

The WCR Model of Creativity. From Concept to Application

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Abstract: The paper reports the attempt to synthesize the main theoretical positions about creative thinking in order to define a coherent framework to be applied in education. Three general mental operations seem to rely on the basis of creativity: widening (W), connecting (C) and reorganizing (R). W concerns the tendency to keep an open mind and to deal with a great number of elements. C refers to the capacity to establish relationships among different elements and to combine them in unusual ways. R consists of changing the perspective and inverting relationships among elements. The model of creativity resulting from the integration of W, C and R: (i) inspired the investigation of the folk conceptions of creativity; (ii) was the basis of a test to measure creative thinking skills; and (iii) was the foundation of a training programme aimed at enhancing such skills in children. The instruments which were devised on the basis of the WCR model are described and some results coming from their application in educational settings are reported.

Keywords: Creativity, naive conceptions, tests, training, metacognition, association, insight.

TOWARD A MODEL OF CREATIVITY

Three Main Perspectives

Nowadays trying to answer the question: “How is it possible to enhance creativity?” is not simple. This is due to the plurality of existing methodologies, which are extremely heterogeneous since they refer to very different theoretical assumptions [1].

The perspective according to which creativity concerns primarily the production of abundant and diverse ideas still survives. Starting from Guilford [2], and according to the factorialistic perspective, creativity is linked to the ability to produce many ideas from a stimulus. This ability is characterized by the richness of the thinking flow and the ability to follow new directions in order to achieve uncommon and original outcomes. The generation of fluid, flexible and original ideas often comes from changing existing ideas [3-5], analyzing scientific discoveries, technological innovations and artistic masterpieces, and found that they always originated from existing ideas that have been modified through gradual adjustments to fit the specific problem or goal the creator had in mind. In fact, information that people gradually obtain while testing solutions that progressively come to their mind by trying to solve a problem leads them to change the direction of their reasoning. Not all changes, however, lead to something useful and valuable. Proposed changes have to be selected. The creative process, hence, becomes similar to the evolution process [6], which is determined by the generation of variations of the characteristics of existing species. The selection of these variations leads to the maintaining of those that provide greater survival capacity [7].

Secondly, associationism is also a resistant conception of creativity. From this perspective, the production of creative ideas would be achieved through the unusual combination of known ideas. Bizarre associations often lead scientists and artists to mature brilliant insights. Vygotsky [8] was one of the first authors who proposed a conception of creativity based on the idea of “association”. According to Vygotsky, creative activity consists of the recombination and processing of information already known or previously acquired, which leads to the production of new realities. In the 1960s, Mednick [9] argued that creativity can be identified by the ability to connect useful ideas which are distant from each other. According to him, creativity is the ability to combine, in a new and unusual way, disparate elements that apparently have little in common. Arthur Koestler [10] named *bisociation* the creative act consisting of bringing together two structures of reasoning usually considered incompatible, or to find similarities between different fields of knowledge. Innovative thinking would be implemented when two independent ways of reasoning come to an intersection, producing something that did not previously exist. The assumption that creativity derives from the association of elements usually considered as unrelated is also present in recent theories. For example, Rothenberg [11] identified creativity with *Janusian thinking* (a name derived from Janus, the ancient Roman goddess having two faces looking at opposite directions). This form of thinking allows one to combine the terms of an antithesis, that is, to simultaneously keep in mind two opposing elements and to attempt their integration. The creative person, therefore, will be able to combine two different elements and to make antagonistic elements coexist in the same line of thought.

Thirdly, some of the suggestions derived from the Gestalt tradition have been used to define an “updated” concept of *insight*. Gestalt psychologists did not generally use the word “creativity”, even if they dealt with acts of thought that produced discoveries and inventions. What is commonly meant by “creativity” refers to what Gestalt psychologists called *productive thinking*, which, as Wertheimer [12]

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claimed, allows individuals to identify new properties of the given elements, which are then conceived and used in new or different roles or perspectives. This implements a restructuring act, which represents: (a) the transformation of the point of view from which the situation is analyzed; (b) the reorganization of available informational data; (c) the discovery of new relationships; and (d) the identification of new functions of the available material. The restructuring act appears to be the core of what De Bono [13] labelled *lateral thinking*. Lateral thinking allows one to switch from one scheme of reasoning to another, to look at problems in new ways, to take new perspectives and to avoid forms of reasoning which are too stiff or familiar.

Gruber and Davis [14] pointed out that not all innovations and discoveries must necessarily proceed from a sudden reorganization of the conceptual field. For example, Gruber [15], by reconstructing the development of Darwin's evolutionary theory, emphasized the presence of slow and incremental changes in the theoretical system that the British naturalist was gradually formulating.

Recently, Schank [16] also maintained that some sort of restructuring is at the basis of creativity. This author suggested that to understand reality we must have specific knowledge structures. A knowledge structure used several times to explain an event constitutes a *pattern of explanation*. Facing a stimulus, the most economical strategy is to treat it as something familiar, namely, trying to apply a pattern of explanation which refers to other known situations. Creativity emerges with new situations. In this case people can apply an "unexpected" pattern of explanation. The creative process comes from a deliberate misapplication of an explanation pattern: facing an event, a person does not apply the usual pattern of explanation for it, but tries a completely different pattern.

Is it possible to find a way to synthesize those different positions, in order to define a coherent framework to conceptualize creativity and to inspire attempts to educate creativity? Apart from the specific aspects that characterize each theory, we can identify three major mental operations which appear to be the basis of creativity.

The first group of authors fundamentally believes that creativity comes from the *widening* of the mental field. If the individual is capable of producing many different and unusual ideas (Guilford), if the individual takes something that exists and tries to change it (Perkins, Simonton, Weisberg), if the individual generates different solutions in order to identify at least one surviving evaluation (Campbell, Johnson-Laird), the individual will discover many mental elements, increasing the probability of finding among them one that could lead to something new and valuable. Hence, expanding the mental horizon through the discovery or invention of new elements contributes to creativity.

The second group of authors recognize, however, that creativity emerges when people establish a relationship between realities which are very different from each other (Vygotsky, Mednick, Koestler) or even opposite (Rothenberg). According to this perspective, *connecting* mental fields usually considered remote, and possibly antithetical, is the basic process of creativity.

Finally, the third group of authors thinks that a creative act occurs when there is a reorganization of the mental field. This can happen through restructuring (Wertheimer, Gruber, De Bono) or through the application of an interpretive scheme that usually applies to other situations but that, when applied to the present one for which it is not the conventional scheme, produces a new vision in which it is possible to grasp not obvious and interesting meanings (Schank).

The WCR model of creativity tries to integrate these operations – widening (W), connecting (C) and reorganizing (R) – to help teachers and trainers design interventions which can enhance each different aspect of creativity. *Widening* concerns the tendency to keep an open mind, to be aware of the great number of elements that can be identified in a given situation, to recognize possible, not obvious, meanings, to discover hidden aspects and to overcome apparent constraints. *Connecting* refers to the capacity to establish reciprocal relationships among different elements, to draw analogies between remote things, to combine ideas in odd ways and to synthesize the multiplicity of disparate elements into an overall structure. *Reorganizing* consists of changing the perspective, assuming a different point of view, seeing things by inverting relationships between their elements, asking original questions and imagining what should happen if unusual conditions occurred.

Widening

The first mechanism that we see operating in creative thinking consists of coming out from the limited conceptual framework within which people spontaneously pigeonhole situations and breaking all the "thinking bonds" that often restrain them. To produce something new and original, it is important to move in a wider mental field that will mobilize ideas and lead to new directions of thinking, helping to find new opportunities and new meanings.

A good example is related to marketing. For decades, manufacturers of tennis rackets were bound to a standard shape and size, when actually no regulation prevented the use of different rackets. Breaking this implicit constraint, the owner of a sporting goods company successfully launched onto the market the "big racket", a tennis racket with a wider than usual tailpiece. A tennis racket with this shape and this size offers several advantages over traditional rackets: first, beginners are more likely to intercept the ball; second, a larger tailpiece allows tennis players to give more strength to the shot; finally, the effects of the return stroke on the elbow ligaments are lower. The designer of this "big racket" expanded the field of mind, acknowledging that tools with better and different features could be produced.

This link between creativity and breadth of the mind field within which people move can be found in early childhood. For example, when faced with disconnected data, individuals enact categorization strategies in order to gather more data within the same class. In such situations it is possible to stress individual differences. On the one hand, there are those (open categorizers) who tend to form broad categories; on the other hand there are those (close categorizers) who tend to make a lot of subtle discriminations among data and gather them under the same class only on the basis of close similarities. A positive correlation between open categorization and creativity has been proven. In fact, open

categorizers – as happens with creative individuals – are prepared to process large amounts of information, not based on categorization – as happens with closed categorizers – but only on well-structured principles, and proceed by changing their own thought patterns and integrating new ideas in a quickly changing mental organization [17].

Connecting

We will consider now the second creative mechanism, namely, the mental operation which leads one to link together apparently disparate realities. Why do unusual associations support creativity?

Sometimes obsolete or bizarre associations have led scientists and artists to mature brilliant insights. For example, Wilhelm Röntgen, while investigating the properties of cathode rays, discovered, almost by chance, that, on a screen near the table on which he was conducting his experiments, a green luminescence was produced. He associated this phenomenon to the rays he was studying and, carrying out specific experiments in this new direction, discovered the existence of X-rays. Similarly, Alexander Fleming, while studying cultures of bacteria, noticed that one of these cultures, carelessly exposed to air, had been destroyed. He associated the exposure to the death of the bacteria – two factors with apparently nothing in common – and came, on the basis of this insight, to the discovery of penicillin. Darwin reported that the insight that led him to develop the theory of evolution was prompted by the reading of an essay of demography and economics written by Malthus and from having established a connection between the dynamics governing the growth of human populations and those of the animal world.

These cases of scientific findings suggest that establishing a link between aspects of reality that we usually separate can lead to identifying useful hidden similarities. This is also true of technical discoveries. For example, Leonardo da Vinci designed a system to automatically move a rotisserie, establishing a connection between the instrument itself and an environmental element that had nothing to do with it. When we cook a dish stuck on the spit over the fire, it produces smoke. Would it not be possible to establish a link between smoke and spit? If the smoke is conveyed in a hood at the end of which is placed a windmill, the smoke, going up, will set it in motion. Such bloodstream motion of the whirlwind can be transmitted, with appropriate couplings, to rotate the spit without any human intervention. In a similar way, Henry Ford was able to reduce the production cost of the Model T, an innovative car that was launched on the market, demanding that the goods supplied to the factories were packed in boxes of a defined size and with the screw holes made in specific locations. The walls of the boxes were actually used, being designed with the right dimensions, as the floors of the cars that were built in the factory. The ingenious idea was to establish a relationship between two elements usually conceived as distinct: packaging material and the product inside the package.

Field-independence, as shown by investigating individual differences in analogical reasoning [18], is one of the personality traits related to *connecting*: mapping the solution strategy embedded in a familiar situation onto a novel problem, so as to integrate two different frameworks, is more

likely to occur in field-independent than in field-dependent individuals. Consistently, creativity can be increased by stimulating people to look beyond the immediate cognitive field and to perceive the opportunities which are at hand in other fields. In fact, training students to make analogies is a successful way to enhance creativity [19].

Reorganizing

If we were asked to determine the volume of a ball, we could use our school memories trying to recall the formula to calculate the volume of the sphere. But if we were required to determine the volume of an irregular solid (e.g., a small rock), there would be no formula or past experience that could help us. Instead, we might think to immerse the rock in a graduated jug, partially filled with water, and measure the resulting increase in the level of the liquid. The increase corresponds to the volume of the dipped rock. In this case the success is caused by setting the problem in different terms: not related to formulas, but as a practical-operational problem. Assuming a new perspective allows us to find an original and effective response.

Another example: if I want to help a depressed friend, rather than following the obvious path and trying to comfort my friend, I could reverse the relationship, pretending to be the one needing help. Reversing the roles – in order to help, my friend, the one in need, I ask him to help me – can, in some circumstances, lead to solution.

Also a historical case can be relevant, particularly relating to the Thirty Years' War. The Spanish army had defeated the French and was spreading out into French territory, destroying villages and raging on the population. A small village received the news of the arrival of the Spanish army and people gathered to decide what they could do to defend themselves. It was clear that trying to oppose the enemy troops with barricades would be futile, given the disproportion between the number of attackers and the villagers. Hence, the men of the village decided to do just the opposite of what people would expect: rather than trying to resist the enemy and defend their home and family, they escaped, leaving in the village only children and women. This reversal of attitude – to leave their loved ones and their properties rather than defend them – proved to be a winning solution. When the Spanish army reached the village, they entered it without a fight. If the soldiers had fought, they would then have had the “right” to persecute the losers, but since they not have “earned” the looting right, according to their military code, they would had been men without honour if they used violence without having to fight for this right. So the Spanish army passed over, respecting the people and properties in the village.

Perspective reversal is a mechanism that we find at the basis of another of Leonardo's inventions. For example, the conception of the cochlea, a tool designed to bring water from one level to the next, involves the mental operation we are discussing. The main aim of this instrument is to bring water upwards; but, to do that, it operates in the opposite direction, actually going down. The spiral wrapped around the rotating cone, “penetrates” the water tank placed in the lower level. Part of the water enters the first segment of the spiral. The rotary motion leads this segment at the top and the water contained in it falls down into the next loop,

which, with the next rotation, finds itself at the top and so the water, lap after lap, reaches the exit at the top.

The number and speed of shifts in the interpretation of ambiguous figures is an individual parameter which resulted in being associated to creativity, so supporting the notion that *reorganizing* is a facet of creativity. Reorganizing can be facilitated by hinting to students at simulating mentally how it is possible to transform given situations. Visual images can be especially helpful to do this [20, 21].

These three operations – *widening*, *connecting*, *reorganising* – appear to embrace most of the ways in which creativity has been conceptualized and can serve as a framework to build tests to assess the abilities of creative people and to develop activities to strengthen creativity.

ASSESSING THE NAIVE CONCEPTIONS OF CREATIVITY THROUGH THE WCR MODEL

The three operations mentioned above, besides being the basic elements of a model of creativity that seeks to integrate contributions coming from different theoretical perspectives, can also become the basis for investigating the folk conceptions of creativity.

The Implicit Theories of Creativity

Research aimed at studying creativity and providing a definition of this phenomenon has recently highlighted the need to investigate what ordinary people think about creativity. The set of beliefs, opinions and attitudes that individuals develop about a certain phenomenon and according to which they provide explanations is called *implicit theory*. Implicit theories of creativity can be hence considered as constellations of thoughts and ideas about creativity [22-24]. The analysis of implicit theories is important in educational settings since they appear to be related to learning outcomes. What students think about creativity, in fact, influences their behaviour since it leads them to develop the attitudes and to apply the strategies which match individual beliefs.

Sternberg [25] explored implicit theories of psychological phenomena with a sample of experts (teachers and students in specific disciplines) and ordinary people, to understand the nature of conceptions of intelligence, creativity and wisdom. He found that people can distinguish between creativity and the other two constructs and that the relationship between intelligence and creativity lies in an intermediate position between intelligence and wisdom on one side (close relationship) and creativity and wisdom on the other (poor relationship). In general, it emerged that people connote positively these three psychological constructs and that there are certain attributes – for example, aesthetic taste and imagination – that are perceived as being exclusively related to creativity.

Also Runco and Bahleda [26] investigated the implicit theories of creativity in different professions (artists, scientists and ordinary people) and found differences stressing three ideas of creativity: one linked to science, an “artistic” one and the last linked to everyday life. Words such as “logical”, “experimental”, “deep” and “patient” characterise the first type of conception; “emotional”, “perceptual” and “expression” define the second type; and

finally, everyday creativity is linked to “utility” and is described as “active”.

Several researchers have focused on teachers’ opinions about creativity. Runco *et al.* [27] conducted two studies on teachers’ and parents’ implicit theories of creativity. Teachers and parents used the same adjectives to describe a creative child, who was considered “adventurous”, “enthusiastic”, “artistic”, “imaginative” and “curious”. In addition, whereas teachers reported some temperamental and social characteristics (“cheerful”, “friendly”, “quiet”), parents indicated intrapersonal characteristics (“impulsive”, “having confidence in himself”, “resourceful”, “industrious”).

Research contributions regarding implicit theories of creativity highlighted a sort of parallelism between naïve people’s opinions and the mental operations underlying the WCR model. Some abilities which experts associate with creativity are also associated with creative thinking by ordinary people: a good example is the production of new and original ideas. Data collected in two surveys carried out in Italy by Eurisko [28] and Ipsos [29] showed that interviewees, when asked to think of creative people, evoked inventors and artists – such as Leonardo da Vinci and Michelangelo – many of whom owe their creations to fortunate and unusual associations. Elements such as fantasy and imagination, which most people stressed as fundamental in a creative person, are a reminder of the individual’s ability to see reality through different “glasses” (that is, different points of view) and to restructure information, often reversing the initial point of view.

The correspondence between implicit theories and the three creative mechanisms described above also emerges from Antonietti and Cerioli’s [30] investigation on teachers’ representations of creativity. More than half the teachers who joined the research described creativity as a skill that can be trained in all children. Teachers represent the creative person as someone who is full of ideas, tends to solve problems in original ways and is versatile.

Children also have clear ideas about creativity. Pizzingrilli and Antonietti [31, 32] explored the representations of creativity with students attending primary and secondary schools using different assessing and evaluating tools. A brief story and a list of adjectives were devised. The first instrument aimed to verify whether students identified the restructuring process; the second aimed to investigate how they considered the creative child. The story talked about two schoolmates: during recreation, a child was drawing a flower but the child left the drawing incomplete (initial drawing). In the creative version of the story another child came and decided to modify it so that it came to represent a human character (intermediate drawing). When the first child returned, they noticed the changes that the second child had made on their drawing and decided to complete it by following the directions suggested by the second child, so that the final drawing depicted a sultan (final drawing). In the control version of the story, the second child modified the initial drawing by adding accessory elements consistent with the initial intentions of the first child. Participants were requested to judge the level of beauty and originality of the drawings and who (between the first and the second child) gave the greatest contribution

to the realisation of the final drawing. The second instrument consisted of a list of 15 couples of adjectives reporting two opposite characteristics (attentive versus inattentive; careful versus careless; tidy versus untidy; curious versus not curious; having many ideas versus having few ideas; obedient versus disobedient; self-confident versus insecure; very intelligent versus little intelligence; very clever versus not clever; fanciful versus not fanciful; dreamer versus practical; interested in novelties versus indifferent to the novelties). Every respondent had to endorse the quality that a creative child should have.

Results showed that, starting from seven years of age, students are aware that the creative act requires specific mental operations such as restructuring, even though young children fail to appreciate the creative contribution of the second character of the story. Moreover, seven-year-old students tend to associate the creative person characteristics as being closely related to the school context (for example being tidy and attentive). This last result emphasizes that it is not easy for children to outline a specific profile of the creative person and the strong influence of the environment on their representations.

A New Instrument

In order to deepen the investigation of the naïve conceptions regarding creativity, Colombo *et al.* [33], devised a specific questionnaire, consisting of three different sections, characterised by the use of different codes (verbal, visual and auditory). The first part (verbal) was meant to investigate the concept of creativity itself (Is it innate? Can it be taught?) and its relationship with intelligence. The main areas investigated were: definition of creativity; singularity versus ordinariness of creativity; creativity versus intelligence; creativity training. Another verbal part was focused on the personality traits of the creative person and was also intended to identify which typologies of persons are conceived as “the most creative”. This section explored the singularity of the creative person (e.g., “Does having a creative personality mean being special, different from others?”), beliefs about the creative person (by using drawings to help people make clear their conceptions and by providing respondents with adjectives that define the personality the qualities and the limits of a creative person, as well as the creative individual in their personal experience as a subject – e.g., “Do you happen to know a creative person?” – examples of creative professions, distinctive aspects of creativity – e.g., “Which of the following aspects is necessary to describe a creative person?”). The visual and auditory parts of the questionnaire were intended to explore the difference of considering a product as creative with reference to visual art and music. Pictures and musical pieces have been selected analyzing creativity traits (fluidity, flexibility and originality) that could be recognised in their inner structure. The first picture was *A woman on the armchair* (by Pablo Picasso) where we could identify a factorial structure, corresponding hence to the *Widening* part of our model. The woman’s portrait is made up of different fragments of reality. Hence, we can say that the artist started from a base element (the woman), presenting it as though divided into the multiple factors that characterise it. Creativity traits can also be identified in this work. Flexibility can be identified in the “creation” of the portrait,

that clearly diverges from the canonical structure that the portrayed situation might have offered; fluidity may be recognized in the ability, belonging to the Cubism movement, by which a theme is represented in different ways, which are changed as often as possible. Originality emerges clearly from this unusual representation of the woman.

A dreaming caused by a bee’s fly around a melagrana a second before waking up (by Salvador Dali) was related to the vision of creativity as an association of ideas, namely, the *Connecting* section of the WCR model. Such a vision considers as the centre of the creativity process the links between a mental element and the other. In this work by Dali we can see bizarre associations, apparently inconsequent since they match ideas that are usually unrelated. But every single association earns a proper (creative) meaning when different independent elements are considered closely. The end of the bayonet that is going to hurt the woman is associated to the bee’s sting, whereas the pain of this sting is associated with the aggressiveness of tigers.

Galatea of the spheres (by Salvador Dali) was associated with the vision of creativity as *Reorganizing*. The picture offers a new, complex reassembling, obtained from the restructuring of the basic visual elements. This work highlights the attention to the general structure of the stimulus and stresses the properties of a new organisation – that, in this specific case, leads to an innovative perception of space – of the single elements and of their relationships and functions. The woman’s face appears to be broken up into different parts: those parts constitute elements and each of them appears to assume a specific role in a dynamic cognitive restructuring that leads to a global vision of the image.

As far as the analysis and selection of musical pieces are concerned, musical pieces that were not too familiar – to avoid emotive responses elicited by previous experiences – were chosen. *Improvisation over Canarios* was meant to represent the factorialistic view of creativity. In this musical piece it is possible to identify several aspects linked to the *Widening* creativity aspect. From Canario’s theme (an ostinato derived from Renaissance traditional popular music) different factors – represented by instrumental voices – can be clearly and singularly identified. Each provides a different variation on the basic theme. Fluidity, flexibility and originality can be perceived when comparing the different juxtaposed variations. Moreover, consistent with factorialistic theory, the more the variations progress, the more the level of originality and complexity grows.

Presto, from Johann Sebastian Bach’s Concerto No. 4 BWV 1049 in G major, was considered as an example of the association between distant and different (musical) ideas (*Connecting*). Musical phrases that constitute this piece are strictly linked. Each musical sentence refers and justifies the following one – passing on the idea of an association chain. The absence of pauses and the pressing rhythm confirm this idea.

Danza de la espadas (by Alger, El Kantara) was associated with *Reorganising*. The piece starts offhandedly and the beginning is marked by the percussions that stress short musical sentences, followed by pauses and sudden

reprises. Such a modality can be easily associated to the creative process, as described by the Gestalt school, that is, progressing by insights. Moreover, in several sections of the musical piece, this “metaphorical insight” involves a re-elaboration of the basic musical line into a more complex or differently articulated one.

A pre-test showed that non-experts were able to recognise the alleged traits in the artistic works inserted in the questionnaire.

The administration of the tool highlighted that creativity is intended by non-experts as an innate faculty that does not coincide with intelligence. It concerns mainly cognitive aspects and can be trained. Being a musician was mentioned as the most creative profession by the whole sample. Differences emerged between those who think being a musician is a creative profession and those who share different beliefs. People who view the musician as a creative person believe the creative person to be a “normal person” characterised by their everyday faults and merits. People who do not associate the creative person with a musician think the creative person is someone with a strong personality and who does not need specific cognitive abilities. With reference to complex musical stimuli, those who think of the musician as a creative person seem to be more able to recognise (and value) musical technical aspects.

A TEST TO MEASURE WIDENING, CONNECTING AND REORGANISING

The WCR model was also taken as a basis for constructing a test to assess creative skills of students [34]. The availability of appropriate tests is a need in education, both to measure students’ starting levels of creativity to choose training procedures which match them and to verify, through test-retest designs, the outcomes of interventions aimed at enhancing creativity. While implementing the WCR test, both quantitative and qualitative information (derived from different types of responses) were taken into account.

The instrument consists of two separate versions: one with multiple-choice questions and one with open questions. This allows us to investigate the same creative abilities in different ways according to the actual educational needs. If the teacher is interested in a preliminary investigation of students’ abilities, the multiple-choice version can be used, since its application – as well as scoring – requires a short time. The answers can be converted into a score that corresponds to the level of creativity of each student. As a second step, teachers can proceed with the application of the open version of the test, which not only allows more qualitative information to be obtained, but also verifies the possible progress made by pupils.

For each version, the test includes two forms, corresponding to two age levels: the junior form is intended for students attending the first two years of primary school, whereas the senior form is intended for students attending the subsequent years of primary school. This additional division allows teachers to adequately verify the actual creative abilities of the child, which change with age.

All items consist of visual stimuli – such as images of objects, geometrical figures or scenes – and verbal stimuli,

ranging from the presentation of single words to hypothetical questions.

In the first sub-test (*Widening*) the child is asked to choose one answer among alternatives. In the second sub-test (*Connecting*) the child is asked to choose, given a list of words or images, the elements that the child would associate with the given situation and to justify the choice. In the third sub-test (*Reorganising*), faced with a hypothetical situation, the child is asked to choose one answer among alternatives that vary gradually from obvious to unusual consequences. The child must choose the scenario that, in their opinion, completes the initial scene and, on the basis of such choice, to invent a little story.

Each version consists of nine items, distributed as follows:

- three items for the sub-test W (*Widening*);
- three items for the sub-test C (*Connecting*);
- three items for the sub-test R (*Reorganising*).

In order to verify the adequacy of the different sub-tests, an explorative application was carried out with pupils attending primary schools. In this way it was possible to obtain an evaluation of the test for both levels of difficulty. The test was incorporated into daily teaching activities and carried out collectively. The two versions of the instrument (open questions and closed questions) were filled in by students in two separate sessions in order to avoid both learning effect and fatigue, the latter due to the complexity of the open version. All classes were first proposed with the close-question version and, at a later time (varying from a few days to a week), the open-question version. In the test booklet an introductory leaflet was attached to clarify the non-judgmental nature of the test, not to affect the performance of pupils. The administration did not require special training for teachers or the classroom.

The *junior* form of the instrument was administered to a sample of 70 children perfectly divided between males and females. With reference to this subsample 54% attended the first class and the remaining 46% attended the second class. The *senior* form was collected on 160 children attending the last three years of primary school.

From the distribution of the percentages of responses to the various options of each type of test – *Widening*, *Connecting*, *Reorganising* – directions were obtained to assign a creativity score to the various choices: the score varied from one (not creative) to four (very creative). More specifically, a policy of gradual deviation from the higher response rate – under the principle that responses which are not frequent tend to be more creative – was followed. In our case, answers that have gained frequency values less than or equal to 10% gained the highest score for creativity (equal to four). Similarly, responses that had the highest frequency rate earned the lowest score of creativity (equal to one). Intermediate values – a score of two or three – were assigned taking into account both the percentile ranks and the content of the response.

A comparison of the frequency distributions of responses for the two forms of the instrument – *junior* and *senior* – showed that younger children often tend, as expected, to

show a greater adherence to the perceptual aspects or to the consistency of content between an element and the whole frame, not using or using only a small part of the full range of responses offered by the instrument.

A first analysis of the characteristics of the instrument highlighted that the scores derived from the three types of tests – *Widening*, *Connecting* and *Reorganising* – were not significantly associated to one another but were significantly associated with the total creativity score. This evidence – which is valid both for the junior and senior form – confirms the close interdependence between the sub-tests and the construct of creativity here under consideration. The test seems to indicate commonalities with overall creative thinking (correlation with the total score), but also distinctive aspects that do not overlap.

Analyses conducted with respect to the gender and educational level variables showed that, for both forms, the answers given by males did not differ significantly from those given by females. Regarding the effects of age, the only statistically significant difference that occurred was found in the junior form and only in the Reorganisation sub-test. This sub-test probably reflects more the effect of narrative thinking which is best expressed by children who have more schooling. In the senior form differences due to age failed to emerge.

The conversion of raw scores in standardized tests scores allows testers to evaluate individual student profiles. In this way we can understand not only the general level of creativity of each child but also if their creative potential is shown primarily in one type of mental operation (as might be the case of a student who is very creative in the Connecting sub-test and uncreative or mildly creative in other sub-tests).

A PROGRAMME TO ENHANCE WIDENING, CONNECTING AND REORGANISING

The WCR model was conceived as the framework to devise a training scheme – entitled the *Child Creativity Development Programme* (CCDP) [35] – designed to enhance creativity in children from 4 to 10 years of age.

Assumptions Underlying CCDP

This training programme tries not only to integrate different theoretical perspectives, each focusing on a dimension of creativity (*Widening*, *Connecting*, *Reorganising*). It also tries to overcome some of the limitations that can be identified in other creativity training programmes. Traditional proposals for the development of creativity, in fact, share some common assumptions that we have tried to change.

First, they typically consider only one or a few aspects of the creative dynamics, favouring a single mental mechanism. For example, brainstorming stresses only the possibilities opened up by cognitive fluidity, while associationist procedures try to promote operations aimed at connecting ideas. However, abundant and original ideas are not necessarily innovative in themselves. Additional cognitive processes seem to be required, but existing proposals rarely suggest an organic development of multiple components of creativity.

Secondly, traditional training programmes in creative thinking mainly consist of an evident lack of relevance to daily activities. Hence, the effectiveness of such programmes has been proven only in situations similar to those originally presented in the training. The empowerment therefore seems to have helped to assimilate creative processes, but these are activated only in contexts similar to those where they have been learned. Basically, educational scenarios that are far from everyday life hinder the transfer of acquired skills to different domains.

Thirdly, the usual training procedures to enhance creativity are focused mainly on the direct exercise of special operations and pay scant attention to the ability to control such operations. In other words, these programmes teach how to make the relevant operations but not to discriminate among situations in which they should or should not be done, what are the steps most appropriate to accomplish them, and what are the most effective ways of doing them.

The limitations mentioned above can be overcome, as in CCDP, if:

- various aspects of creativity are involved and various mechanisms activated;
- links between the programme and aspects of real everyday life are encouraged and fostered;
- metacognitive activities are included in the training.

For an organic development of creativity, however, a further step seems to be needed. Individuals should not only be trained to make unusual cognitive and metacognitive operations, but they should develop attitudes that allow them to accept, or even to seek for those situations – new complex, unexpected – in which these skills can be activated.

The CCDP

CCDP is based on a story of two children (Sarò and Sarà), approximately five to seven years of age, who are gradually included in a fantastic adventure consisting of a journey in search of the secret of Pensone, a mysteriously extinguished volcano of bubbles. During the journey the children are accompanied and supported by three tutor-characters, each representing an essential aspect of creative thought: the expansion of the mental outlook (*Widening*: Fluò, the cat), the ability to make comparisons and analogies (*Connecting*: ComeComè, the rabbit), the ability to change the point of view (*Reorganising*: Piedaria, the butterfly). The journey requires Sarò and Sarà (and, indirectly, the group of children following the story) to face various emotional and cognitive challenges, the passing of which allows access to the next screen and, finally, to the secrecy of Mount Pensone.

The narration activates – on different levels of reality and fantasy – different characters and confusing situations. There are symbolic characters that correspond to attitudes and cognitive styles generally opposed to creativity and attitudes that foster them. These characters inhabit Mount Pensone and constitute obstacles to the discovery of the secret of the volcano. Overcoming these obstacles is generally allowed by insights that lead Sarò and Sarà and their tutors/friends to supplement the “bad parts” of symbolic characters, returning

to them (and to themselves) vitality and creativity. Mount Pensone is the mysterious destination of the journey, which ultimately seems to dissolve in a symbolic way within the psychological resources of children themselves, so that the search for the secret of Pensone takes on the meaning of a search for the secret and individual potentialities.

The most striking feature of the programme is the set of activities that are proposed to invite the children:

- to keep in mind all attempts to solve the problems that are activated by the characters of the story;
- to reproduce personally the mental dynamics illustrated and exemplified in the narration.

The second level of pupils' involvement passes through more direct forms of emotional identification with the characters of narration, which have the implicit purpose of "bringing" the children into the story, so that they can live and emotionally elaborate by themselves the situations described in the narration. In other words, children are invited from time to time to exercise their cognitive potential while practicing their emotional skills, through a not explicit game based on fictions, projections, identifications, situations of "as if".

The story has been built with some requirements:

- *Effectiveness*: while favouring an essential narrative, the story is aimed to promote and increase the creative potential of children, encouraging them to think and imagine without any mental automatism.
- *Pervasiveness*: the story involves a variety of languages and skills (verbal, graphic and pictorial, gestural-mimetic, musical), which children are encouraged to use autonomously.
- *Compatibility*: the narration is meant to be activated in a normal educational setting, and is meant to be useful (from a cognitive and affective point of view) for children between 5 and 10 years.
- *Generalisability*: a complex narrative offers the possibility of a cognitive or an emotional-relational use. While in the first case teachers can implement the programme with their students individually, in the second case an initial training session and small group supervision is essential.
- *Interactivity*: the structure of the narration requires continuous interactions among children and the characters of the story, activating a dynamic system where children sometimes reproduce, and some others anticipate, characters' initiatives.
- *A modular structure*: although the story is characterised as a global narration, it also has partially autonomous units, in order to be sufficiently flexible for school implementation.
- *To be open* to the group and to each person. The planned interactions are actually aimed at activating the group of children as well as each individual child.
- *To be motivating*, since it is aimed at promoting curiosity, it is based on symbolic play and on the discovery of individuals' inner world.

- *To be gradual*, since it progressively and alternately stimulates various aspects of creativity and autonomy, focusing both on individuals and group;
- *To be empowering*, as it promotes the assumption and integration of distinctive ways of perceiving and thinking about reality.

Testing the Efficacy of CCDP

The CCDP was applied in two large experiments that were designed to verify its effectiveness in promoting creativity in children attending kindergarten and primary school [36].

The objective of the first research was to assess:

- if an educational activity aimed at developing creative thinking – the CCDP – was capable of increasing the creative performance of children attending primary school, compared to control children not receiving the training;
- whether there were differences between the possible improvement in children with teachers who were previously trained about the relational dynamics related to creativity ("CCDP with training") and those children with not-trained teachers ("CCDP without training").

Statistical analysis showed higher differences in performance, between the pre- and post-assessment, among pupils in the "CCDP with training" condition. The potential of CCDP emerges to a greater extent if it is proposed by teachers previously trained to assimilate issues related to creativity. Teachers only instructed about the methodological procedures required by CCDP were still able to contribute to the enhancement of children's creative resources through the use of this programme, although the improvement, in this case, was lower.

In some cases, statistical analysis revealed significant interactions between treatment and age. In general, it is noted that differences in performance between children aged four and five tend to emerge in relation to the CCDP without training. More specifically, concerning children aged four, the effects of "CCDP without training" – which did not produce significant increases in the levels of creativity compared to the control condition – were significantly lower than those of "CCDP with training"; in five-year-old children, on the contrary, even without the specific teacher formation, the CCDP led students to deviate significantly from the levels of creativity in the control group and the effects of "CCDP without training" did not differ much from those of "CCDP with training". In conclusion, four-year-old children – probably because they are more sensitive to contextual aspects linked to interaction and communication – benefited from CCDP especially if it was implemented by a teacher who has been trained to consider also the relational aspects related to creativity. Five-year olds, instead, were, because of higher cognitive skills, more sensitive to the quality of stimulation provided by the CCDP, regardless of the fact that educators were or nor trained previously.

A second experiment was conducted also involving children attending the first two years of primary school [37]. In this investigation, in addition to the effects of CCDP with

trained and untrained teachers on issues of creativity, researchers intended to study the effects of a new instrument (called the *Child Creativity Development Activities: CCDA*), consisting of simple cards that proposed creative exercises. Results showed that younger children benefited especially from CCDA, whereas the older ones did not receive many benefits from this instrument, but benefited more from the CCDP, regardless of the specific training arranged for the teachers. The second study also tried to answer the question of whether the effectiveness of CCDP depends on the initial level of creativity of the child. In other words, researchers tried to discover whether children took advantage, in terms of increased creative performance, regardless of the baseline level of creativity. Statistical analyses showed that only CCDP implemented by trained teachers increased creativity scores of children starting with high creativity levels. Pupils with a low and medium baseline level of creativity improved to a similar extent in the CCDP and CCDA conditions.

In these two studies researchers also questioned whether a teachers' educational style affects the development of creativity. It is possible to speculate that the same stimulation produces different effects depending on interaction modalities used by the teacher. Using a specific questionnaire, teachers' educational styles were identified. A "close" educational style produced lower values of creativity scores and the "open" mode of interaction caused the highest increases in creativity. Situations where children had teachers with differing educational styles were associated with improvements in originality scores. In summary, the effectiveness of the programme to foster children's creativity is limited by the "close" educational style. However, it is to be noted that, contrary to what has been observed regarding the baseline creativity, there was no systematic influence of the educational style on the increase of the creative performance produced by CCDP. The educational style appears to have a significant effect only in some sub-tests. Overall, the trend of increasing creative performance did not follow a constant direction. The overall picture suggests that the effectiveness of the training is not always favoured by an accepting relational style. At certain times, during the implementation of the programme, teaching activities may require some directivity, so that children working with teachers who tend to share the "close" style are more advantaged. At other times, on the contrary, it is the open interaction that favours the improvements stimulated by the CCDP.

CONCLUSIONS

The present paper proposed an integrated view of creativity by highlighting that three main mental operations – *Widening, Combining* and *Reorganising* – can be meant as the core mechanisms of creativity. The WCR model was assumed as a basis to devise both an instrument to assess the common beliefs associated with creativity and to measure creativity skills. Such tools are useful in educational settings in order to identify students' and teachers' preconceptions – to detect if they need to be changed in case they do not match each other or fail to correspond to the current theories about creativity – and to evaluate pupils' creativity levels and possible increases depending on age and/or instructions. The WCR model was also conceived as a framework to devise a program – the CCDP – to train creative thinking.

The studies summarized above have shown that in kindergarten and primary school it is possible to train creativity skills taking as a reference the WCR model. Results showed that training programmes such as CCDP can stimulate mental dynamics in children that favour the emergence of streams of thought which are rich, varied and original. Data, however, did not merely confirm the possibility of enhancing children's creativity, but also provided more precise suggestions about the manner in which this can be done. Investigations have shown that the CCDP increases the creative performance of children both if it is implemented by teachers previously trained to use it and by teachers without any specific training on related issues. In this sense, the CCDP is an easy-to-use tool. However, the figure of the teacher can influence the effectiveness of CCDP when the programme is used with younger children. In this situation it is more useful when the teacher was previously involved in an educational process on issues concerning children's creativity. Most likely, the younger children are more sensitive to the mode of interaction through which the teacher leads the activities proposed in the CCDP. Consequently, teachers encouraged, through a specific training programme, to pay attention to their attitudes, can focus more on their communication style, using confirming and non-directive procedures so that pupils take part in the educational activities covered by CCDP with the relevant attitude.

Unlike what happens with the "basic" creativity, the "open" style of interaction is not always the best option to promote the development of cognitive components of creativity in structured activities specifically aimed at this goal. In some cases it is a "close" style that is associated with more significant increases between pre- and post-training assessment. Therefore, improvements in creative thinking resulting from programmes such as CCDP, appear to require teachers to be able to build educational relationships in which elements of "openness" and "closing" are co-present.

In order for them to be successful, the structured nature of such programmes probably requires part of the activities to be run in a "steering" way. Hence, a conduction marked by excessive freedom and acceptance – such as those implemented by the "open" teachers – would be to not allow the educational occasions potentially provided by the training to be fully exploited. The data also argues in favour of generalisation. CCDP can be proposed to children by teachers with different relational attitudes without fearing that the particular educational style of the teacher can affect the effectiveness of the programme.

Results showed that the greatest benefits derived from CCDP are in children who start with a low aptitude for creativity. The smaller improvements recorded by participants with a high creativity baseline could be due to a sort of "ceiling effect": these pupils could not have improved more. Alternatively, we could conclude that the CCDP has triggered an opportunity for growth especially for those children who receive little attention from their environment, whereas children who already have other cognitive stimulations considered this training as just one more element placed alongside many others.

If we consider the results of these studies as a whole, we are induced to stress the relevance of dissemination. Developing creativity emerged as a possible educational operation in the school environment [38]. Requirements to optimise this operation have been identified. The reliability and validity of the materials to evaluate the creative potential of children and to promote more creative thinking has been examined and proved. The development of creativity – through the integration that takes place between divergent and convergent aspects, spontaneity and control, emotion and intelligence, imagination and rationality – is characterised, therefore, as a stimulus to overcome two opposing dysfunctional trends: stereotypes and rigidity on the one hand, and, on the other, destruction and unreality of thought. This goal has a significant expression in these images proposed by Levi-Strauss [39]: “Man is not like a person climbing a ladder, who with his every move adds a new step to all those already won”, but as a player of dice that “as often as throws them, see them spread on the carpet, resulting in different combinations” or “as the knight in the chess game, who always has at its disposal a variety of progressions, but never in the same direction”. The question is then to give the individual – in a much more important game than chess, that is, life – the ability to perform, in addition to the fast and straight moves of the tower or of the bishop (the linear logical thinking), the most imaginative and unpredictable moves of the horse.

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CONFLICT OF INTEREST

None declared.

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