creative products" (Weisberg, 2006, p.70). Two main points from Weisberg's definition allow students' solutions to be considered creative. One is the fact that the value of their solutions in society is not regarded. The other is that their solutions only need to be novel to each individual.

The National Council of Teachers of Mathematics (NCTM) defines a problem as "a task for which the solution is not known in advance" (Problem Solving, 2016). Along this line, in his book *Creativity*, Weisberg notes that,

> The critical characteristics of problem solving are that the situation be novel and that the person devise a sequence of operators that changes the problem into the goal. Since the person has never been in the situation before, if he or she solves the problem then the solution must be novel. […] The novelty of a problem means that you must go beyond what you know and devise a method that is new for you and that fits the situation you are facing (Weisberg, 2006, p.126).

In the case considered for this paper, it is assumed that all of the problems posed to students are new to them, and thus the solutions they produce are also novel to them. When presented with a problem, students use the skills and knowledge they have to create a solution via their own unique thought process. According to Weisberg, if a student were to retry the problem at a later date with the solution already in mind, then a creative product would only arise if the new solution were different from the previous one. In this case, the teacher serves as the external verification that Weisberg mentions is necessary in order to confirm that the product is novel to the creator.

Similarities with Gestalt Insight Problems

Early in the twentieth century, Gestalt psychologists began to discuss the presence of leaps of insight, or *Aha!* experiences, which occur when "new ideas seem to flash into consciousness from nowhere, bringing with it a way of looking at a problem that is totally different from what one had just been thinking about" (Weisberg, 2006, p. 94). The relevance of insight in this discussion of creativity is supported by research cited by Weisberg when he notes that, "the question of the role of insight in problem solving is important because there is a close connection between insight and creativity" (Weisberg, 2006, p. 291). In particular, leaps of insight occur within the unconscious processing in creative thinking. These moments commonly result in creative ideas or problems being solved.

Weisberg compiled a set of insight problems that psychologists have used in research and that do not include content from any particular field of study. In fact, the problems require little to no prior knowledge to solve them. One most commonly used is the Candle Problem shown in Figure 1. In this problem, several items are placed on a table and the individual is asked to attach the candle to the wall so that it will burn properly. The objects provided are a candle, matches, and a box full of tacks.

The solution involves taking the tacks out of the box and attaching the empty box to the wall using the tacks. Then, the candle is placed on the box for support while it is lit.

In their study, Weisberg & Suls (1973) found that when solving insight problems, a failed attempt resulted in the acquisition of new knowledge which affected subsequent attempts. In the example of the problem shown in Figure 1, this often occurs when attachment of the candle to the wall with seemingly useful objects fails and new information such as the weight of the candle is realized. Subsequent attempts involving sturdier mechanisms to hold up the candle may lead to a solution. This process is an example of what Ohlsson (1992) calls *restructuring.* Furthermore, Fleck and Weisberg (2004) researched the use of verbal protocols of solvers attempting the candle problem, and found that restructuring mostly occurred when realizing that initial attempts did not work. This restructuring is viewed as coming out of a sudden moment of insight.

Ohlsson also did a study on "The Mechanism of Restructuring in Geometry" in 1990. In his study, Ohlsson examined 52 verbal protocols of participants solving geometry problems. In particular, he sought evidence of restructuring and found that this occurred in three different ways: deliberate restructuring, goal driven restructuring, and restructuring in response to a hint. The goal restructuring case involved the solution to the geometry problem shown in Figure 2.

The subjects were given this problem along with a set of theorems, some of which were useful to the solution of the problem. In an attempt to solve this problem, one participant viewed the figure in such a way that he thought the proof could be transformed to show triangle EDC was isosceles. However, this caused him to reach

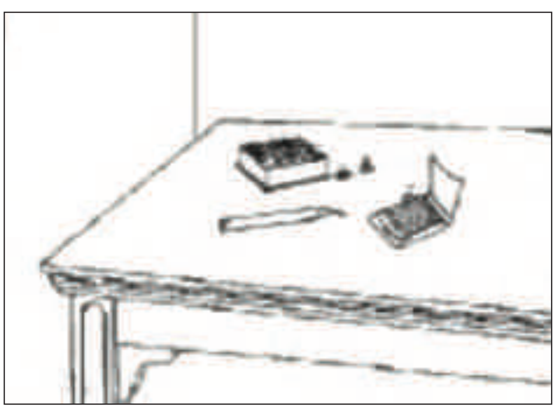

Figure 1. Candle Problem (Weisberg, 2006).

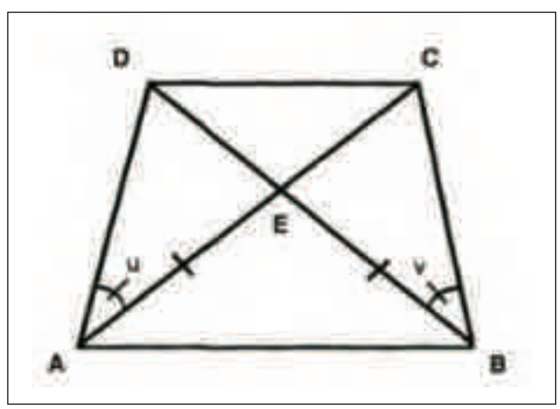

Figure 2. Problem 1 (Ohlsson, 1992).

an impasse, which is a period of no progress. After restructuring in the sense of seeing the figure "from another angle" (Ohlsson, 1992, p.9), the participant realized that ED and EC were corresponding sides of triangles EDA and ECB. This realization resulted in a correct solution.

This example illustrates how some geometry problems require the restructuring found in insight problems. Often times, when students are stuck on a problem (i.e. when they reach an impasse) it takes visual image restructuring to realize what information given is relevant and how to proceed to a solution. In particular, in geometry problem solving, "restructuring involves a change in the mental representation of the current search state" (Ohlsson, 1992, p.6). Restructuring, or analytic thinking as Weisberg would say, is what allows students to succeed in solving these problems.

G. Hartmann (1937) provided another simple example shown in Figure 3 that brings forth the notion of *fixation.* Fixation is another common characteristic of the thought process involved in insight problem solving and some geometry problems. Fixation in the Candle Problem most commonly occurs when students take the function of the tack box as being fixed to just a container to hold the tacks. It is not until they eliminate this fixation and open their minds to an alternative purpose for the box, that they can solve the problem by using it as a stand for the candle. Similarly, when students are shown Figure 3(a), and asked to find the area of the circumscribed square knowing only the radius of the circle, they may be fixated on the position of *r* and have trouble seeing how it is related to the side length of the square. They need to look beyond this fixation and consider alternative, more convenient positions for *r* as shown in Figure 3(b). The presence of fixation in solving both problem types further supports the close relationship between the thought processes involved in solving certain geometry problems and insight problems.

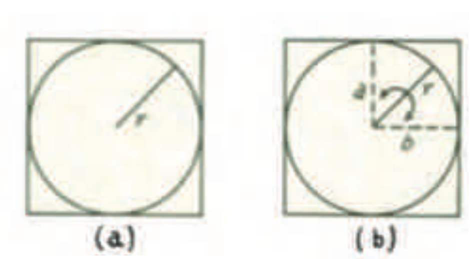

Figure 3. How insight operates with quantitative relations (Hartmann, 1937).

Closing Remarks

It is important to note that although geometry was used as a focal point for this discussion, a similar analysis can also be applied to other areas of mathematics. Beyond the proposed similarity between the cognitive processes involved in solving Gestalt insight problems and certain geometry problems, one might seek to demonstrate a cause-and-effect relationship between mathematical problem solving ability and performance on Gestalt insight problems. This could, in turn, lead to a broader exploration of how the development of mathematical thinking can positively benefit creative thinking as defined by certain theorists.

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