University "Al. I. Cuza" from Iasi
Faculty of Psychology and Educational Sciences

Summary of Thesis

Strategies and teaching methods for stimulate creativity by teaching mathematics

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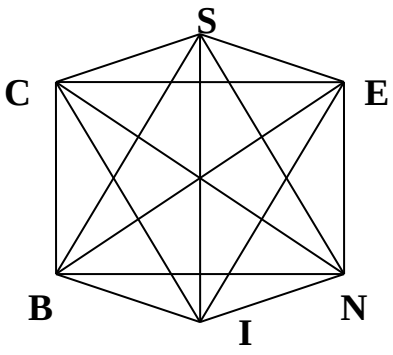
CONTENTS

Summary

Conceptual

Following one of the modern trends in the systematic analysis of reality, namely semiological approach, we started from the definition of creativity situation hexada, structured



in six poles, identified by "B"- biological structure, "I"- intellectual factors, "N"- non-intellectual factors, "E"- education, "S"-socio-economic, "C"-spiritual and material culture. We chose this model of analysis, since it has the advantage of complexity and suggestive characteristic, encompassing creative foundation dyad (BN), triad talent (BIN), tetrad creative action (BINE) and pentad creative approach (BINES).

In this paper, we define creativity (**G. Allport**, 1937) as a multidimensional construct teachable (**S. Odobleja**, 1982, p. 562), resulting from the interaction of six interrelated fields, which are the determinations of the creative process. I believe

that every interactions are time dependent, which means that they are unrepeatable, unique, resulting an occurring creative product. The vectorial analysis of biological structural dimension, that occurs in determining the creative process, reveals that biological factors is the primary matrix that allows only certain further developments depending on her stored changes, who are operated by the other determinations and their interactions active at a time. The vectorial analysis of the intellectual dimension of creativity process reveals that operational-cognitive factors, cognitive style factors, learning style factors (**M. Zlate**, 2001), communication style factors (**H. Gardner**, 1953), thinking style factors (**J. Klein**,1951) are anentropics vectors that crystallizes information received after the pattern generated by the interaction of bio-psycho-structural and socio-cultural-educational moment. The vectorial analysis of the non-intellectual dimension of the creative process reveals that non-intellectual factors (values, attitudes, interests and beliefs, personality factors and motivational, affective or behavioral, and ability to use the full range of personality dimensions) is the engine that employs holistic personality in the creative process. The vectorial analysis of social contextual dimension that occurs in determining the creative process reveals that environmental factors are the catalyst that promotes the escapist creative process. The vectorial

analysis of the cultural dimension of contextual type that occurs in determining the creative process reveals that the cultural factors represent the generating vectors, a matrix (which is in constant metamorphosis by contextual influences and ingredients of the moment) that generates the main coordinates of the creative process. Material culture and spiritual influences decisive the creative process by designate the selection nature made in existing information fields, remanented over time.The vectorial analysis of the contextual dimension type that occurs in determining educational creative process reveals that educational factors are vectors modelers who finished the main coordinates of the creative process.

Mathematical creativity is a multifactorial determined construct, which is a particular case of logic creativity whose scope is the sphere of mathematic problems.

Resolvent style Was deduced experimentally the relatively stable nature of how a person reacts to problem solving (**P. Golu**, 2002). Resolvent style represents the specifically approach that a person retroacts intellectually to problems. Solving problems is a complex cognitive activity multifactorial determined by the learning style (**M. Zlate**, 2001), the communication style (**H. Gardner**, 1953), the thinking style (**J. Klein**, 1951), the cognitive style (**S. Ball, I. R. Davitz**, 1978) and the affective-behavioral style. Corroborating these data, I

detected three types of resolution styles: empiric style, algorithmic style and heuristics style. This classification is achieved in terms of a multidimensional criterion (how to address each step in solving a problem, the creative problem solving techniques, the problem solving type). It is noted that a person addresses the most common problems using the resolvent own style but, depending on the strategy adopted successfully to solve the task, the predominant style can be combined with other styles resolution.

The empiric style is characterized by a superficial decoding, without reporting the significant relations between information who are needed to establish the solution. The solution is often abortive (evading essential information for the correct solution) or incorrect (containing incorrect information specific assumptions axiomatic system problem). The modeling of the mathematical language is deficient or wrong. Additionally, the construction of the resolution is incongruously reasoning, because the solving type is risky or impulsive, that means the process of inferring is prevailing over the process of control. Finally, the reflection is inadequately, because there are no justification for the inferences made and no tendency to generalization of the method of finding the solution.

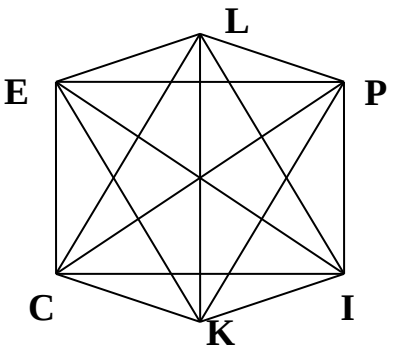
Algorithmic style is characterized by an information decoding broadly correct but incomplete, noticing the significant

relationships between information necessary to determine the solution. The modeling of information from text problem in mathematical language is minimalistic and the resolvent construction is mainly algorithmic reasoning. Additionally, the solving type is inertly or prudently, because the process of control is prevailing over the process of inferring. The reflection is convergent, with standard justification of inferences made and trends to transfer settlement method in similar cases. Such resolvent style promotes creative solving techniques that maintain paradigms and offers solutions in the immediate vicinity of the problem, without significant changes.

The heuristic style is characterized through a correct decoding, an appreciating complete solution for establishing significant relationships, a mathematical modeling language based on content problem formalization, an using abstract symbols, mainly resolvent construction heuristic reasoning, solving actual balanced type. Additionally, there is a fine balance between process of inferring and process of control, reflecting divergent inferences with complex justifications made and tendencies to generalize and transfer appropriate method of resolving cases. Such resolvent style promotes creative solving techniques that expand or destroy paradigms and produce truly innovative ideas.

Taxonomy mathematical creativity

By analogy with the hexadic model of the creative situation, we have structured a model of ***eurema*** (derivative from the Greek: *eu+rhema* which means *utterance good*),involved in the creative



mathematical situation. In this model, "L" is the ***accumulation and comprehension of information eureme*** ("L" derivative from the Greek "*logomnem*" *mneme*, which is signified *precise imagery*). "E" is the ***associative combinatorial eureme*** ("E" derivative from the Greek "*euritema*" from *heuriskein+rhema* which is signified *intelligent fantasy*). "C" is the ***energetic-stimulation eureme*** ("C" derivative from the Greek "*conatema*", which is signified *conative fiction*). "K" is the ***critical eureme*** ("K" derivative from the Greek "*criterion"*, which is signifies *analytical imagination*). "I" is the ***perceptive ideation eureme*** ("I" derivative from the Greek "*idea"*, which is

signifies *ideation vision*).“P” is the ***objectification image eureme*** (“P” derivative from the Greek “*praxi”*, which is signifies *pragmatic innovation*).

L-creative student (know) has a well represented cognitive background, with better capacity for understanding and retention, with the information structured on the declarative level (knowing what to do) and procedural level (knowing how). Functionally, his creative capacity is reduced to the sphere of accumulation and comprehension eureme, because he can solve only reproductive problems, belonging to type replicative teaching contexts.

E-creative student (imagine) has a smart fantasy, without extensive field knowledge operator, but he is able to imagine, anticipate, combine to make novel connections between simple representations, ideas or concepts related; functionally, his creative capacity is reduced to associative combinatorial eureme, because he can solve heuristic problems, belonging to type associative learning contexts.

C-creative student (determined) wants to be creative and rules monitoring and self-regulating systems, that generate self-efficacy in resolution activities; functionally, his creative capacity is reduced to the creative energetic-stimulation eureme, with only motivational efficiency, based on an empirical resolvent style, practiced in applied learning contexts.

K-creative student (analyze) has an analytic perceptual style, appreciating relevant depths of the content, and structuring the information on strategic level; functionally, his creative capacity is reduced to critical eureme field and can solve problems demo-explanatory type, having a resolvent style algorithms, applied in educational contexts replicative type, related to registry symbolic knowledge representation.

I-creative student (view) have divergent thinking, which involves all components of perceptual or ideation, being able to make some associations between related knowledge; but functionally, his capacity creative is reduced to perceptive ideation eurema, because he can solve heuristic type problems, applied in contexts of associative learning.

P-creative student (apply) is action-oriented, to the praxiological size, to the pragmatic side of problems, with type procedural knowledge that capitalizes on educational contexts applicative type; but functionally, his creative capacity is reduced to the sphere of objectification image eureme.

Investigative approach

The purpose of this investigative approach is to determine how student originality is dependent on his resolvent style; to see how his cognitive background, self-efficacy in mathematical problem solving and metacognition, handled by creative teaching approaches, influences each other.

In addition, the purpose is to demonstrate that the operationalization of the didactic demarche to teaching mathematics, involved in the education of the mathematical creativity, stimulates general creativity student. Finally, the purpose is to determine the extend which the creative learning restructures the student's pre-existing resolvent style, enabling high scores to general and mathematical creativity.

Research hypotheses:

1. Originality of creativity learner is dependent on his resolvent style, *id est:*

a)A predominantly empirical resolvent style can develop maximum expressive level of creativity (free play of the mind).

b)A predominantly algorithmic resolvent style can develop a maximum production level of creativity (free play of the mind limited, but the technique improves).

c)A predominantly heuristic resolvent style can develop a maximum inventive level of creativity (it perceives new relationships between previously separate elements).

2. Highly creative people are receptive to suggestions. People with cognitive extensive background are more responsive to suggestions.

3. Students receptive to suggestions are more self-efficacy.

4. Evolved cognitive background develops high levels of self-efficacy.

5. Steps operationalization of didactic demarche configured on the modern creative methodologies for teaching mathematics has the effect in the development of general creativity.

6. Steps operationalization of didactic demarche configured on the modern creative methodologies for teaching mathematics has the effect in the development of mathematical creativity.

During that educational investigation, the ***experiment*** is divided into three measurements (test of general creativity, test of mathematical creativity, questionnaire for establishing the self-efficacy and the responsiveness to metacognitive suggestions). The experimental tools are the following: Test battery for creative thinking, developed by prof. dr. **A. Stoica Constantin** and prof. dr. **M. Caluschi** (2005) (Appendix 1); Creative thinking mathematics test (Appendix 2); Mathematical creativity education program; Questionnaire to determine the self-efficacy and the responsiveness to metacognitive suggestions (Appendix 3); Protocol establishing the construct validity of mathematical creativity test, by **Evans** technique (Appendix 4), Results of the tests (Appendix 11).

The experimental design was conceived diachronically, since November 2010 to June 2011, and it focused on initial and final testing of experimental and control groups, and initiating the experimental group in creative activities with resolution character. Mathematical creativity education program is totaled

22 lessons focused on the foster of creativity and on the managing of a creation and noologic knowledge favorable microclimate. Also in the experiment was designed and was tested a special tool, named diagnostic teaching test, which was prepared according to the methodology developed by **G. Evans** in 1985, **L. Crocker, J. Algina**, in 1986, that **I. Radu**, in 2000, aiming to diagnose the development level of creative thinking qualities. In context of this research, detecting the resolutiv style has achieved scoring solving problems of mathematical creativity tests battery. Battery (time limit 90 minutes) consists of 15 problems (each solution can receive between 0 and 3 points, depending on the intuition of the elements that serve completely solve the problem).

Statistical analysis was applied to the research hypotheses and found that the first research hypothesis (***Originality of creativity learner is dependent on his resolvent style***) is validated sequence. The novelty of the study lies in demonstrating the level of interdependence between resolvent style and creativity levels. Thus, the investigation targeted on categories of resolutive style, show that empirically resolvent style can develop a maximum production level of creativity, with significant opportunities to achieve expressive level of creativity, which supports sequential research hypothesis.

Assumption of research on algorithmic resolvent style would be reconsidered from the following perspective: algorithmic resolvent style can develop inventive maximum level of creativity, with significant opportunities to achieve production levels of creativity. Histogram analysis shows again the direct dependence of the background and creativity level, meaning that a background better represented has results in restructuring the configuration, in which are proportionate the levels of creativity. Namely, in terms of an algorithmic resolvent style, the chances that the creativity reach the productive level threshold (if the first test is the productive represented in proportion of 16.96%, in the second test, the production is currently at a rate of 29.68%, so a percentage increase of about 10 percent). The research hypothesis concerning heuristic resolvent style is confirmed.

Both the first test, and the second shows that the peak of creativity is the inventive (the percentages being 45.45% and 52.63%). The second hypothesis is fully supported (albeit minor statistical correlation Pearson coefficient is below 0.5 bidirectional p, percentage histogram shows that the inventive creativity develops a greater receptivity to suggestion, at a rate of 57.14%). The third hypothesis was not statistically verified. But, a multiple regression analysis step by step showed positive dependence, statistically significant, between receptivity to suggestion and gender (55.75% of girls are more receptive to

suggestions than 43.33% of boys), and between receptivity to suggestions and background. The fourth research hypothesis is medium supported by statistical analysis performed (correlation coefficient Spearman's rho is set to bidirectional equal to ρ = 0.467 being statistically significant at 0.01 level). The fifth hypothesis is supported by statistical analysis (**Pearson**'s correlation coefficient has value 0.493, significance below 0.01). The correlation is minor, since neither of the cognitive background value, obtained by participating on the creative program, was not significantly increased. The sixth research hypothesis is medium supported by statistical analysis (**Pearson**'s correlation coefficient has value 0.487, significance below 0.01).

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