Training of Creative Thinking in Primary School

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Abstract
The article deals with the problem of development of creative thinking. There are different and opposite perspectives in psychology and education analysing the possibilities to train creative thinking of children, adolescence and adults. The authors suggest that it is possible to train creative thinking of children using special creative learning methods and creating special conditions of students learning. The Anticipatory Model of Creative Thinking also is suggested.
Keywords: Creative thinking, training creativity.

1 Introduction

The aim of this research is – to analyse possibilities of training of creative thinking of primary school students using different methods of generation of new ideas, based on the theories of Guilford, J. P., Torrance, E. P., Altshuller, G., et all. and to test if our Anticipatory Model of Creative Thinking (Beresneviciene, Kirvelis, et all, 2006) is answering to the data of our experimental study.

As our Anticipatory Model of Creative Thinking suggests (Beresneviciene, Kirvelis, et all, 2006) the effects of the creative action $\mathbf{CT\ [t_H]}$ consists of two components:

- Creative abilities $\mathbf{C[t_H]}$, and
- Learning contribution $\mathbf{L[t_H]}$.

It is supposed, that learning contribution L[tH] grows with age linear with rate coefficient kL and the creative abilities changes with age $\mathbf{CT\ [t_H]}$ and has a maximum in teenage age. The parabolic and exponential mathematical models of the creative abilities are considered. Obviously, that creative actions maximum $\mathbf{CT_{MAX}}$ drift in age with growing of the learning coefficient $\mathbf{k_L}$, if $\mathbf{k_L > 2T_{0H}}$. The creative thinking maximum $\mathbf{CT_{ntMAX}}$ particularly drift in age if constructyvistic learning is usable.

Hypothesis of research: It is possible to train creative thinking of children using creative learning methods, based on theories of Guilford, Altsuller and other methods.

Methods of research:

- comparative analysis of psychological literature on development of creative thinking and possibilities to train creative abilities;

- educational experiment method, based on theories of Osborn, A., Bredekamp, S., Amnuel, P., Altsuller, G. (quat., according Beresneviciene, 1996) and other methods of helping students to develop creative thinking abilities);
- test of creative thinking abilities using children drawings of non existing animal;
- test-retest of parameters of creative thinking (the amount of ideas, originality, detailed thinking and etc.) using Guilford's tests before experiment and after it;
- statistical analysis of research data, etc.

Sample of research:

There participated 100 primary school students of 7^{th}–8^{th} years old: 39 girls and 61 boys in the experiment.

The objectives of research were the following:

- To train primary school students' creative thinking, using different methods of generation of new ideas, based on the theories of Guilford, J. P., Torrance, E. P., Altshuller, G., et all. and to measure effectiveness of training process;
- To compare parameters of primary school students creative thinking according to Guilford's theory (the amount of ideas, originality, detailed thinking and etc.) before educational experiment and after it;
- to analyze gender differences of creative thinking among primary school students;
- To find correlations among parameters of creative thinking (the amount of ideas, originality, detailed thinking, etc.) and learning achievements, colorfulness of pictures and hostility.

2 Development of Creative Thinking in Ontogenesis

Guilford (1950) describes creative thinking as one of the factor of human Intelligence. Creativity he related with divergent thinking. According to the Guilford divergent thinking has four characteristics: flexibility, originality, fluency and elaboration. Those who are fluent can produce a great many ideas, those who are flexible can produce multiple types of ideas, those strong in originality can produce unique ideas, and those good at elaboration can take their ideas and expand upon them (Kaufman, 2005).

Schaie (1990) discovers that Intellectual flexibility is correlated with better cognitive abilities in older age. Intellectual flexibility acts with other parameters of creative thinking. For example, complex environment can necessitate Intellectual flexibility and force it (Schooler, 1990). Extreme exertion required conditions in work place and possibility to do tasks in self-dependent way could improve Intellectual flexibility. The work with lack of such possibilities has negative influence to Intellectual flexibility.

Empirical data of Simonton (1988) show the growing process of creativity in many people. This process reaches its peak near 40 years old and then slowly goes down.

There are big fluctuations for individuals for many reasons. Simonton suggests changing the "age" in to "career year" conception. People who start their career later can reach their peak in older year that these who starts earlier.

The year in which people reaches their biggest creativity and productivity depend on field of their activity (Dennis, 1966; Horner, Rushton and Vernon, 1986; Simonton, 1989). Such disparity on creative age can be explained on demand of different abilities requested in the field. One field request youthful enthusiasm, another request experience accumulated in many years.

3 Possibility to Train Creative Thinking

Horn (1967; 1982) and Cattell (1965) studying life span development of intelligence divided intelligence in two parts: crystallized and fluid intelligence. Crystallized intelligence contains such aptitudes as verbal thinking, problem solving based on knowledge and experience, skills and culture. Crystallized intelligence is increasing with growing. Experience of human is developing via life-span. Verbal aptitudes are even in creasing in older age. Fluid intelligence is not based on the knowledge or culture. Fluid intelligence helps us to solve new unusual problems. Fluid intelligence contains working memory, speed of thinking, understanding of space relations, so we (Beresneviciene, Beresnevicius) can describe fluid intelligence as creative thinking. In some tasks both intelligence may be used (Papalia, Camp and Feldman, 1996).

According to the Cathel and Horn date fluid intelligence is increasing gradually and reaches its peak in adolescence and in young adulthood starts to decrease (Beresneviciene, 1996).

Baltes and his colleagues (1984) have proposed a Dual-process model of adult intelligence, based on Horn and Cattell's conception on fluid and crystallized intelligence. The model identifies and seeks to measure mechanics and pragmatics intellectual processes. Mechanics of intelligence is linking with working memory and are basic, physiologically determined functions of the brain. Pragmatics of intelligence is processes involve a wide range of accumulated, culture based knowledge and skills. This dimension is similar to crystallized intelligence and depends on long term memory.

Middle-aged and older adults are likely to improve in the use of information they have garnered from education, work, and other experience. These pragmatic abilities often outweigh the brain's mechanical condition (Baltes, 1993).

The Sietle Longitudinal Study of Adult Intelligence, conducted by Schaie and his colleagues over a span of more than three decades shown that most fairly healthy adults apparently experience no significant impairment in most abilities until after age 60 (Papalia, Camp and Feldman, 1996). If they live long enough most people's intellectual functioning will show some decline at some point, but not in all or even most abilities. These and other findings suggest that no single measure, such as IQ, can adequately describe either age changes in individuals or age differences among groups (Schaie, 1990).

Baltes (1992) describes inability to develop fluid Intelligence in older age. This position takes and Csikszentmihalyi M. He believes that the right combination of

personal characteristics and encouraging environment produces creativity, and that children cannot be taught creativity.

Rogers (2004) recognized, that ability to create is potential ability of everybody, we just need to create appropriate psychological conditions for it's development:

1) safe psychological atmosphere without fear;
2) freedom for everybody;
3) responsibility for everybody.
4) it's necessary to accept every personality as unique without any evaluation of human being.

Rogers (2004) described creative personality, process of creativity and results of the process of creation as three different components of creativity and all these three components is necessary to analyze the same time.

Beresneviciene (2005) trying to define hierarchy of needs, described such pyramid of the development of human needs:

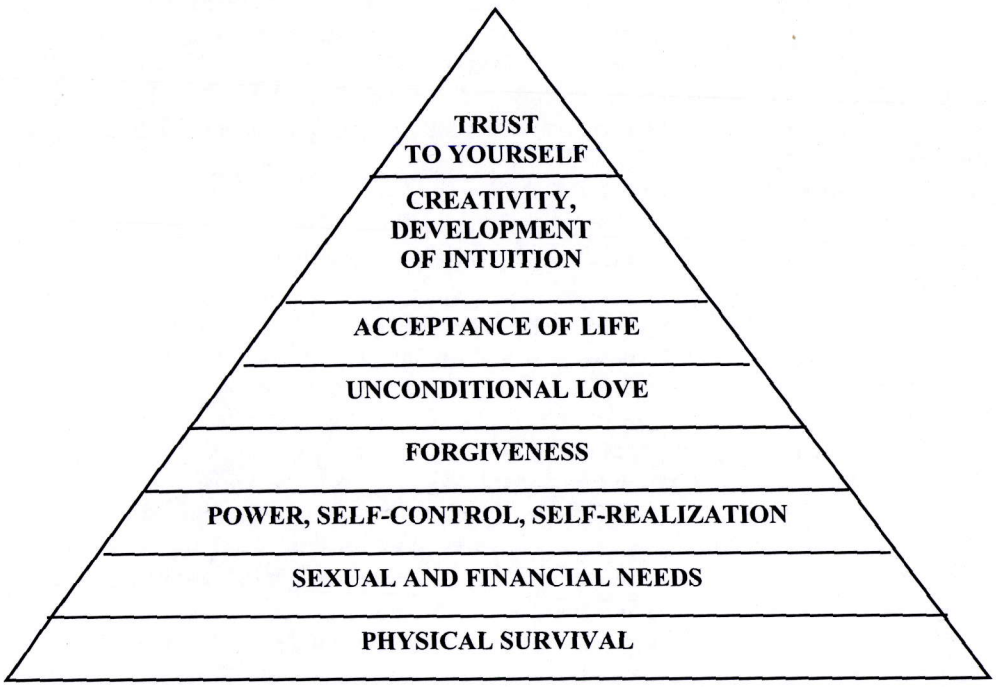

Figure 1: Pyramid of the development of human needs.

During process of ontogenesis and phylogenesis the basical needs of human beings such as (needs of safety, physiological and other needs necessary for survival) are common to all our collective unconsciousness.

Individual unconsciousness needs to fulfil sexual and financial needs, individual consciousness understands it's needs of power, self-control or self-realizations needs.

The hierarchy of needs (Beresneviciene, 2005) containing needs of survival, sexual, financial, power, self-controls and self-realization needs we can call needs „To have" (according Eric Fromm definitions).

Higher needs such as the need to forgive, need to love unconditionally, to accept life as it is, the need to develop intuition and to create, to trust to yourself are transcendental needs (according Maslow z-theory) and we can define them as the needs „To be" (according Eric Fromm definitions: „To have or to be?").

According Beresneviciene (2005) theory of personality, the need to create person's life is the need to develop person's intuition and is reachable to everyone, who is seeking „to be", not only „to have".

The development of needs is going according to the personality's need to grow as a person, to find his place in life, to stop to be only a tool in somebody's will, but to become free person, which is able to develop intuition and to create his own life via need to forgive to others, to situations, to his own life and to himself and to develop the need for unconditional love to himself and to everybody in the Universe and to accept life as it is without egoistic interventions seeking „to have" more profit from everything.

New born child already has all these needs, but possibility to understand all his needs consciously depends of maturity and learning possibilities in the family from parents.

If it is possible organize special training of creativity at school and to create necessary conditions of creative learning, fulfilling children needs for forgiveness, unconditional love and respect, need to trust to himself, child is able to learn very quickly and to become creative personality (Beresneviciene, 2005).

In summing the observation of many research data, Papalia and others (1996) conclude that research has demonstrated that it is possible for adults to improve their intellectual performance throughout the lifespan, eve in tasks involving fluid intelligence.

It is possible to train creative thinking using special learning methods, such as the Simple transformations of the object, Time-space-value operator, Focus object, Morphological construction, Construction of the steps and other methods were used (Beresnevicius, 2004). These methods are based on visual thinking, modelling, combination of pieces of known world, free associations, mental transformations, etc.

To achieve the goal of the task creator must have huge amount of ideas (de Bono, 1992).

Another point of view has proponents of algorithmic method of problem solving. The founder of TRIZ (abbreviation of Russian words which we can translate as Theory of Invention) Altshuller (1985), Horowitz, author of Advanced Systematic Inventive Thinking (2005), claim that it is not necessary to have many ideas and used the strong follow of thinking steps we can reach great creative solution of the very complicated problem. Thinking process in the algorithmic way not depends on abilities of creativity. All we need is to know the algorithm and to be its master.

The teaching in a way that encourages and rewards creativity can improve school performance (Sternberg, 2003). It is also argued that children can learn to make certain kinds of decisions that will enhance their creativity.

4 Anticipatory Model of Creative Thinking

With the aim to create anticipatory model of creative thinking the mathematical modelling was used (Kirvelis).

The intellectual abilities and creativeness is a specific property of warm-blooded organisms and the human as a procedure of thinking *e.g.* anticipatory activity. This property is of special structure of the brain – of the neocortex's virtual to create plans-projects, programs of possible actions, for anticipatory control.

The intellectual abilities $\mathbf{I_{nt}[t_H]}$ consist from two components:

- Creative abilities $\mathbf{C[t_H]}$, and
- Learning contribution $\mathbf{L[t_H]}$.

The intellectual abilities as a creative and learning contribution abilities of the person, which are inseparable from abilities to anticipate changes in development with age $\mathbf{t_H}$. The creativity as well as intellect it is measured by the special tests revealing ability in different situations to see of as much as possible variants of interpretations and explanations. By experimental investigations it is noticed, that creative abilities $\mathbf{C[t_H]}$ grow with age $\mathbf{t_H}$ and the maximum $\mathbf{C_{0MAX}}$ in the period of the teenager reaches (achieves), and then falls down. The learning contribution $\mathbf{L[t_H]}$ grow linear with rate coefficient $\mathbf{k_L}$

The mathematical model of the intellectual abilities $\mathbf{I_{nt}[t_H]}$

$$\mathbf{I_{nt}[t_H] = C[t_H] + L[t_H] = \{C_{0MAX} - [t_H - T_{0H}]^2\} + k_L * t_H}$$

5 Method of Research

Sample of research

There participated 100 primary school students of 7^{th}–8^{th} years old: 39 girls and 61 boys in the educational experiment.

Phases of research

During the I phase of research it was organized diagnostic experiment of different parameters of creative thinking (the amount of ideas, originality, detailed thinking and etc.) using Guilford's tests using students' drawings of non existing animal.

During the II phase of research was organized educational experiment which took place 3 months during 24 classes at school. The aim of educational experiment was to develop creative thinking abilities of children. During class's primary school students were asked to generate new ideas working in groups and teacher was using brain storm method, creative learning methods, described by researcher Amnuel, P., G. Altshuler and others.

During the III phase of research it was organized post test and evaluation of different parameters of creative thinking (the amount of ideas, originality, detailed thinking and etc.) using Guilford's tests and students drawings of non existing animal took place.

6 Results

It was collected 200 pictures of non existing animal, among them – 100 pictures before training of creative thinking of primary's school children and 100 pictures after the experiment.

Analysis of pictures were done using Guilford's tests of creative intelligence parameters such as amount of ideas (before and after the experiment), it was measured detailed thinking and originality.

Data revealed, that amount of ideas increased statistically significant after the experiment (t (99)=-7,186, p=0,000, but there were no found statistically significant changes in detailed thinking (see table 1).

Table 1: Training of creative thinking of primary school students

Parameters of creative thinking	Before training		After training		Results of t-test		
	x	σ	x	σ	t	df	p
Amount of ideas	4,52	2,58	6,35	2,52	-7,186	99	0,000**
Detailed thinking	45,67	45,38	43,17	37,84	0,570	99	0,570
Originality	34,00	29,20	81,50	24,26	-13,269	99	0,000**

Analysis of pictures also revealed that after the experiment also increased originality of students thinking: t(99)=-13,269, p=0,000 (see table 1).

Analysing pictures of non existing animal of girls before and after training period, it was revealed, that girls expressed much more ideas in their pictures after the experiment than they were able to do before it. Compare the average of amount of ideas according Student's t - criteria, it was found, that t(38)=-4,352, p = 0,000 (see table 2).

Table 2: Training of creative thinking of primary school girls

Parameters of creative thinking	Before training		After training		Results of t-test		
	x	σ	x	σ	t	df	p
Amount of ideas	4,05	2,28	5,82	2,38	-4,352	38	0,000
Detailed thinking	57,33	61,46	55,54	47,12	0,196	38	0,845
Originality	34,62	26,04	82,05	24,30	-9,160	38	0,000

Training of creative thinking of primary school girls also statistically significant increased girls' originality. Compare the average of level of originality according Student's t - criteria, it was found, that t(38)=-9,160, p = 0,000 (see table 2).

Data of training of creative thinking of girls also revealed, that there were no found

statistically significant changes in detailed thinking of girls after the experiment (see table 2).

Analyzing pictures of non existing animal of boys before and after training period, it was revealed, that boys expressed much more ideas in their pictures after the experiment than they were able to do before it. Compare the average of amount of ideas according Student's t - criteria, it was found, that t(60)=-5,675, p = 0,000. (See table 3).

Table 3: Training of creative thinking of primary school boys

Parameters of creative thinking	Before training		After training		Results of t-test		
	x	σ	x	σ	t	df	p
Amount of ideas	4,82	2,74	6,69	2,56	-5,675	60	0,000
Detailed thinking	38,21	29,33	35,26	28,16	0,691	60	0,492
Originality	33,61	31,25	91,15	24,43	-9,744	60	0,000

Training of creative thinking of primary school boys also statistically significant increased boys' originality. Compare the average of level of originality according Student's t - criteria, it was found, that t(60)=-9,744, p = 0,000. (See table 3).

Data of training of creative thinking of boys also revealed, that there were no found statistically significant changes in detailed thinking of boys after the experiment. (See table 3).

Compare boys and girls parameters of creative thinking before the experiment it was found that there were no statistical differences in amount of ideas, originality of thinking among boys and girls, but girls thinking was more detailed than boys: t(98)=2,090, p<0,05. The same difference was found after experiment as well (see table 4 and table 5).

Table 4: Gender differences of creative thinking before experiment (pre-test)

Parameters of creative thinking	Girls		Boys		Results of t-test		
	x	σ	x	σ	t	df	p
Amount of ideas	4,05	2,28	4,82	2,74	-1,459	98	0,148
Detailed thinking	57,33	61,46	38,21	29,33	2,090	98	0,039
Originality	34,62	26,04	33,61	31,25	0,168	98	0,867

Before training period boys expressed more ideas in their pictures of non existing animal before the experiment than did girls, but compare average of amount of ideas according Student's t - criteria, it was found, that difference is not statistically significant: t(98)=-1,459, p = 0,148 (see table 4).

Before the educational experiment girls expressed more originality in their pictures

of non existing animal than did boys, but compare average of amount of ideas according Student's t - criteria, it was found, that difference is not statistically significant: t(98)=0,168, p = 0,867 (see table 4).

Table 5: Gender differences of creative thinking after training (post-test)

Parameters of creative thinking	Girls		Boys		Results of t-test		
	x	σ	x	σ	t	df	p
Amount of ideas	5,82	2,38	6,69	2,56	-1,699	98	0,093
Detailed thinking	55,54	47,12	35,26	28,16	2,695	98	0,008
Originality	82,05	24,30	81,15	24,43	0,181	98	0,857

Compare boys and girls parameters of creative thinking after the experiment it was found that there were no statistical differences in amount of ideas, originality of thinking among boys and girls, but after training period girls thinking was more detailed than boys: t(98)=2,695, p<0,05 (see table 5).

After training period boys expressed more ideas in their pictures of non existing animal than did girls, but compare average of amount of ideas according Student's t - criteria, it was found, that difference is not statistically significant: t(98)=-1,699, p = 0,093 (see table 5).

After training period girls expressed more originality in their pictures of non existing animal than did boys, but compare average of amount of ideas according Student's t - criteria, it was found, that difference is not statistically significant: t(98)=0,181, p = 0,857 (see table 5).

It was found statistically significant correlations among parameters of creative thinking and different parameters of behavior and achievements of learning. It was found negative correlations among achievements of learning and amount of ideas: (r=-0,189, p=0,059), not significant negative correlations among achievements of learning and originality: (r=-0,084, p=0,408) and positive significant correlations among achievements of learning and detailed thinking: r=0,205, p<0,05 (see table 6).

It was found statistically significant correlations among parameters of detailed thinking and hostility: r=0,678, p=0,000. It was found statistically significant correlations among parameters of colorfulness of pictures of non existing animal and hostility: r=0,584, p =0,000 (see table 6).

Analyzing data on relationship among parameters of creative thinking and learning achievements, it was found that amount of ideas as well as originality were negatively correlated with all learning achievements (see table 7).

Table 6: Correlations among parameters of creative thinking and achievements of learning, colourfulness of pictures

	Amount of ideas	Detailed thinking	Originality	Hostility
Amount of ideas	1,000 0,000 100	0,181 0,072 100	0,172 0,088 100	0,180 0,073 100
Detailed thinking	0,181 0,072 100	1,000 0,000 100	-0,104 0,304 100	0,678 0,000 100
Originality	0,172 0,088 100	-0,104 0,304 100	1,000 0,000 100	-0,096 0,344 100
Hostility	0,180 0,073 100	0,678 0,000 100	-0,096 0,344 100	1,000 0,000 100
Achievements of learning	-0,189 0,059 100	0,205 0,041 100	-0,084 0,408 100	0,215 0,032 100
Colorfulness of pictures	0,224 0,025 100	0,579 0,000 100	-0,034 0,734 100	0,584 0,000 100

Table 7: Correlations among parameters of creative thinking and achievements of music, visual arts and work

	Achievements of visual art and work	Achievements of music	Achievements of learning	Colorfulness of pictures
Amount of ideas	-0,176 0,079 100	-0,159 0,114 100	-0,189 0,059 100	0,224 0,025 100
Detailed thinking	0,171 0,089 100	0,195 0,052 100	0,205 0,041 100	0,579 0,000 100
Originality	-0,084 0,406 100	-0,064 0,530 100	-0,084 0,408 100	-0,034 0,734 100
Hostility	0,181 0,071 100	0,201 0,044 100	0,215 0,032 100	0,584 0,000 100
Colorfulness of pictures	0,122 0,229 100	0,076 0,450 100	0,113 0,264 100	1,000 0,000 100

And it was found positive significant correlations among achievements of learning and detailed thinking: r=0,205, p<0,05. Amount of ideas and colourfulness of pictures correlated also positively: r=0,224, p<0,05 (See table 7).

7 Conclusions

Data of research confirmed hypothesis, that it is possible to develop the abilities of creative thinking of students from primary school (originality, the amount of new ideas, detailed thinking) using appropriate learning methods.

Data of research confirmed that creative thinking **CT $[t_H]$** consists of two components:

- Creative abilities **$C[t_H]$**, and
- Learning contribution **$L[t_H]$**.

Data revealed, that amount of ideas increased statistically significant after the experiment (t (99)=-7,186, p=0,000. Analysis of students originality before and after the training revealed that after the experiment also increased originality of students thinking: t(99)=-13,269, p=0,000, but there were no found statistically significant changes in detailed thinking.

The study revealed, that girls expressed much more ideas in their pictures after the experiment than they were able to do before it: t(38)=-4,352, p=0,000. Training of creative thinking of primary school girls also statistically significant increased girls' originality. Compare the average of level of originality according Student's t - criteria, it was found, that t(38)=-9,160, p=0,000.

The study revealed, that boys also expressed much more ideas in their pictures after the experiment than they were able to do before it: t(60)=-5,675, p = 0,000. Training of creative thinking of primary school boys also statistically significant increased their originality: t(60)=-9,744, p=0,000.

It was found, that Detailed thinking as a parameter of Creative thinking (according to Guilford) was more developed among 7-8 years old girls than among boys: t(98)=2,090, p<0,05. The same gender differences appeared after the experiment as well.

It was found statistically significant correlations among parameters of creative thinking and different parameters of behaviour and achievements of learning. It was found negative correlations among achievements of learning and amount of ideas: (r=-0,189, p<0,05) and positive correlations among achievements of learning and detailed thinking: r=0,205, p<0,05.

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