

DEVELOPMENT AND EVALUATION OF INTELLIGENCE AND CREATIVITY THROUGH THE *HIDDEN FIGURES* AND *CREATIVE FIGURES* TEST

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Abstract: *The paper briefly presents the concepts of creativity, intelligence and then presents "Hidden Figures" and "Creative Figures" Tests allowed to develop and evaluate people's intelligence and creativity by the following 12 psycho-cognitive-ideational factors. We present the test functions, the implementation methods and the strategies of the test based on the problem solving as well as the difficulties in the analysis and the evaluation of the test results.*

Key words: *creativity, intelligence, Hidden Figures, Creative Figures.*

1. Synthesis

This publication is addressed to every scientist and every operator of Human Sciences, Psychology, Education Sciences who are interested on the development of the creativity, of the intelligence and of the psycho-cognitive-ideational processes of the people.

The topics addressed in this publication a want to give a constructive contribute:

- 1) for the researches in the psychological area on the capacities and on the potential of ideation and mental representation of the people;
- 2) to provide precise methodological criteria for the application of the Test and the evaluation of the mental capacities expressed during the realization of the “Hidden Figures” and “Creative Figures” Test;
- 3) to explicit the model and the professional competences that should be owned by who applies ad assess the “Hidden Figures” and “Creative Figures” Test, so those can be understood and developed:
 - the psycho-cognitive-ideational process of the people who realizes the Test,
 - a relational solution between who applies and who realizes the test.

2. The Concepts of Intelligence and Creativity

“Intelligence” shall mean the mental capacity to find satisfying solutions, elaborating information or previously learnt knowledge, in a way to utilize them in different contexts or combining them to shape new solutions or different implementation strategies.

So, the intelligence is not a static element (a fact-finding data) that remains unchanged

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over time, once it was learned, but is a dynamic ability that is utilized depending on the situation, on the type of the topic and of the personal interest. The capacities and the intellectual processes are shaped and are developed based on their function and on the importance that the subject and the society assign to them.

Hence the elaboration and mental interpretation abilities should be continuously reinforced and improved, otherwise they waste away and they are not being used in the daily decisions. For this reason, it is possible to verify that a 5 aged-child can find more genial and original solutions than an adult (than his parent or his teacher too), detecting a major and better use of the intellectual and creative capacities.

“Creativity” shall mean a particular type of reasoning that allows to imagine and to build hypothesis, projects, ideas, understanding and interpretation models about the reality, in a way to customize it depending on the mental universe of the person.

The creativity is expressed by three components combination:

- the formulation of different logic and functional associations regarding the same stimuli, that allows a considerable variation of paths and solutions;
- the creation of new answers (originals or customized) about the task implementation;
- the implementation of a thinking fluidity and flexibility to structure the reasoning.

To make clear and to explain the concept of “creativity” must be distinguish this term from “fantasy” and “imagination”.

The Fantasy is characterized by personal needs and momentary wishes, without a practice utilization finalization; the Fantasy is limited to a expression and internal living needs.

The Imagination is characterized by a well-defined conceptual representation, but that is not necessary utilized in that moment and for that contextual situation; hence the imagination allows to conceive logic solutions that are able to create a satisfying mental project.

The Creativity is a logic structuring of the conceptual representation, that are mental elaborated and implemented into the reality to customized it; thus, the creativity allows to modify the reality depending on the imagine of the mental project created by the person.

The main mental characteristics of the creativity are: the originality, the ideation, the imagination, and the problem-solving ability.

The essential elements of the psycho-cognitive-ideational processes of the Creativity are:

- the global perception,
- the customized intuitions,
- the ideational fluidity and flexibility,
- the multifaceted and plural dimensional vision,
- meta-communicative symbolic expression.

During many centuries, the creativity was conceived as a dysfunction of the cognitive capacities of the people and, as one, it was opposed or excited depending on the cultural model that the person made reference. To date the majority of the cultural groups (exception for the behaviorist, empiricist, rationalist and positivist schools of thought) assigns to the creativity an essential importance to develop the capacities and the personality of the people and the belonged society.

To date, people live in a Technologic-Computerized Society based on the economic-cultural organization more and more complex that requires Technologic-Scientific and socio-humanistic competences more and more high; in this type of society, the creativity

is an essential element to be successful in the work context and to develop an intense and satisfying quality of life for the individual.

Without creativity and social relationship, the individual is inclined to become alienated from the reality, because he cannot succeed to find a sense of its existence and of its daily activities.

For this reason, the evaluation of the creativity, through the psychological Test has become important to understand the intellectual capacities and the personality characteristics of each person.

3. Presentation of the Instruments for the Intelligence and the Creativity

The Intelligence and the Creativity are the mental characteristics that allow to live in a aware and democratic way, to reflect about his own existence, to behave in a logic and original way, to turn the reality to his taste.

- But, what is the Human Intelligence?
- Which are the capacities and the determinants mental processes for the Intelligence?
- How is evolving the Intelligence from the infant to the adult?
- Is the children Intelligence similar to the adult Intelligence?
- Which are the characteristics of the Intelligence in the different development stages of the life?
- Which are the mental abilities and operative procedures implemented?
- Which is the relation between Intelligence and the environmental context?
- And between the Intelligence and the social influence?
- And between the Intelligence and the personality?
- Which are the existing relation between the Intelligence and the Creativity?
- How much and which type of Creativity do the people have?
- How much are the people fluid and flexible in the reasoning?
- How much are the thoughts multifaceted and originals?
- How the ideas are born and how they shape the reasoning?
- Why are any solution elaborated and not others?
- Why are the answers structured in a certain order?

The question above exposed are the problems that the "Hidden Figures" and "Creative Figures" Tests face with the intention to provide a support to the development, to the analysis and to the evaluation of the Intelligence and the Creativity of the people. This would allow to detect the Cognitive Word and the Personality characteristics of each person.

The implementation and the interpretation of the "Hidden Figures" and "Creative Figures" Tests are functional to the psycho-intellectual development of the people in the social context where they live and evolve.

The two Test, "Hidden Figures" and "Creative Figures", are elaborated by myself in the 1978 ©, they are build based on the neuro-psychological model regarding the structure of the mental process and the personality characteristics of the individuals.

The neuro-psychological model of the "Hidden Figures" and "Creative Figures" Test is based on the plurality of Intelligences (different type of intellectual structure), made up activities:

- *plural dimensional* (made up different psycho-cognitive-ideational processes and strategies of reasoning),
- *multiples* (several communicative expressions)
- *contextual* (regarding the social-cultural context, the experience situation and the particular moment of the interpersonal relationship between the subject that realizes the Test and who implements it).

In addition to the plurality of Intelligences, the two Tests allow to have a clear and defined vision about the psycho-cognitive-ideational processes (mental strategies and reasoning structures) and about the intellectual / creative abilities of each individual.

The usefulness to realize and to analyze both Tests is determined by the fact that they take into account:

- the same intellectual / creative abilities,
- by using two opposite and complementary mental process.

Given that the union of the two Test allow to have a complete vision, the obtained results on the “Hidden Figures” and “Creative Figures” Test should be globally considered, as a whole, because only in this way they allow to detect the complexity and the multidimensionality of the Intelligence, of the Creativity and of the various psycho-cognitive-ideational processes of the people.

Both the “Hidden Figures” and “Creative Figures” Tests are structured by the following mental representation:

visual stimuli → *mental ideation* → *representation of images*

The psycho-cognitive-ideational processes activated by the two Test are characterized by the following mental elaboration:

- the psycho-cognitive-ideational processes del Test “Hidden Figures” are characterized by the mental elaboration starting from the representation of images to arrive at the mental ideation (from concrete to abstract activities):

representation of images → *mental elaboration* → *mental ideation*;

- the psycho-cognitive-ideational processes of the “Creative Figures” Test allows to detect the mental elaboration starting from the mental ideation to arrive at the representation of images (from abstract to concrete activities):

mental ideation → *mental elaboration* → *representation of images*.

It is easy to point out that the psycho-cognitive-ideational processes of the two Tests utilize opposite and complementary processes. Globally considering the provided answer of the two Tests is possible identify-develop-analyse-evaluate the psycho-cognitive-ideational processes of the Intelligence / Creativity elaborated through two opposite and complementary processes.

The “Hidden Figures” and “Creative Figures” Tests are psycho-cognitive-ideational instruments that can be utilized in different ways depending on the type of intervention an of the typo of goal that we want to achieve.

To understand the intention with which it can be utilize this instrument and its evaluation potential, must be analyzed the following topics:

- the concept of “Test” implemented in the educative-didactic area;
- the structure of the Test based on the Problem-Solving;
- the application types of the Test;
- the presentation and setting strategies of the Test.

4. The Concept of “Test”

“Test” shall mean a Scientific Test that can be able to evaluate the capacities of the subjects, based on the obtained results and on the social and environmental context control where it is implemented.

As “Scientific Test” shall not mean the achievement of a result obtained by:

- the quantitative measurement,
- a methodological objectivity in the implementation of the Test
- an evaluation certainty.

As “Scientific Test” shall mean the utilization of instruments and of shared methodologies, that document the processes the results allowing to create some scientifically measurable hypothesis based on the measurement of the obtained results and on the indication of the considered variables.

As a result, the experimentation of the formulated hypothesis allows an operative verification that can modify or develop even more the hypothesis to realize a next experimentation ... and so on, in an endless progressive cycle, in which the results need to refute or value the elaborated conceptions based on the daily experiences.

Thus, the scientific merit is not an objective to achieve, but the method (hypothesis-experimentation-verification) with which are implemented the Test.

The scientific merit of the Test is determined by the analysis and by the evaluation of the human relationship, in which is not sufficient a quantitative measurement of the results and of the behavior, but must be verify, at the same time, the socio-environmental influence joined to the psychological and motivational estates of the subject facing and performing the Test.

The scientific merit of a test is characterized by the fact that is based on registered data (written or recorded) of the experience, whoever can verify the analysis and the elaborated evaluations, everywhere, every time (ten or one hundred years later, too). The methodology criteria of the Human Sciences need to cancel spatial and temporal distances by the detection of what is happened in that precise moment and determined place (“here and now”).

The methods and the techniques utilized to implement the “Creative Figures” and “Hidden Figures” Test, as every Human Sciences instruments have two intentions:

- a) to obtain the quantitative and qualitative results, that are comparable and valuable with other people and with the same subject results in different times and ways;
- b) to keep under control the social, contextual and psychological variables, that are developed during the implementation of the Test. So, often, it is enough vary the place, the investigator, the motivation to the Test, the mood of the subject to obtain different results. The control of these variables allows to have the necessary requirements of reliability (loyalty, validity and objectivity) and of predictability of the Test results.

5. The Test Based on the Problem Solving

The “Creative Figures” Test, as the “Hidden Figures” Test, is a scientific proof that evaluates the intellectual and creative capacities of the subjects based on Problem-Solving technique.

Problem-Solving technique is characterized by the following factors:

1. the test is based on the *problem solution*, the data are inserted in a situational context to understand and to conceptually produce;
2. the answer to find includes *several possible solutions*, all are correct both the logic and formal point of view;
3. there are *different didactic procedures* in order to achieve the conceived answer.

Hence, the “Hidden Figures” and “Creative Figures” Tests are not simple didactic exercises having only one exact answer and a only one solution procedure; these Tests are determined by the Problem Solving technique in which is essential the knowledge of the reasoning and the mental strategies elaborated by the subject.

By this type of Test it is not only important and significant the results evaluation (“what he knows”), but the mental and procedural implemented process (“how resolve it” and “how achieve the solution”) too. So, the subject can know many things, but he could not how to use in an appropriate way or he could not remind them in the appropriate time; the knowledge, without the “how to use” the knowledge during the right moment and in the right way tale, becomes an arid data transmission that hinder the development of the Intelligence and of the Creativity.

The “Hidden Figures” and “Creative Figures” Tests are strong psycho-cognitive-ideational instruments and are useful to analyze and to evaluate the Intelligence and the Creativity of the individuals, because they do not stop measuring the knowledge, but they investigate the way to use this knowledge and the way to utilize them during the problem solution too. Hence, during the evaluation of the Intelligence and of the Creativity, it is neglected the maturation of the quantity of the subject knowledge, instead it is highlighted the ability to gather the knowledge in a way to obtain a new and unpredictable solution.

6. The Types of Application of the Test Based on the Problem Solving

The “Hidden Figures” and “Creative Figures” Tests can be implemented in four different ways, depending on the type of goals that we want achieve.

The four implementation types are:

1) collective implementation of the Test with final evaluation of the answers. In this case the Test is predominantly useful for a didactic evaluation, characterized by the analysis and the development of the scholastic activities regarding the graphic-pictorial area, the imagine education, artistic education and the topologic dimension of the geometry. In this view the Test becomes a didactic exercise, that is inserted in the scholastic program of the teacher, in which the mainly goals are a stimulation of the study topics and the analysis of the subjects' focus capacity and visual modeling.

2) individual implementation of the Tests with a collective socialization of the conceived images. In this case the Test is predominantly useful for an educative evaluation, characterized by a clarification and by a collective discussion of the given answers by each subject. The answers allow an extension of the knowledge and of the mental ideation of each individual inside of the group-classroom. In this view, the collective discussion becomes the essential moment of the training and of the spontaneous evolution of the intellectual and creative processes in the thoughts and concepts elaboration and communication. In addition, the discussion series about the subjects' answers and the reasoning allow the use of the Test to organize a didactic path.

That can be able to develop cognitive abilities and imaginative of the individuals; the mainly merit of this didactic path is that, is based on the initial stimulation of the Test, the subjects themselves are the main characters and the authors of their education. The implementation of this educational path allows the evaluation of the subjects' socialization and learning capacities.

3) individual implementation of the Test with a statistic analysis of the results, referred to the social-cultural context. In this case, the Test is predominantly useful for a psycho pedagogical evaluation, characterized by a research to detect the subject ways of the reasoning, the psychological organization of the concepts and the images of the Test. In this view becomes important to take into account:

- the observation of the subject's behavior and the listening of the verbal communication
- the structured interview between the subject and the investigator;
- the comparison between the subject's results and the results in the socio-cultural context where the subject lives.

The detection and the analysis of this information allow highlighting the subject's cognitive and the personality styles and the operative strategies. This analysis allows to conceive the psycho pedagogical hypothesis and to build the educational intervention adequate to the needs type and the cognitive and relational characteristics of each individual.

Moreover, the Test allows:

- to discriminate the complexity and the extension levels of the reasoning and of the psychological autonomy of the individual;
- to detect the limits and the intellectual potential of each subject.

4) individual implementation of the Test with a analysis referred to the subject's personality structure. In this case the Test is predominantly useful for a psycho diagnostic evaluation, characterized by the knowledge needs to know the mental and the psychological structures and the subject's operative procedures.

The psycho pedagogical analysis allows to detect in a more correct way, to act with an individual, hence is useful to know "how" to intervene and which type of cognitive and the personality styles and the operative strategies should be adopted to support the subject's learning and socialization capacities. The psycho diagnostic analysis allows to know "because" is useful to act in that determinate way, so it is useful to know the causes and the deep motivations of each subject's mental universe. That allows empathizing with the psychic characteristics and with the intellectual abilities of the individual. In this view, the investigator can highlight the possible psycho-mental transformations and, if there is the need, is able to plan the modification of the dysfunctions and of the disharmonies in the subject's way to reason and to act.

Finally, the "Hidden Figures" and "Creative Figures" Tests, as every Test based on the Problem-Solving, can be four different functions:

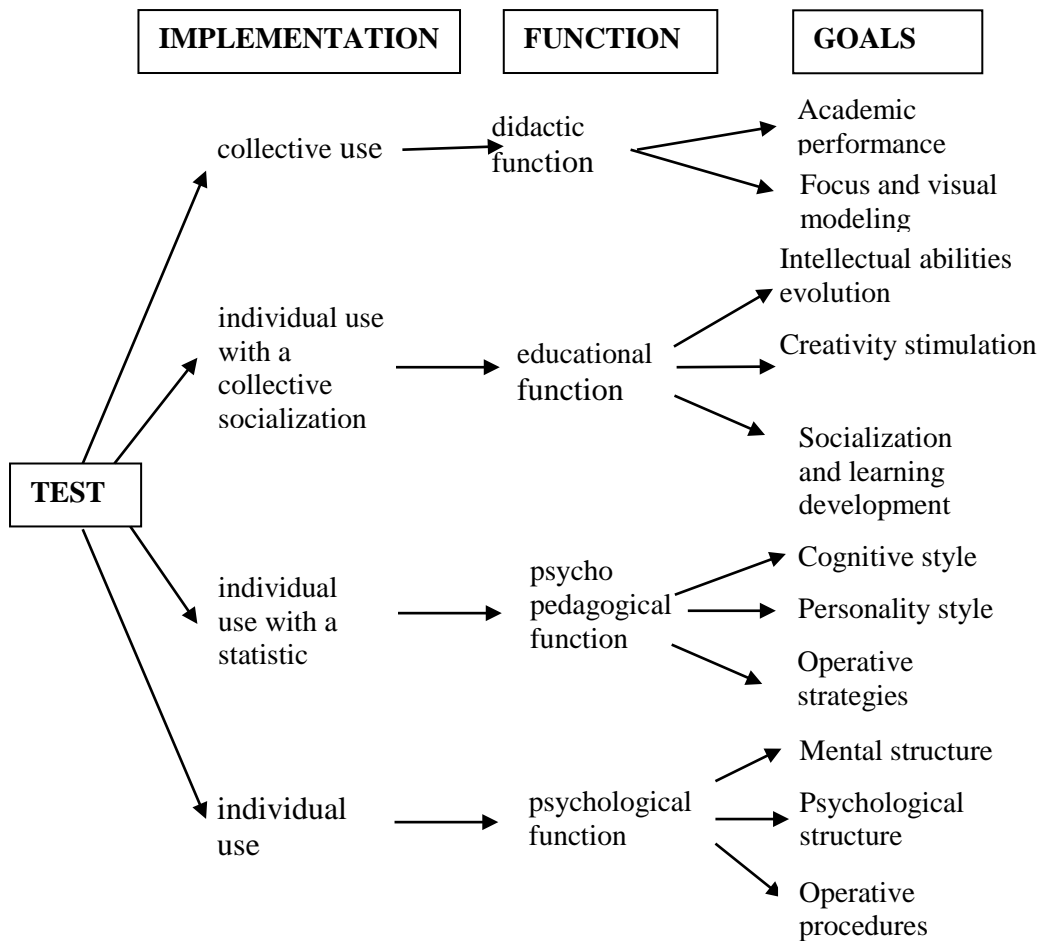
- *didactic function*, for which the Test become a scholastic exercise that allows an evaluation about the cognitive performance, about the attention and about the visual memorization of the subject;
- *educational function*, for which the Test become a scholastic itinerary for the development of the Intelligence and the Creativity and for the evaluation of the socialization and the learning capacities of the subjects;
- *psycho-pedagogical function*, for which the Test become an evaluation test of the cognitive stiles, of the personality stiles and of the operative strategies of each subject, about the potential of intellectual and creative development;

- *psychological function*, for which the Test become an instrument of analysis of the mental-psychological-operative abilities of each individual, about his personality structure and his Mental Universe.

Based on the goal that we want to achieve, the Test is implemented following the methodology and evaluation criteria of one of the aforementioned functions, in a way to obtain a valid, efficacy and significant:

- didactic analysis,
- educational analysis,
- psycho pedagogical analysis,
- psychological analysis.

Summary scheme



7. The Presentation Strategies of the Test Based on the Problem Solving

Generally, before the Tests implementation, the need to introduce this instrument occurs, both to the subject and to the social context where we operate.

Often, the moment of the Tests presentation is overlooked or considered unimportant, instead that influences in a considerable way the Test implementation, because the

motivations and the individual and social expectations are conceived in this moment and they affect the subject's reasoning types and the answer choices

Regarding the Tests presentation must be separate two times: the moment of the presentation to the social context and the moment of the Test implementation to the subjects.

For example, in the scholastic context, it is essential the detection as the Test is introduced to the manager, to the boarding school, to the parents and to the Institutional Bodies. Later, it is essential to analyze as the Test is introduced to the classroom teachers, to the classroom students and to each subject. That determinates the socio-educational relationship created around the Test implementation, characterized by the expectations and by the needs of the social context and by the personality structure of each individual.

At the same time, must be to verify if there are discrepancies between how the Test is introduced and how is perceived by the social context and by subjects investigated.

For example, the perceptions discrepancies of the Test between the parents and the teachers, or between the manager and the investigator, or between the students and the teachers, can create conflicts, often no explicit, that hinder a peaceful and harmonic Test implementation and that affect the final results.

So, must be analyze how the Test is perceived by the school world, by the classroom and by each student and must be compare if this perception matches with the imagine given by the investigator.

The type of perception and of imagine that the Test assumes into the social context characterizes the validity and the significance levels assigned to it, hence, how the instrument is recognized and supported by the social context.

A positive or negative influence of the Test affects the implementation climate and the obtained results.

While the implementation methodology criteria of the "Creative Figures" Test are strictly determined and they cannot be changed, the Test presentation is adaptable depending on the socio-context needs and on the personalities style of the investigator.

The "Creative Figures" and "Hidden Figures" Test can be introduced to the social context and to the subjects with one of the following strategies as:

- a) an *Intelligence game*, where the subject can provide any answer because the main characteristic is the pleasure to do and the joy to imagine;
- b) a *didactic activity*, based on the logic capacities, on the ideation and on the invention of images;
- c) an *evaluation test*, of the academic performance, where the cognitive and creative capacities of the subject will be verified based on the results.

Regarding the type of adopted strategy is possible analyze and evaluate the expressed or not expressed psychological anxiety by the subject; indeed if the psychological anxiety:

- is managed by the subject, is useful to support and develop solutions and creative concepts, realizing to the best of its capacities. Generally, in this case the subject does show competitive, stimulated, participated and interested;
- is not perceived, the subject gives the essential answer to the Test realization, without a stimulation to improve or to answer in a complex or original way. In general, in this case the subject does show indifferent, determined, peaceful but no interactive;
- dominates the subject's thoughts, so it affects and clouds the intellectual and creative abilities during the Test resolution. In general, in this case the subject does show unsure, fearful, undecided and hesitant.

Each of these strategies can be opportune depending on social context and on the subject to which the Test is implemented.

Utilizing the “Intelligence game” strategy, we obtain that some subjects are stimulated, others indifferent, others fearful; utilizing the “evaluation test” strategy many subjects will be stimulated and will change the indifferent and the fearful subjects. The really important fact is that the presentation will be described in a detailed and complete way to have a created climate vision and the reactions in the social context; that allows to carry out an analysis and a scientifically significant evaluation.

During the Test presentation it is important to describe exactly:

- the educational context and, for example, if the investigator knows or not the subject;
- the relationship between the investigator and the subject, focusing on the behavior, the verbal Communication and the provision around the table;
- the environment where the Test is implemented and the path that the subject has to make to reach the place where the Test will be implemented;
- the subject's motivation with which he starts the Test and the type of interest showed in the realization.

The environment where the Test is carried out affects the implementation and the obtained results.

It is essential to describe the relationship between the investigator and the subject before the Test starting too; for example, if the investigator accompanies the subject to the place where the Test will be implemented, what the subject says while is sitting, how the investigator proposes the Test.

Moreover, it is important to detect if the task to carry out during the Test is lived as easy or difficult, as pleasant or bored, as liberating and funny respect to the scholastic activities or as a didactic control by the subject. If the subject expresses the feeling that the Test it is easy or simple for him, the investigator could intervene stimulating: “if it is easy, is better for you, you will provide many answers”. If the subject expresses the feeling that the Test it is difficult or complex for him, the investigator could affirm: “do not worry, think to provide some answers only ... you will enjoy it”. In the majority of the experiences it is highlighted that the Test was pleasant and stimulating, indeed, often, the subjects ask to do it again or to performer others.

The Test could be perceived in unpleasant way if, during the implementation, the investigator is feeling unsure or not adequate to the task. The Test could be perceived in unpleasant, also, when the subject is afraid to be evaluated in a cold and detached way; In this case the investigator must success to make him comfortable. Often, the difficulties of acceptance of this type of Test depending on the subject's psychological problems.

The Test is not valid:

- if the investigator does not carefully follow the methodology criteria, explained in the next chapter. It is enough reverse the questions, provide involuntary suggestions or modify the way to provide the question, that is not possible to carry out an analysis and a scientific significance evaluation;
- if the subject is informed on how to answer to the Test or it knows some solutions because he has already heard them by the contemporaries or by others, before the test; In this case It is sufficient go a week to perform the Test.

It must demand to the subjects that have already performed the Test to not provide information to the others, they can express feelings or judgments (for example, it is funny, tiring, easy, nice ...) at most.

The interpretation and the evaluation of the “Creative Figures” Test is based on:

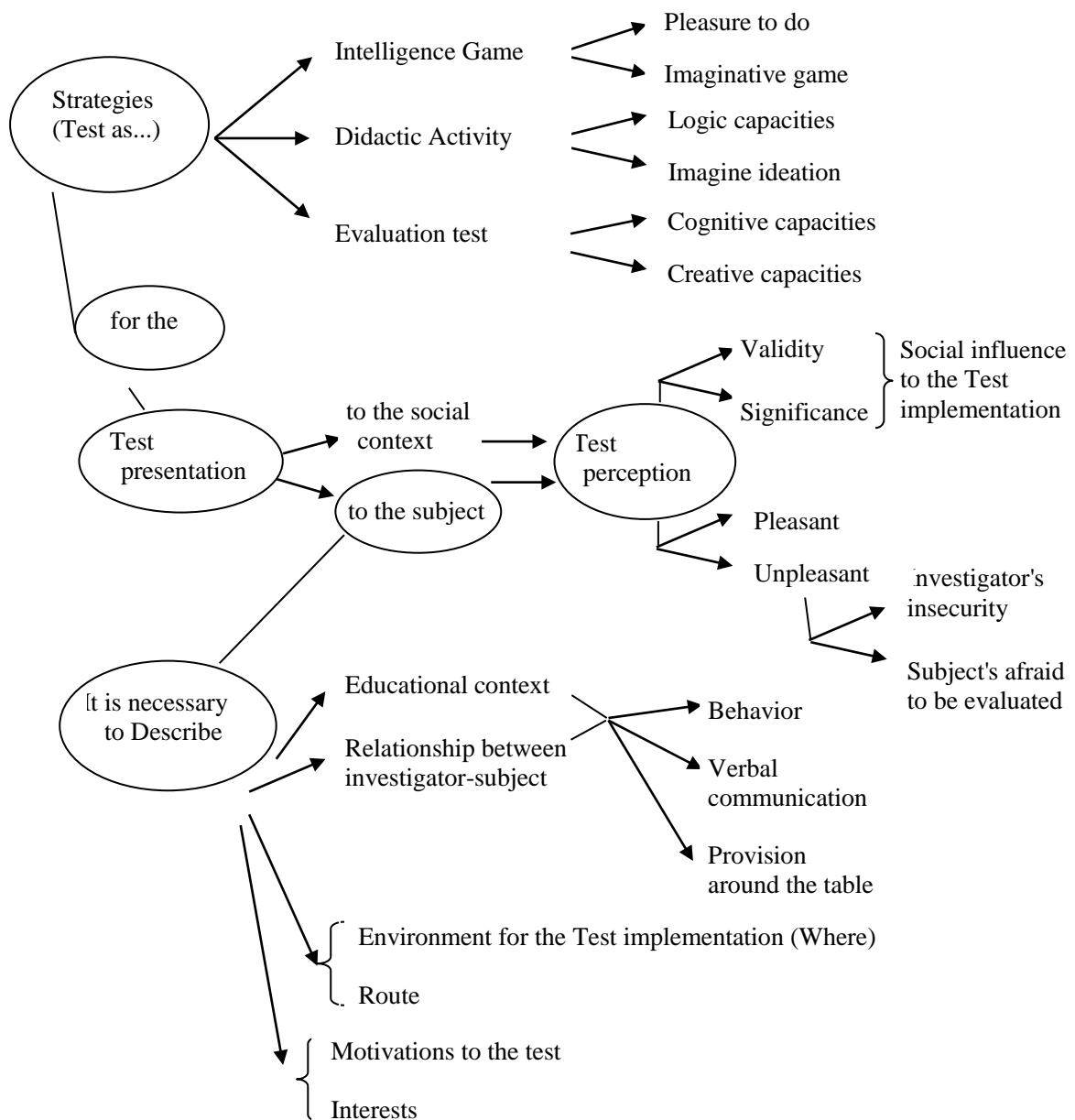
- a) the general analysis of the answers of each subject;
- b) the analysis of each single figure created by each subject;
- c) the statistic tabulation of the recognized images;
- d) the tabulation and the analysis of the educational relationship and of the achieved results during the Test implementation.

The tabulation and the analysis of the results of each Test to have a significant and a scientific validity, must be referred:

- to the social context where we operate;
- to the cultural level and the educational stimulation where the subject perform;
- to the chronologic age of the subject.

Comparing the obtained results by the subject with the others obtained by the individual with the same socio-cultural-chronologic characteristics, it is possible to know the level of intellectual and creative development of the subject, so, taking a picture about his mental level and his evolutionary potential.

Summary scheme



The difficulties in the analysis and in the evaluation of the “Creative Figures” Test, which the interpretative criteria are similar to the “Hidden Figures” Test, is characterized by the fact that the considered activity is based on the Problem-Solving that can have different and multifaceted answers, structured on different ways, that make unique and personalized the implementation of the Test and the development of the subject's reasoning.

Hence, in each Test a new and original result is obtained about the:

- achieved solutions;
- adopted processes;
- the context where is implemented (the influence of the investigator, of the place, of the moment which is implemented and how is lived by the subject).

The uniqueness of the Test implementation, each time that is implemented, allows to put into perspective and to compare the acquired results with other test and repeating the same Test later. That allows detecting moment (the “carpe diem”) of the subject's intellectual and creative capacities, linking the various results among them.

8. Intelligence and Creativity Factors

The “Hidden Figures” and “Creative Figures” Tests allow developing and evaluating the people's intelligence and the creativity by the following 12 psycho-cognitive-ideational factors. The 12 factors identify three different types of intelligence: 1) rational-constructive intelligence factors; 2) creative-generated intelligence factors; 3) communicative-expressive intelligence factors.

1. Rational-constructive intelligence

The development of the rational-constructive intelligence could be identified and developed by the strengthen of the obtained results in the following psycho-cognitive-ideational factors:

- factor no 1: *the perceptive structure and the quality of the conceived answers,*
- factor no 2: *the spatial sequence and the visual modeling,*
- factor no 3: *the complexity of the reasoning,*
- factor no 4: *the mental coordination abilities and the global vision*

2. Creative-generated intelligence

The development of the creative-generated intelligence could be identified and developed by the strengthen of the obtained results in the following psycho-cognitive-ideational factors:

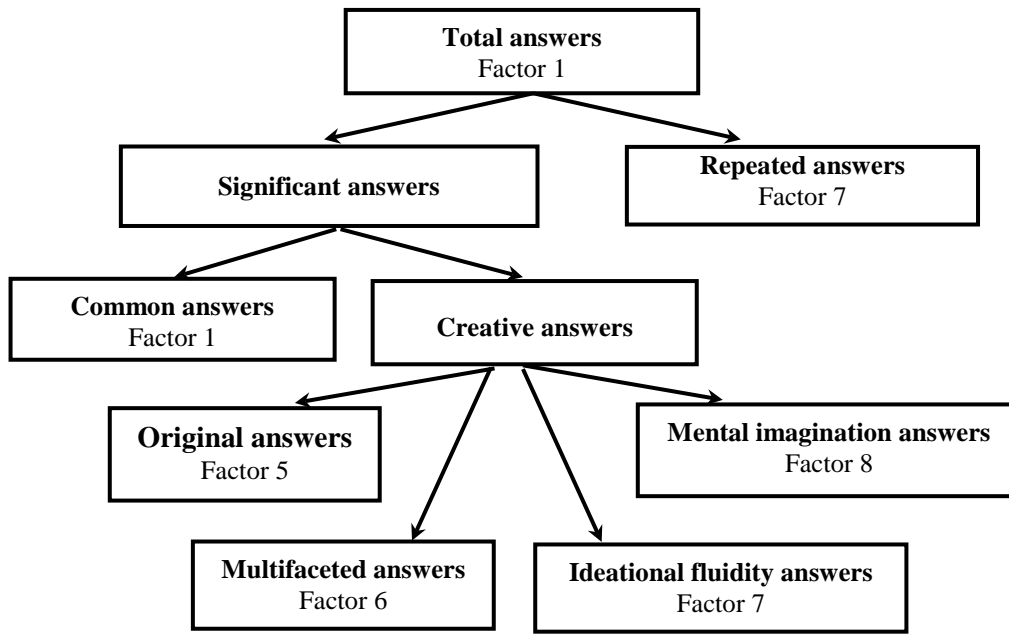
- factor no 5: *the original creative abilities,*
- factor no 6: *the multifaceted creative abilities,*
- factor no 7: *the fluidity of the solution conception,*
- factor no 8: *the mental imagination abilities.*

3. Communicative-expressive intelligence

The development of the communicative-expressed intelligence could be identified and developed by the strengthen of the obtained results in the following psycho-cognitive-ideational factors:

- factor no 9: *the communication structuring competences,*
- factor no 10: *the communicative conception abilities,*
- factor no 11: *linguistic competences,*
- factor no 12: *the communicative and meta-communicative expression abilities.*

Analysis of the creative-generated intelligence



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