Chapter 10
The Relationship of the Five Legs of Creativity Theory and Uncertainty in the Generation of Mathematical Creativity

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Abstract The Five Legs of Creativity Theory is one in which affective states are said to influence the prospect for the emergence of creative mathematical process and product (Chamberlin SA, Mann EL (2021) The relationship of affect and creativity in mathematical giftedness: how the five legs of creativity influence math talent. Prufrock Academic Press). In the Five Legs Theory, affective states called Iconoclasm, Impartiality, Investment, Intuition, and Inquisitiveness are mental states that may greatly influence the extent to which creative process is rewarded and valued in the classroom. When the aforementioned states are said to be high or positive, it is likely the case that creative thinking in mathematics may be engendered, thus enhancing the likelihood of creative products. The converse is also true. When such affective states are said to be low or predominantly negative, the likelihood for creative process and subsequently product in mathematics may be greatly compromised. The focus of this chapter pertains to the relationship of the Five Legs of Creativity Theory in relation to uncertainty in mathematical learning episodes, with a special focus on mathematical problem solving situations.

10.1 Introduction

The Five Legs of Creativity Theory is one that originated after a several year exploration and discussion of literature in mathematical creativity and affect (Chamberlin and Mann 2021). Not surprisingly, Drs. Chamberlin and Mann had completed a dissertation on affect in mathematics and creativity in mathematics respectively, and had subsequently acquired an interest in their peer's field. Thus, the theory originated from three sources. First, the theory was predicated on empirical data and

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second, the theory originated from extensive reviews of the literature in which the relationship between the two constructs had not yet been considered with any degree of comprehensiveness. Third, discussions between Drs. Chamberlin and Mann were instrumental in conceptualizing the theory. With the exception of several chapters in edited books (e.g., Chamberlin and Mann 2014; Cropley 2017; Goldin 2009; Mann et al. 2017; Movshovitz-Hadar and Kleiner 2009) and scant empirical articles, the constructs of mathematical creativity and affect have rarely been considered as a relationship (Imai 2000; Kozlowski et al. 2019; Leu and Chiu 2015; Tuli 1980).

In this chapter, the Five Legs Theory is explicated so that readers can consider it in relation to needs in mathematics education. Second, the relationship of the Five Legs to uncertainty is discussed, with a particular emphasis on uncertainty in problem solving episodes. To conclude the chapter, three focus questions are considered. For an extended discussion of the Five Legs of Creativity Theory, please access *The Relationship of Affect and Creativity in Mathematical Giftedness: How the Five Legs of Creativity Influence Math Talent* (Chamberlin and Mann 2021). In this book, the authors provide extensive discussion of the theory and situate it in the context of classroom expectations, types of problems that should be utilized and classroom instruction, as well as applications to gifted and general population students.

10.2 The Five Legs of Creativity Theory

Prior to the discussion on the theory, several caveats are issued. First, the Five Legs Theory of Creativity was generated on empirical data, in addition to theoretical discussions about mathematical creativity (domain-specific perspective) and general creativity (a domain neutral perspective). Second, the Five Legs Theory of creativity is considered applicable to mathematics and mathematical problem solving episodes in specific, and not other domains such as literacy, science, humanities. The extent to which it is applicable to other domains is contingent upon multiple factors and should be made by scholars in non-mathematical domains. In this section, each of the Five Legs is discussed so that readers can make sense of the theory and apply it as necessary. Third, sections should be carefully read because in some situations, terminology has been adopted that may be used in a somewhat altered context and use of the terminology should be dictated by its use in mathematical contexts. Fourth, all discussions of the Five Legs are somewhat abridged versions of the more lengthy discussion, presented in *The relationship of affect and creativity in mathematics in mathematical giftedness: How the five legs of creativity influence math talent* (Chamberlin and Mann 2021).

10.2.1 Iconoclasm

Iconoclasm is the first subcomponent of the theory, conceptualized seven years ago (Chamberlin and Mann 2014). Initially revealed at the International Group of Mathematical Creativity and Giftedness (2014), the construct of Iconoclasm was well received by peers. In short, Iconoclasm pertains to a mathematicians' penchant to challenge commonly accepted or conventional mathematical ideas, and not to accept the standard procedure or algorithm (Chamberlin and Mann 2021). In so doing, mathematicians are not satisfied with solutions that are congruent with or patterned after those that are presented in textbooks or by instructors. If, for instance, the most commonly accepted method to divide fractions is to (1) invert the second fraction and (2) multiply it by the first fraction, a problem solver that is high in Iconoclasm might wonder why a prospective solution could not be to (1) make like denominators, and (2) divide the numerators, which of course works. This solution, however, is not the one that many instructors present because it has often not been investigated by them. Upon first sight of such a solution, open-minded instructors may look at the solution with confusion and consider its merit. A close-minded instructor, by the way, might be inclined to simply tell the problem solver that this is not a viable solution, when indeed it is. The second, less well-prepared instructor, may be negatively influencing the prospect for creative emergence among a capable young mathematician.

Instructor responses are shared because they are instrumental in understanding the affective state known as Iconoclasm. This is because Iconoclasm is based on a problem solver's interaction with an instructor and the climate produced in which to do mathematics. In this sense, there is a socio-cognitive (Bandura 1988, 1989) aspect to Iconoclasm because the individual mathematician that is making sense of mathematics and better still, prospectively engaging in creative thought, relies on a mediation process with a mentor or instructor, as well as peers in some cases. Iconoclasm is utilized when a mathematician has the courage to challenge accepted ideas, not necessarily as wrong, but as not the most efficient or most aesthetically pleasing, elegant, and/or sophisticated. In the division of fractions example, inverting the second fraction and multiplying the two values is not an incorrect approach to dividing fractions. It may be the desire then of the problem solver to try a novel approach, such as making like denominators and dividing the numerators, to see if it works. Though this may not be creative per se in the context of mathematics as a discipline, and hence not Pro C, Big C, or even Little C creativity (Kaufman and Beghetto 2009), it may well qualify as a Mini C contribution because the student, and perhaps even the teacher, were not familiar with the approach prior to it being investigated, in situ.

10.2.2 Impartiality

Somewhat closely tied to Iconoclasm is the affective state known as Impartiality. Impartiality is conceptually defined as, "an openness to appreciate and see multiple perspectives and to consider utilizing unconventional ones" (Chamberlin and Mann 2021, p. 43). In this respect, the mental state known as Impartiality may help a mathematical problem solver avoid adopting conventional ideas. Moreover, it possesses a similarity with Iconoclasm in the respect that unconventional or mathematical procedures not typically accepted or promoted in textbooks, online, or in professional development sessions are considered ideal for the emergence of creativity. With Iconoclasm, one is in a mental state of having substantial courage to share ideas and with Impartiality one is open to various ideas and not always the one creating them. It is, however, the openness to accept new ideas that may help facilitate creative thinking among problem solvers.

In addition to not being limited to one solution, the best problem solvers are not limited by one rigid style of thinking, which is another facet of impartiality. As Hersh and John-Steiner (2011) suggest, "Thus, mathematicians are not limited to a single mode of thought. They rely on intuition, logic, visual and verbal processes, inferences, and guesses (p. 56)." When problem solvers are limited by the pursuit of a single solution or a single mode of thought, they are said to have constraints imposed upon them (Öllinger et al. 2017) and may have compromised flexibility (Krutetskii 1976). Flexibility in thinking is a component discussed by Krutetskii and it is considered essential to the development of mathematically creative thoughts. Hence, this notion of an open-minded or unbiased state of mind, so-called Impartiality in this theory, is essential to enable problem solvers to have free reign of thoughts, without being impeded by externally imposed ideas or artificially imposed constraints. An analogy regarding the generation of ideas in solving mathematical problems may be providing the problem solver with the opportunity to select from endless ideas, as would be done with an essay examination, as opposed to selecting from a menu of mathematical solutions, as might be done on a selected response assessment. With the completely open-ended approach to assessment, the propensity for highly creative ideas is expanded beyond the menu approach to solving problems.

10.2.3 Investment

An affective construct that is ostensibly not related to thought process in the respect of generating ideas is the third component of the Five Legs of Creativity Theory, which is referred to as Investment. Investment in this sense is used in much the same manner as it is in the economic or business world, not as Sternberg (2006) discussed. When one makes a financial investment, be it in a business, stock or mutual fund, or in any financial endeavor, a form of commitment is made. If one opts to pursue an advanced degree, a time and financial commitment is involved. Likewise, when mathematical problem solvers commit to solving a problem, an emotional investment is made. More specifically, Chamberlin and Mann (p. 50, Chamberlin and Mann 2021) suggest that Investment in the domain of mathematical creativity pertains to, "an emotional contribution to finding a solution to a task for one or more reasons." When an emotional investment is made to virtually any endeavor, the prospects for success are enhanced. Renzulli (1978) generalized the necessity of commitment a step further in stating that it was essential as one of the three rings of giftedness.

Nearly all authors in the McLeod and Adams (1989) book on affect and mathematical problem solving refer to persistence as a requisite characteristic in success. The relationship between investment and commitment to persistence has been made (Tinto 1975) and is instrumental in facilitating creativity in problem solving episodes.

10.2.4 Intuition

The affective component known as Intuition plays a critical role in development of mathematical creativity. It was, after all, Wilder (p. 43, 1984) that stated, "Without intuition, there is no creativity in mathematics." Wilder was not using the construct intuition in precisely the same manner as it is utilized in this chapter and in the Five Legs Theory, but it was discussed in a very similar manner. In fact, Wilder referred to intuition as requisite to mathematical creativity emerging. In the Five Legs of Creativity Theory, Intuition is thought of as similarly as critical to creative process and product emerging. However, in this theory, Intuition takes on a slightly altered conception than it does in other discussions in educational and mathematical psychology. In this theory, Intuition is not considered an overt cognitive state, inasmuch as it is an affective state. Specifically, Intuition is, "An inescapable drive to be pulled to a response or solution" (p. 22, Chamberlin and Mann 2021). An analogy has been made to one driving an automobile without a map, yet relying on past experience to find a location. Unbeknownst to the driver, intuition may play a significant role in identifying previously seen landmarks and other landmarks that perhaps were not noticed on the earlier visit. In this respect, Intuition, in the Five Legs Theory, is a motive to follow a 'hunch, cognizance, or motive' in pursuing a correct solution to a perplexing mathematical problem.

Ideally, Intuition may lead to increased persistence, thus enhancing the likelihood of success in solving a problem. However, Intuition and its many positive byproducts may not be limited to success in finding successful solutions, but it is theorized that it has applications to identifying particularly creative mathematical solutions. Persistence, it might be postulated, has ramifications for enhancing the likelihood of creativity, since most creative output is not a result of a small investment of time in anything that is cognitively engaging. As Wallas (1926) suggested, the necessity of persistence may be instrumental in the incubation stage. Intuition also may have applications to working in novel situations, much like a surgeon that can apply previously learned concepts from earlier work to a new situation. Mathematicians may find situations in which they have been successful solving problems in a domain and when prompted for a solution in a new domain or another area of the initial domain, insufficient knowledge exists to solve the problem. However, highly creative individuals may be in a situation to rely on Intuition to identify a successful process and product to a novel problem, based on Intuition. Finally, a high degree of Intuition may serve an advanced problem solver well in the respect that (s)he may realize that a successful solution is imminent, given their understanding of the domain, even though the problem solver may not be able to explain why a solution is forthcoming. There are instances in which a problem solver simply *knows* that (s)he is close to solving a problem.

10.2.5 Inquisitiveness

The fifth leg of the theory is referred to as Inquisitiveness. Inquisitiveness shares some characteristics with interest. When one thinks of an inquisitive mind, one may think of the inquiry process, which is jumpstarted with affective states such as wonderment, curiosity, and a desire to find answers to questions. Dyasi (1999) suggests that children are naturally curious and that curiosity is a fundamental human trait. Interest, therefore, is at the heart of reported high levels of curiosity and an inquisitive mental state (Kashdan and Silvia 2009) and there is an established relationship between interest and engagement (Flowerday and Shell 2015; Renninger and Bachrach 2015). In short, the psychological construct of Inquisitiveness encompasses several positive attributes that enhance the likelihood of mathematically creative processes and products emerging.

A component of the construct Inquisitiveness that facilitates mathematical creativity is its close relationship to Intuition, based on persistence. As suggested, creative output is not a facile or quick process per se (Penaloza and Calvillo 2012) and persistence, coupled with periodic breaks in work, is likely to provide a greater likelihood of success than working continuously. This may be a result of a reduced likelihood of fixation on behalf of the problem solver. Moreover, an individual in a highly inquisitive mental state may generate questions at a much greater rate than peers with reported low levels of interest. Such questions may serve as the drive to seek highly creative solutions in mathematical problem solving episodes.

10.3 The Relationship of the Five Legs Theory of Creativity to Uncertainty

The construct of uncertainty in creativity is an intriguing, yet a frequently dismissed one. It is, however, not to be overlooked in the generation of creative output or process in mathematical episodes. Prior to engaging in a discussion of the relationship between uncertainty and the Five Legs of Creativity Theory, it is necessary to conceptualize the construct known as uncertainty. A characteristic of many psychological constructs is that they are deemed fuzzy, or not well defined. Closely related to uncertainty is the psychological construct of doubt (Beghetto 2020). In fact, uncertainty may be considered an antecedent to doubt in mathematical problem solving episodes. Hence, learning about features associated with them can provide some understanding. In Tracey and Hutchinson's (2018) work, they suggest that uncertainty is a mental state that most individuals involved in the creative process would like to avoid altogether or resolve (Adair and Xiong 2018; Bar-Anan et al. 2009), while other researchers such as Lane and Maxfied (2005) find it highly worthwhile, or as they deemed it potent, for innovation. Menger et al. (2014), refer to uncertainty as a prerequisite mental state for creativity to emerge. In other words, the precise mental state that many experience in creativity and hope to avoid is the very same mental state that likely facilitates highly creative output. In part, the successful outcomes that may come as a consequence of uncertainty are likely a result of an intensification of emotions among problem solvers. A secondary by-product of uncertainty is likely the notion that uncertainty may precipitate additional learning in a domain to mitigate the effect of uncertainty.

Uncertainty in problem solving episodes may be marked by a lack of confidence in the outcome of the situation. It may be postulated that the construct on which uncertainty has the greatest effect is self-efficacy (Bandura 1977), because self-efficacy is conceptualized to be one's belief that an outcome can be positively influenced. When dealing with uncertainty, therefore, one must contemplate how one can deal with situations that contain unknowns, and overcome them to instill confidence to successfully obtain a positive outcome. To compound the issue, the construct of creative self-efficacy exists, which is, "an individual's beliefs that they have the ability to produce something creative" (Liu et al. 2017), and it is a prerequisite trait for creative production to occur according to Hallack et al. (2018) and Tierney and Farmer (2002). Hence, uncertainty, perhaps in the form of ill-structured problems (Sales and Wakker 2009; Stepien et al. 1993), can present a challenge with respect to uncertainty for problem solvers. It may be postulated, however, that once problem solvers can creatively solve a sufficiently challenging ill-structured problem, their creative self-efficacy, as well as their general self-efficacy, may be greatly enhanced relative to its previous state. This positive change in dealing with ill-structured problems may result in increased confidence and self-beliefs (Miller et al. 2021; Pitsia et al. 2017) in one's ability to successfully navigate and solve a mathematical problem in a creative manner. In turn, such classroom experiences may enhance problem solvers' abilities to engage in creative process and the emergence of products in mathematical learning episodes.

Moreover, one consideration that is central to the relationship of uncertainty in mathematical creativity and affect in mathematics is that each pertain to students' feelings, emotions, and dispositions. As has been suggested in the discussion of the Five Legs Theory, the more certain and confident that a problem solver is about personal affect, the greater the propensity of the problem solver to realize success in mathematics. Conversely, uncertainty naturally suggests that a mathematical problem solver is not sure about something. This something may be the environment in which the problem is solved (e.g., a classroom), the learning facilitator, the constraints of the problem, emotions, the expectations of the problem regarding assessment, or any number of remaining components. Most instrumental though may be uncertainty in identifying a solution. Any such uncertainty can have negative ramifications on problem solver self-efficacy, which could have deleterious effects on one's ability to successfully engage in cognition. Hence, the relationship of uncertainty to the Five Legs Theory of creativity in mathematics must resemble a balancing act, insofar as a problem solver must be able to maintain a delicate balance between dealing with uncertainty in identifying a creative mathematical solution and seeking positive affect. When the relationship of uncertainty and affect are said to be imbalanced, as shown below, the likelihood of positive outcomes in creativity may be reduced.

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Without perseverance while engaging in high level mathematics, the prospect for success in solving problems, creatively or not, is likely in jeopardy. Perhaps most significant to success in finding creative solutions to mathematical problems is openness. Openness has already been established as a prerequisite characteristic to creative output and perseverance plays a considerable role in realizing full benefits of openness (Kutlu et al. 2017). Interestingly, motivation may play a role as well as an intervening variable in the equation of openness and perseverance and one outcome in which it may influence mathematical creativity pertains to the type of tasks that problem solvers attempt to solve (Nicholls 1983). This is likely because problem solvers with a high degree of motivation and intent to reach mastery goals may select more challenging mathematical problems than their peers with presumably lower, performance or achievement goals (Poortvliet 2016). Selecting in depth problems that may require greater cognitive effort than problems in which low cognitive and emotional investment are required may result in problem solvers working on problems that are rich. As a consequence, such problems may pose greater risk for failure than less engaging problems, but the result when success is achieved may be a highly insightful process and product. In turn, highly creative solutions to the problems may be the result. Hence, despite what may appear to be a tenuous relationship between affective constructs such as openness, perseverance, motivation, goals, and creative output, it is apparent that emotions play a critical role in outcomes. Still, uncertainty in solving problems would appear to be almost endemic.

This is to suggest, however, that uncertainty is inherently negative. The ability to cope with uncertainty has been known to derail problem solvers' success in finding solutions. A certain element of it though may be instrumental in ultimate goal achievement, as overcoming obstacles in identifying solutions may lead to increased confidence and advanced levels of self-efficacy in solving problems. All of this may be a result of successfully managing anxiety (Pajares 1996).

10.4 Costs and Benefits Associated with Uncertainty in Educational Settings

With virtually all efforts in improving education, costs can be a concern. In most cases, budget expenditures are not the primary concern, inasmuch as costs to related efforts are a concern. However, in overlaying the Five Legs Theory to engender creative process and product in learning episodes, the principal cost is familiarizing teachers with the approach and fundamental principles of the theory so that they can utilize adjustments in teaching philosophies and classroom atmosphere, learning theories, curricular manipulations such as types of tasks adopted, and assessment feedback. In short, costs will be minimal to have teachers invest attention to student affect and the prospective return on investment could be substantial. That is to say, the degree of creative output in mathematics classrooms could be considerable in relation to the amount of effort invested. Moreover, investing efforts in making educational changes may ideally create lasting effects in a cultural shift because problem solving will become the bedrock of mathematics instruction, as it should be (Hiebert et al. 2000).

A secondary, and rather unintended cost to mathematics efforts, may be that efforts to meet state or national mathematics standards in an attempt to perform well on standardized assessments, may be compromised. This is because creative efforts are rarely, if ever, engaged, utilized, addressed, or assessed in (inter)national assessments. Moreover, they are rarely even suggested in standards documents for several reasons. Perhaps the first reason that they are rarely mentioned in standards documents may pertain to the difficulty in assessing them. A second reason may be that minus experts in academia, quantifying the value of mathematical creativity, and for that matter creativity in general, is similarly difficult to ascertain. A third reason may be educators' lack of familiarity with mathematical creativity and when teachers are not prepared to pay attention to creativity and intentionally try to facilitate it, they may be in a challenging position to precipitate it among learners (Grégiore 2016). It is likely a safe assumption that few teachers have had (any) undergraduate coursework relevant to mathematical creativity. Until recently, it could be argued that mathematical creativity was merely a construct that academics discussed at conferences and in books. The practicality of creating scenarios that might enhance the likelihood of mathematical creativity emerging was considered not a valuable investment of time or money, when standardized assessments loomed. Simply stated, facilitating creativity in mathematics has never been an endeavor that was designed to support standardized assessment performance. Instead, aiding problem solvers in learning how to deal with uncertainty has enhanced implications for advanced mathematical understanding and solutions.

10.5 Practical Implications of Uncertainty Plays in Creativity and Learning

The practical implications for understanding the role that uncertainty plays in creativity, learning, and development are various. Regarding creativity, the better a problem solver deals with uncertainty, the greater the likelihood that the problem solver realizes success in attaining a successful and sophisticated solution. Such outcomes have a relationship to students making sense of mathematics (Hiebert et al. 2000), which speaks of true mathematical learning. Development is intricately intertwined with learning, because without conceptual understanding, often promoted through enabling students to deal with uncomfortableness and messiness, mathematical learners may not advance in development of mathematical concepts. Dealing with uncertainty successfully in mathematics is not something that may happen serendipitously. According to Grégiore (2016), uncertainty is inherent in the problem solving process among professional mathematicians and may be among younger mathematicians. The question remains, "So, what can teachers practically do in the classroom to encourage problem solvers to cope with and ideally overcome uncertainty?" The logical answer to this question is to prepare problem solvers for the rigors and expectation of uncertainty, so that they are prepared to deal with it. When uncertainty presents itself in any sort of situation and problem solvers are not expecting it, prospective outcomes could pose problems that are insurmountable to success. Helping students to overcome uncertainty by promoting, "…development of intrinsic motivation, associating positive emotions with uncertainty and exploration" (Grégiore, p. 32) can prove valuable in stimulating the development of creative cognitive thinking approaches.

10.6 Needed Directions for Future Work in Uncertainty and Creativity

The needs for research regarding uncertainty in mathematical creativity are extensive. This is because the chasm between that which is known about uncertainty and that which is known about certainty in solving problems is vast. In particular, researchers must start with developing a system for quantifying uncertainty in the context of mathematical creativity. Additional needed directions are a concrete understanding of how dealing with uncertainty positively, and perhaps negatively, influences learning and creativity in mathematics. The construct of uncertainty contains many characteristics about it that are unknown, or at best unclear in the world of mathematics learning and creativity. This position may serve to fascinate researchers and scholars in the world of mathematics education and mathematical psychology because clarifying unknown components of a psychological construct, in this case uncertainty, is the reward that experts realize for many years of efforts. From a practicality perspective, educators in the classroom may not have much tolerance for uncertainty because with it comes unknown outcomes and doubt. Practitioners may enjoy relating an input with an output, in anticipation of control of learning scenarios. However, as has been seen for over a century, dating to at least Poincaré's (1913) day, much still needs to be learned about creativity from a theoretician's perspective and how it can be engendered in classrooms from a practitioner's perspective.

10.7 Applications to Educators

Mathematics educators with an interest in investigating the Five Legs of Creativity Theory are strongly encouraged to access the complete book (Chamberlin and Mann 2021), mentioned in the introduction. As a snapshot of what should be done in the classroom, a primary focus in relation to this work, and in particular creativity and uncertainty, hastens the question, "What, precisely, is an apropos amount of uncertainty in the mathematics classroom, to engender creative process and product?" As discussed in the previous sections, uncertainty is something that is inherent in mathematical problem solving. In fact, without a modicum of uncertainty, no novelty (Chamberlin 2008) exists. Without novelty, problem solving is said to be absent (Chamberlin 2008). Hence, for creativity to emerge in mathematics and mathematical problem solving episodes, uncertainty must exist. The question remains, what constitutes a suitable amount of uncertainty and how is it managed by problem solvers. The essence of the first component pertains to mathematics problems that are developmentally appropriate (Baroody et al. 2003). Mathematically appropriate tasks are essential to foster mathematically appropriate teaching (Clements et al. 2017). Nevertheless, problem solvers must be conditioned to deal with uncertainty so that it is not a surprise to them. This struggle is likely necessary for productive thinking to transpire. If not pushed to solve a challenging problem, solvers may not engage in substantially high(er) level thinking and thus be in a position to identify and originate creative responses.

The second question pertains to how uncertainty is managed by problem solvers. Problem solvers should not merely be encouraged to cope or deal with uncertainty. Instead, they should be encouraged to embrace it because without uncertainty, the opportunity for true challenge may be compromised (Chamberlin 2002). Imperative to this process is the concept of identifying mathematical problem solving tasks that are accessible to students and solvable.

10.8 Conclusion

The lingering question after all of this discussion is, "How can creativity be facilitated in the classroom, especially in mathematics that may be fraught with uncertainty?" Twenty five years ago, Westby and Dawson (1995) provided some insight on teachers' perception of creative individuals in stating, "One of the most consistent findings in educational studies of creativity has been that teachers dislike personality traits associated with creativity. Research has indicated that teachers prefer traits that seem to run counter to creativity, such as conformity and unquestioning acceptance of authority." In other words, teachers prefer working with students that play the school game well, but highly creative individuals do not always want to play the school game, and thus may not be accepted openly by teachers. It would appear as though one of the ways to encourage teachers to become more amenable to mathematical creativity is to enact a culture change, whereby it is valued. To accomplish this, unfortunately, a much larger, seismic shift must ensue, in that administrators will need to identify a means to maintain some element of assessment accountability in mathematics, while overlaying mathematical creativity in the entire milieu of assessment.

Perhaps, the more salient and pragmatic question with respect to uncertainty and mathematical creativity, or simply creativity in general, pertains to how teachers help their students deal with uncertainty. It is important to issue the caveat that uncertainty and anxiety, each share at least two similarities as psychological constructs. First, they are likely inherent in solving mathematical problems. Second, they are typically a positive attribute of solving problems (Lane and Maxfied 2005), insofar as a modicum of uncertainty and anxiety (incidentally, anxiety may well be increased as a correlate of uncertainty), may encourage problem solvers to commit themselves to persist in successfully finding creative solutions to mathematical problems. Learning facilitators, generally teachers, of mathematical problem solving tasks can implement one simple approach in an attempt to aid students in dealing with uncertainty. They should psychologically prepare problem solvers for uncertainty, and accordingly increased anxiety that may accompany uncertainty or doubt as Beghetto (2020) calls it, by suggesting prior to problems that problems solvers should be expected to incur a degree of uncertainty and thus anxiety, as a result of doubt. When problem solvers realize that uncertainty is an expected by-product of seeking creative solutions, it may serve to assuage their nervousness.

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