Creative and Critical Thinking in the Context of Problem Finding and Problem Solving: A Research Among Students in Primary School

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Abstract
In the present research we are studying (on a sample of 153 students 6th grade) the relationship between the two forms of thinking: critical and creative, in the context of problem finding and problem solving situations. Our hypothesis is that when there is a change in the context of study (problem solving- problem finding), then the students' creative and critical way of thinking is differentiated, but these differentiations are not independent (statistically) between them. The results of this research reinforce those educational methods where thinking is cultivated holistically and is measured in terms of expression during particular learning experiences and not in terms of constant capacities.

Keywords: Creative thinking, critical thinking, problem finding, problem solving

1 Introduction

The sciences studying thinking in the educational field focus mainly on the development of critical thinking and less on cultivating creative thinking. The fact that scientific research distinguishes between these two levels, leads to the hypothesis that these are two different kinds of thinking or two kinds of thinking which demand different intellectual and therefore brain processes. However, a number of scientists consider that these two kinds of thinking should be studied either as parallel levels, or complementary, or even not distinct fields of thinking (Paul, 1993, Perkins, 2000, Runco, 1994a).

   Instructional programmes drafted for the field of education usually aim at one or the other kind of thinking, or, at best, include parallel instructional performances which cultivate both kinds: in any case, the instructional experience which develops critical thinking is differentiated from that which fosters creativity (Hudgins & Edelman, 1986, Kagan, 1988, Nickerson, 1981, Yang & Lin, 2004). This is derived by the distinct methodological theoretical approach for each kind of thinking, where both critical and creative thinking are analyzed in the separate cognitive functions constituting each one of them (Norris & Ennis, 1989, Paul, 1993). The result of this methodological approach is that no common fields seem to exist, on a research and an empirical level, between these two forms of thinking, no matter how they are defined.

   These last few years however, it becomes more and more evident that the distinction between the aforementioned forms of thinking is a methodologically artificial distinction (Marzano, 1998, Paul, 1993, Perkins, Jay & Tishman, 1993) rather than a real one on the level of intellectual brain functions. More holistic approaches of thinking pave the way to new educational programmes which do not aim at many different functions of one kind of thinking but exercise students' thinking in a holistic manner in different contexts and different kinds of instructional stimuli and experience (Bleedorn, 1993, Perkins, Tishman, Ritchhart, Donis & Andrade, 2000, Sternberg, 1997). The center of gravity seems to move from the artificial exercise of various intellectual functions to the authentic use of any intellectual functions in

different learning contexts with multiple demands and using multiple dispositions both as regards the content and the tools.

2 Objective – hypothesis and methodology of research

2.1 Objective

The objective of the present research is to study the relationship between the two forms of thinking, that is, critical and creative thinking. It will be conducted according to the different methodological approaches for each category of thinking separately. Both creative and critical thinking are studied in the context of problem finding and problem solving. The questions of the present research, coming from our daily contact with students both as teachers and researchers, are as follows:

We know from literature that the cognitive processes of creative and critical thinking are distinct. However, they present correlations, when the context of thinking demands changes from finding to solving. We wonder therefore whether we are not dealing with only partial functions of thinking which by themselves are not enough to describe the thinking phenomenon.

Thus, the objective of the present research, originating in our research questions, is to confirm of reject the working hypotheses, presented as follows:

A) The various intellectual processes assessed and attributed to each kind of thinking (creative – critical) are distinct processes corresponding to different intellectual functions [faculties] but not independent between them.

B) When there is a change in the context of study of creative and critical thinking – problem finding, problem solving – then the students' performances are differentiated, but these differentiations are not independent (statistically) between them

2.2 Sample

153 students (75 boys and 78 girls) in the 6th grade from 6 different elementary schools participated in the research (3 schools in Athens and 3 schools in the province). The total number of students in the 10 classes participating in the research was 188, but 35 students were not included, either because they were absent (26 of them) at some stage of the research, or because their participation (of the other 9) was deemed by their teachers and the researchers inadequate or not valid in relation to the conditions of the research (these students didn't follow the guidelines). These 35 students were evenly distributed in all 6 schools, so there was no impact on the results.

2.3 Procedure

The students were given a passage from an ancient Greek myth unknown to them, but the beginning and the end of the myth were not given and no one could infer that it was a myth. The plot in this passage was not clear: the problem was missing, as well as its cause, the characters were not clear either and the events were hovering between reality and imagination. And of course, the end, the solution was also missing. The students were asked:

1st PFCreative (problem finding – creative thinking) to formulate any questions they wished in order to understand what was going on in the passage.

2nd PFCritical (problem finding – critical thinking) to write afterwards their own scenario that could precede the passage and explain what was described in the latter.

The following day, the students were given the first part of the myth revealing the original story, without however revealing the end, the solution. Then the students were asked to:

3rd PSCreative (problem solving – creative thinking) to write as many original ideas they could on a possible ending of the story.

4th PSCritical (problem solving – critical thinking) to select and develop in writing their own original ending of the story.

The tasks of the first day incited the students to think about possible eventualities in an unclear situation and to thus identify elements of the problem (problem finding), whereas the tasks of the second day asked the students to provide solutions (problem solving) in the story. Each day's first task was graded based on the dimensions of divergent thinking, fluency, flexibility and originality, whereas the second tasks were graded based on the criteria of critical thinking.

2.4   Data collection means

2.4.1   Grading techniques

The two 'Creative' tasks (1st and 3rd) with the open-ended questions were graded regarding their fluency, flexibility and originality as suggested by Torrance in the Test of Creative Thinking – T.T.C.T. Each different idea received a grade for fluency, each idea from a new category received a grade for flexibility, and finally each idea given by 1 to 6 students received a grade for originality. These three cognitive dimensions of creative thinking have been used extensively in research for assessing creativity, and although they are not identified with creative thinking, they constitute basic indicators of it (Fishkin & Johnson, 1998, Mouchiroud & Lubart, 2001, Puccio & Murdock, 1999, Runco, 1994b). Based on these three dimensions a total creative expression indicator was calculated. .

2.4.2   Categories of critical thinking

The other two 'Critical' tasks (2nd and 4th) were graded based on 8 characteristics of critical thinking as defined by Ennis (1993, 1996), adapted accordingly for the demands of the present research. More specifically, the following characteristics – categories of critical thinking were identified in the students' written texts:

1. To seek a clear statement of the thesis or question. The character's actions (verbs). The actions repeated were recorded once.
2. To seek reasons: Sentences, phrases or statements that justify a person's actions (usually causative clauses or explicative ones with a causative nature).
3. To try to be well informed - Information within the context of reference: The words certifying that the author takes into account the information provided in the text as a reason and uses it to shape either the beginning of the scenario or the solution to it.
4. To try to be well informed - Information outside the context of reference: Words showing that the author uses additional information material (words – phrases) not mentioned in the text, but uses them in a productive manner (either to shape the beginning or the end of the scenario).
5. To use credible sources and mention them: Data pertaining to the shaping of the scenario were identified here (structure).
6. Relevance: Solution oriented to the myth-to the social convention: Total number of meanings referring to the means the problem is formulated or solved.
7. To seek as much precision as the subject permits: (accuracy) Proper exploitation of the information leading to the solution.
8. Open mind: Total number of sentences referring to the means of solving the problem. When this is outside the context of the myth or in general outside commonly accepted conventions it is classified into independent sub-categories.
9. Logical sequence: Search for a logical sequence in the structure of the text.
10. Respect of others: Sentences denoting that the author takes into account his public.

The check for regularity of the distributions showed that three out of these (open mind, logical sequence and respect of others) should have been excluded from the research because their distributions did not satisfy the demands for valid further statistical analysis. There were very few differences between the students' answers according to the histograms of frequencies. This exclusion didn't affect the results because we didn't unify the categories in order to compute a total critical thinking indicator.

3 Results

3.1 Critical and creative thinking.

The correlations (Spearman's rho) between the subjects' performance as regards the dimensions of creative thinking and critical thinking are presented in Table 1.

Table 1. Correlations between **Critical** and **Creative** thinking variables

		PF Problem Finding				PS Problem Solving			
Spearman's rho		Fluency	Flexibility	Originality	Creativity total index	Fluency	Flexibility	Originality	Creativity total index
PF Problem Finding	Clear statement	**.002**	**.143**	**-.010**	**.040**	.149	.111	.187*	.212**
	Seeking reasons	**.124**	**.094**	**.078**	**.114**	.210**	.242**	.065	.180*
	Meaningful information within the context	**.188***	**.230****	**.072**	**.189***	.225**	.012	.096	.159*
	Meaningful information outside the context	**.255****	**.351****	**.210****	**.308****	.324**	.240**	.278**	.337**
	Structure	**.183***	**.230****	**.142**	**.220****	.298**	.173*	.184*	.285**
	Relevance	**.203***	**.255****	**.189***	**.256****	.372**	.290**	.235**	.374**
	Accuracy	**.004**	**.116**	**.006**	**.039**	.112	.018	.068	.114
PS Problem Solving	Clear statement	.044	.107	.142	.116	**.038**	**.013**	**-.079**	**-.018**
	Seeking reasons	-.028	-.002	-.162*	-.068	**.241****	**.092**	**.104**	**.199***
	Meaningful information within the context	.072	.125	.120	.120	**.336****	**.236****	**.147**	**.273****
	Meaningful information outside the context	.118	.102	.035	.104	**.315****	**.214****	**.123**	**.234****
	Structure	.19*	.258**	.158	.244**	**.306****	**.339****	**.224****	**.342****
	Relevance	.085	.148	-.002	.095	**.185***	**.104**	**.110**	**.188***
	Accuracy	.100	.170*	.089	.131	**.225****	**.181***	**.158**	**.226****

Note: PF = Problem Finding; PS = Problem Solving;
*$p < .05$ ** $p < .001$

The statistically significant correlations appearing among the variables of creative thinking and the variables of critical thinking are very moderate, that is, around .20 and .30. Regarding

creative thinking, fluency and flexibility present more correlations with some dimensions of critical thinking, whereas originality has extremely few correlations and only with the information outside the context and the structure in both contexts (PF and PS) and with relevance and clear statement only in the context of PS.

Fluency and flexibility of the subjects' ideas for PF and PS are correlated mainly with variables of critical thinking in PF and PS respectively. The only variable of critical thinking not correlated with creative performance is clear statement. Seeking reasons and accuracy in PF are not correlated to creative performance in PF. However, fluency and flexibility in PS are correlated to critical thinking variables in PF. In other words, the students' performance in critical thinking in both cases, is mainly correlated to their creative performance in the context of problem solving.

3.2 Problem finding – Problem solving

The correlations of indicators of critical thinking between problem finding and problem solving are presented in Table 2, whereas Table 3 presents the correlations among the variables of creative thinking.

Table 2. Correlations between **problem finding** and **problem solving** in **critical** thinking variables

Spearman's rho		PS	Problem Solving					
		Clear statement	Seeking reasons	Meaningful information within the context	Meaningful information outside the context	Structure	Relevance	Accuracy
PF Problem Finding	Clear statement	**.159**	.108	.138	.072	.147	.189*	.278**
	Seeking reasons	-.025	**.124**	-.068	.091	.116	.031	-.043
	Meaningful information within the context	.071	.026	**.100**	.062	.119	.222**	.115
	Meaningful information outside the context	.174*	.134	.053	**.183***	.203*	.265**	.112
	Structure	.090	.139	.280**	.200*	**.119**	.218**	.222**
	Relevance	.183*	.214**	.132	.134	.150	**.260***	.141
	Accuracy	.206*	.097	.048	.018	.093	.173*	**.160***

Note: PF = Problem Finding; PS = Problem Solving;
*$p < .05$ ** $p < .001$

The students' performances as regards critical thinking variables are quite differentiated between PF and PS. Statistically significant correlations between them are indeed few and low. There are however, variables, which, although they are not correlated between them, have a statistically significant relationship with other variables between PF and PS.

Creative thinking variables have statistically significant correlations between them in PF and PS, varying between .32 and .46.

Table 3. Correlations between **problem finding** and **problem solving** in **creativity** variables

Pearson		**PS**	**Problem Solving**		
		Fluency	Flexibility	Originality	Creativity total index
	Fluency	**.319****	.333**	.314**	.385**
PF **Problem** **Finding**	Flexibility	.351**	**.368****	.382**	.445**
	Originality	.287**	.375**	**.397****	.429**
	Creativity total index	.345**	.400**	.405**	**.463****

Note: PF = Problem Finding; PS = Problem Solving;
*$p < .05$ ** $p < .001$*

4   Conclusion

The results confirm at large our hypotheses. The cognitive dimensions of creative thinking present certainly correlations with some of the dimensions of critical thinking, but these correlations are quite low; this is especially obvious when the students are thinking in the context of problem solving. Cognitive processes, consequently, have a common basis and elements that influence each other, nevertheless, they do not constitute a predictor for one another. When the students are thinking in a given context, they make use of various thinking processes and it is the interaction among them that yields the result.

The properties of critical thinking seem to be linked more to the creative abilities during problem solving rather than problem finding. The students' performance in the creative task of problem finding seems to be more independent than their performance in critical thinking tasks. Therefore, the context within which the students are thinking activates corresponding intellectual processes of creative and critical thinking, which are not independent from it. We end up with the same conclusion when we correlate the variables both of creative and critical thinking between problem finding and problem solving: low correlations denote that the change of context of reference modifies performance and activates in a different way the intellectual functions.

The conclusions of this research reinforce those educational methods that are not oriented to the exercise of a list of intellectual strategies of creative or critical thinking. Such educational methods, compel the students to face multiple instructional environments and multiple tools, that they are called upon to use in order to exercise their thinking, adapting its various functions to the different demands in a holistic way. Therefore, the research on teaching Thinking should turn from the exercise of isolated forms of thinking to various instructional environments where thinking is cultivated holistically and is measured in terms of expression during particular learning experiences and not in terms of constant capacities.

References

Bleedorn, B. D. (1993). Toward an Integration of Creative and Critical Thinking. American Behavioral Scientist, 37(1), 10-21.

Ennis, R. H. (1993). Critical Thinking Assessment. Theory into Practice, 32 (3), 179-186.

Ennis, R. H. (1996). Critical Thinking. Upper Saddle River, NJ: Prentice-Hall.

Hudgins, B., & Edelman, S. (1986). Teaching Critical Thinking Skills to Fourth and Fifth Graders Through Teacher-Led Small-Group Discussions. Journal of Educational Research, 79(6), 333-342.

Fishkin, A.S., & Johnson, A.S. (1998). Who is Creative? Identifying Children's Creative Abilities, Roeper Review, 21(1), 40-46.

Kagan, D. M. (1988). Evaluating a Language Arts Program Designed to Teach Higher Level Thinking Skills. Reading Improvement, 25(1), 29-33.

Marzano, R.J. (1998). What are the General Skills of Thinking and Reasoning and How do you Teach them? Clearing House, 71, 268-273.

Mouchiroud, C. & Lubart, T. (2001). Children's Original Thinking: an Empirical Examination of Alternative Measures derived from Divergent Thinking Tasks", Journal of Genetic Psychology, 162(4), 382-401.

Nickerson. R. (1981). Thoughts on Teaching Thinking. Educational Leadership, 39, 2:21.

Norris, S. P. & Ennis, R. H. (1989). Evaluating Critical Thinking. Pacific Grove, CA: Midwest Publications.

Paul, R. (1993). Critical Thinking: What every person needs to survive in a rapidly changing world. (3rd Ed.). Robnert Park, CA: The Center for Critical Thinking and Moral Critique, Sonoma State University.

Perkins, D. N., Jay, E., & Tishman, S. (1993). Beyond Abilities: A Dispositional Theory of Thinking. The Merrill-Palmer Quarterly, 39(1), 1-21.

Perkins, D. N. (2000). The Eureka Effect: The Art and Logic of Breakthrough Thinking. New York: W. W. Norton & Company.

Perkins, D. N., Tishman, S., Ritchhart, R., Donis, K., & Andrade. A. (2000). Intelligence in the Wild: A Dispositional View of Intellectual Traits. Educational Psychology Review, 12(3), 269-293.

Puccio, G.J. & Murdock M.C. (Eds.). (1999). Creativity Assessment. Readings and Resources. New York: Creative Education Foundation Press.

Runco, M. (Ed.), (1994a). Problem Finding, Problem Solving, and Creativity. Norwood, NJ: Ablex.

Runco, M.A. (1994b). Creativity and its Discontents. In M.P. Shaw & M.A. Runco, (Eds.), Creativity and Affect. (pp. 102-123). Norwood, NJ: Ablex.

Sternberg, R.J. (1997). Successful Intelligence: How Practical and Creative Intelligence determine Succes in Life. New York: Plume.

Yang, S.C., & Lin, W.C. (2004). The Relationship among Creative, Critical Thinking and Thinking Styles in Taiwan high School Students, Journal of Instructional Psychology, 31(1), 33-46.

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