This is a manuscript version of Cropley, A. J. (1995). Fostering creativity in the classroom: General principles. In M. Runco (Ed.), *The creativity research handbook* Vol. 1 (pp.83-114). Cresskill, NJ: Hampton Press.

If you cite it, please use this reference.

NOTE: The table on page 5 is an updated version of the table in the published version of the chapter. The figure on page 21 is also an updated (although somewhat simplified) version of the figure in the published version of the chapter.

Fostering Creativity in the Classroom: General Principles

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The upsurge of interest in creativity following the Sputnik shock in the 1950s was initially driven by educational issues. These centered on the view that schools and universities were producing large numbers of graduates, but that most of them were trained simply to apply the already known in conventional ways. The call was for forms of education that encourage creativity. This call initially aroused a controversy centering on the argument advanced by some thinkers that creativity is a special property found in only a few individuals, and that it cannot be promoted or fostered. Most educators reject this view, concentrating on psychological aspects of creativity that they believe are present, at least as potentials, in everyone. Deliberately fostering creativity in schools rests on the proposition that characteristics necessary for creativity can be helped to unfold by providing appropriate learning conditions. This chapter concentrates on defining what it is that teachers should foster and on principles they can apply in order to do this.

Many teachers and parents seem to be uneasy about emphasizing creativity in school because this might mean encouraging unruly, disobedient, careless, imprecise, or just plain naughty behavior. Others see the call for creativity in the classroom as meaning that any and all behaviors would be tolerated, and that basic skills, standards, and principles such as being correct or incorrect would be abandoned. Other commentators regard talk of fostering creativity as pretentious, intimidating, or elitist because it seems to involve finding little geniuses and force-feeding them until they become Michelangelos, Mozarts, or Einsteins. Such doubts make it necessary to clear up two issues right from the start. As will be shown later, it is not necessary for teachers interested in fostering creativity to set their sights on achieving scientific, technological, literary, artistic, or other revolutions (although fostering creativity in the classroom might make a modest contribution in this direction by sowing the seeds). The processes and personal properties involved in fostering creativity in the classroom are seen in all children and young people, and fostering creativity brings benefits for all students, not just the few who go on to establish reputations as famous creators.

It is also important to recognize from the start that the desire to foster creativity is part of a tradition in educational thinking going back at least to the Ancient Greeks. In this tradition, all children should be given the opportunity to develop their potentials to the fullest, and education should help prepare young people for the richest and most productive life possible. The promotion of creative potentials brings benefits to the individual in terms of better learning (e.g., Schubert, 1973) and improved mental health (e.g., Cropley, 1990), as well as benefits to the society (see Walberg & Staniha [1992] for a comprehensive review). In this context it is important to note that the purpose of creativity is not self- aggrandizement or domination of other people, but the making of contributions to the common good. For this reason, any

discussion of the fostering of creativity should have an ethical element (Gruber, 1993).

EXISTING CREATIVITY TECHNOLOGY

Over 20 years ago, Treffinger and Gowan (1971) identified more than 50 procedures for training creativity. Davis and Scott (1971) listed 20 separate creativity facilitating activities such as attribute listing, idea matrix, and creativity toolbox. Sometimes, as in the case of Endriss (1982), such activities are presented as games: bridge building, idea production, or creative productions. In contrast to some degree with such discrete activities (often referred to as "techniques") are creativity training programs—packages of materials that are meant to be used regularly for creativity training, according to a schedule. (These programs often make systematic use of various techniques.) It has become common to refer to such materials (both the discrete activities and the packages) as involving the *technology* of creativity training, in much the same way as the machines in a gymnasium constitute the technology of bodybuilding. The basic idea is that it is possible, with the help of this technology, to do mental workouts, just as athletes do physical workouts.

Among the techniques that have become relatively well known are synectics, bionics, brainstorming, morphological methods, imagery training, the KJ Method, the NM Method, and mind maps. Several of these were described by Torrance (1992). The U.S. Patent and Trademark Office (1990) compiled an extensive overview of relevant techniques and materials. They listed about 25 packages aimed at promoting creative thinking—several hundred separate activities in all. About a dozen sets of materials they listed were concerned with fostering critical thinking, once again encompassing hundreds of individual activities. Also listed were materials on fostering decision making, higher order thinking skills, and problem solving. This publication is an invaluable source of information on creativity technology.

Some of the better known programs for fostering creativity are listed in Table 1 (see next page). Particularly important for the present discussion are the psychological characteristics that the programs aim at promoting. As can be seen from Table 1, most give greatest weight to the *cognitive aspects of* creativity (getting ideas, combining elements of information, and the like), even those that do not specifically see themselves as focusing on creative thinking. Only one program focuses on *aspirations and feelings,* and another gives some weight to *attitudes* to problem solving.

There is only limited evidence that such approaches actually increase creativity. Torrance (1972) acknowledged that many researchers would be likely to discredit his evaluation of some 142 studies of attempts to enhance creativity. However, he still maintained that many procedures really do have a positive effect, especially those that emphasize not only cognitive but also affective aspects (e.g., the courage to try something new, positive feelings about creativity). Franklin and Richards (1977) demonstrated that deliberate attempts to increase creativity via formal training are more effective than simply reducing the level of formality in the classroom or exposing children to a wider variety of experience (i.e., systematic promotion is superior to mere openness or tolerance). However, Cropley and Feuring (1971) showed that the results of such training are mediated by other factors: What was effective with girls did not necessarily work with boys, and the effects of training depended on the conditions under which the criterion data were obtained.

Table 1. *Main characteristics of well-known creativity programs*

Program	Age Level	Material	Aimed at Promoting
Imagi/Craft	Elementary School	Dramatized recordings of great moments in the lives of famous inventors and discoverers	• The feeling that their own ideas are important • Widened horizons • Career aspirations of a creative kind
Creative Problem Solving	All levels	No special material–makes great use of brainstorming	• Problem finding • Data collection • Idea finding • Solution finding • Implementing of solutions
Talents Unlimited	All levels	Workbooks based on idea of "inventive thinking," aimed at problem solving– emphasis on brainstorming	• Productive thinking • Communication • Planning • Decision making • Forecasting
Productive Thinking Program	Fifth- and Sixth grade pupils	Booklets containing cartoons	• Problem-solving abilities • Attitudes toward problem solving
Purdue Creative Thinking Program	Fourth-grade pupils	Audiotapes and accom-panying printed exercises	• Verbal and figural fluency, flexibility, originality, and elaboration
Osborne-Parnes Program	High school and college students	No special materials	• Getting many ideas • Primary emphasis on brainstorming, with separation of idea generation and idea evaluation
Myers-Torrance Workbooks	Elementary school pupils	Workbooks containing exercises	• Perceptual and cognitive abilities needed for creativity
Khatena Training Method	Adults and children	No special materials; simple teacher-made aids are employed	• Ability to break away from obvious • Transposing ideas • Seeing analogies • Restructuring information • Synthesis of idea
Clapham-Schuster Program	College students (Engineering)	No special materials; – Relaxation exercises Definition of creativity as involving combining ideas – Various exercises (brainstorming, synectics, etc)	• Getting ideas • Understanding creativity • metacognitive techniques (setting goals, expecting success, coping with failure

Many creativity training procedures seem to improve performance only on activities that closely resemble the training procedures. In a detailed review of evidence, Rump (1979) came to the conclusion that the effects of training are strongest when the criterion closely resembles the training procedure, and weakest when this similarity is weak. In the case of personality, interests, and preferences (as against thinking skills), only limited effects are obtained. Consequently, it is possible to conclude that training procedures have little effect on attitudes, values, self-image, or motivation. There is even a danger that creativity training may have the opposite effect from the desired one. For instance, children could become aware that certain kinds of behavior are preferred by the teacher and could alter their own approach to problems accordingly, thus engaging in conformist, not original, behavior. Although children may be encouraged by the training to work hard on a variety of tasks, they may learn that it is easy to give "original" answers by engaging in hairsplitting, giving rambling answers without regard to accuracy or relevance, or offering unexpected banalities. Commenting on brainstorming, Parloff and Handlon (1964) suggested that instead of becoming more creative as a result of offering ideas freely and without evaluation, people may simply become less self-critical.

The idea of deliberately encouraging creativity is clearly very attractive to teachers. However, many training procedures seem to be too specific: To adapt an analogy suggested by Wallach (1985), teaching sprinters how to hammer down their starting blocks might well lead to better times, but it can hardly be regarded as teaching them how to run faster. To take a concrete example he mentioned, students in a creative writing program practiced for two years by working on creativity tests. At the end of this time they were noticeably better on such tests, but their writing had hardly become more creative at all. The basic weakness of techniques and programs aimed at facilitating creativity is that they are too narrow in their

psychological content, and are usually confined to brief periods in the school week, often linked with a particular discipline. The creative process does not depend on a few specific skills that can be learned like tables in arithmetic, in much the same way as specific muscles can be developed via specialized bodybuilding. What is required is facilitating creativity by means of special teaching and learning methods diffused throughout the whole curriculum.

WHAT SHOULD TEACHERS FOSTER?

Early studies of creativity focused primarily on creative thinking (see specifics later). However, it has become increasingly apparent that children only display creativity when they *want* to and when they *feel able to.* In addition, children need appropriate skills and abilities, such as the capacity to recognize inconsistencies and to get ideas. These aspects of creativity will be discussed in more detail in later sections. I have described creativity as arising from a constellation of psychological characteristics including expertise (knowledge of a field), creativity-related skills and abilities, motivation, and personal properties such as self-confidence (see Cropley, 1992a). Some of these are—at least in theory—easy to promote in schools, although school traditions and conventional classroom practice often make this more difficult than theory suggests. It is necessary at this point to outline the main aspects of this constellation, for these are the processes and properties teachers need to foster in the classroom in order to promote the emergence of creativity.

Achieving Effective Surprise

In an early study summarizing research up to his time, Morgan (1953) concluded that the central element of creativity is *novelty.* Bruner (1962) referred to novelty's capacity to evoke surprise, but pointed out that *relevance* and *effectiveness* are also important; otherwise, every crazy idea, irrational behavior, or absurd product that surprised people would be creative.

The first thing that students need to learn is how to achieve effective surprise. For Perkins (1981), the surprise can be effective for a single individual alone (usually the creator), whereas others (earlier, Stein, 1963; later, Csikszentmihalyi, 1988) emphasized that recognition by the society (validation) is necessary for surprise to be effective. Otherwise, the less a person knew, the greater the creativity: Any idea would be surprising to somebody who knew nothing! This in turn implies that creativity requires *communication;* if it lies hidden within the individual it cannot be validated by the society. In view of the strongly positive connotations of the term *creativity,* it is unlikely that a society would recognize and acknowledge evil, criminal, or otherwise socially proscribed acts as creative, so that an element of creativity as a social phenomenon is *ethicality* (see Eisenman 1991; Grudin, 1990). To Wallas's (1926) well-known cognitive approach to creating effective surprise, which involves *preparation* (obtaining information), *incubation* (processing it internally), *inspiration* (hitting on a solution), and *verification* (evaluating the solution), I would add *communication* and *validation.* These principles offer important guidelines to teachers seeking to foster their students' creativity. Teachers should consider gathering information, special ways of thinking about it, inventiveness in finding solutions, ability to evaluate ideas, ability and willingness to communicate solutions to others, and evaluation of solutions in the context of the real world as the core elements of creativity.

Heinelt (1974) made a distinction that helps to differentiate effective from ineffective novelty by distinguishing between pseudo-creativity and quasi-creativity. The former involves mere unconventionality (such as wearing a large ring through the nose to a high society ball), whereas the latter involves fantasy and the like—properties of genuine creativity, it must be admitted, but of a kind more characteristic of daydreaming or children's play. Taylor (1975)

also offered insights into the distinction between the genuinely creative (the effectively surprising) and other forms of novelty. He described five levels of creativity: (a) *expressive spontaneity* manifests itself in the uninhibited production of ideas; (b) *technical creativity* is seen in exceptional skill with language, tools of a trade, instruments, and the like; (c) *inventive creativity* involves using the already known in a novel way; (d) *innovative creativity* occurs when known principles or paradigms are used to develop new ideas; and (e) *emergent creativity* results in the development of new principles or paradigms. Expressive spontaneity and technical creativity are everyday phenomena that can easily be fostered in schools. However, teachers should set their sights on encouraging inventive creativity and at least elements of innovative and emergent creativity.

Other researchers have also drawn a distinction between novelty achieved via new applications of the already known and via the working out of new principles: Ghiselin (1963), for instance, distinguished between *secondary* and *primary* creativity (primary requires development of new principles), whereas Mumford and Gustafson (1988) differentiated between *minor* and *major* creativity. Rejskind, Rapagna, and Gold (1992) emphasized the practical usefulness of distinguishing between *assimilative* and *accommodative* creativity, these two terms being used in the Piagetian sense. This distinction is important for educators, as it emphasizes that fostering creativity involves both broadening and deepening the existing organization of knowledge in a process of enrichment (i.e., promoting assimilative creativity), as well as fostering the building of novel ways of seeing the world (accommodative creativity).

Fostering Creative Thinking

In an early study by Platt and Baker (1931), 83% of a group of people publicly acclaimed as highly creative attributed their creativity to sudden inspiration. On the other hand,

Edison ("genius is 1% inspiration, 99% perspiration"), Pasteur, Disraeli, and Land emphasized the importance of hard work and knowledge of a field. Campbell (1963) proposed that creativity is the result of logical thinking carried through to its logical conclusion. In their review, Tardif and Sternberg (1988) identified a group of researchers who favor sudden inspiration (Feldman, Ghiselin, Taylor, Wallas), a group who take a middle position (Gardner, Sternberg, Torrance), and a group who reject inspiration as a source of creativity (Gruber, Weisberg, Simonton). The sudden inspiration view is explicitly rejected in this chapter on the grounds that it does not provide a basis for systematic, purposeful broadening of students' intellectual activity.

A related question is whether or not creativity can result from chance or sheer good fortune. Both Beveridge (1980) and Rosenman (1988) gave many examples of famous chance discoveries in the work of Pasteur, Fleming, Rontgen, Becquerel, Edison, Galvani, and Nobel, to name a few. According to Austin (1978), there are four forms of luck that can lead to "accidental" creativity: pure chance (the creative person is irrelevant), serendipity (anyone who is very active in an area may have a lucky break), the luck of the well informed (anyone who knows a great deal about an area may stumble on something novel), and self-made luck (a combination of knowledge and skill, hard work, and the like, creates fertile ground for creativity). Austin's view was that the highest levels of creativity occur when all aspects of luck are simultaneously present. The important point for educators is that, apart from sheer chance – which cannot be harnessed by any classroom procedures because its essence is that it is blind and random – even accidental creativity requires a strong base involving activity in a field, a rich stock of information, and possession of appropriate attitudes, values, skills, and the like. Promotion of all of these lies within the teacher's province.

Simonton (1988) and Langley, Simon, Bradshaw, and Zytkow(1986) documented empirically the role of thorough knowledge of a field for creativity. Snow (1986) supported this view and discussed its consequences for the fostering of creativity in schools. To take several simple examples, a child would be greatly aided in displaying musical creativity if it could play a musical instrument, literary creativity requires knowledge of language, scientific creativity knowledge of mathematics or other areas. A large number of researchers have argued that, in addition to knowledge, creativity is the result of systematic cognitive processes. Without these, luck, as it was defined earlier (except blind chance), would lead to nothing. Among these processes is *problem finding.* This involves recognizing that a problem exists, producing a large number of relevant ideas, evaluating these ideas, and drawing appropriate conclusions. Tardif and Sternberg (1988) and Runco and Okuda (1988) stressed the importance of finding *good* problems, and Getzels and Csikszentmihalyi (1978) showed that this also applies to practical, artistic creativity. According to Dillon (1982), there are three levels of problem finding: (a) identifying obvious problems on the basis of knowledge of the field, (b) discovering hidden problems on the basis of concentrated work in an area, and (c) inventing problems as a result of reorganizing existing knowledge. Teachers are accustomed to specifying the problems on which students are to work and evaluating the extent to which students' solutions coincide with the correct answer, which is usually known in advance to the teacher. However, an instructional approach that emphasizes making the students responsible for finding problems, showing them how to distinguish between good problems and mundane ones, and teaching them to go beyond obvious problems to discover hidden ones is a major aspect of teaching to foster creativity.

Other writers have emphasized surprising associations as the core of creative thinking. Mednick's (1962) concept of remote associates is well known: Each person develops a

hierarchy of associations to any stimulus, with commonly occurring associations standing high in the hierarchy, unusual associations low. Creative individuals are able to bypass obvious associations and find those low in the hierarchy (hence, surprising). Koestler (1964) adopted a somewhat different approach by emphasizing *bisociation.* According to this view, ideas exist in matrices: Conventional associations involve linking ideas from the same matrix and surprising associations ideas from two different matrices (i.e., bisociation). Simonton (1988) proposed the chance configuration model: Creativity requires a basic stock of mental elements (information, ideas, memories, concepts, beliefs, feelings, emotions, etc.). Now and then combinations *(configurations)* pop up that offer solutions to problems. Weisberg (1986) emphasized that such creative configurations do not occur by chance, but are the result of strictly logical chains of associations.

Perhaps the best known definition of creative thinking is Guilford's (1950) distinction between convergent and divergent thinking. *Convergent thinking* involves applying conventional logic to a number of elements of information in order to home in on the one and only best answer implied by the available information—the answer that would be arrived at by everyone who possessed the same stock of information and applied the rules of conventional logic. Because the answer is unique and arises more or less inevitably from the available information, in a certain sense it already exists and must only be discovered. By contrast, divergent thinking involves making up answers by branching out from the available information (diverging), for instance, by seeing unexpected aspects that others might not notice. There are as many answers implied by a given set of information as human ingenuity can invent. Many of them may be of equal value, and different thinkers may come up with drastically different sets of solutions.

This cognitive approach has more recently been further extended, for instance, by the psychoanalyst Rothenberg (1988), who introduced the idea of *Janusian* thinking. This term derives from the Roman God Janus, after whom the month of January is named. Janus could look ahead and backward simultaneously, and was thus aware of information coming from two directions at the same time This approach emphasizes the bringing together of apparently contradictory ideas; such ideas are then combined into a new whole by means of homospatial thinking. In contrast to Weisberg (1986), Rothenberg regarded Janusian thinking as essentially illogical, because the ideas that are brought together are contradictory.

The idea of a kind of thinking that permits irrational linking of ideas is also found in traditional psychoanalytic explanations of creativity (e.g., Kris, 1950; Kubie, 1958). Primary process thinking is dominated by the unconscious and is not bound by the rules of reality. Anything can be combined with anything, an advantageous condition for creativity. However, the ego is dominated by the reality principle, engages in secondary process thinking, and does not allow primary process thinking into consciousness. In order to think creatively, a person must be willing to "regress in the service of the ego" and admit primary process material into consciousness (see Suler [1980] for a summary). A related view is that creativity requires *biphasic* thinking or *tertiary process* thinking (Arieti, 1976), through which primary and secondary thinking are combined. Gestalt psychology distinguishes between *reproductive* thinking, as a result of which groups of elements are brought together to form a familiar gestalt, and *productive* thinking, which leads to surprising (creative) gestalts. Such novel gestalts are necessary to deal with "dynamic gaps" (Henle, 1974) in conventional gestalts (contradictions, unexpected similarities, strange forms, inadequacies of the gestalt). The ability to recognize such gaps derives from knowledge of the field (Birch, 1975).

What these findings on the cognitive aspects of creativity mean for teachers can now be summarized in the following way. They should strive to promote in their students:

1 Possession of a fund of general knowledge

2 Knowledge of one or more special fields

3 An active imagination

4 Ability to recognize, discover, or invent problems

5 Skill at seeing connections, overlaps, similarities, and logical implications (convergent thinking)

6. Skill at making remote associations, bisociating, accepting primary process material, forming new gestalts, etc. (divergent thinking)
7. Ability to think up many ways to solve problems
8. A preference for accommodating rather than assimilating
9. Ability and willingness to evaluate their own work
10. Ability to communicate their results to other people.

Personal Properties Favorable for Creativity

McLeod and Cropley (1989) summarized research findings on special properties of creative individuals: They can, among other things, break boundaries easily and build broad categories. They are field independent, build more complex cognitive structures, and generate ideas more rapidly, as well as express them more fluently. Mehlhorn and Mehlhorn (1985) showed that the variance of such characteristics was low in groups selected for high creativity and increased steadily in groups displaying successively lower levels of creativity.

Eysenck (1983) went so far as to argue that creativity is the result of a particular pattern of personality. Many studies have investigated this area by studying people already

acknowledged as creative (see Hocevar & Bachelor [1989] for a recent review and Delias and Gaier [1970] for an earlier one). These studies showed that properties such as flexibility, sensitivity, tolerance, responsibility, autonomy, and positive self-image are strongly related to creativity. Albert and Runco (1989) showed that independence is significantly correlated with creativity: Creative people are marked by greater autonomy and nonconformity and less willingness to conform, lower self-control, and less desire to make a good impression. Both Maslow (1959) and Rogers (1959) regarded openness to the new as crucial for creativity. McCrae and Costa (1985) defined openness as an interest in novelty for its own sake; the open person simply likes to go beyond the conventional, is spurred on by the unexpected, and seeks alternative explanations for everything. McCrae (1987) demonstrated the relationship between openness and creativity in an empirical study. I have emphasized the importance of "openness to the spark of inspiration" (Cropley, 1992b).

Fromm (1980) and Helson (1983) drew attention to the fact that descriptions of the creative personality cross the boundaries of gender stereotypes: Inspiration is thought to be stereotypically female, for instance, and elaboration stereotypically male. In a similar way, sensitivity and responsibility are regarded as female, autonomy and positive self-image as male. Thus, the creative personality is said to involve a mixture of stereotypically male and stereotypically female characteristics. Shaughnessy and Manz (1991) summarized studies that supported this view empirically, especially regarding creative women. However, evidence on gender differences in creativity is equivocal. Nonetheless, in a review of studies on this topic, Bramwell Rejskind (1988) concluded that there is probably an advantage in favor of girls. According to McMullan (1978), creativity results from a *paradoxical personality,* which requires an integration of seven polarities: (a) openness versus the forming of good gestalts; (b)

acceptance of the unconscious into the conscious; (c) a distanced attitude versus being strongly engaged; (d) a critical, questioning attitude versus constructive problem solving; (e) ego centeredness versus centeredness versus altruism and empathy; (f) self-criticism and self-doubt versus self-confidence; and (g) relaxedness versus concentration. According to Block (1984), gender differences arise from the different socialization of girls and boys—boys being trained to be, in Piagetian terms, more accommodative, and girls more assimilative.

Creative individuals differ from less creative in *motivational patterns* as well. Dynamic gaps (Henle, 1974) motivate them to create new order out of chaos (to accommodate), whereas less creative people seek to return things to the way they were before (to assimilate). A further motivational characteristic of highly creative individuals is their obsession with a task. They are usually entirely willing to strive to their mental and physical limits (Mehlhorn, 1988). This requires a fascination with the field and a sense of invincibility, which is only possible when the drive comes from within, that is, when motivation is intrinsic (Amabile, 1983). Empirical studies of mathematicians (Biermann, 1985) and musicians (Csikszentmihalyi, 1988) have demonstrated the importance of motivation. According to Tardif and Sternberg (1988), the motivational prerequisites for creativity are curiosity, willingness to take risks, tolerance for ambiguity, dedication, stamina, and fascination for the task. Briggs (1988) concluded that of these, dedication and tolerance for ambiguity are most crucial. Tolerance for ambiguity is so highly developed that it does not involve simple tolerance for two alternatives (ambivalence), but a willingness to see that anything could be combined with anything else (omnivalence).

Shaw (1989) offered a further vital point when he complained that creativity research has scarcely been concerned with the role of *feelings and emotions* in the process of finding effective novel solutions. In a study with creative engineers and physicists, he demonstrated the

importance of a number of feelings: fascination for the task, self-confidence, frustration when progress was blocked, excitement at the moment of illumination, and satisfaction upon successful verification. These are all aspects of what might be called "the joy of creating." Interestingly, Shaw's respondents made little mention of competitiveness or aggressiveness, perhaps because these feelings are socially undesirable. Shaw concluded that aspects of creativity are positively affected by feelings such as fascination or excitement, and negatively by the feeling of stress.

Finally, it is important to bear in mind that the personal disposition to be creative has a *social aspect.* As Moustakis (1977) put it, being creative means living your life your own way. Barron (1969) postulated a connection between creativity and "resistance to socialization," and this was confirmed empirically by Aviram and Milgram (1977) in studies conducted in Israel, the Soviet Union (as it then was), and the United States. Harrington, Block, and Block (1987) reviewed the relevant literature and concluded that—under appropriate circumstances—a low level of family control facilitates creativity. Low levels of control must, however, be accompanied by warmth and support, as they may otherwise be interpreted by the child as aloofness and lack of concern for his or her well-being.

Several authors have emphasized the role of social factors such as norms and conformity pressure in inhibiting creativity. According to Anderson and Cropley (1966), this involves "stop rules." Children learn that certain things are simply not done and thus acquire general rules forbidding certain lines of action (e.g., "You shouldn't question what the teacher tells you.") As a result, whole classes of theoretically possible solutions are banned *en masse.* Fromm (1980) argued that society has "filters" with which certain behaviors, even certain thoughts, are blocked. To take a concrete example, a grade-two class was given the task of

drawing a person's head. They worked away at their places for some time, and then one boy went to the teacher's desk, explaining that he had a problem. When he explained his problem to the teacher, she realized that he was drawing the *inside* of a head! Her reaction was to fly into a rage. She made him hold up his drawing so that all the others could see it, then said, "Everybody look at what Mr. Clever has drawn. He couldn't draw a *proper* head, could he? Oh no. He had to be different from everybody else and draw the inside." She then had all the other children hold up their drawings for the offending boy to see. 'There, Mr. Clever, you see what a proper head looks like. Everybody else got it right, all except you!" The other children took their lead from the teacher and looked shocked or pointed their fingers and jeered. The offender sat down with a red face. What this boy had learned was far more than how a proper head looks: He had been taught that unusual viewpoints are not wanted, that the right way is the way everybody else does things, and that it is very dangerous to reveal in public that you have (in this case, probability unwittingly) looked at something from a novel perspective.

A more positive aspect of the effect of social factors on creative achievement was demonstrated by Bloom (1985). His studies of the factors that led to the emergence of creative potential in young people showed that in many cases a single significant person played a crucial role, for instance, by making the young person aware of his or her own potential. This was often done by a person in a fairly humble position, such as a grade school teacher who demonstrated passionate interest in a topic and awakened it in the child, showed a creative youngster that he or she was not alone, or helped the student make contact with peers, experts, or other supportive adults. Despite this, a major aspect of social factors seems to be their powerful role as inhibitors. Thus, in fostering creativity teachers must seek not only to provide releasers, but also to eliminate blockers. Combining summaries such as those of Cropley

(1992a) and Torrance (1992), the findings just presented suggest that teachers should value and promote in their students properties such as:

1. Task commitment, persistence and determination
2. Curiosity, adventurousness, and tolerance for ambiguity
3. Independence and nonconformity
4. Self-confidence and willingness to risk being wrong
5. Drive to experiment and willingness to try difficult tasks.

This might prove to be sooner said than done, given that teachers often frown on traits associated with creativity. Research has shown that many teachers actually dislike such characteristics. Torrance's (1970) early findings to this effect have been supported by more recent studies in the United States (e.g., Bachtold, 1974), as well as in other countries (Howieson, 1984; Obuche, 1986; Raina, 1972). Stone (1980) found that Grade Two students who scored highest on tests of creativity were rated by their classmates as the ones most often in trouble with teachers. It might be asked what feedback teachers give creative students if their behavior is seen as undisciplined, disruptive, defiant, or even an attempt to humiliate the teacher. Nonetheless, there is evidence that teachers overwhelmingly state their support of creativity as something that should be fostered in the classroom—Feldhusen and Treffinger (1975) reported that 96% of teachers expressed this view. The problem seems to be that of recognizing "immature" creativity or creative potential; undoubtedly many teachers are often confronted by genuinely disruptive behavior, and such behavior cannot simply be excused and tolerated in the hope that it is a sign of creativity. Once again, the issue of recognizing indicators of creative potential and distinguishing between these and misbehavior is emphasized here.

An interesting finding in this regard is that creative teachers tend to be more supportive of creative students. Milgram (1979) showed that there were correlations between teacher creativity and that of students. McLeod and Cropley (1989, p. 245) referred to "creativity fostering" teachers, who seem to get along particularly well with creative students. As Cropley (1982) pointed out, such teachers provide a model of creative behavior, reinforce such behavior when students display it, protect creative students from conformity pressure from their peers, provide a safe refuge for the students when they are subjected to ridicule or criticism from peers, parents, or other teachers, and establish a classroom atmosphere that is supportive of creativity. According to Cropley (1982), creativity fostering teachers are those who:

1 Encourage students to learn independently

2 Have a cooperative, socially integrative style of teaching

3 Motivate their students to master factual knowledge, so that they have a solid base for divergent thinking

4 Delay judging students' ideas until they have been thoroughly worked out and clearly formulated

5 Encourage flexible thinking in students

6 Promote self-evaluation in students

7 Take students' suggestions and questions seriously

8 Offer students opportunities to work with a wide variety of materials and under many different conditions

9 Help students to learn to cope with frustration and failure, so that they have the courage to try the new and unusual.

A HOLISTIC MODEL OF CREATIVITY

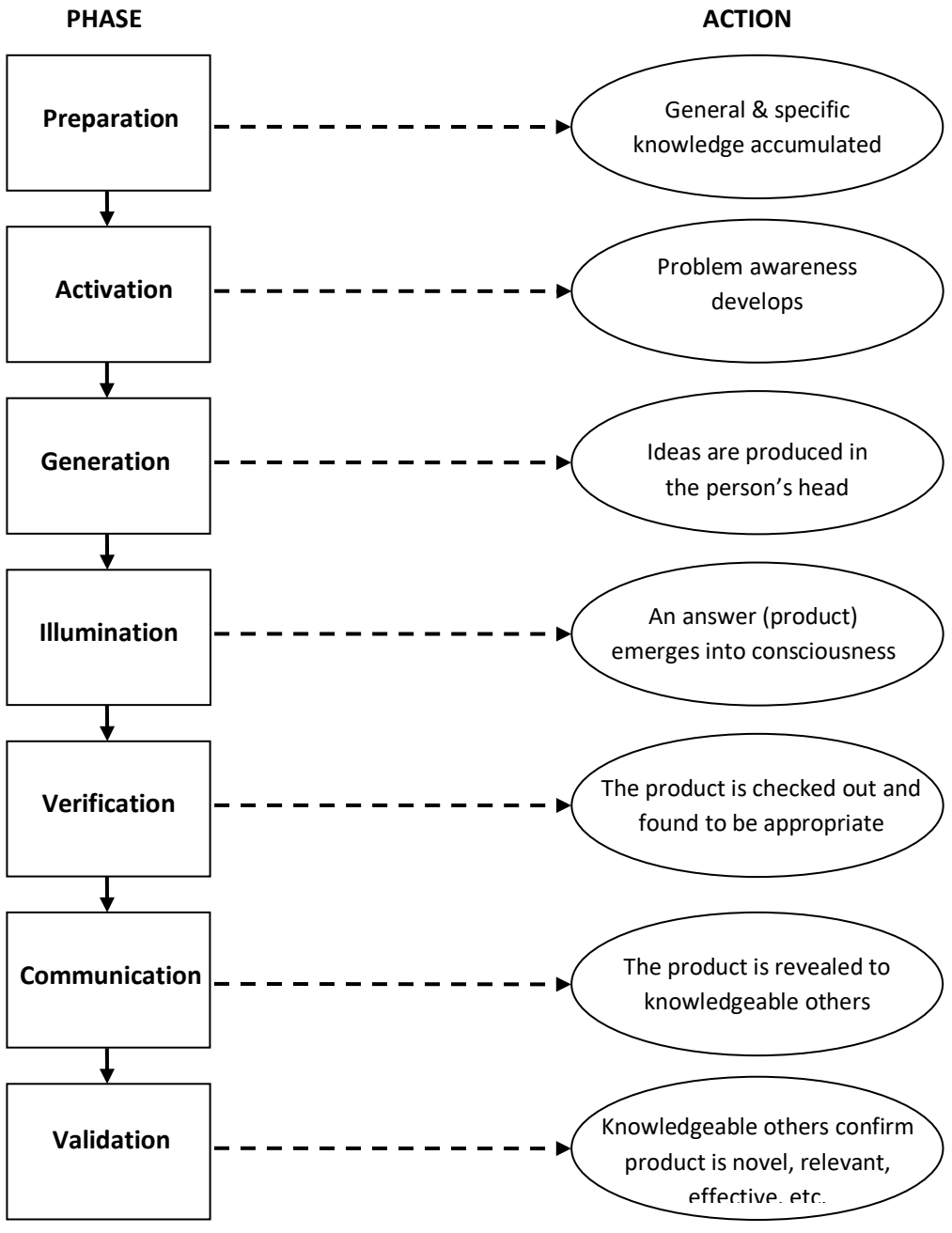
In modern discussions, creativity was initially conceived of as primarily a matter of thinking, especially divergent thinking. This approach was particularly attractive to educators because it provided an explanation of many behaviors seen in the classroom (it was plausible), and it generated simple suggestions for fostering creativity (it was practical). However, as has just been shown, an approach to creativity focusing on divergent thinking is too simple, although far better than nothing. The discussion of affective, motivational, personal, and social factors in creative behavior outlined earlier has implied and supported a holistic approach, holistic both with regard to the psychological elements of creativity and also with regard to the stages of the creative process. The question now arises as to how thinking, motivation, and personality combine to yield information, incubation, communication, and so on.

In a seminal study of Romanian engineering students, Facaoaru (1985) showed that successful creative work in practical settings required a combination of psychological elements. In the case of cognition, this meant a combination of convergent and divergent thinking. However, motivation and personal characteristics were also important in distinguishing between highly and less creative students. According to Perkins (1981), creativity arises out of a combination of six elements: (a) the drive to create order out of chaos, (b) the ability to ask unexpected questions and to tolerate criticism, (c) mental mobility, (d) willingness to take risks, (e) openness for the new, and (f) the feeling of being challenged. Necka (1986) suggested that the particular combination of elements constitutes a profile for each individual. He regarded these profiles as dynamic in nature, in the sense that they can change with experience. Gruber and Davis (1988) developed this point further. For them, a creative product is not an isolated event but the result of a developmental process that may stretch over many years. In their

"evolving systems" model, knowledge, attitudes, values, and the like are constantly not only acquired, but also reorganized, to yield changing and developing cognitions, emotions, and goals.

The creation of effective surprise was described by Shaw (1989) as involving "loops" between the stages of the creative process. He called this the Eureka Process. For instance, there is a loop between information and incubation because incubation occurs on the basis of information. Shaw called this interaction the *Arieti loop.* The loop between incubation and illumination was labeled the *Vinacke* loop, that between illumination and verification the *Lalas* loop, between verification and communication the *Communication* loop, and between communication and validation the *Rossman* loop. (Except for the communication loop, these labels all derive from the names of eminent researchers on creativity.) Shaw made the point that these loops are not confined to interactions between two stages: In all probability there are loops involving three or more stages—for instance, validation (or lack thereof) is itself a piece of information, which would be expected to have consequences for subsequent incubation.

The crux of the arguments just spelled out is that creativity results from the interaction of cognitive, affective, motivational, and social/personal factors. Figure 1 (see next page) shows schematically how this interaction could occur. The left-hand column in Figure 1 divides the process of producing a creative product into stages (Wallas's stages supplemented by the stages of communication and social validation discussed earlier). In each stage, certain cognitive processes are dominant (e.g., convergent thinking in the stage of incubation, divergent thinking in the stage of illumination). The results of each particular stage (shown in the right hand column) form the contents of the following stage. In the stage of illumination, for example, divergent thinking is applied to cognitive elements formed in the stage of incubation


PHASE
ACTION
Preparation
General & specific knowledge accumulated
Activation
Problem awareness develops
Generation
Ideas are produced in the person's head
Illumination
An answer (product) emerges into consciousness
Verification
The product is checked out and found to be appropriate
Communication
The product is revealed to knowledgeable others
Validation
Knowledgeable others confirm product is novel, relevant, effective, etc.

to yield configurations. At the same time, the configurations (which are the result of divergent thinking in the stage of illumination) are the subject matter of the stage of verification. These steps in the creative process are accompanied by feelings and emotions. If the process is to continue, these need to be positive—for instance, confrontation with a complex mass of cognitive elements must excite not frighten the individual. In Figure 1, the whole process was successful in that a societally acclaimed (validated) product resulted. However, it is possible for the production sequence to cease in an earlier stage: obviously, not all products are validated. It is also possible that the divergent thinking in the stage of illumination might not yield a configuration, or that the creator might not possess sufficient information about field for appropriate cognitive elements to be formed, and so on.

This analysis of the emergence of creative products is easy to apply in practical settings. Reduced for simplicity's sake to its basic elements, the process of achieving a creative solution could be specified in the following paradigm: Exposure to a rich variety of information leads not anxiety and avoidance, but to increased interest and desire for re information; information is not blindly accepted (assimilated) and later regurgitated, but causes a re-evaluation of the situation in question, and the formation of expanded or enriched configurations (i.e., accommo-dation). Fascination, openness, and a "nose" for the incongruous lead to ways of coming to grips with the situation that are marked by attention to peripheral aspects of the information in question, willingness to try the unexpected, search for the novel, and so on. Possession of a fund knowledge in the area allows the individual to "feel" that a solution is near, to recognize a good solution, and to experience the satisfaction of solving a problem (the problem might be technical, scientific, philosophical, artistic, commercial, or whatever, depending on the area in which activity is occurring). Self-confidence yields the courage to present the solution in a form

understandable to the teacher and classmates in the hope of convincing them and receiving recognition. Ultimately, in the ideal case, the whole process culminates in the creator experiencing the satisfaction of creative achievement.

The sequence of events just described requires possession of the basic skills necessary for obtaining information: the three Rs, library and computer literacy, and the like. People also need a basic fund of knowledge of how the world around them is structured and how it functions (i.e., conventional schoolhouse knowledge of literature, history, science, and so on). In addition, however, and of central importance to this chapter, they need skill in other processes closely related to creativity: making remote associations, seeing the world without censorship, admitting :unconscious material into consciousness, dealing with information in a playful way, seeing gaps (in the gestalt sense), experiencing fascination for a subject area, feeling the joy of creating, evaluating their own work, and so on. Helping students to acquire the knowledge and skills just specified and to experience the emotions related to them provides a set of tenable goals for educators in the classroom.

RECOGNIZING CREATIVE POTENTIAL

Capturing the essence of creativity and defining behavioral indicators that give evidence of creative potential has proved difficult. Obviously, no indicators are needed in the case of individuals already recognized by virtue of their creative achievements, but very few schoolchildren belong to this group. Furthermore, the concern here is not so much with certifying acknowledged creativity after the fact but with fostering its development and emergence in cases in which this might otherwise not happen. Educators already have at their disposal a substantial armory of tests of ability, particularly intelligence tests. The question that now arises is whether these tests (and the IQ scores they yield) are capable of detecting creative

potential. Over 30 years ago, Torrance (1962) pointed out that defining the highly able on the basis of an IQ score alone overlooked about 30% of students with high creative potential. Early research in Canada (Cropley, 1967b) and Great Britain (Hudson, 1966) confirmed that assuming that a high IQ indicates high creativity involves missing a substantial proportion of the most creative youngsters. Thus, there is a need for identification procedures that go beyond the measurement of conventional intelligence. This task lies somewhere beyond the boundaries of conventional standardized tests, given that creative thinking requires innovation and novelty (which are inherently difficult to express in standardized forms), as well as combining cognitive, affective, and social components. Despite this, a variety of procedures for assessing creativity as a psychological trait has been developed, some of them quite strongly resembling conventional abilities tests in certain respects, although there are also striking differences, as is shown in the next section.

Creativity tests

As might be expected, increasing interest in creativity saw the emergence of a new kind of test, a test of creativity. Strictly speaking, such tests had already existed for many years. Binet himself had suggested that interpretations of inkblots could be used to assess creativity and, as Barren and Harrington (1981) pointed out, there had already been "a proliferation of studies" by creativity investigators prior to 1915, adopting Binet's open ended multiple solution format. A substantial number of creativity tests also appeared between the world wars, including tests of "imagination," "recreative imagination," "ideational fluency," and "idea combinations" (see McLeod & Cropley, 1989, for a review). Such tests had largely fallen into disuse and were exerting little influence by the time Guilford (1950) reopened discussions in a seminal address to the American Psychological Association. Some psychologists (including

Guilford himself) thus began to construct tests of divergent thinking— usually called creativity tests, although the appropriateness of this label is discussed later. The best known among this flood of tests in the 1950s and 1960s were the *Alternative Uses* test, the *Product Improvement* test, and a revived *Consequences* test, seen in their most highly developed form in the work of Torrance and associates. All of these tests were later incorporated into the battery of creativity tests published by Torrance in 1966 and recently revised (Torrance, 1990), and referred to today as the *Torrance Tests of Creative Thinking* (TTCT). An often cited creativity test of the same period was the *Remote Associates* test (Mednick, 1962), although this has since been criticized on the grounds that it is really a test of convergent thinking. The other influential set of creativity tests to appear during this period was that of Wallach and Kogan (1965), whose major contribution was perhaps their emphasis on a game-like atmosphere and the absence of time limits in the testing procedure.

The crucial aspect of these tests is that they concentrate on measuring kinds of thinking that branch out from the conventional and seek unusual answers, in other words, divergent thinking. The prototypical tests of this kind are those of Torrance. People taking the tests are confronted with simple situations and asked to generate unusual or unexpected ideas, for instance, "Write down as many uses as you can think of for a tin can" *(Uses),* or "What would the consequences be if the clouds all had strings hanging down from them?" *(Consequences).* The nonverbal test, *Product Improvement,* presents children with a toy (e.g., a stuffed monkey) and asks them to suggest as many ways as possible to change the toy to make it more fun to play with. Scoring of such tests involves ascertaining the sheer quantity of responses by counting their number *(Fluency)* or focusing on their unusualness. This is done by ascertaining the number of separate categories to which responses belong *(Flexibility)* or the number of

novel responses *(Originality).* To take an example, "Use a tin can as a saucepan," "Use it as a jug," and "Make it into a suit of armor for a mouse," would yield three points for Fluency (total number of responses), two for Flexibility (one point for the category "container of fluids" [saucepan and jug] and one for the category impenetrable object [suit of armor]), but only one point for Originality (saucepan and jug are commonplace, only suit of armor is unusual). Extraordinarily uncommon answers may be given several points for Originality (see for instance Torrance, 1990, and Cropley, 1967a).

Similar tests appeared in Europe, including the *Test zum divergenten Denken* [Divergent Thinking Test] (Meinberger, 1977), the *Verbaler Kreativitätstest* [Test of Verbal Creativity] (Schoppe, 1975), and the *Kreativitätstest für Vorschul-und Schulkinder* [Creativity Test for Preschool and School Children] (Krampen, Freilinger, & Wilmes, 1988) in Germany and the *Espressioni* test [Expressing Ideas] in Italy (Calvi, 1966). However, despite their widespread acceptance, it has repeatedly been pointed out that such tests have only low face validity (they do not resemble what common sense suggests creativity is like) because they seem to have little in common with the kind of mental activities involved in painting the Mona Lisa or writing, for example, *Gone with the Wind* (see Schubert, Wagner, & Schubert, 1988, for a recent discussion). Bachtold and Werner (1973) reported that more than half of a group of acknowledged creative women refused to fill out creativity tests sent to them by mail on the grounds that the tests were stupid, banal, or boring.

Newer Tests

An important advance in creativity testing in recent years derives from increasing recognition of the fact that creative production depends not only on divergent thinking, but also on convergent thinking. This point of view has already been emphasized in several places and

in earlier sections. Facaoaru (1985) called for a "two-track" testing procedure, which assesses the "area of overlap" between the two kinds of thinking. The *Divergent-Convergent Problem Solving Processes Scale* (Facaoaru & Bittner, 1987) assesses, among others, "goal-directed divergent thinking," "flexibility," and "task commitment." A somewhat different, although still essentially cognitive approach, is that of Rothenberg (1988). His test of Janusian thinking is based on the idea that creative people are particularly good at bringing apparently incompatible ideas into a state of harmony via *homospatial* thinking. In one version of his test stimulus words are exposed to subjects for very short periods; the subjects are required to make verbal associations to these words, and scoring is based on the number of associations opposite in meaning to the original stimulus word to which they were offered. Schubert's (1973) *Creative Imagination Test* requires subjects to suggest solutions to real-life problems presented in the test. Responses are evaluated according to number and quality of problem-solving suggestions.

Other tests have attempted to measure creativity in terms of specific, non-cognitive models of psychological processes. Urban (1991) designed the *Test for Creative Thinking-Drawing Production,* which differs from the tests listed in the previous section in that scores are derived not from the statistical uncommonness of verbal or figural associations, but from what Urban called "image production." Although respondents are asked to complete incomplete figures, as in several other tests, scoring is based not on the unusualness of the figures created, but on nine psychological aspects of creativity derived from Gestalt psychology. These include "boundary breaking," "proportion of new elements," and "humor."

Adopting a psychoanalytic approach, the Swedish psychologist Smith (Smith & Carlsson, 1989) developed the *Creative Functioning Test.* This test regards creativity as dependent on the ability to communicate with one's own subconscious and involves gradually

prolonged tachistoscopic exposure of a still-life painting. Subjects who quickly "recognize" the painting and identify it as an object with subconscious overtones (in the Freudian sense) are adjudged to be more willing to admit unconscious material into consciousness, and thus be potentially more creative. The *Myers-Briggs Type Indicator* (Myers & McCaulley, 1985), which is based on Jungian concepts, has recently enjoyed a new lease of life, in the course of which it is frequently used as an indicator of creativity. Based in Jungian personality theory, the scale measures four bipolar dimensions: Thinking-Feeling, Sensing-Intuiting, Judging-Perceiving, and Extroversion-Introversion. The combination Feeling/Intuiting/ Perceiving/Introversion is regarded as indicative of creativity.

Reliability and Validity of Creativity Tests

Early studies such as those of Mackler (1962) and Wodtke (1964) concluded that the reliabilities of the Guilford and Torrance tests were unsatisfactorily low. Nonetheless, Dewing (1970), who administered the *Circles* and Uses tests on two occasions six weeks apart, reported reliabilities of .68 for fluency and .54 for originality on the *Circles* test, and .51 and .39, respectively, for the *Uses* test. Cropley and Clapson (1971) calculated reliabilities over several years for boys and girls separately, for the same tests, and obtained coefficients ranging from .33 to .58. In a 10-year longitudinal study, Howieson (1981) reported reliabilities for the TTCT ranging from .15 to .37, according to sex and method of scoring. A tally of the test-retest reliabilities quoted in the manual for the TTCT is more optimistic, yielding a median value of .68. Wallach and Kogan (1965) reported reliabilities in excess of .90 for their tests, and this was confirmed by Cropley and Maslany (1969) and Kogan and Pankove (1972). Reliabilities between about .50 and .90 compare favorably with the reliabilities of the subtests of, for instance, the WISC, so that it can be said that individual creativity tests display levels of

reliability that are, at the very least, high enough to justify further work.

Probably more interesting for practitioners is the question of the validity of creativity tests—do they really measure creativity? The construct validity of tests based on divergent thinking has largely been investigated by comparing creativity scores with IQs. Early studies indicated that correlations *among* creativity tests were usually lower than correlations *between* creativity and intelligence tests (McLeod & Cropley, 1989). These findings have been extended by studies of correlations of creativity scores with school grades. Hocevar and Bachelor (1989) reviewed the results of a large number of studies of the construct validity of creativity tests and showed that it is not possible to draw unequivocal conclusions. Nonetheless, both early (e.g., Gibson & Light, 1967) and more recent (e.g., Sierwald, 1989) studies have shown that IQs alone do not distinguish adequately between high and low achievers in academic settings: Sierwald confirmed in Germany much earlier findings in Australia (Cropley, 1967a) and Canada (Cropley, 1967b) that students who obtain high scores on *both* intelligence and creativity tests surpass others in school achievement. Zarnegar, Hocevar, and Michael (1988),Milgram (1990), and Runco (1991) each concluded that creativity test scores yield information over and above that provided by conventional intelligence tests.

Barren and Harrington (1981) reviewed over 70 studies of the predictive validity of creativity tests and showed that correlations with creative performances in real life were often significant. One especially relevant approach in this area has involved what Wallach and Wing (1969) called *nonacademic talented accomplishments.* They showed that high scorers on creativity tests obtained significantly higher scores in life areas such as leadership, art and music than low scorers. Sierwald reported low but significant correlations (r = .20) between out-of-school accomplishments and creativity test scores in German high school students, and

Okuda, Runco and Berger (1990) reported coefficients of approximately .50, using creativity tests based on solving real-life problems. Torrance (1981) conducted several longitudinal studies covering periods of 6, 7 and even 22 years. He concluded that the creativity tests had measured aspects of ability not covered by intelligence tests. A 10-year study by Howieson (1981) came to the conclusion that creativity tests predicted creative achievements 10 years later for boys but nor for girls, a finding supported by a five-year longitudinal study by Cropley (1972a) in Canada. A longitudinal study by Harrington, Block and Block (1983) also found a significant relationship between creativity scores and creativity in real life. In a cross-cultural study in Brazil, Israel, Japan and the United States, Milgram (1990) demonstrated that creativity scores are related to creative activity in real life. In addition to satisfying psychometric concerns, this reinforces the argument that creativity is a worthwhile educational objective.

Conditions of Administration

Part of the lack of unanimity about the reliability and validity of creativity tests may well result from test content, variability in conditions of administration, and differences in methods of evaluation. Wallach (1985) pointed out that test are highly reliable when they concentrate on ideational fluency. This also seems to be the case when the focus on a narrow set of contents – the more general the contents, the lower the reliability and validity (much like a bandwidth-fidelity dilemma). There is also something of a literature on conditions of administration (group vs. individual testing, presence or absence of time limits, etc.). Hattie (1977, 1980) showed that administering tests under different conditions led to substantial differences in performance. He concluded that conventional test conditions are best. Wallach and Kogan (1965) emphasized absence of time limits, individual administration and game-like

atmosphere. Cropley (1972b) showed that time limits affected children's scores: some respondents gave original answers quickly, but others only after a warm-up period. These latter children obtained low creativity scores under timed conditions and high scores under untimed conditions. Milgram (1990) made an important distinction here between *stringent* and *nonstringent* test administration and scoring: the more test contents are specific and concrete, and the more scoring emphasizes practical usefulness (i.e., the more they are *stringent*), the higher are reliability and validity.

CLOSING REMARKS

If all children's creativity is to be fostered effectively in the classroom, it seems unlikely that narrow, limited exposure to cookbook creativity-facilitating exercises will achieve the desired effects. Although limitations of space preclude a detailed discussion here, this is especially the case with children from disadvantaged groups and children of low intellectual ability. What is needed is an approach in which all aspects of teaching and learning adhere to basic principles for fostering creativity. These involve, as has been pointed out in this chapter, not only intellectual, but also personal, motivational, emotional, and social aspects of creativity. As Runco and Albert (1986) put it, children need contact with complexity, ambiguity, puzzling experiences, uncertainty, and imperfection. Scott (1988) listed three central tasks for parents (which can be transferred to teachers): Challenge children to be open for the novel; give them courage to think for themselves and to seek the new; and show respect for children and their achievements in order to foster in them self-confidence and high expectations. What is needed is to infuse all aspects of educational experiences with such contacts and such actions.

REFERENCES

Albert, R.S., & Runco, M.A. (1989). Independence and the creative potential of gifted and exceptionally gifted boys. *Journal of Youth and Adolescence, 18,*221-230.

Amabile, T.M. (1983). *The social psychology of creativity.* New York: Springer.

Anderson, C.C., & Cropley, A.J. (1966). Some correlates of originality. *Australian Journal of Psychology, 18,*218-227.

Arieti, S. (1976). *Creativity: The magic synthesis.* New York: Basic Books.

Austin, J.H. (1978). *Chase, chance, and creativity.* New York: Columbia University Press.

Aviram, A., & Milgram, R. (1977). Dogmatism, locus of control and creativity. *Psychological Reports, 40,* 27-34.

Bachtold, L.M. (1974). The creative personality and the ideal pupil revisited. *Journal of Creative Behavior, 8,* 47-54.

Bachtold, L.M., & Werner, E.E. (1973). Personality characteristics of creative women. *Perceptual and Motor Skills, 36,* 311-319.

Barron, F.X. (1969). *Creative person and creative process.* New York: Holt, Rinehart & Winston.

Barron, F.X., & Harrington, D.M. (1981). Creativity, intelligence and personality. *Annual Review of Psychology, 32,*439-476.

Beveridge, W.I.B. (1980). *Seeds of discovery.* New York: Norton.

Biermann, K.R. (1985). Űber Stigmata der Kreativität bei Mathematikern des 17. bis 19. Jahrhunderts [Characteristics of creative mathematicians of the 17th to 19th centuries]. *Rostocker Mathematik Kolloquium, 27,5-22.*

Birch, H. (1975). The relation of previous experience to insightful problem solving. *Journal of*

*Comparative Psychology, 38,*367-383.

Block, J.H. (1984). *Sex role identity and ego development.* San Francisco: Jossey-Bass.

Bloom, B.S. (1985). *Developing talent in young people.* New York: Ballantine.

Bramwell-Rejskind, F.G. (1988). *Sex differences and specialization in the divergent thinking styles of gifted children.* Unpublished doctoral dissertation, McGill University, Montreal, Canada.

Briggs, J. (1988). *Fire in the crucible: The alchemy of creative genius.* New York: St. Martin's Press.

Bruner, J.S. (1962). The conditions of creativity. In H. Gruber, G. Terrell, & M. Wertheimer (Eds.), *Contemporary approaches to creative thinking* (pp. 1- 30). New York: Atherton.

Calvi, G. (1966). // *problemo psicologico della creativita* [The psychological problem of creativity]. Milan: Ceschina.

Campbell, D.T. (1963). Blind variation and selective retention in creative thought as in other knowledge processes. *Psychological Review,* 380-400.

Cropley, A.J. (1967a). Divergent thinking and science specialists. *Nature, 215,* 671-672.

Cropley, A.J. (1967b). Creativity, intelligence and achievement. *Alberta Journal of Educational Research, 13,*51-58.

Cropley, A.J. (1972a). A five year longitudinal study of the validity of creativity tests. *Developmental Psychology, 6,*119-124.

Cropley, A.J. (1972b). Originality scores under timed and untimed conditions. *Australian Journal of Psychology, 24,*21-36.

Cropley, A.J. (1982). *Kreativität und Erziehung* [Creativity and childrearing]. Munich: Reinhardt.

Cropley, A.J. (1990). Creativity and mental health. *Creativity Research Journal, 3,167-178.*

Cropley, A.J. (1992a). *More ways than one. Fostering creativity in the room.* Norwood, NJ: Ablex.

Cropley, A.J. (1992b). Gluck und Kreativität: Forderung Aufgeschlossenheit fur den zundenden Gedanken [Luck and ativity: Fostering openness to the spark of inspiration]. In Urban (Ed.), *Begabungen entwickeln erkennen und fördern* [Developing, recognizing and fostering ability] (pp. 216-222). Hanover: Faculty of Education, University of Hanover.

Cropley, A.J., & Clapson, L.G. (1971). Long term test-retest reliability creativity tests. *British Journal of Educational Psychology, 41,* 206-208.

Cropley, A.J., *&* Feuring, E. (1971). Training creativity in young children *Developmental Psychology, 4,*105.

Cropley, A.J., & Maslany, G.W. (1969). Reliability and factorial validity of the Wallach-Kogan creativity tests. *British Journal of Psvchology, 60,395-398.*

Csikszentmihalyi, M. (1988). Society, culture, and person: A system view of creativity. In R.J. Sternberg (Ed.), *The nature of creativity* (pp. 339). New York: Cambridge University \ Press.

Davis, G.A., & Scott, J.A. (1971). *Training creative thinking.* New York Holt, Rinehart & Winston.

Dellas, H., & Gaier, E.L. (1970). Identification of creativity: The individual. *Psychological Bulletin, 73,*55-73.

Dewing, E. (1970). The reliability and validity of selected tests of creative thinking in a sample of seventh grade West Australian children *British Journal of Educational Psychology,*

40, 35-42.

Dillon, J.T. (1982). Problem finding and solving. *Journal of Creative Behavior, 16, 97-111.*

Eisenman, R. (1991). *From crime to creativity: Psychological and social factors in deviance.* Dubuque, IA: Kendall Hunt.

Endriss, L. (1982). *Entwicklung und Auswirkung eines Kreativitätstrainings —Förderung des spielerischen Denkens bei jungen Erwachsenen* [Development and evaluation of a procedure for fostering creativity—Facilitating playful thinking in young adults.] Unpublished master's thesis, University of Hamburg.

Eysenck, H.J. (1983, May). The roots of creativity: Cognitive ability or personality trait? *Roeper Review,* pp. 10-12.

Facaoaru, C. (1985). *Kreativität in Wissenschaft und Technik* [Creativity in science and technology]. Bern: Huber.

Facaoaru, C., & Bittner, R. (1987). Kognitionspsychologische Ansätze der Hochbegabungsdiagnostik [Cognitive approaches to assessing giftedness]. *Zeitschrift fur Differentielle und Diagnostische Psychologie* [Journal of Personality and Assessment], *8(3),* 193-205.

Feldhusen, J.F., & Treffinger, D.J. (1975). Teachers' attitudes and practices in teaching creativity and problem solving to economically disadvantaged and minority children. *Psychological Reports,* 37,1161-1162.

Franklin, B.S., & Richards, P.N. (1977). Effects on children's divergent thinking abilities of a period of direct teaching for divergent production. *British Journal of Educational Psychology, 47,* 66-70.

Fromm, E. (1980). *Greatness and limitations of Freud's thought.* New York: New American

Library.

Getzels, J.W., & Csikszentmihalyi, M. (1978). *The creative vision: A longitudinal study of problem finding in art.* New York: Wiley.

Ghiselin, B. (1963). Ultimate criteria for two levels of creativity. In C.W. Taylor & F. Barren (Eds.), *Scientific creativity: Its development and validation* (pp. 30-43). New York: Wiley.

Gibson, J., & Light, P. (1967). Intelligence among university scientists. *Nature, 213,*441-443.

Gruber, H.E. (1993). Creativity in the moral domain: Ought implies can implies create. *Creativity Research Journal, 6,* 3-15.

Gruber, H.E., & Davis, S.N. (1988). Inching our way up Mount Olympus: The evolving-systems approach to creative thinking. In R.J. Sternberg (Ed.), *The nature of creativity* (pp. 243-270). New York: Cambridge University Press.

Grudin, R. (1990). *The grace of great things.* New York: Tichnor and Fields.

Guilford, J.P. (1950). Creativity. *American Psychologist, 5,* 444-454.

Harrington, D.M., Block, J., & Block, J.H. (1983). Predicting creativity in preadolescence from divergent thinking in early childhood. *Journal of Personality and Social Psychology, 45,* 609-623.

Harrington, D.M., Block, J.H. & Block, J. (1987). Testing aspects of Carl Rogers's theory of creative environments: Child-rearing antecedents of creative potential in young adolescents. *Journal of Personality and Social Psychology, 52,*851-856.

Hattie, J.A. (1977). Conditions for administering creativity tests. *Psychological Bulletin, 84,*1249-1260.

Hattie, J.A. (1980). Should creativity tests be administered under test like conditions? *Journal*

*of Educational Psychology, 72,*87-98.

Heinelt, G. (1974). *Kreative Lehrer—kreative Schüler* [Creative teachers— creative students]. Freiburg: Herder.

Helson, R. (1983). Creative mathematicians. In R.S. Albert (Ed.), *Genius and eminence: The social psychology of creativity and exceptional achievement* (pp. 311 -330). Elmsford, NY: Pergamon.

Henle, M. (1974). The cognitive approach: The snail beneath the shell. In S. Rosner & L.E. Aber (Eds.), *Essays in creativity* (pp. 23-44). Croton on Hudson, NY: North River Press.

Hocevar, D., & Bachelor, P. (1989). A taxonomy and critique of measurements used in the study of creativity. In J.A. Glover, R.R. Ronning, & C.R. Reynolds (Eds.), *Handbook of creativity* (pp. 53-76). New York: Plenum.

Howieson, N. (1981). A longitudinal study of creativity—1965-1975. *Journal of Creative Behavior, 15,*117-134.

Howieson, N. (1984, August). *Is Western Australia neglecting the creative potential of its youth?* Paper presented at the 1984 Annual Conference of the Australian Psychological Society, Perth, Australia.

Hudson, L. (1966). *Contrary imaginations.* London: Methuen.

Koestler, A. (1964). *The act of creation.* London: Hutchinson.

Kogan, N., & Pankove, E. (1972). Creative ability over a five year span. *Child Development, 43,*427-442.

Krampen, G., Freilinger, J., & Wilmes, L. (1988). Kreativitätstest fur Vorschul- und Schulkinder (KVS): Testentwicklung, Handanweisung, Testheft [Creativity test for

preschool and schoolchildren: Test development, instructions for administration, manual]. *Trierer Psychologische Berichte, 15,* Heft 7.

Kris, E. (1950). On preconscious mental processes. *Psychoanalytic Quarterly, 19,* 539-552.

Kubie, L. (1958). *Neurotic distortion of the creative process.* Lawrence: University of Kansas Press.

Langley, P.W., Simon, H.A., Bradshaw, G.R., & Zytkow, J.M. (1986). *Scientific discovery: Computational exploration of the creative process.* Cambridge, MA: MIT Press.

Mackler, B. (1962). *Creativity and lifestyles.* Unpublished doctoral dissertation, University of Kansas.

Maslow, A.H. (1959). Creativity in self-actualizing people. In H.H. Anderson (Ed.), *Creativity and its cultivation* (pp. 83-95). New York: Harper & Row

McCrae, R.R. (1987). Creativity, divergent thinking and openness to experience. *Journal of Personality and Social Psychology, 52,* 1258-1265.

McCrae, R.R., & Costa, P.T. (1985). Openness to experience. In R.R. Hogan & W.H. Jones (Eds.), *Perspectives in personality* (Vol.1, pp. 145-172). Greenwich, CT: JAI Press

McLeod, J., & Cropley, A.J. (1989). *Fostering academic excellence.* Oxford: Pergamon.

McMullan, W.E. (1978). Creative individuals: Paradoxical personages. *Journal of Creative Behavior, 10,*265-275.

Mednick, S.A. (1962). The associative basis of creativity. *Psychological Review, 69,*220-232.

Mehlhorn, H.-G. (1988). *Persönlichkeitsentwicklung Hochbegabter* [Personality development in the gifted]. Berlin: Volk und Wissen Volkseigener Verlag.

Mehlhorn, G., & Mehlhorn, H.-G. (1985). *Begabung, Schöpfertum, Persönlichkeit* [Giftedness, creativity and personality], Berlin: Volk und Wissen Volkseigener Verlag.

Meinberger, U. (1977). *Test zum divergenten Denken (Kreativität) fur 4. bis 6. Klassen (TDK 4-6)* [Test of divergent thinking (creativity) for the 4th to 6th grades (TDK 4-6)]. Weinheim: Beltz.

Milgram, R.M. (1990). Creativity: An idea whose time has come and gone? In M.A. Runco & R.S. Albert (Eds.), *Theories of creativity* (pp. 215-233). Newbury Park, CA: Sage.

Morgan, D.N. (1953). Creativity today. *Journal of Aesthetics, 12,*1-24.

Moustakis, C.E. (1977). *Creative life.* New York: Van Nostrand.

Mumford, M.D., & Gustafson, S.B. (1988). Creativity syndrome: Integration, application, and innovation. *Psychological Bulletin, 103,* 27-43.

Myers, I.E., & McCaulley, M.H. (1985). *Manual: A guide to the development and use of the Myers-Briggs Type Indicator.* Palo Alto, CA: Consulting Psychologists Press.

Necka, E. (1986). On the nature of creative talent. In AJ. Cropley, K.K. Urban, H. Wagner, & W.H. Wieczerkowski, (Eds.), *Giftedness: A continuing worldwide challenge* (pp. 131-140). New York: Trillium.

Obuche, N.M. (1986). The ideal pupil as perceived by Nigerian (Igbo) teachers and Torrance's creative personality. *International Review of Education, 32,*191-196.

Okuda, S.M., Runco, M.A., & Berger, D.E. (1990). Creativity and the finding and solving of real world problems. *Journal of Psychoeducational Assessment, 9,*45-53.

Parloff, M.D., & Handlon, D.H. (1964). The influence of criticalness on creative problem solving. *Psychiatry, 27,*17-27.

Perkins, D.N. (1981). *The mind's best work.* Cambridge, MA.: Harvard University Press.

Platt, W., & Baker, R.A. (1931). The relation of the scientific "hunch" to research. *Journal of Chemical Education, 8,*1969-2002.

Rejskind, F.G., Rapagna, S.O., & Gold, D. (1992). Gender differences in children's divergent thinking. *Creativity Research Journal, 5,*165-174.

Rogers, C.R. (1959). Toward a theory of creativity. In H.H. Anderson (Ed.), *Creativity and its cultivation* (pp. 25-42). New York: Harper and Row.

Rosenman, M.F. (1988). Serendipity and scientific discovery. *Journal of Creative Behavior,* 22,132-138.

Rothenberg, A. (1988). Creativity and the homospatial process: Experimental studies. *Psychiatric Clinics of North America, 11,* 443-460.

Rump, E.E. (1979). *Divergent thinking, aesthetic preferences and orientation towards arts and sciences.* Unpublished doctoral dissertation, University of Adelaide.

Runco, M.A. (Ed.). (1991). *Divergent thinking.* Norwood, NJ: Ablex.

Runco, M.A., & Albert, R.S. (1986). The threshold hypothesis regarding creativity and intelligence: An empirical test with gifted and nongifted children. *Creative Child and Adult Quarterly, 11,*212-218.

Runco, M.A., & Okuda, S.M. (1988). Problem-discovery, divergent thinking, and the creative process. *Journal of Youth and Adolescence, 17,* 213-222.

Schoppe, K.J. (1975). *Verbaler Kreativitätstest* [Test of verbal creativity].Göttingen: Hogrefe.

Schubert, D.S. (1973). Intelligence as necessary but not sufficient for creativity. *Journal of Genetic Psychology, 112,*45-47.

Schubert, D.S.P., Wagner, H.E., & Schubert, H.J.P. (1988). Family constellation and creativity: Increased quantity of creativity among lastborns. *Creative Child and Adult Quarterly, 13,* 97-103.

Scott, M. (1988). Gifted-talented-creative children's development. *Creative Child and Adult*

*Quarterly, 13,*119-132.

Shaughnessy, M.F., & Manz, A.F. (1991). Personalogical research on creativity in the performing and fine arts. *European Journal for High Ability, 2,* 91-101.

Shaw, M.P. (1989). The Eureka process: A structure for the creative experience in science and engineering. *Creativity Research Journal, 2,* 286-298.

Sierwald, W. (1989, September). *Kreative Hochbegabung—Identifikation, Entwicklung und Förderung kreativ Hochbegabter.* [Creative giftedness—identification, development and fostering of the creatively gifted]. Paper presented at the second annual meeting of the working group, Educational Psychology of the German Psychological Society, Munich.

Simonton, D.K. (1988). *Scientific genius. A psychology of science.* Cambridge: Cambridge University Press.

Smith, G., & Carlsson, I. (1989). *The creative process.* New York: International Universities Press.

Snow, R.E. (1986). Individual differences in the design of educational programs. *American Psychologist, 41,*1029-1039.

Stein, M.I. (1963). A transactional approach to creativity. In C.W. Taylor & F.X. Barron (Eds.), *Scientific creativity: Its discovery and development* (pp. 217-227). New York: Wiley.

Stone, B.G. (1980). Relationship between creativity and classroom behavior. *Psychology in the Schools, 17,*106-108.

Suler, J.R. (1980). Primary process thinking and creativity. *Psychological Bulletin, 88, 144-165.*

Tardif, T.Z., & Sternberg, R.J. (1988). What do we know about creativity? In R.J. Sternberg

(Ed.), *The nature of creativity* (pp. 429-440). New York: Cambridge University Press.

Taylor, I. A. (1975). An emerging view of creative actions. In I. A. Taylor & J.W. Getzels (Eds.), *Perspectives in creativity* (pp. 3-12). Chicago: Aldine.

Torrance, E.P. (1967). *Education and the creative potential.* Minneapolis: University of Minnesota Press.

Torrance, E.P. (1972). Predictive validity of the Torrance Test of Creative Thinking. *Journal of Creative Behavior, 32,*401-405.

Torrance, E.P. (1981). Predicting the creativity of elementary school children (1958-1980). *Gifted Child Quarterly, 25,*55-62.

Torrance, E.P. (1990). *Torrance Tests of Creative Thinking.* Beaconville, IL: Scholastic Testing Services.

Torrance, E.P. (1992, January/February). A national climate for creativity and invention. *Gifted Child Today,* pp. 10-14.

Treffinger, D.J., & Gowan, I.C. (1971). An updated representative list of methods and educational materials for stimulating creativity. *Journal of Creative Behavior, 6,*236-252.

United States Patent and Trademark Office. (1990). *The Inventive Thinking Curriculum Project.* Washington, DC: U.S. Patent and Trademark Office.

Urban, K.K. (1991). On the development of creativity in children. *Creativity Research Journal, 4,*177-192.

Walberg, H.J., & Staniha, W.E. (1992). Productive human capital: Learning, creativity, and eminence. *Creativity Research Journal, 5,* 323-341.

Wallach, M.A. (1985). Creativity testing and giftedness. In F.D. Horowitz & M. O'Brien (Eds.), *The gifted and talented: Developmental perspectives* (pp. 99-124). Washington, DC:

American Psychological Association. Wallach, M.A., & Kogan, N. (1965). *Modes of thinking in young children.* New York: Holt, Rinehart & Winston.

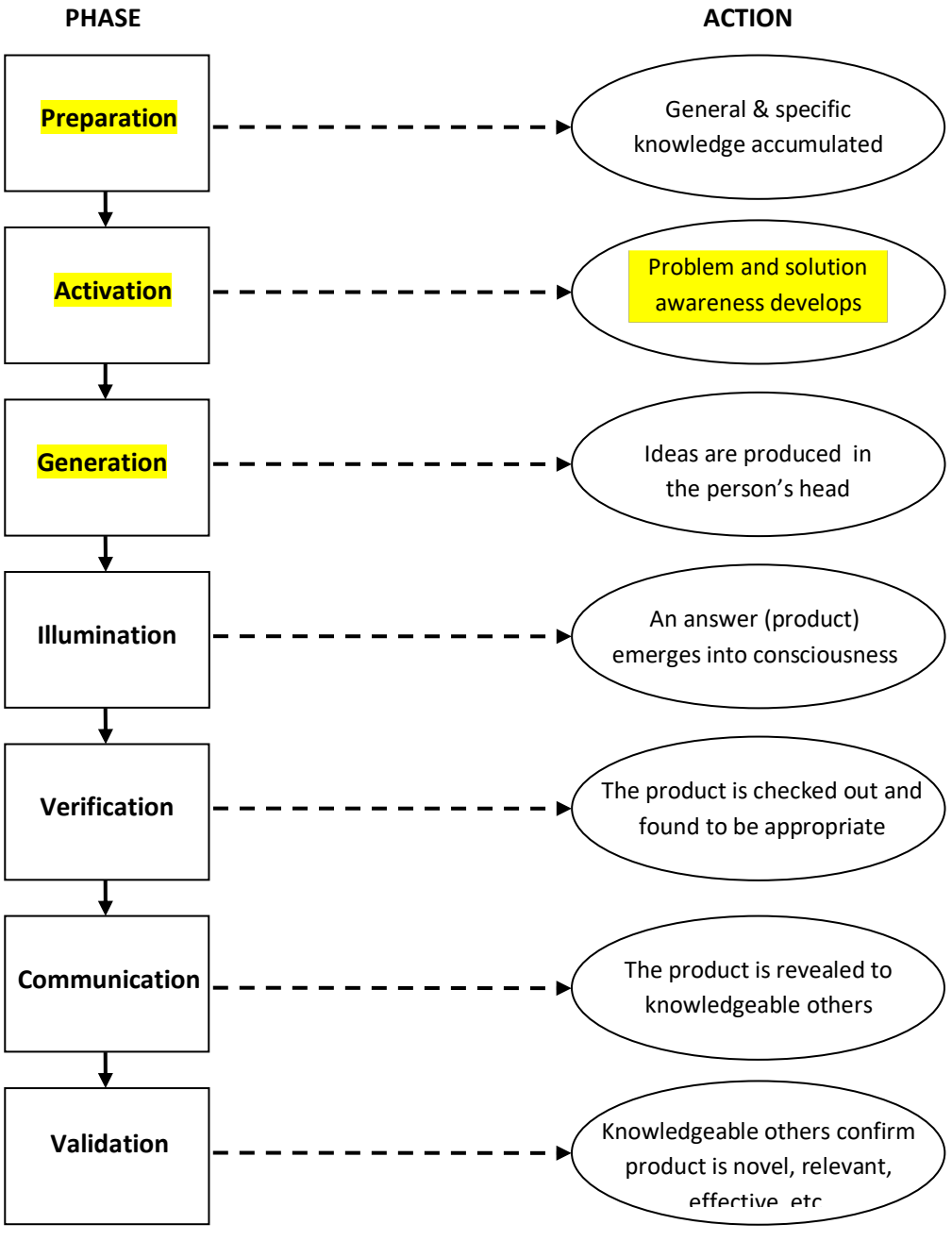
Wallach, M.A., & Wing, C.W. (1969). *The talented student.* New York: Holt, Rinehart &Winston.

Wallas, G. (1926). *The art of thought.* New York: Harcourt Brace.

Weisberg, R.W. (1986). *Creativity.* New York: Freeman.

Wodtke, K.H. (1964). Some data on the reliability and validity of creativity tests at the elementary school level. *Educational and Psychological Measurement, 24,*399-408.

Zarnegar A., Hocevar, D., & Michael, W.B. (1988). Components of original thinking in gifted children. *Educational and Psychological Measurement, 48,*5-16.


PHASE
ACTION
Preparation
General & specific knowledge accumulated
Activation
Problem and solution awareness develops
Generation
Ideas are produced in the person's head
Illumination
An answer (product) emerges into consciousness
Verification
The product is checked out and found to be appropriate
Communication
The product is revealed to knowledgeable others
Validation
Knowledgeable others confirm product is novel, relevant, effective, etc