Journal of Tourism and Sports Management (JTSM) (ISSN: 2642-021X)
SciTech Central Inc., USA

2023
Vol. 5(3)
1712-1718

AGAINST THE TERM CREATIVITY STUDIES MATHEMATICAL CREATIVITY EXAMPLES

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Received 20 June 2023; Revised 22 June 2023; Accepted 23 June 2023

A SHORT STORY OR A LONG INTRODUCTION

Almost 50 years ago, when studying for a teaching license in mathematics and physics at the Hebrew University in Jerusalem, I participated in the compulsory course: "The Educational Meaning of Science Teaching". The lecturer was the late Prof. Yeshayahu Leibowitz, one of the greatest Jewish scholars of the 20th century. He was both a scientist and a philosopher, a professor of biochemistry, organic chemistry and neurophysiology at the Hebrew University, a Kantian philosopher, the writer of enormous amount of scientific and philosophical articles and books, written from his unique political and religious point of view, as an Ultra-Orthodox Jew who belonged to the "hard core" left in Israel. Leibowitz was also one of the editors of the Hebrew Encyclopedia (Leibowitz, 1954-1971). and starting in volume 17 – its sole main editor. Rumors about his involvement claimed that in addition to serving as the main editor of the whole Encyclopedia, the main editor of natural sciences department, and the editor of the chemistry, biology and medicine sections, but also contributed hundreds of encyclopedic entries to various other sections, such as religion, bible, philosophy, history and more.

At that time Leibowitz was considered quite unique also because he was living as an Orthodox Jew, while outing his opinions about Israeli politics and politicians. He publicly criticized Israeli policy of depriving civil rights from about two million Arabs under Israeli occupation, and even "invented" the creative term "Judeo-Nazis" (Ravitzky, 2011). to describe the mentality existing among some Jewish Israelis regarding their attitude and behavior towards Arabs in general and Arabs living in the Gaza strip and the west bank in particular. In fact, Leibowitz excluded himself from the "Israeli consensus", which resulted in being condemned by many Israeli public figures. In protest of these opinions and expressions the late Israeli Prime-Minister, Yitzhak Rabin, threatened to boycott the ceremony of the Israeli Prize Prof. Leibowitz had been awarded (Hoffman, 1993).

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So, when in winter 1973 this 70-year-old giant figure, looking like an old prophet, walked into the auditorium, all of us, students of the faculty of natural sciences learning for a teaching certificate in natural sciences and mathematics, were holding our breath. We admired him for his sharp mind and accomplishments, and for teaching us voluntarily: as a retired professor receiving a monthly pension he was not paid for teaching. But we were quite frightened of his sharpened tongue, that earned him the label "the apocalyptic prophet" (e.g. Marilus, 2011) of Israeli society, so we were all silent. But then, the thin, somewhat hunchbacked man walked slowly towards the podium, put his worn-out brown leather bag on the chair, straightened his back and while moving his thumb up in a slow motion, cutting the air in an imaginary arc, he shouted: "teaching sciences has NO educational meaning". That was the most important class I had during the two years of lectures, pre-service training, supervised teaching and workshops I took for the certification for teaching high school math and physics.

The main lesson I learnt form the late Prof Leibowitz was to ask the basic questions. In the case of creativity studies, it would be, in my opinion, "can creativity be studied? If not - why teaching it?

This short story/long introduction violated many rules of writing a "scientific article". 1. A short story should not replace either an abstract or an introduction. 2. The introduction should be strictly connected to the main parts of the article. 3. An article should include many references to prove that the author had done their homework - go over past works, agree or disagree with each of them, before "daring" to express any new idea, proving (or disproving) one or more assumption. By choosing a different way I have tried to be more creative in order to get the reader's attention, which maybe will contribute to opening the gate to write social sciences papers in more creative ways.

ARGUMENTS AGAINST CREATIVITY STUDIES

In my opinion, creativity cannot be taught, and thus cannot be learned. Learning is a process that can be complete either with others' help: teachers, parents, friends, etc., or, as happens quiet frequently among the gifted, with no such assistance (Kay, 2002; Winner, 2000). In fact, according to (Gagné,2005). the major developmental agent for gifts is maturation, closely followed by informal learning. In the case of talents, it is the opposite, with institutional (or autodidactic) systematic learning accounting for most of the developmental impact.

Let us examine the term: "giftedness studies". It includes, for example, "giftedness research" (e.g. Plucker, & Callahan, 2014; Ziegler, 2009), Conceptions of Giftedness (e.g. Moon, & Brighton, 2008; Renzulli, 1978; Sternberg & Davidson, 2009), and Definitions of giftedness (Carman, 2013). All these terms, broadly used and easily understood, and supposed to be well-defined. However, researchers, educators and mental health professionals refer to each of them separately, considering that there is not always a general agreement as to their exact meaning, or to the one and only one accepted definition. For example: any concept of giftedness depends on the definition used for "giftedness"; while

some definitions of giftedness depend on the means taken for their measuring (e.g. Fernández et al., 2017; Pfeiffer, 2002; Pfeiffer & Jarosewich, 2003; Rodríguez et al., 2017), others are not depended on any unified measuring, e.g. self-, parent, or peer-nomination (e.g. Bevan-Brown, 2009; Kaya, 2013; Zavala Berbena, & de la Torre García, 2021; Weston, 2001; Wu Hensley, 2010).

Examining the term "creativity" will probably result in similar conclusions. Creativity has been defined by various multi criteria (e.g. Glück, Ernst, & Unger, 2002; Renzulli, & Gaesser, 2015; Runco, & Jaeger, 2012). But unlike giftedness, which when deeply examined does have some widely-accepted criteria, such as IQ, measured by more- or less valid and reliable criteria, with entities such as p-value calculation, up to now creativity lacks any such definitions. Indeed, there are creativity tests, but both their validity and reliability are poor and all of them – including the one most used, Torrance Tests of Creative Thinking (TTCT), have severe limitations (e.g. Kim, 2006). According to Cropley, (2000) creativity assessment should not be based on one single- but rater on several tests. The most comprehensive longitudinal study, which presented the results of the 50-year follow-up of the longitudinal study E. Paul Torrance started in the late 50ies showed, that scores were moderately correlated with personal, but not with public, achievement. On the other hand, the interaction of intelligence and creativity was significantly related to public achievement but not to personal achievement (Runco, 2010).

Creativity has been considered the essence of human achievements, as the product of giftedness and many other components - psychological, cognitive, musical, artistic, etc. In spite of this, until the third decade of the 21st century no creativity test has been fully accepted by researchers or educators as good-enough for any age-group in any population or culture. Maybe it is time to accept the fact that regarding creativity - the role of educators, parents, and mental health professionals is not to suppress it rather than to teach or practice it.

The main reason for giving up the ambition to "teach creativity" should be connected, in my opinion, to "[…] the lack of a universally acceptable operational definition of creativity" (Abedi, 2002). But unlike the case of cognitive giftedness, for example, when in spite of the lack of one well-accepted definition and a variety of tools can be used, quite successfully, to measure verbal and mathematical-logical abilities, the situation of measuring creativity is quite different, as. "[…] many different instruments have been developed that not only differ in the number and type of questions but also differ in what they measure" (ibid).

LET US LOOK AT THE CONCEPT CREATIVITY IN MATHEMATICS

Mathematical creativity is a scientific field that had been intriguing scientists, educators and psychologists for many years, but it had become one of the main research areas of educators, philosophers and mathematicians especially during the 20th century (e.g. Birkhoff, 1969; Hadamard, 1945; Muir, 1988; Poincaré, 1910, 1920). However, not even one of these scholars suggested, that creativity can be taught; all of them focused on the knowledge needed in order to

achieve high enough level of knowledge in order to materialize one's creativity. Furthermore, when discussing the nature of mathematical creativity, these scholars show that there are various ways towards it; sometimes creativity needs "undoing" - sleep (Hadamard, 1945). or other kind of "time off" makes creativity flourish. In mathematics there are no "big" or "great" problems versus small ones, and thus every new idea, new way to solve a problem, or an idea that helps proving that a problem is insolvable is creative. (Polya,1968).1954]) had phrased this truth as "A great discovery solves a great problem, but there is a grain of discovery in any problem" (p. 458). In any case, the accepted belief about mathematical creativity is that without a solid basis of learning mathematics as a language, as a set of rules needed to be rehearsed time and again until it is clear enough to start "the game" (Birkhoff, 1969), there is no space for creativity.

In his famous book: Aha! insight and in the following one: Aha! Gotcha: Paradoxes to Puzzle and delight" (Gardner,1978). 1982, consequently) has offered a variety of mathematical problems, riddles, "mysteries" and oddities for the interested, curious, challenged individual. In order to come to a solution the reader needs first to love mathematics and/logic; in order to be good at coming to a solution mathematical practice is needed/ Persistence is also needed; sometimes a wrong answer is the result of a lot of mathematical work, and the knowledge acquired during the process of thinking in mathematical and logical terms, as well as developing to overcome the frustration when after a lot of effort does not result in the right answer, will be in use when climbing up on the mathematics ladder. Sometimes it looks as if a person "has got it" when solving a problem much quicker than expected, but in most cases the quick, right answer is a result of many hours of exercising elementary math and trying to solve problems in logic.

The great mathematician (George Polya,1954). had formulated the inability to teach creativity in mathematics by explaining the difficulty in teaching how to use math intuition or guessing:

I do not believe that there is a foolproof method to learn guessing. At any rate, if there is such a method, I do not know it, and quite certainly I do not pretend to offer it on the following pages. The efficient use of plausible reasoning is a practical skill and it is learned, as any other practical skill, by imitation and practice. I shall try to do my best for the reader who is anxious to learn plausible reasoning, but what I can offer are only examples for imitation and opportunity for practice.

In what follows, I shall often discuss mathematical discoveries, great and small. I cannot tell the true story how the discovery did happen, because nobody really knows that. Yet I shall try to make up a likely story how the discovery could have happened. I shall try to emphasize the motives underlying the discovery, the plausible inferences that led to it, in short, everything that deserves imitation. Of course, I shall try to ^impress the reader; this is my duty as teacher and author. Yet I shall be perfectly honest with the reader in the point that really matters: I shall try to impress him only with things which seem genuine and helpful to me (Preface, pp. 6-7).

Another example is Matchsticks puzzles, namely, the rearrangement of matchsticks as squares, rectangles or triangles, where the problem to solve is usually formulated as: "move n matchsticks to make m squares, triangles, or rectangles", or "move n matchsticks so that the math exercise in the left side will have the same value as in the right side" require a certain amount of creativity. However, the only way to increase the ability to solve such puzzles is by exercising, as is the highway to improve math abilities in all other areas.

UNTRADITIONAL SUMMARY

In fact, almost all math students so not come across any problem that requires creating something new until the end of their MSc formal classes, when they have to choose a subject for their thesis. Even then in most cases it is their MA counselor that suggests the subject of their thesis, and in many cases their thesis is approved when it shows that the problem, they had worked on is improvable.

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