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The tower of creativity

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In the field of creativity research, two paradigms can be distinguished. Both can be traced back to a seminal publication, the *Art of Thought* by Graham Wallas and Richard Smith in 1926, and to Joy Paul Guilford's *American Psychologist* paper entitled *Creativity* in 1950. While Wallas and Smith conceptualized creativity as a thinking process, Guilford envisaged creativity as a personal trait. Nevertheless, a common element of both paradigms was that creativity is bound to an individual. Similarly, this is also the prevailing view in giftedness research: Creativity is a characteristic of an outstanding individual who is capable of either seeing clearly what is still indistinct for everybody else or of perceiving the outline of something that others cannot yet fathom. Individuals can use these abilities in many domains, such as the creative arts, science, interpersonal relations, leadership or sports. The individualistic paradigm of creativity has spurred many educational approaches, fostering such elements as fantasy, imagination, self-confidence, artistic skills and so on.

Gifted education has relied heavily on the outcomes of creativity research. Indeed, in some conceptions of giftedness, creativity was explicitly included as an important component (cf. Jarrell & Borland, 1990; Sternberg, 2003). However, this conceptual import also raises some problems for gifted educators and these are connected to the individualistic paradigm of creativity. While we acknowledge the merits of this contribution to gifted education, we will challenge readers to explore a broader perspective on creativity.

1 Modern challenges and gifted education

Modern societies are based on development, progress and innovation. The demand for constant change – notably, the slogan of the recently successful US presidential candidate, Barack Obama – will undoubtedly be one of the distinctive characteristics of the third millennium. Of course, change does not necessarily imply a radical overthrow of everything; to cite a common aphorism, we don't want to throw out the baby with the bath water. Rather, we sometimes have to change in order to preserve what we value.

Nevertheless, we still struggle for solutions for many problems that call for change. Representative examples include:

- Facing a human-made climate change, the agenda is to preserve nature and to prevent, reduce or mitigate harmful effects. However, despite numerous conferences, public hearings, official speeches, it becomes increasingly obvious that humankind is running out of time.
- The civil war in Darfur began on 2 February 2003. It is an ethnic war. The estimates on

the number of casualties differ, but non-governmental organizations claim over 400,000 people have been killed.

- Many believe that the future of mankind lies in space as natural resources on Earth are diminishing. The estimated costs for getting a kilogram into a stationary orbit around earth (satellite, space station, rocket and so on) are currently around 20,000 US dollars. Since 2005, NASA has held a Power Beaming and Tether Competition wherein the challenge is to discover wireless power transmission. To this end, competitors build mechanical devices (climbers) to propel themselves up a vertical cable. The prize purse is approximately $2 million.
- Fifty years ago, the estimated life expectancy of new products was 400% longer than it is today. Consequently, companies are now forced to update their products at a hitherto unknown speed. The pressure to innovate is bigger than ever.

A crucial question is who will bring about these desired and crucial changes? The traditional answer of giftedness researchers was unequivocally that it would be gifted, creative individuals. Such individuals would be identified and then gifted education would take over. We contend, however, that this answer is only partially correct. We will first offer a new view on creativity and then return to these four illustrative examples.

2 Four Constraints for a Theory of Human Creativity

Imagine that you observe a child asking her mother, "Why is the princess so beautiful?" The answer startles you, "Because of her beauty." After a short while, you observe another child asking her father, "Why is the giant so tall?" To your irritation, he answers, "Because of his tallness." Later you observe a third child asking his mother, "Why is the dwarf so short?" And predictably, the child gets the answer, "Because of his shortness." A minute later, you see a fourth child asking his older brother, "How is it possible that this woman practices witchcraft?" And, again predictably, the child receives the answer, "Because she is a witch."

All the respondents in this hypothetical situation committed the same fallacy, which we term 'reification' and is the act of representing an abstraction, a theoretical construct as a real thing. By extension, then, what explanation would be given by researchers or educators of the gifted when they are asked what makes creative writing, creative drawing, or creative thinking possible? Creativity? If so, they are also caught in the same trap of reification. *Basic principle 1*: Creative actions cannot be simply explained by a trait termed 'creativity'.

In the example above, creativity was the explanatory variable that explained a creative action. This resembles the method of the vast majority of creativity researchers. For them, too, creativity is an explanatory variable that explains creative actions. An alternative view is offered by the Actiotope Model with its focus on creative actions (Ziegler, 2005; see below). This view seems to be shared by an increasing number of fellow scientists. For example, Anders Ericsson (e.g., Ericsson, Nandagopal, & Roring, in press) maintains that creative, innovative contributions in a domain are the result of a very long dedicated period of learning. Excellence is attained when, for example, a soloist has found a new interpretation of an old master piece, or a scientist has developed a new theory. There is no need to assume the existence of a magic trait called 'creativity'. *Basic principle 2*: The focus of creativity research should be on creative actions as an outcome variable.

The Actiotope Model is a systemic approach. Similar to Csikszentmihalyi and Wolfe (2000), we commence with the premise that the individual mind is not the place where genius and creativity can be found. Their location is not in any particular individual's mind, but in a system where an individual interacts with a cultural domain and with a social field. *Basic principle 3*: The capacity for creative actions is located in systems – not in traits such as creativity.

An important attribute of creative and innovative actions is their adaptivity. The development of excellence and hereby of innovative and creative actions is viewed as a permanent extension of a person's action repertoires governed by the principle of the survival of the fittest action. At this point, the Actiotope Model converges with some conceptions of creativity. For example, Sarah Meadows (2006) proposed this definition of creativity: "Something is said to be 'creative' if it is original and adaptive or appropriate: A 'creative' person is someone who produces original and adaptive ideas, reasoning or compositions" (p.253). We would assume that most creativity researchers share the view that creativity implies originality. They also presumably agree that not every expression of originality can be labelled 'creative' as we want to exclude random and blind variations of actions. Meadow's concept of adaptivity is, therefore, extremely important. It tempers originality and restricts it to non-random, meaningful and purposeful actions. *Basic principle 4*: Creative actions are original and adaptive.

The adoption of these four basic principles could enrich creative students' gifted education. Our (western) point of view of creativity is oriented towards a prototype of creativity, which is characterized by the idea of children who, compared to their peers, draw highly imaginative pictures and play fanciful games, do something unusual or hold unexpected ideas and surprising opinions and views. In the following section, we would like to break away from this point of view and test a broader approach to the topic of creativity utilizing the Actiotope Model. Creativity refers to creative actions that are adaptive and are considered as an outcome variable. Thus creativity is not an individual trait, but the successful development of a system. The rest of this chapter contains three parts. First, we will give a short overview of the Actiotope Model of Giftedness. After that we will distinguish six idealized evolution stages of creativity. We will be doing this by means of an allegory: the Tower of Creativity. We will then investigate the theoretical and pedagogical implications. Finally, we will briefly come back to our illustrative examples.

3. The Actiotope Model of Giftedness

The main characteristic of persons who have attained excellence in a field is their ability of competent and creative action (cf. Hacker, 1992). Accordingly, the Actiotope Model tries to explain 1) the acquisition, and 2) the (creative) application of an excellent action repertoire, as well as 3) analyze the best possible conditions of promotion of excellent actions. In doing so, it draws on various synergies with a number of scientific disciplines.

As with all creatures, human beings are a selective open system consisting of several subsystems. Its characteristics and behaviors are the result of a multitude of successful adaptations to environments, which have – on a large scale – taken place before the individual's existence. For example, human beings have adapted to the earth's climatopes, various ecotopes (that is, inanimate parts of ecosystems) and numerous biotopes. Their organs, susceptibility to certain diseases, sleeping rhythm, linguistic competence, speed limits in sprinting, and so on, only become understandable when viewed in the context of a species that is adapting to environments.

However, the human being is not only a biological being. As a social being, it adapts itself to sociotopes, which are culturally and socially determined action spaces. For example, even a layperson in music recognizes very clear differences when comparing the music of Quantz, Hasse, the Marcello brothers, the three Scarlattis, Cimarosa, Lotti, Galuppi, Caldero, Jommelli, Parpora, Albinoni, Tartini, Händel and Vivaldi with that of The Birds, The Kinks, Motorhead, Nirvana, The Police, The Who, The Rolling Stones, Sex Pistols, David Bowie, George Michael, Phil Collins, Cat Stevens, Peter Frampton and Elton John. The former group of musicians have acquired their musical action repertoire, among other things, in the Venice of the 18th century where they worked over a period of 50 years. The latter group comprises London bands and musicians of the second half of the 20th century. In the course of their musical socialization, all these musicians have acquired an excellent musical action repertoire that represents an active adaptation to their respective social environments' music.

It is not implausible that, had the 20th century musicians grown up in the 18th century, or the 18th century musicians grown up in the 20th century, they would have developed, musically, in totally different ways. Yet at the same time, we also find striking differences *within* the epochs themselves, for example, between the rock music of the Rolling Stones and the first punk pieces of the Sex Pistols. Action repertoires are thus not only a reflection of time, but they also reflect very individual styles. The creative actions of the Marcello brothers and of the two Scarlattis, the Rolling Stones and the Sex Pistols thus cannot simply be understood as mere individual accomplishments. Indeed, they are result of progressive adaptations to individual actiotopes (cf. Ziegler, 2005). Such an actiotope of a person has, on the one hand, a uniqueness and individuality. On the other hand, many of its aspects only become understandable through the principle of membership on different levels of the system, as it is a member of ecological, biological and social systems. An actiotope can be defined, then, as the section of the world with which an individual interacts and to which it adapts while acting.

4 The Tower of Creativity

The Actiotope Model offers an analytic frame for the investigation of any kind of intelligent action which is understood as "goal-directed adaptive behavior" following Sternberg and Salter (1982). As a consequence, the intelligent and creative action of animals or even artificial intelligences can be analyzed. However, creativity researchers usually tie creativity to outstanding individuals. However, even a mere glance into history books teaches us that a point of view referring to individuals is much too simple. Such an approach would not be able to explain the Golden Ages. For instance, there were unforgettable geniuses, such as Michelangelo, Leonardo da Vinci, Sandro Botticelli, Pietro Perugino, Andrea del Verrocchio, Giorgio Vasari and Raphael, living in the Florence of the Medici for half a century. In the 17th century the Netherlands experienced an unprecedented heyday, which is linked to names like Descartes, Spinoza, Huygens, Leeuwenhoek, Rembrandt, van de Velde and Vermeer. In the German language area, many of the greatest composers of all time were born within a 100-year span: Johann Sebastian Bach, Georg Friedrich Händel, Ludwig van Beethoven, Joseph Haydn, Wolfgang Amadeus Mozart, Franz Schubert and Robert Schumann. There are also parallels in the modern age. For example, no fewer than eleven pupils or colleagues of the Noble prize winner, Ernest Rutherford, also received the Nobel prize.

If one breaks away from the individual approach towards creativity, the question arises where could we first observe creativity in history? Only with the advent of human beings? Only from a particular age or era? In fact, the topic of new, creative solutions did not coincide with the appearance of Homo sapiens. It is as old as the existence of living systems that they have to change in order to survive. To clarify this we would like to make use of an allegory proposed by the philosopher Daniel Dennett (1994) in his investigation of the role of language in intelligence. In this piece of work, we would like to use his basic tenet in order to explore the issue of creativity and, for this purpose, we expand on it considerably. We imagine a tower of creativity whose six floors are inhabited by different creatures.

4.1 Darwinian Creatures

Life is not possible without development. Environments constantly change and what was once well-adapted, thereafter becomes dysfunctional. This observation applies to different levels: the species, groups, individuals along with their tools and ideas. All of them need innovations of various kinds, without which they would perish.

For the longest time in history, development has been synonymous with the Darwinian evolution of species, driven by natural selection and selective mate choice (Miller, 2000). Species have been successful with their adaptations for quite a long time. After all, their average lifespan comes to approximately 200,000 years. Over this period of time, the environments to which they have adapted can change drastically. A species' life cycle can thus also be considered as a history of continuous innovations in order to improve its own adaptation and fitness. Sometimes, however, the capacity for a further essential adaptation is lacking and the species becomes extinct. But there is also another possibility. The species can change itself so vigorously in the course of this constant innovation process that we are speaking of a new species (for a discussion of the criteria when this is the case, see Mayr, 2001).

In the allegory of the Tower of Creativity, Darwinian creatures inhabit the ground floor. They cannot plan their innovations. They are dependent on the more or less haphazard processes of recombination and mutation of genes. Most of these innovations prove to be useless and, commonly, they lead to an organism's death. Thus, Darwinian creatures need a tremendously huge number of variations until one variation turns out to be useful. The whole process of alteration lasts for generations and is consequently extremely slow.

4.2 Skinnerian Creatures

One of the most crucial events in evolutionary history was the appearance of creatures we would like to denote Skinnerian Creatures in accordance with Dennett. In fact, Skinner made himself clear from the start that Darwinian evolution has experienced an enormous increase in innovation potential through operant learning: "Where inherited behavior leaves off, the inherited modifiability of the process of conditioning takes over" (Skinner, 1953, p.83). According to the so-called Baldwin effect, adaptations with survival value acquired during the lifetime of organisms tend to become part of the genetic composition of the species over time. That is why the successful development of a species is no longer only pushed on by variations and the field testing of genes. Organisms also have the possibility to create variations of actions and select the most successful. Elsewhere this has been denoted the process of "survival of the fittest action" (Ziegler, 2005).

Skinnerian creatures are still dependent on the more or less haphazard production of many action alternatives. This is reminiscent of the infinite monkey theory (cf. Borel, 1913) in mind, according to which a monkey that haphazardly types on a keyboard for an infinite time will eventually write all books in the French Bibliothèque nationale de France. Nonetheless, they can reach a breathtakingly fast speed with innovations by comparison with Darwinian creatures. However, this speed of innovation has a major disadvantage. When testing if a certain plant has some medicinal benefit, for example, one can very easily get to a poisonous plant. Here, an ability seems to be necessary and which only the creatures of the next floor possess.

4.3 Popperian Creatures

The philosopher Karl Raimund Popper distinguishes between three different worlds:

- The physical world,
- The world of individual perception and consciousness, and
- The world of human knowledge and culture, ideas, concepts and so on.

Popperian creatures are characterized by their ability to create their own models of the world and to manipulate these in their minds. These possibilities represent immense progress. In contrast to Skinnerian creatures, Popperian creatures do not necessarily have to die when testing new actions. In a certain sense their ideas die when they turn out to be wrong. In fact, "mental actions" are possible and whether a plant is poisonous, for example, can also be found out by its own considerations.

Skinnerian creatures survive innovations because they are lucky. Popperian creatures survive innovations because they are – in the usual sense – intelligent and creative. In fact, the possibilities which offer a mental manipulation of inner worlds are tremendous and breathtaking developments. It enables every one of us today to understand scientific or artistic ideas that were unthinkable for our grandparents. This may explain why creativity researchers mainly investigated creativity on Popperian creatures and thus only climbed halfway up the Tower of Creativity.

4.4 Spencerian Creatures

The next floor is inhabited by Spencerian creatures who owe their intelligence and creativity to the group or society in which they live. Their name derives from the English philosopher and sociologist Herbert Spencer who applied the concept of evolution and adaptation into the analysis of social development. In fact, it was Spencer (and not Darwin!) who coined the term "survival of the fittest". The term, though, is a little misleading. It seems to imply that only one society – that is, the fittest – is going to assert itself. Spencer's opinion, however, was that there can be several societies at a certain time which are adapted (Barker, 1997). However, this only applies in the absence of competition.

The view that whole societies are creative or offer the possibility for creation, has already been indicated with respect to the Golden Ages. We would like to illustrate this further with the help of a spectacular research study of Qin and Simon (1990). Their subject was the laboratory replication of one of the greatest scientific discoveries.

The famous mathematician of the 17^{th} century, Johannes Kepler, had, like other astronomers at that time, a data set at his disposal which described the distance between the planets and their solar orbital periods. At first, he described that for the five innermost planets, the periods increased with the square of the distances. However, he was never content with his publication, since the fit was not good. For ten years he was unable to find a better solution until he finally realized that the square of the orbital periods are proportional to the cube of their distances from the sun. This law is still valid today and is known to us as Kepler's third law. If the Nobel prize had existed then, Kepler would undoubtedly have received it. Qin and Simon provided college sophomores with the data set used by Kepler. At the time, these sophomores had in no way attracted attention by any special talent. However, some of the students were actually capable of recognizing, in less than an hour, the mathematical relationships in this data set which Kepler needed 10 years to verify. How were these otherwise unspectacular sophomores able to accomplish a creative performance for which the estimated genius Kepler needed 10 years? And would Kepler nowadays still have needed 10 years or would he have made the discovery much faster? Of course, answers to these questions are highly speculative. But it is nonetheless plausible that Kepler would have come to his discovery much faster in the third millennium. While in the 17^{th} century the conviction that one could describe the physical world mathematically was nascent, this is now one of the central convictions of the natural scientific world-view. Kepler was among the first who tried to gain some insight with this approach.

The sophomores in the study of Qin and Simon had, on the other hand, adapted as Spencerian creatures in their individual socialization to a world of knowledge that contained totally different methodological and mathematical capacities than the world of the 17th century. The background made available by social community allowed them to make discoveries, which the Popperian creatures in this example – Kepler and the best of his contemporary astronomers at that time – failed to achieve or were only able to achieve after an extremely long period of time. In this study, the reasoning of the modern age out-performed Kepler in the analysis of the data set, not the individual sophomore.

4.5 Galileian Creatures

Now let us move up a floor of the tower of creativity, where we find the Galileian creatures. Their creative possibilities again outreach those of the Spencerian creatures. These creatures are named after Galileo Galilei who played a major role in the scientific revolution. His achievements include improvements to the telescope and the development of ingenious experimental devices. Like no other, his work illustrates an idea that has long since been familiar to anthropologists in an indirect way: the introduction of tools and devices enlarges our intelligence and our creative possibilities enormously. One can illustrate this fact best by drawing a comparison with Popperian creatures. They are only able to come to new realizations by mental manipulation of their inner mental world. By contrast, Galileian creatures have substantially expanded their creative possibilities by especially designed sections of the outer environment. Let us look at some examples of this.

The year 1856 was a turning point in painting. The chemist Mauvein produced the first artificial dye, Mauve, which primarily serves as textile colorant. Subsequently, Henry William Perkins developed the first aniline dye (aniline purple, known as mauve or mauveine) in 1856. The first synthesis of a dye ushered in a true revolution in painting, which multiplied the artist's possibilities in terms of color in the following centuries and rendered modern painting possible (Garfield, 2000). Further, not only new colors were discovered, but also the colors' properties were revolutionized. Who knows how the famous painting contest between Leonardo and Michelangelo would have ended, if today's colors had been available? Leonardo obtained the commission to immortalize the victorious Battle of Anghiari on a wall in the Florence town hall. He experimented for this painting with a special coating which led to the work's destruction due to awkward drying methods. On a small scale, the experiment was successful but the hall's heat was sufficient for only half of it, the colors in the upper section were dissolving. If the painting contest between Leonardo and Michelangelo was carried out today, the question of the colors' durability would only play an extremely minor part and a totally different set of abilities would decide the creative contest's outcome.

In the same way that synthetic colors enlarge creative possibilities in painting, technical devices enlarge the creative possibilities of scientists. The telescope enabled Galilei to examine the Copernican world system. With the aid of radio telescopes, Penzias and Wilson reached deep into the universe as far as its origin and discovered cosmic background radiation. The discoveries of Leeuwenhoeks, the inventor of the microscope, instigated the so-called century of Animalcula, the world of the minor, with the sensational discoveries of red blood corpuscles in 1668 and of microorganisms in 1675.

Leeuwenhoeks' discovery is also a very nice example of how Galileian creatures can overcome the genome's limitations to which Darwinian creatures are subject. If we did not have a facial sense, we would not be able to use a microscope in order to look at the Animalcula. In this respect, our genome only provides us with the opportunity to recognize microorganisms. On the other hand, it is astonishing that Homo sapiens could exist for 100,000 years without having known of the microorganisms' existence which make up more than 60% of the total biomass on our planet and comprise an abundance of about 3,000,000,000 species. This is a multiple of the species that are visible to us.

4.6 Blue Brain Creatures

As impressive as the Galileian creatures' creative possibilities are, they are by far outshone by the historically youngest creatures who inhabit the top floor of the Tower of Creativity. Blue Brain creatures are no longer single individuals, but they consist of cognitively networked individuals. They are named after Blue Brain, a project that was launched in May 2005. It is a collaboration between IBM and Henry Markram's Brain and Mind Institute at the École Polytechnique in Lausanne, Switzerland. The project's aim is the first computer simulation of the entire human brain.

Projects like Blue Brain can no longer be carried out by a single creative person. For their completion, many scientists, engineers, programmers, and so on, are needed. Thus Blue Brain reflects a trend that has tremendously increased in the last centuries in science: discoveries are increasingly rarely made by individuals alone; rather, they are made more frequently by very large, international research teams. Blue Brain creatures are, of course, not only occupied with science. For example, the performance of a piano concert is the collective work of a composer (who may long since have died), of a creative conductor, of a pianist and of the musicians of the accompanying orchestra. Many unforgettable pieces of art, which are often ascribed to Botticelli, Rembrandt, or Vermeer, for example, were the result of the collaboration of a whole workshop of artists. The famous painters themselves had presumably only painted minor parts of the work (and were only concerned on the periphery with further things like the mixing of the colors).

The scientists involved in Blue Brain are aware that they themselves do not yet have the knowledge which allows them to simulate the human brain. Furthermore, they realize that the computers' computing efficiency is also not yet sufficient for this so. Nevertheless, IBM has provided them each with the latest computer models. Indeed, they start the creative process as a team with insufficient skills and insufficient tools!

5 Theoretical and Practical Implications

The allegory of the Tower of Creativity itself is, of course, not an explanatory theory of creativity. Still, if one accepts the present prerequisite that the Tower's creatures all showed creativity, then it can serve as a fruitful heurism. In fact, it offers a whole host of theoretical and pedagogical stimuli. Unfortunately, we have to confine ourselves to some key points due to lack of space.

Seen from a theoretical point of view, the Tower of Creativity explains how important the four basic principles are that we presented earlier. (1) Creative actions cannot be explained by an undifferentiated human creativity trait as, for example, even species or social groups have to innovate. (2) The focus of creativity research should be on creative actions as an outcome variable. All six creatures meet the requirement to show creative solutions in different ways. Speaking of *the* creativity thus does not make much sense. It is rather to be investigated in the individual case exactly how *this* creative action was possible. (3) The capacity for creative actions is located in systems. For example, Spencerian Creatures or Blue Brain Creatures rely on the development of various social systems. (4) Creative actions are original and adaptive and give each creature an advantage or solve a specific problem.

The allegory of the Tower of Creativity offers further theoretical stimuli beyond the four basic principles. We would like to briefly mention some of these. (5) Context dependence: the creative actions of each creature are an adaptation to a specific environment which allows them to act more efficiently in order to attain a goal. These goals do not only apply to the goal of survival, but they also comprise scientific, artistic and other goals. (6) Equifinality: creative actions can come about in different ways. Each creature has its own characteristic approach. (7) The capacity to creative actions exists on various levels (mutations, trial-error, individual thinking, group decisions, and so on). (8) Emergence: it is traditionally supposed that creative actions can be attributed to clearly identifiable reasons. It is further assumed that their effect would be linear. These ideas are regarded as obsolete after the rise of biology to the level of modern physics. In contrast to mechanistic-linear thinking, systematic thinking focuses on *nonlinear* processes that lead to certain effects.

Seen from a pedagogical point of view, diverse stimuli can be gained from the allegory of the Tower of Creativity. For example, the linking to the principle of adaptivity requires the following skills of individuals before they can act creatively:

- Realistic assessment of one's own action repertoire;
- Realistic goal-setting;
- Strategic planning how to attain the goal;
- Competent acting;
- Self-monitoring of the progress of the action;
- If necessary, modification of the action; and,
- Unbiased assessment of the result of the action.

Obvious further goals for creative education are social skills (cf. Spencerian creatures), mastery of tools (cf. Galileian creatures) and a low need for cognitive closure (cf. Blue Brain creatures). In short, the allegory of the Tower of Creativity can help us to expand our traditional objectives of creativity education immensely.

6. Epilogue

Creative education is typically pointed at Popperian Creatures, i.e. at individually acting persons. However, is this individualistic approach really sufficient to find creative solutions for the problems we have presented at the chapter's beginning: climate change, the civil war in Darfur, space travel, new products? Obviously not. Although sudden inspirations have contributed immensely to human development and progress, the complexity of modern problems seems to require the efforts of many cooperating persons with access to certain tools (computers, satellites, video conference equipment, and so on) and the competency to handle these tools effectively.

Furthermore, all these problems are ill defined. Neither the exact goal nor the starting point nor the way forward are clear from the start. Additionally, it is unknown whether the involved persons/groups possess the necessary competencies or the necessary tools to solve these problems. They have to be Blue Brain creatures, i.e. they are permanently evolving creatures.

It is important that we see the analogy between creativity education itself and the life of Blue Brain creatures. Those involved in creativity education must anticipate the creative actions our pupils (homogeneous teams, groups based on division of labor, and so on) have to accomplish one day. We neither know what competencies they will need nor what tools they will use in order to be successful. Having this in mind there should be no doubt that the subjects of creativity education are no longer Popperian creatures, but mainly Blue Brain creatures. We need much more research in order to understand them, how to live like them and how to best educate them.

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