Insights into the creativity process

John Munro

Identifying and measuring creativity

An examination of creative thinking and the teaching conditions necessary to foster it would be incomplete without an examination of the ways in which people have attempted to identify and assess creative thinking and its outcomes. Before we review the various procedures used to measure creativity, there are a number of conceptual, procedural and ethical questions that need to be raised about the assessment of creativity.

Some issues that relate to the assessment of creativity ?

How is the assessment of an individual's creativity similar to and different from the assessment of their mathematics or history knowledge, their ability to perform various physical skills such as throwing a ball or their intellectual ability ?

There are number of issues here that need to be examined. In the assessment of some educational outcomes, for example, an extended project or research activity, students are often assessed in terms of a number of criteria that have little to do directly with creativity, in addition to an assessment of the creativity of their outcome. The criteria frequently include

- the clarity and precision of the topic, purpose or research question
- the procedures they used to analyse the research question, including the appropriateness both of the information base sampled and investigation tools used
- the extent to which the relevant materials, sources, data and evidence were selected, interpreted and analysed appropriately
- the extent to which the research question or purpose is investigated systematically.
- the development, organisation and clear expression of the argument, to address the research question
- the inclusion of a conclusion consistent with the contention or issue.

These criteria, while worthy in their own right, have little to do with creativity. As well, some of them can actually restrict the student's display of their creativity. A student can sometimes have difficulty describing their creative thinking in written paragraphs; they find it easier to draw it, to demonstrate it or make a model of it. They may also have difficulty organising their creative thinking into a logical argument.

Assessing a student's creative understanding of a topic is different from assessing either their learnt knowledge of a topic, their ability to do what they have learnt or their ability to write about what they have learnt in coherent paragraphs. Knowledge that is creative is often not easy to show in these ways.

There are a number of issues teachers need to keep in mind when assessing creative thinking. Some of these are discussed in the following section.

Why assess or measure an individual's creativity ? The first issue relates to an individual's motives or reasons for assessing creativity in the outcomes of another person. Why would you want to assess the level or extent of creativity in another person's outcomes ? Two related questions are :

- Should you assess a person's creativity ?
- Why would you bother assessing a person's creativity ? What do you want to know about them ? What questions are you wanting to answer ?

Some people argue that we should not bother attempting to assess creativity because we can't. because the it is harder to quantify than, for example, one's knowledge of mathematics or history, there is no value in attempting to assess it.

We generally assume that by assessing how a person performs on some tasks, we can infer and generalise about what their knowledge is like and how they would perform on other tasks. How does this apply to creativity ?

In order to examine this question further, it is useful to reflect on the distinction between assessment and evaluation. Both involve the act of making a judgment but differ in what and how they it. I distinguish them as follows:

• assessment involves judging students and their educational accomplishment within a particular domain, in this case, in the area of creative thinking.

• evaluation involves judging the value or worth of a programme, in this case, teaching and programmes intended to foster creative thinking.

One reason for assessing creativity may be to get an impression of a person's potential or capacity to be creative in other tasks, in related areas. This assumes, of course, that a person's creativity capacity can be transferred or generalised across situations. Some educators would argue that creativity is subject – or domain specific. It may be restricted to particular areas of knowledge for any person; an individual is not necessarily creative on all areas of knowledge. This means that a measure of creative ability in one area does not mean creative ability in another. Several of the models of creativity we examined in earlier sections would support this.

When you are assessing creativity, what do you measure ? When you are measuring creativity, what are you measuring ?

One aspect of what you measure is what you actually focus on. Do you focus your judgment on:

• ***the person (student) who is the creator*** ? As I noted above, your intention may be to examine the extent to which a person can be creative. The validity of this type of question is another issue.

Our earlier discussion has drawn attention to a number of issues to do with assessing factors in individuals to do with creativity. These include the following:

- Individuals can be creative in a huge range of areas and domains. Across this range how much of the creativity depends on the area ? Are there common aspects of creativity across all of these.

- Some people will show creativity across most areas of their activity while others may show it in a much more narrow band of activities.

- Both cognitive and emotional / personality factors contribute to creativity. How do you include these in any assessment ?

These issues show how broad-based the issue of creativity measurement is. An approach to assessment may need to take account of some of these issues.

Some of the conventional 'creativity' tests would argue that they are assessing an individual's 'creativity potential' - the relative capacity of the person to be creative in the future. This attempts to narrow down what is measured. Assessing the individual means you see a prognostic value or purpose of the assessment, that you seek to make future prediction.

The assessment of the outcome by the creator, that is, in the case of educational contexts, student self-assessment of the outcome in terms of its level of creativity, may also be a

2

relevant dimension for assessment. Student self-assessment recognises the ownership of the creative outcome by the creator and the creator's intellectual independence. It also communicates this value to the culture in which the creation occurred.

It is possible that the autonomous judgment of the creator may not be consistent with the 'objective' or 'independent' judgment of the teacher. This tension is possible whenever one individual assesses the outcome in terms of its contribution to them and a second person evaluates in terms of a different set of criteria decided by the culture or context. The assessor of creative outcomes needs to be mindful of this potential tension.

- **the creation ?** In this case you assess the outcome of the creativity in terms of particular criteria. This allows you to compare comparable items in terms of their level of creativity. This assessment is done by necessity after the outcome has been created and delivered for scrutiny. Relevant attributes or criteria for assessing the creativity of an outcome have been suggested by various creativity assessment inventories (Besemer and O'Quin, 1987; Taylor, 1975) and include

  - its novelty; how novel, original, unexpected?
  - its effectiveness; how well does it achieve its purpose, how functional or relevant is it ?
  - its elegance ; how understandable, elegant, polished, finished, aesthetic is it ?
  - its integration; how well does it operate as a 'whole', a outcome that has integration or synthesis ?
  - its germinality; how well does it open up new perspectives or opportunities, generate new creativity ?
  - its emotionality; its capacity to stimulate positive emotions such as surprise or other relevant feelings, the 'wow' factor.
  - its elaboration; the extent to which it has elaborated or reformulated what was known or done previously.

This set of criteria may not be relevant to creative outcomes in all domains or areas of human endeavour.

A similar list of attributes are used by test designers to assess creativity potential:

Creativity criterion	ability	How it is scored
fluency	produce a large number of ideas in words, figural images or actions	(total number of relevant responses
flexibility	produce a variety of kinds of ideas, draw in relevant ideas from a variety of domains, shift between domains easily	number of different categories of relevant responses
originality	produce ideas that are less obvious or expected but that are uncommon or unique	the frequency of the responses
elaboration	develop, embellish or elaborate ideas	amount of detail in the responses
abstractness	sense the essence of a problem or an issue, its level of abstraction	level of abstraction
resistance to premature closure	keep an open mind, unanswered questions, unresolved issues and to work on information from a variety of perspectives	total number of unanswered questions, unresolved issues

The judgment can also attempt to focus on the thinking used to generate the creation.   In this case you assess the thinking strategies individuals say they used during the creative activity.

- ***the social conditions surrounding the act of creative production***. In this case you are assessing the evaluation of the creative outcome by the culture or environment in which it was generated.   In the case of Hori described earlier, his work organisation did not initially value his creative activity. It took a second community, the community of academic peers, to evaluate his outcome differently. This recognition lead led to a changed evaluation by his organisation.   His work culture initially did not evaluate his creative outcome in the way that it did evaluate it later.

  In school contexts, evaluation of the potential of the creative outcome for the culture or context needs to be done carefully, in terms of explicit criteria. Similarly, the capacity of the culture or context in which the outcome occurred to evaluate it adequately also needs to be determined carefully.   It is possible for a culture to perceive a creative outcome as a threat to the status quo, or unnecessary.

The key question of whether it is students, their work or the social evaluation of it that is assessed, requires, as a bottom line, an ethical position being taken.   Some individuals and institutions may prefer to gather assessment data from all three sources. A decision they then face it how to integrate and synthesise the data from the different sources.

How can you judge creativity ?   A second consideration here is how informed and independent judgments about creativity can be made.   The criteria specified above involve a level of subjective judgment. Can you allocate absolute scores for different attributes ?   How objective can an assessor's judgment be ? What constitutes a standard in the assessment of creativity ? What do scores actually tell you ?

Many researchers in the area of creativity would prefer to make comparative judgments on each of several attributes than more absolute judgments.   How the 'scores' gained from assessing attributes of creativity lead to a range of ethical questions and issues. Again, the issue of self-assessment by the creator is relevant here.

There are, obviously, many other aspects of the issue of what is measured during the assessment of creativity.   What, mental abilities, for example, are assumed to be used to achieve creative outcomes in figural and verbal contexts.   How can assessment procedures be applied cross-culturally ?   Some of these issues will be pursued in the following sections.

In order to assess creativity, what outcomes or processes do you use ?

Following on from the preceding section, if you agree that it is preferable to assess the outcomes and processes of creative activity, the issue arise of what outcomes do you assess. You have various options, for example

- The outcomes from items on tests of 'creativity '
- What individuals believe about their creative style and ability
- Assignments that encourage students to think creatively about topics and subjects they have learnt earlier, to think about possibilities and extending the topics into areas not previously mentioned.
- Outcomes that individuals generated as a result of their interests and drive, not under fixed time constraints, perhaps in their own time

The conditions should let the students know that they are encouraged to operate creatively and what this means in practice,

Is it reasonable or acceptable to assess creativity in subjects or areas of knowledge in which the students have not learnt how to be creative ? What do students learn in any subject that is creative (and therefore available to be assessed) and distinct from things they learn that is not creative (and therefore not available to be assessed ?   These are additional questions to consider when one is deciding what outcomes to assess.

How can you judge creativity in different subject or domain areas ?   Another issue is how you can judge creativity in different subject or domain areas such as music, media, sport, design and technology and drama ?   Do the same criteria for an outcome apply across different subject areas ? Obviously experts in each discipline would be able to rate or sequence items in terms of the criteria mentioned above.

It is sometimes argued that it is easier to display creative outcomes in some discipline areas (for example, the arts) that in other areas such as geography or biology and what this means for the assessment of creativity in these subjects. I don't agree with this contention; I believe that one can be creative in any subject area. Whether creative outcomes are more likely in an educational context depends in part on what students learn about that knowledge area. A subject in which the content is taught as fixed, 'correct' and not available to be questioned or changed is less likely to elicit creative thinking than one in which students learn that the content being taught represent our beliefs at this point in time. I believe that the latter position holds for most areas of knowledge.

Reviewing creativity assessment scales.

An excellent article reviewing a range of creativity assessment scales has been written by Cropley (2000).   Over 250 scales have been reported.   Reviewers have questioned their usefulness and in particular, their technical limitations (Hocevar & Bachelor, 1989; Cooper, 1991).   This article examines the main scales developed during the modern creativity era introduced by Guilford (1950).   It describes the abilities they measure and the consistency with which they do this. It describes the procedures used to assess creative products, creative processes, creative people).

The Centre of Creative Learning web site (http://www.creativelearning.com/) lists provides a brief descriptions and review of more than 70 instruments for assessing creativity. www.gifted.uconn.edu/resource.html#02170

Assessing creative outcomes or products

We noted earlier a number of criteria used to assess the level of creativity of outcomes. The attributes came from various creativity assessment inventories (Besemer and O'Quin, 1987; Taylor, 1975) and include

- its novelty; how novel, original, unexpected?
- its effectiveness; how well does it achieve its purpose, how functional or relevant is it ?
- its elegance ; how understandable, elegant, polished, finished, aesthetic is it ?
- its integration; how well does it operate as a 'whole', a outcome that has integration or synthesis ?
- its germinality; how well does it open up new perspectives or opportunities, generate new creativity ?
- its emotionality; its capacity to stimulate positive emotions such as surprise or other relevant feelings, the 'wow' factor.
- its elaboration; the extent to which it has elaborated or reformulated what was known or done previously.

The dimensions covered by the two scales are as follows:

Creative Product Inventory (Taylor, 1975)	Generation, Reformulation, Originality, Relevancy, Hedonics, Complexity and Condensation.
Creative Product Semantic Scale (Besemer and O'Quin, 1987)	Novelty (product is original, surprising and germinal), Resolution (product is valuable, logical, useful, understandable), Elaboration and Synthesis (product is organic, elegant, complex, well-crafted)

Besemer and O'Quin's scale measures the three dimensions with high reliabilities, ranging from 0.69 to 0.87. When different raters were asked to rank the same items using the scale, reliabilities of the ratings of creativity ranged from .70 to .90.

What do creativity tests measure ?

Creativity tests

• measure specific cognitive processes such as thinking divergently, making associations, constructing and combining broad categories, or working on many ideas simultaneously.

• measure affective aspects of creativity such as motivation (such as a desire for novelty, risk-taking), and personal features that assist creativity such as flexibility, tolerance for independence, or positive attitudes to being different. Raters can score the various kinds of test with substantial agreement, while scores are internally stable to an acceptable degree.

• correlate with criteria of creativity such as teacher ratings and are predictors of adult behavior.

These tests measures of creative potential- creative achievement depends on additional factors not measured by creativity tests, such as technical skill, knowledge of a field, mental health, or even opportunity. The multidimensional creativity concept they define indicates that assessments should be based on several tests, rather than on a single score.

The Creative Process

The Creativity Tests for Children comprises 10 types of tasks that assess primary and secondary level students' divergent production of units, classes, relations, systems, transformations and implications in the verbal and nonverbal areas. Examples of tests are "Names for stories," "Different letter groups," and "Making objects." It measures free production of a large number of ideas rather than originality or effectiveness.

Torrance Tests of Creative Thinking (TTCT), (Torrance, 1966, 1999) tests divergent thinking in the verbal and nonverbal areas as follows:

Areas of creative thinking	Aspect of creative thinking	Activities
verbal Thinking Creatively with Words	Fluency, Flexibility Originality	Asking, Guessing Causes, Guessing Consequences, Product Improvement, Unusual Uses, Unusual Questions and Just Suppose
nonverbal or figural Thinking Creatively with Pictures	Fluency, Originality, Elaboration, Abstractness of Titles, Resistance to Premature Closure.	Picture Construction, Picture Completion and Lines/Circles

Each area has two matching forms. The verbal activities have high test-retest reliabilities and inter-rater reliabilities for quality, complexity and originality. Composite verbal creativity scores explained approximately 50% of the spread of scores on the criterion of publicly recognized creative achievements 20 years after assessment and predicted about three times as much of the criterion variance as IQ measures. The TTCT scores differentiate well between those who do and don't subsequently achieve public acclaim recognition as creative (Plucker, 1999).

Modes of thinking in young children (Wallach & Kogan, 1965) measures creativity in a game like context without time limits. It comprises
- three verbal subtests (Instances, Alternate Uses and Similarities) and
- two subtests consisting of ambiguous figural stimuli (Pattern Meanings, Line Meanings).

Alternate Uses, which asks respondents to give as many unusual uses as they can for various common items (e.g., newspaper, knife, car tire, button, shoe, key), is the most widely used subtest. It can be scored for
- fluency by counting the number of responses and
- uniqueness by identifying responses that were unique to a person within the group being tested .
- flexibility by counting the number of responses,
- originality (statistical uncommonness); rate answers on 7-point scale (not original - very original).
- usefulness (practicality and relevance to reality); rate answers on a 7-point scale (not useful - very useful).

The scale has high validity and reliability.

Remote Associates Test (RAT; Mednick, 1962) measures creativity by asking individuals to suggest remote associates to stimulus words. It comprises 30 sets of several apparently unrelated words each, (e.g., moon, cheese, and grass). The respondent needs to suggest a remote fourth word that links these words (blue would be appropriate for the example given). The score is the number of correct solutions. The test has high internal consistency coefficients and distinguished well between y students rated as rated as high or low on creativity and correlates reasonably well with creative behavior in non test situations.

Test of Creative Thinking (Divergent Production) (TCT-DP) (Urban & Jellen, 1996) assesses creativity through drawing; respondents finish off an incomplete figure of 8 fragments by drawing whatever they think appropriate. Their outcome is rated in terms of dimensions derived from a Gestalt theory of creativity. These include

- Boundary Breaking,
- New Elements,
- Humor and Affectivity.

The test, with forms, A and B, has high inter-rater reliability, moderate test-retest reliability. It distinguishes moderately well between people who are more and less creative in non-test contexts.

Process-based measures of creative problem-solving skills (Mumford, Supinski, Baughman, Costanza & Threlfall, 1997) assesses creative thinking in five areas of problem solving:

- Problem Construction,
- Information Encoding,
- Category Selection,
- Category Combination
- Reorganization.

As an example, Category Combination problems consist of sets of four instances from each of three categories, for example:

table, chair, lamp, bed	banana, pineapple, orange, peach	telephone book, search warrant, marriage certificate, map

The ways in which respondents need to deal with each set, and a sample set of responses is shown in the following table :

• name the categories defined by the exemplars	furniture, fruit and printed documents
• combine the categories to create a new, superordinate category	super category of "forest products"
• describe it in one sentence	Furniture, fruit and wood could be made from trees which grow in a forest."
• list as many additional exemplars of the super category as possible	Fuel, shoes, thatch for roofs
• list additional features linking the exemplars combined in the new category	Items that have been important for human life in history

Inter-rater reliabilities for quality and originality range from moderate to high (Mumford et al.)

Creative Reasoning Test (CRT) (Doolittle, 1990) assesses three aspects of creative thinking, associative, inductive and divergent thinking, through problem solving, with the problems presented as riddles. The test has two levels.

- Level A (Grades 3-6) : 4 -line rhymes, in which an animal or object gives clues to its identity, for example, I grow in the park, / where I stand tall and green./ For birds I am home./When the wind blows I lean.
- Level B for secondary and college level.

The Creative Person

Rather than asking respondents to complete tasks intended to elicit creative thinking, these assessment scales ask respondents to comment either on factual aspects of their lives believed to be indicative of creativity (biographical inventories) or on how they believe they operate in various learning or problem solving contexts (creativity thinking self beliefs) . Alternatively, their teachers, parents or peers may be asked to comment on the behaviours they display that may be interpreted as indicative of creativity.

Biographical inventories These scales ask respondents to comment on aspects of their lives that are believed to be indicative of creativity activities. The focus here is on scoring the frequency of this involvement and the quality of the outcomes.

Biographical Inventory (Schaefer & Anastasi, 1968) asks respondents to comment on five areas: their

- family background (eg parental education, level of public recognition of parents or siblings),

- intellectual and cultural orientation (e.g., interests and hobbies, the availability of demanding literature, frequency of visits to museums or art galleries),

- motivation (use of special equipment such as a microscope, willingness to skip meals to work on a project, jobs in a field of interest)-referred to as pervasive and continuing enthusiasm,

- breadth of interest (number of hobbies pursued, number of favorite school subjects), and

- drive towards novelty and diversity (level of interest in unusual art forms, extent of unconventional collections such as spider webs).

Responses are scored in terms of the level of artistic creativity and the level of scientific creativity. The scale discriminated between more and less creative adolescents when compared with how teachers rated the level of creativity of student products.

Life Experience Inventory (LEI) (Michael & Colson, 1979) had a set of items that discriminated between more and less creative electrical engineers.   The items covered four areas:

- self-striving or self-improvement (enjoy competition, show curiosity, committed to one's area of interest),

- parental striving (parent emphasises getting ahead, need to do well to satisfy parents),

- social participation and experience (member of organizations, help others with schoolwork),

- independence training (allowed as children to choose their friends, allowed to set their own standards in judging their own accomplishments).

Creative Activities Checklist, (Dunce, 1987), asks fifth to eighth graders to indicate how frequently they participated recently in activities in six areas:
- literature,
- music,
- drama,
- arts,
- crafts,   and
- science.

The number of instances of participation is summed (e.g., writing a story or poem, playing at a school, church or club concert, acting in a school play, participating in a science fair, and so on). In some studies respondents list their three most creative achievements that are rated for degree of creativity.   High inter-rater reliabilities have been reported.

Special personal properties

A number of assessment scales that either (1) ask respondents to comment on how they believe they operate in various learning or problem solving contexts (creativity thinking self beliefs by rating themselves on a number of criteria relevant to creative thinking or (2) ask others, for example, their teachers, parents or peers, to rate their behaviours in various learning and problem solving contexts have been designed.

These differ in the aspects of creative thinking they target, the year levels (primary or secondary) for which they are intended and whether they involve self rating, usually in terms of the frequency which the respondents judge a particular attribute to apply to them or rating by others.   As well, most of the scales have been evaluated in terms of their Internal consistency, their test-retest reliability and the extent to which they correlate with other measures of creativity for the student group, either teacher ratings of the creativity of student outcomes or scores on creativity potential scales.

	GIFT	GIFFI	ASCT	CAP	CCL	CBI
Rating by self or others	s	s	s	S, o	o	o
curiosity	√			√		√
originality	√		√	√		
independence	√				√	
flexibility	√		√	√	√	
risk taking	√			√		
fluency,			√	√	√	
elaboration			√	√		
imagination, fantasy				√		√
preference for complexity				√	√	
ingenuity,					√	
resourcefulness					√	
positive self-referencing					√	
contact,						√
consciousness,						√
Grade levels for use	P	S	P, S	P, S	P, S	P, S
Internal consistencies	m-h	m-h	m		h	
test-retest reliability	m-h	m-h		m		
teacher ratings of the creativity of student outcomes	l- m		l	m	m	m
Scores on creativity potential scale			l			

GIFT : The Group Inventory for Finding Creative Talent () (Rimm & Davis, 1980)
GIFFI :   Group Inventory for Finding Interests (Davis & Rimm, 1982)
ASCT : Abed-Schumacher Creativity Test   (O'Neil, Abed &Spiel Berger, 1994)
CAP Creativity Assessment Packet (Williams, 1980).
CCL :   The Creativity Checklist   (Johnson, 1979)
CBI : The Creative Behavior Inventory (CBI 1 for grades 1-6 and CBI 2 for grades 7-12)
     (Kirschenbaum, 1989)

Measures of reliability and correlation : low = l, moderate = m,   high = h,
Primary school years = P,   Secondary school years = S

Some scales that examine attributes different from these are described in the following.

Creativity Styles Questionnaire(CSQ) (Kumar, Kemmler & Holman, 1997) involve self ratings
on of frequency of personal applicability on seven dimensions:

- Belief in Unconscious Processes (for example, "Creative ideas occur to me without even thinking about them";
- Use of Techniques;   for example, "I typically create new ideas by combining existing ideas"),
- Use of Other People;
- Final Product Orientation;
- Environmental Control;
- Superstition;
- Use of Senses.

Internal consistency ranged from moderate to high.

The Creatrix Inventory (C & RT) (Byrd, 1986) is a self-rating scale that measures two
dimensions of creativity :

- creative thinking (cognitive dimension of creativity) and
- risk-taking (motivation dimension of creativity).

Respondents rate each item in terms of its frequency of personal applicability. Their score on each dimension is rated as high, medium, or low and is mapped onto a two-dimensional grid (creativity versus risk-taking) and the person assigned to one of eight styles:
- Reproducer, low on both risk taking and creativity
- Modifier
- Challenger, high on risk taking but not creativity
- Practicalizer,
- Innovator, high on both creative thinking and risk taking
- Synthesizer
- Dreamer, high on creativity but not risk taking and
- Planner.

Adaptation-Innovation Inventory (KAI) (Kirton, 1989), is a self rating scale used to assess the preferential use of two processes in creative problem solving:

- adapting; adaptors solve problems by using what they know and can do and

- innovating; innovators try to reorganize and restructure the problem to solve it.

The innovative preference (which has higher motivation to be creative, higher risk taking and higher self-confidence) usually leads to higher productivity. Respondents self rate on the ease with which they perform behaviours from each area. They are scored on:
- Originality,
- Conformity, and
- Efficiency.

The scale has moderate internal consistency and test-retest.

Procedures that use Adjective Check Lists Some scales have asked individuals and observers to read lists of adjectives and to decide the extent to which each describes the respondent. Three scales are:

- The Adjective Check List (ACL) (Gough & Heilbrun, 1983) can be used for both self- and observer- ratings .

- Domino developed Domino Creativity Scale, (Domino, 1994). a subscale of the ACL

- Creative Personlity Scale (Cps) (Gough, 1992; Gough &Heilbrun, 1983

The scales differ in the number of adjectives they have. Some of the adjectives have a positive weighting with creativity (e.g., clever , wide interests, original) and some have a negative weighting.

The scales have been shown to discriminate between groups of high school students judged by their teachers to be more or less creative, university students judged by their instructors and adults judged on the basis of a biographical inventory and between inventors and noninventors. They correlate moderately to highly with other measures of creativity and therefore have reasonable construct validity. They have moderate to high test-retest reliability.

Overview of creativity assessment procedures Cropley comments on a number of key findings in relation to these scales

Their comparatively high levels of inter-rater reliabilities, internal consistencies and test-retest reliabilities suggest that the scales are measuring particular human capacities consistently.

The assessment of divergent thinking has higher validity than the assessment of self ratings of creativity and the ratings by observers. Given the multifaceted nature of creativity as measured by tests, the recommendation that assessments should be based on several different tests (Davis & Rimm, 1998) is emphasized.

Creativity tests seem to be less valid in predicting future creativity than intelligence tests predict future school grades. This may be in part because the tasks on creativity tests are less like real-life creative behavior than the tasks on intelligence tests are like school tasks. Real-life creative achievement may require more than creativity (convergent thinking, youthful openness and unconventionality are strongly predictive of adult creative achievement when associated with depth, commitment and self-discipline, but not when accompanied by unresolved identity problems, lack of persistence, self-defeating behavior, or overt psychopathology they are not. The creativity tests can best be seen as tests of creative potential, not of creativity (e.g., Kitto, Lok & Rudowicz, 1994; Helson,1999)

Cropley notes that some writers suggest that there is no need for a separate concept creativity at all. If this were the case, there would be no gain in assessing it as construct.

References

Auzmendi, E., Villa, A., & Abedi, J. (1996). Reliability and validity of a newly constructed multiple-choice creativity instrument. Creativity Research Journal, 9, 89-96.

Baldwin, A. Y. (1985). Programs for the gifted and talented: Issues concerning minority populations. In F. D. Horowitz & M. O'Brien (Eds.), The gifted and talented: Developmental perspectives (pp.223-250). Washington, D.C.: American Psychological Association.

Basadur, M., & Hausdorf, P. A. (1996). Measuring divergent thinking attitudes related to creative problem solving and innovation management. Creativity Research Journal, 9, 21-32.

Besemer, S. P. (1998). Creative Product Analysis Matrix: Testing the model structure and a comparison among products-three novel chairs. Creativity Research Journal, 11, 333-346.

Besemer, S. P., & O'Quin, K. (1987). Creative product analysis: Testing a model by developing a judging instrument. In S. G. Isaksen (Ed.), Frontiers of creativity research: Beyond the basics (pp. 367-389). Buffalo, NY: Bearly.

Besemer, S. P., & O'Quin, K. (1999). Confirming the three-factor Creative Product Analysis Model in an American sample. Creativity Research Journal, 12, 287-296. Brophy, D. R. (1998). Understanding, measuring and enhancing individual creative problem-solving efforts. Creativity Research Journal, 11, 123-150.

Byrd, R. E. (1986). Creativity and risk-taking. San Diego, CA: Pfeiffer International Publishers.

Carroll, J. B. (1993). Human cognitive abilities. New York: Cambridge University Press.

Colangelo, N., Kerr. B., Huesman, R., Hallowell, N., & Gaeth, J. (1992). The Iowa Inventiveness Inventory: Toward a measure of mechanical inventiveness. Creativity Research Journal, 5, 157-164.

Conoley. J. C., & Kramer, J. J. (Eds.). (1989). The I Ith Mental Measurements Yearbook. Lincoln: University of Nebraska Press.

Cooper, E. (1991). A critique of six measures for assessing creativity. Journal of Creative Behavior, 25, 194-204.

Cropley, A.J. (2000). Defining and measuring creativity: Are creativity tests worth using? *Roeper Review*, 23, (2), 72-79.

Cropley, D. H., & Cropley, A. J. (2000). Fostering creativity in engineering undergraduates. High Ability Studies, 12.

Csikszentmihalyi; M. (1996). Creativity: Flow and the psychology of discovery and invention. New York: Harper Collins.

Davis, G. A., & Rimm, S. B. (1982). Group Inventory for Finding Interests (GIFFI) I and 11: Instruments for identifying creative potential in junior and senior high school. Journal of Creative Behavior, 16, 50-57.

Davis, G. A., & Rimm, S. B. (1998). Education of the gifted and talented. Needham Heights, MA: Allyn and Bacon.

Domino, G. (1994). Assessment of creativity using the ACL: A comparison of four scales. Creativity Research Journal, 7, 21-23.

Doolittle, J. H. (1990). Creative Reasoning Test. Pacific Grove, CA: Midwest Publications/Critical Thinking Press.

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

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

Gough, H- G., & Heilbrun, A. B. (1983). The Adjective Check List Manual (2nd. ed.). Palo Alto, CA: Consulting Psychologists Press.

Gough, H- G., & Heilbrun, A. B. (1983). The Adjective Check List Manual (2nd. ed.). Palo Alto, CA: Consulting Psychologists Press.
Gough, H. G. (1992). Assessment of creative potential in psychology and the development of a creative temperament scale for the CPI. In J. C. Rosen & P. McReynolds (Eds.), Advances in psychological assessment (Vol 8, pp. 225-257). New York: Plenum.

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

Helson, R. (1999). A longitudinal study of creative personality in women. Creativity Research Journal, 12, 89-102.

Hennessey, B. A. (1994). The consensual assessment technique: An examination of the relationships between ratings of product and process creativity. Creativity Research Journal, 7, 193-208.

Hewish, A. (2001). Prelude to discovery. The Kenyon Review, 23, 2, 147-157.

Hocevar, D. (1981). Measurement of creativity: Review and critique. Journal of Personality Assessment, 45, 450-464.

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.

Johnson, D. L. (1979). The Creativity Checklist. Wood Dale, IL: Smelting.

Kaltsounis, B., & Honeywell, L. (1980). Instruments useful in studying creative behavior and creative talent. Journal of Creative Behavior, 14, NNNNN56-67.

Kasof, J. (1997). Creativity and breadth of attention. Creativity Research Journal, 10, 303-315.

Kirschenbaum, R. J. (1989). Understanding the creative activity of students. Mansfield, CT: Creative Learning Press.

Kirton, M. J. (Ed.). (1989). Adaptors and innovators: Styles of creativity and problemsolving (pp. 56-78). London: Routledge.

Kitto, J., Lok, D., & Rudowicz, E. (1994). Measuring creative thinking: An activity-based approach. Creativity Research Journal, 7, 59-69.

Kogan, N. (1983). Stylistic variation in childhood and adolescence: Creativity, metaphor, and cognitive styles. In P. Mussen (Ed.), Handbook of child psychology, Vol. 3 (pp. 631-706). New York: Wiley.

Kramer, J. J., & Conoley, J. C. (Eds.). (1989). The 11th Mental Measurements Yearbook. Lincoln: University of Nebraska Press.

Kumar, V. K., Kemmler, D., & Holman, E. R. (1997). The Creativity Styles Questionnaire-Revised. Creativity Research Journal, 10, 51-58.

Mednick, S. A. (1962). The associative basis of the creative process. Psychological Review, 69, 220-232.

Meeker, M. (1985). Structure of Intellect Learning Abilities Test. Los Angeles: Western Psychological Services.

Michael, W. B., & Colson, K. R. (1979). The development and validation of a life experience inventory for the identification of creative electrical engineers. Educational and Psychological Measurement, 39, 463-470.

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.

Milgram. R. M., & Hong, E. (1999). Creative out-of-school activities in intellectually gifted adolescents as predictors of their life accomplishments in young adults: A longitudinal study. Creativity Research Journal, 12, 77-88.

Mumford, M. D., Marks, M. A., Connelly, M S., Zaccaro, S. J., & Johnson, J. F. (1998). Domain-based scoring of divergent-thinking tests: Validation evidence in an occupational sample. Creativity Research Journal, 11, 151-163.

Mumford, M. D., Supinski, E. P., Baughman, W. A., Costanza, D. P., & Threlfall, K. V. (1997). Process-based measures of creative problem-solving skills: V. Overall prediction. Creativity Research Journal, 10, 73-85.

O'Neil, H. F., Abedi, J., & Spielberger, C. D. (1994). The measurement and teaching of creativity. In H. F. O'Neil & M. Drillings (Eds.), Motivation: Theory and research (pp. 245-263). Hillsdale, NJ: Lawrence Erlbaum.

Plucker, J. A. (1999). Is the proof in the pudding? Reanalysis of Torrance*s (1958 to present) longitudinal data. Creativity Research Journal, 12, 103-114.

Puccio, G. J., Treffinger, D. I., & Talbot, R. J. (1995). Exploratory examination of relationships between creativity styles and creative products. Creativity Research Journal, 8, 157-172.

Rickards, T. J. (1994). Creativity from a business school perspective: Past, present and future. In S. G. Isaksen, M. C. Murdock, R. L. Firestien & D. J. Treffinger (Eds.), Nurturing and developing creativity: The emergence of a discipline (pp. 155-176). Norwood, NJ: Ablex.

Rimm, S., & Davis, G. A. (1980). Five years of international research with GIFT: An instrument for the identification of creativity. Journal of Creative Behavior, 14, 35-46.

Runco, M. A. (1987). Interrater agreement on a socially valid measure of students'creativity. Psychological Reports, 61, 1009-1010.

Runco, 2001). Modes of Thinking in Young Children / The Talented   Roeper Review; 23 3 167-168.

Russ, S. W., Robins, A. L., & Christiano, B. A. (1999). Pretend play: Longitudinal prediction of creativity and affect in fantasy in children. Creativity Research Journal, 12, 129-139.

Sattler, J. M. (1992). Assessment of children. San Diego, CA

Schaefer, C. E., & Anastasi, A. (1968). A biographical inventory for identifying creativity in adolescent boys. Journal ofApplied Psychology, 52, 42-48.

Schaefer, C. I. (1971). The Creative Attitude Survey. Jacksonville, IL: Psychologists and Educators Inc.

Schaefer, C. I. (1971). The Creative Attitude Survey. Jacksonville, IL: Psychologists and Educators Inc.

Smith, J. M., & Schaefer, C. E. (1969). Development of a creativity scale for the Adjective Check List. Psychological Reports, 25, 87-92.

Sternberg, R. J. (1997). Intelligence and lifelong learning. What's new and how can we use it? American Psychologist, 52, 1134-1139.

Sweetland, R. C., & Keyser, D. J. (1991). A comprehensive reference for assessment in psychology, education and business. Austin, TX: Pro-Ed.

Taylor, A. (1975). An emerging view of creative actions. In I. A. Tylor, & J. W. Getzels (Eds.), Perspectives in creativity (pp. 297-325). Chicago: Aldine.

Taylor, C. W., & and Ellison, R. L. (1968). The Alpha Biographial Inventory. Greensboro, NC: Prediction Press.

Torrance, E. P., & Goff, K. (1989). A quiet revolution. Journal of Creative Behavior, 23, 136-45.

Torrance, E.P. (1999). Torrance Test of Creative Thinking: Norms and technical manual. Beaconville, IL: Scholastic Testing Services.

Treffinger, D. J. (1985). Review of Torrance Tests of Creative Thinking. Ninth Mental Measurements Yearbook (pp. 1632-1634). Lincoln, NB: University of Nebraska Press.

Unsworth, K. (2001). Unpacking creativity. *The Academy of Management Review*, 26, (2), 289-297.

Urban, K. K., & Jellen, H. G. (1996). Test for Creative Thinking - Drawing Production (TCT-DP).   Lisse,   Netherlands: Swets and Zeitlinger.

Vosburg, S. K. (1998). Mood and quantity and quality of ideas. Creativity Research Journal, 11, 315-324.

Wallach, M. A. (1976, January-February). Tests tell us little about talent. American Scientist, 57-63.

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

Williams, F. E. (1972). A total creativity program for individualizing and humanizing the learning process.   Englewood Cliffs, NJ: Educational Technology Publications.

Williams, F. E. (1980). The Creativity Assessment Packet. Chesterfield, MO: Psychologists and Educators Inc.