

Notes from the Field: creativity kidnapped. Discussion essay

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Abstract: *The essay discusses the process through which the subject of creativity has been limited in scope by the imposition of external to creativity professional standards. The primary focus of creativity research in mathematics is on the relationship of creativity with giftedness, which habitually is determined by SAT and other scholastic scores. This focus eliminates attention to the creativity of the ‘rank and file’ learners to the degree that almost nothing is known about creativity of ‘normal’ students, and in particular, about the creativity of underrepresented. That’s the content of Creativity Kidnapped. The second part of the essay offers the avenue for Liberation of Creativity, which is anchored in the concept of bisociation by Koestler, (1964), that is in the creativity of the Aha!Moment. Aha!Moment is widely known, common experience of creative insight.*

SECTION 1. INTRODUCTION

The presented essay is the outgrowth of the recent work of the Teaching-Research Team (TRT) of the Bronx focused on preparing the conference grant Creativity in STEM for the NSF INCLUDES program (Dear Colleague Letter 17-111). The NSF INCLUDES program is a recent progressive initiative of NSF whose aim is to increase participation of women, minorities and working class students in STEM industry. After two yearly solicitations, the program’s portfolio has around hundred successful awards for the pilot projects from around the nation. Each pilot project explores a new avenue of teaching and/or organization which hopefully will lead to the increase of participation of ‘underrepresented and underserved’ in STEM careers.

The TR Team of the Bronx has been exploring the creativity of Aha!Moment in mathematics classrooms for the last 8 years. Our attention was attracted to the NSF INCLUDES portfolio of awards because none offered mathematical, scientific or engineering creativity as a fundamental motivational and cognitive component for the dreamt about increase of participation. 8% of the projects listed creativity in their abstracts as an interesting by-product of the project. The dissonance between the absence of attention to STEM creativity by educators and the explicit need has been expressed more often by the industry as:

- ARMONK, NY - 18 May 2010: According to a major new IBM (NYSE: IBM) survey of more than 1,500 Chief Executive Officers from 60 countries and 33 industries worldwide,

chief executives believe that – **more than rigor, management discipline, integrity or even vision** –successfully navigating an increasing complex world **will require creativity**.

- Jul 31, 2015 *Creativity in Engineering*, SpringerLink noted that Creativity is concerned with the generation of effective and novel solutions to problems. Engineering is concerned more specifically with generating technological solutions to problems. ... **Engineering, in short, is fundamentally a process of creative problem solving**. Cropley (2015) asserts that, “*Because creativity is concerned with the generation of effective, novel solutions, creativity and engineering are, in essence, two sides of the same coin*”. (p.2).
- Cooper and Hevearlo (2013) inform that according to the National Academy of Engineering, students need to begin associating the possibilities in STEM fields with the need for creativity and real-world problem-solving skills.

offered us rich food for critical thought which produced remarks below.

The approach we take here is aptly characterized by mathematics researchers as critical mathematics pedagogy, which is an approach to mathematics education that includes a practical and philosophical commitment to liberation. (Tutak et al, 2011) Approaches that involve critical mathematics pedagogy give special attention to the social, political, cultural and economic contexts of oppression, as they can be understood through mathematics (Frankenstein, 1983). They also analyse the role that mathematics plays in producing and maintaining potentially oppressive social, political, cultural or economic structures (Skovmose, 1994). Critical mathematics pedagogy demands that critique is connected to action promoting more just and equitable social, political or economic reform.

Thus, in Section 2 we describe the process by which educational profession had ‘kidnapped’ the knowledge about creativity for the benefit of giftedness, which is traditionally defined by the high scores in high stake tests such as SAT scores. The kidnapping of creativity left the researchers and practitioners without an approach which can address the creativity of “underrepresented and underserved”. The Section 3 focuses on the process of liberating creativity with the help of bisociation theory of Arthur Koestler, as the theory of “creativity of and for all”.

SECTION 2. CREATIVITY KIDNAPPED

The assault on creativity started in 2001 when Anderson, L & Krathwohl, D. with their team published the revised Bloom taxonomy based on the new research conducted between 1995-2000. The process resulted in significant changes in the original Bloom (1956) taxonomy. The comparison of the two is shown in Fig. 1 below. There are three essential changes in the revised taxonomy: (1) use of verbs instead of nouns, (2) changing Synthesis to Creativity and (3) the change of order between from Synthesis → Evaluation in the original Bloom’s taxonomy to the Evaluation → Creativity in the revised one.

One could argue that the priority of verb (or process) over the noun (the product) is equally biased as the priority of noun over the verb we see in the original taxonomy; both are necessary for the

full description of the cognitive content. We know, following Sfard (1992) that the object/process duality is one of central concepts in learning algebra.

However, the main issue as it relates to kidnapping creativity is not in the point (1) nor (2) - creativity often involves, of course, synthesis. The kidnapping process starts in the point (3) – the change of order between Evaluation and Synthesis/Creativity in the revised taxonomy. Note that Evaluation in the original taxonomy, which comes after Synthesis is characterized by the statement “*Judge value of [obtained] material for a given purpose*” while the evaluation in the revised one introduces a different element, significantly, before reaching creativity of the pyramid: “*make judgements based on criteria and standards*”. In other words, whereas Synthesis/creativity was the matter solely between the creator and the purpose of the creation in Bloom’s taxonomy, the revised taxonomy imposed the limitation upon creativity by requiring it to be in agreement with professional standards and criteria outside of the creative process. The adherence to the standards and rules was placed in advance of promoting learner’s thinking to the creative top of the revised taxonomy. These extraneous standards or criteria often serve as a filter.

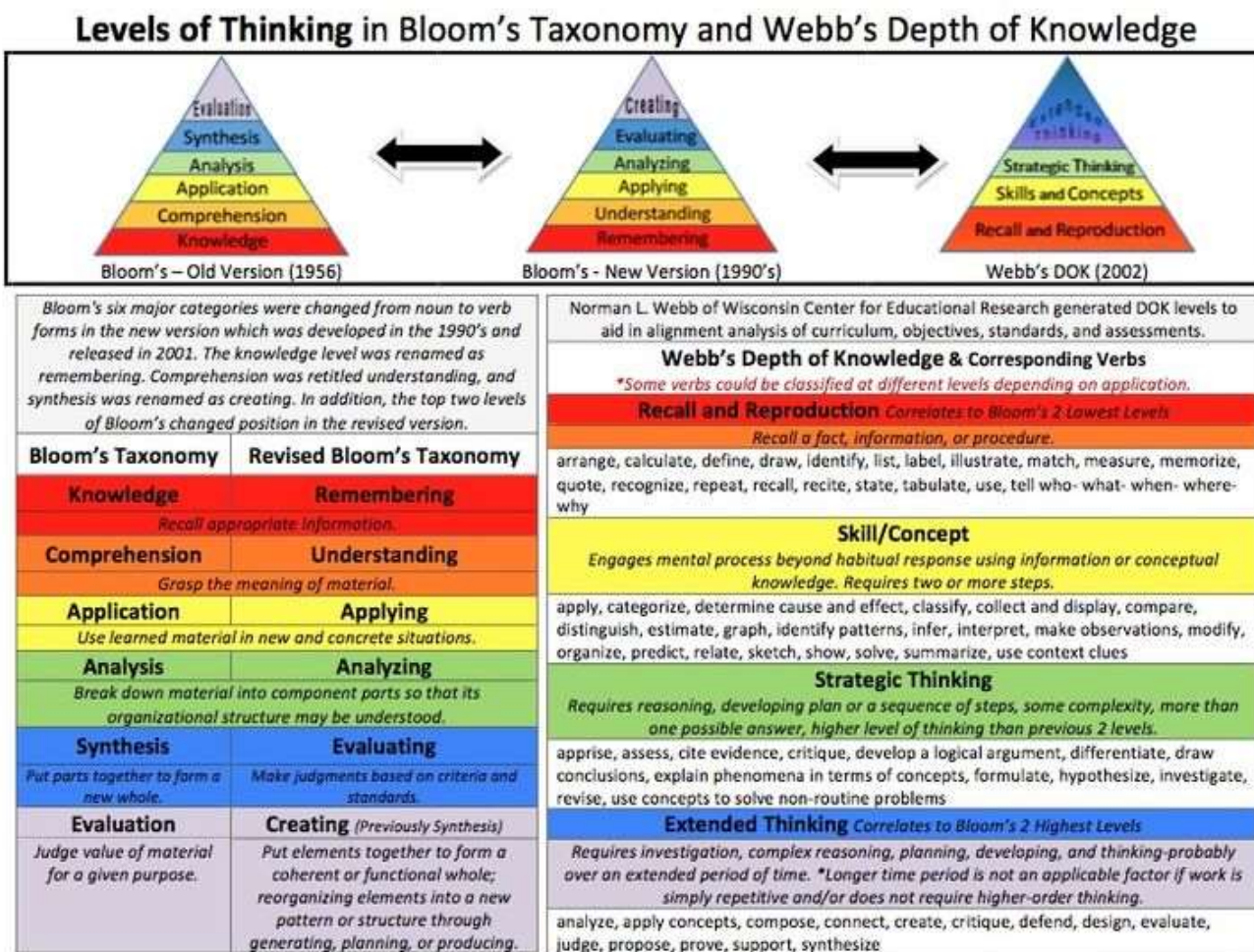


Fig. 1

How does this change impact our own profession of mathematics creativity research?

The creativity research in mathematics education has been focused on the relationship between creativity and giftedness. The majority of recent publications on creativity (Leikin and Koichu, 2009; Sriraman and Lee, 2011; Leikin and Sriraman, 2016) emphasize the creativity of the gifted. According to Wagner and Zimmerman (1986) giftedness is identified by high achievement in two tests: The Scholastic Aptitude Test (SAT) and the HTMB, a set of seven problems designed especially for talent search.

We see here clearly how the role of standards external to creativity is impacting research on creativity in mathematics education.

The work of Sriraman (2004) confirms the SAT paradigm in his choice of four gifted students for research on the creativity of their giftedness by pointing out that all of them scored in the first one percentile of the Stanford Achievement Test. This means that giftedness is traditionally found among students who are very good in school measures of achievement in mathematics. This approach filters out those students who might be creatively gifted, but who are not fluent in mathematics language and procedures. What does it mean to be mathematically creative, but not fluent in mathematical language? It means finding oneself in a remedial classroom filled with many other talented students who either don't know their own creative gift or are destroying it under emotional or material poverty stress. And that's why Prabhu (2016) notes on the basis of her teaching-research experience that *"the creativity in teaching remedial mathematics is teaching gifted students how to access their own creativity."*

How is creativity being blocked here in relationship to classroom instruction? There are at least two blocking spots. The first is within the realm of critical thinking. A lot of what we do in the classroom is supporting the interaction of ideas between students. In such a situation the importance of peer interaction or teacher student interaction may outweigh the need to verify if the ideas considered are up to professional standards. The second place I can see this interference is when you are trying to get students to involve their spontaneous intuitive knowledge and bring it to bear on a problem this requires conscious thought on semi-conscious actions. This process is helped along by critical analysis especially as the situation presented moves out of their intuitive comfort zone.

Keyung Hee Kim (2012; 2008) has made recently a significant and relevant observation of the decrease in Creative Thinking Scores on the Torrance Test of Creative Thinking. The significant decrease of Fluency and Originality scores was observed between 1990 and 2008. The largest decrease was for the kindergarteners through third graders; the second largest decrease was for four through six graders (p.292). These very students have now become the majority of the population entering community colleges across the nation. Kim (2008) reviews the studies and theories that have shown that once underachievers are placed in an environment that fosters their creative needs with motivation, mentors, understanding, freedom, and responsibility, they can become highly productive. She notes that *"many gifted students are underachievers and up to 30%*

of high school dropouts may be highly gifted.” Naturally that percent is higher in the community colleges where former high school dropout students enter through GED exams. Thus, similarly, to Prabhu (2016), Kim suggests that once “underrepresented” are surrounded by the creative learning environment, their motivation for learning and understanding of STEM disciplines increases.

The imposition of professional standards upon the definition of creativity have eliminated a sizable sample of creative ‘rank and file’ students from attention of our professional research. In fact, Sriraman et al (2011) point out understanding “*The role of creativity within mathematics education with students who do not consider themselves gifted is essentially non-existent* (p.120).” Chamberlin (2013) asserts that “*Missing is information on what initiatives are in place to develop and facilitate mathematical creativity in underserved and under-identified populations. This type of discussion would be informative to the field of gifted education and counter the criticism that field is not inclusive.* P.856)”. We not only don’t know the nature of creativity of ‘rank and file’ students, but we also don’t have tools to investigate it. The tools developed in the context of mathematical giftedness cannot fit the tools needed here (Czarnocha et al, 2016).

SECTION 3. CREATIVITY LIBERATED

The act of creation is

The act of liberation:

The defeat of habit by originality.

Arthur Koestler, *The Act of Creation*

The search for the appropriate approach to creativity which can take the creativity of the “underrepresented” into account, or the search for “creativity of and for all” is on.

Our own team, the Teaching-Research Team of the Bronx has focused attention on the commonly known Aha!Moment called also Eureka experience as the manifestation of creativity in our classes and in their communities. Vrunda Prabhu (2016) coordinated the bisociation theory of Aha!Moment Koestler (1964) with classroom events in remedial mathematics, showing, together with Liljedahl (2013), its high positive motivational and cognitive value. The definition of bisociation as *the spontaneous leap of insight which connects two or more unconnected frame of reference*, (Koestler, p.45) and makes us experience reality along two planes at once, offers hints how to facilitate Aha!Moment (Czarnocha and Baker, 2016) and how to measure the depth of knowledge (DoK) reached during the moment of insight (Czarnocha, 2018). The DoK assessment is based upon the coordination of bisociativity with theories of learning by Piaget, in particular, PG Triad of conceptual development (Piaget and Garcia, 1987). Baker (2016) had demonstrated that two central components of reflective abstraction, interiorization and transcendence are reachable, in the context of problem solving, through the insight of Aha!Moment.

Interiorization defines the distinction between students who appear to understand during the social classroom learning experience and those who do not internalize and hence suffer from the so called ‘next day effect.’

The question here is how to free creativity from extraneous standards and criteria. Focus on the nature of the creative insight suggests itself as helpful in that very respect. Since the intrinsic quality of such an insight is connecting unconnected frames of reference or matrices of thought, that is building a schema of thinking, the natural approach is to look upon it from the viewpoint of the development of the schema. That’s why PG Triad as the theory of schema development is so useful as a DoK assessment tool. It measures content of insight – the change in understanding during the ‘leap’ of insight.

The analysis of Aha!Moments reached by students in remedial mathematics classrooms (Czarnocha, 2018) shows the inadequacy of standard taxonomies of Bloom, Anderson and Krathwohl revised taxonomy of Bloom as well as following them DoK instrument by Webb (2002) due to their static character. Absence of the dynamical instrument tracing the development of conceptual understanding from one level to another makes it difficult to analyse dynamics of insight. The process of understanding present during an Aha!Moment may involve several dynamic cycles of movement from elementary understanding of mathematical concepts through their analysis to the creative synthesis, all in an instant. Coordination of bisociativity with reflective abstraction offers exactly the instrument of analysis responding to the dynamics inherent in the insight. Reflective abstraction is used in educational research to assess and analyse student learning. While most authors use of this concept reflect Piaget definition, they tend to vary in application and interpretation. Koestler work on creativity, in particular on bisociation provides a lens through which to interpret the work of Piaget on schema development though the creation of meaning i.e., schema.

One of the central observation which allows and promotes the investigations of creativity of every student has been brought to light by Shriki (2010) who indicates two of the main reasons for the absence of research into creativity of the rank and file: “(1) *The significance of creativity in school mathematics is often minimized because it is not formally assessed on standardized tests, which are designed to measure mathematical learning.* (2) *The problem with relating to students’ work as ‘creative’ is rooted in the definition of creativity as a useful, novel, or unique product...Although according to the traditional view of creativity; students’ work would not be considered as creative, the researchers agree that students’ discovery may still be considered creative if we examine the issue of creativity from a personal point of view, namely, whether the students’ discoveries were new for them.*”

This important broadening of the domain of creativity to include its subjective component is supported by several statements by mathematicians and scientists based on experience:

- (1) According to French mathematician Hadamard: “*Between the work of the student who tries to solve a problem in geometry or algebra and a **work of invention**, one can say that there*

is only the difference of degree, the difference of a level, both works being of similar nature” Hadamard, (1945, p.104). Similar assertion is known of Polya (1981).

- (2) Applebaum and Saul, (2009) observe *“a remedial algebra student can exhibit creativity as often and as clearly as an advanced calculus student”* after which they assert (Assertion III) *“Creativity in mathematics can be found at any level of the subject matter, and at any level of mastery.”*
- (3) Koestler asserts *“minor subjective bisociative processes...are the vehicles of untutored learning (p.658).”* The contemporary meaning of *“untutored learning”* is given in Larkin (2005), who realizes that *“the active process of creativity in learning is not something we do to the student. Rather, learning through the creative experience is something students can and must experience for themselves”*. The closest classroom approximation to such conditions of untutored learning, allowing students to ‘experience creativity for themselves’ is the Discovery method of teaching in many of its variations, i.e., inquiry and/or guided discovery, problem solving, project-based learning, or faculty/student research.

The TR Team of the Bronx has studied bisociative creativity within the framework of problem solving and inquiry-based learning focusing on the synthesis of planes of reference. For example, through the coordination of different actions, the reversal or a process of the application of an action to more structural or abstract object outside the students’ comfort zone, and the comparison of different strategies-actions to solve a problem. Questions that arise are (1) where does creativity come into play within critical thinking? and (2) when does bisociative experiences within a social situation lead to internalization of knowledge i.e., the next day effect.

The point of view of Shriki (2010) is closely connected with the terms “c-creativity” and “C-creativity” referring to the creative novelty being new to the individual and the novelty being new to the larger human community. That distinction allows to free creativity from the grasp of giftedness as defined by SAT scores and those of other similar instruments, and redirect research and practice attention to creativity of every individual.

SECTION 4. CONCLUSIONS

We have sketched here an argument, which strings together seemingly unconnected decisions concerning the subject of creativity:

- changes in Bloom’s taxonomy,
- the choice of criteria for giftedness within academia together with the focus of professional research attention on creativity of giftedness so defined;
- absence of research knowledge of the creativity of ‘rank and file’;

- absence of emphasis on STEM creativity in the NSF INCLUDES pilot projects, whose aim is to increase STEM participation of the “underrepresented”.

The common theme for these decisions is participation in the systematic and systemic process of eliminating access to creativity from the ‘rank and file’ learners by imposing, consciously or unconsciously, criteria extraneous to creativity, which limit creativity research and teaching practice. In response, the TR Team of the Bronx (Prabhu and Czarnocha, 2014) proposed the bisociation theory of Aha!Moment of Koestler (1964) as the tool for the democratization of creativity.

As a final comment we would like to offer the following observation. Both decrease in creativity observed by Kim (2012) and work leading to the revised Bloom taxonomy started in the first half of the nineties decade of the last century. That is also the decade of the final world-wide victory of uniform globalization, which eliminated previous highly disconnected bipolar world. Since the conditions for the creativity of Aha!Moment is the gap between two or more separate frames of reference one can conjecture that the process of kidnapping creativity was initiated exactly with the global uniformity of globalization.

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