Duality and the Importance of Dual Treatments' Inclusion in Teaching

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Abstract

Mathematics lies at the root of duality. In the category of essential meanings of mathematics there are many meanings that coexist in their dual plane. We think that some deficiencies still exist in the teaching process particularly in the way the teacher transmits this knowledge to the students. Aiming to help the teachers to give in an accurate manner the mathematical knowledge we have built a new model in learning and teaching, which includes dual treatments in elementary education. In this paper are described some deficiencies during mathematics' teaching and their elimination through implementation of dual treatments in teaching. The results from implementation of dual treatments in teaching are evaluated from the statistic analysis. ANCOVA and t-test were employed to determine that: 1) Experimental group versus control had significant difference in successful thinking in mathematics; and 2) Male versus female had not significant difference in successful thinking.

Keywords: elementary education, duality, dual treatments, teaching, successful thinking

1. Introduction

In 1990 Albania transitioned from a totalitarian state into a democratic system and the country entered to a new social, political and economical status, therefore these two facts created the possibility for the gradual realization of reformative processes. In the education the reforms included the legislative-administrative management, curriculums and the professional competence. The interaction of the Institute of Pedagogical Studies with some Organizations, Foundations (UNICEF; SOROS; UNESCO) and some foreign experts made possible the application of some projects in the function of a new conception of the entire educational system. The first project that was applied in the field of Albanian education was RIEDEA (Intensive Reform of Teachers and Educators in Albania). It began in November 1992 and was supported technically and financially by UNICEF. The methodical models presented in this project by Baçi (1995), Mialaret (1995), Muka (1995), Orlich et al. (1995), Sadger and Sadger (1995), Simeoni (1995), Xhanari (1995) guided the work of Albanian experts about the restructuring of curricula based on Bloom's Taxonomy (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956) in order to realize teaching objectives. After RIEDEA, in Albania started AEDP (Albanian Education Development Project) (1995), followed in 1997 by "The Development of Critical Thinking through Reading and Writing" project, created and guided by International RWCT (Reading and Writing for Critical Thinking) Consortium. The project had the aim to bring in the class teaching methods which encourage the development of creative and critical thinking in all the subjects between the students of all ages (Antologji, 1998). The translations in Albanian language of Fisher (1995), Unrau (1997), Entwistle (1988), the publications Steele et al. (2000a,b,c,d,e,f), Temple et al. (2006), and also the models of Mita (1999), Musai et al. (2001) about the development of critical thinking in different subjects, brought new teaching experiences. Today the vision of Albanian education is the guarantee of an educational national contemporary system, which stimulates the development of economical stability, increases the competition and consolidates democracy (Ministry of Education and Science, 2009). The initiation of the countries of UE, "The little ones in change" as part of Europe's Strategies 2020 (Communication from the Commission, 2011) has been implemented also in Albanian education. Roles, aims and functions of educational institutions have changed significantly. School curriculum is now

reformed completely and teaching environments are turning into contemporary ones. Nowadays, there is a growing request for teachers to answer the structure and the content of the new curriculum with much more comprehensive strategy (see Gjini, 2004; Gjoci, 2008; 2009a,b,c; Gjokutaj et al., 2005; Kërënxhi & Gjoci, 2008; Llambiri, 2007; Musai, 2003; 2005a,b,c; 2009). Annual analysis report of Regional Education Office - Elbasan (2011) noted that the most used methods by primary school teachers were student-centered ones (67.45%). Over 20% of teachers use two or three combined methods. Most used student-centered methods are those for the development of critical and creative thinking (57.09%)**.** On the other hand the conclusions of the conducted survey by Rama (2011) express the high interest of teachers to new teaching strategies. The results show that 85% of surveyed teachers preferred new teaching methods and strategies, versus 15% who still tend to use traditional methods. There are teachers who give more importance to the textbook compared to those among teachers who prefer traditional methods. This learning method where the aim is explanation and not learning is considered as the text-centered teaching (Llambiri, 2007).

We can mention an episode described by Llambiri (2007): A test was done in mathematics with students who had just started the fifth grade on behalf of the project "Secret Abandonment"[1]. One of the problems of the test was: five kilograms of oranges cost 400 ALL. What is the price of oranges? Surprisingly only 30% of students answered correctly. When teachers were asked why the score was so low, they justified it in this way: In the text this problem is not formulated as in the test. If the request would be directed otherwise, for example, -how much does 1 kg of oranges cost? Then there would be more students to answer correctly. Then Llambiri continues: As I was describing to an Australian colleague the text-centered teaching he smiled and said to me: even in Australia there are a lot of text-centered teachers. In fact, in pedagogical foreign literature, often you can find claims that teachers sometimes forget the student and are more interested in the subject (Llambiri, 2007, p. 27).

We mentioned this episode in order to understand the importance of implementation of dual treatments, which makes possible that similar cases to the one mentioned by Llambiri to be minimized. In this paper we describe the results of the study conducted during 2009-2010 academic year for the effect of teaching through dual treatments. In the study were included the students of two 9-years schools of Elbasan city, in Albania.

2. Effect of dual treatments in successful thinking

Purpose of the study was to take information about the effect of teaching through dual treatments in successful thinking. The hypotheses which were tested:

Ho1: Teaching through dual treatments will not have significant differences according to groups (experimental and control), in successful thinking.

Ho2: Teaching through dual treatments will not have significant differences according to gender, in successful thinking.

3. Method

3.1 Participants and instruments

The participants of the study were 53 students (24 females, 29 males), 6-7 years old, of the first grade of elementary education. They were separated in two study groups: experimental group (27 students, 14M, 13F) and control group (26 students, 15M, 11F). In the experimental group the teaching through dual treatments during teaching of mathematics was implemented whereas, and in the control group was used the traditional teaching method. The teachers, who taught in these classes, had a college degree, with a relatively long teaching experience (more than 20 years of teaching) with the same level of qualification. The teachers implemented the curricula in these classes approved by the Ministry of Education and Science for the school year 2009-2010. Teaching of mathematics was carried out using the textbook "Matematika 1" by Dedej, et.al., (2009).

Pre-test/post-test of quasi-experimental design with experimental group and control group was used in the study to evaluate the influence of dual treatments in successful thinking. Both groups were tested before and after treatment. As pre-test has been used the test which was done in the first week in the first semester to measure mathematics achievements, while post-test was developed in the end of May. A fourth-level scale was conducted to measure successful thinking. Eight categories (39 issues) were combined at four levels, that would classify as: Level 1 -

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[1] This project was implemented during the period 2003-2005 from the consortium "The Development of Education", together with Regional Education Office of five districts of Albania and was supported by UNICEF.

comprehension, Level 2 - application, Level 3 - evaluation, and Level 4 – critical and creative thinking. The distribution of eight categories according to four levels and description of students' activities is presented in Table 1.

Table 1. Evaluation of outcomes for successful thinking

Level	Categories	Description
Level 1	(1) The comparison between the two sets (2) The comparison of numbers	Ability to compare two sizes, two quantities, two lengths and interpret them in duality Ability to compare two numbers and apply dual interpretation
Level 2	(3) Addition and subtraction of numbers up to 20 (4) Addition of numbers up to 100	Ability to add and interpret in duality; use different methods of addition and subtraction implementing dual solution. Ability to use different methods of addition implementing dual solution in new situations.
Level 3	(5) Solution of equations with proofs (6) Solution with proofs of the inequalities	Ability to solve the equation putting instead of the unknown, numbers selected from a finite set and make the dual analysis Ability to solve inequation putting instead of the unknown, numbers selected from a finite set and make dual analysis
Level 4	(7) Application and problem solving (8) Mixed problem solving	Ability to solve the problem implementing two different strategies, evaluates dual solution Ability to formulate the dual problem; to give original ideas for the dual solution making it clear through schemes

Cronbach's alpha reliability coefficient of the total scale was .84, so the scale can be considered reliable with our sample. As Cronbach's alpha for each level varied from .76 to .83, all level were evaluated as acceptable. The inter-correlacion between levels was investigated using Pearson Product-Moment Correlation coefficient. The data are shown in Table 2. Can say there are strong and very strong relationships between levels. There are strong relationships between application and evaluation. This means that students taught with applied dual treatments, evaluate easier.

Table 2. Inter-Level correlation coefficients

Measures	Level 1	Level 2	Level 3	Level 4
Level 1	1.00			
Level 2	.655**	1.00		
Level 3	.628**	.848**	1.00	
Level 4	.589**	.544**	.672**	1.00

**p<0.01

3.2 Analysis and Results

The statistical analyses were done by using both descriptive statistics and inferential statistics. For descriptive statistics the mean (M), standard deviation (SD), and histograms of covariate were presented. For inferential statistics in order to test the null hypotheses, statistical techniques named Analysis of Covariance (ANCOVA), Pearson correlation and Independent samples t-test were used.

In Table 3, there is shown data about the mean scores and standard deviation of the experimental and control groups in pre-test (covariate) and post-test (dependent variable). The means scores of the experimental and control groups in post-test were 44.0 and 40.8 respectively, so it is indicated that the mean score of post-test in experiment group is higher than that of the post-test of control group.

Table 3. Descriptive statistics for variables

Measure	Experimental Group (n=27)		Control Group (n=26)	
	M	SD	M	SD
Pre-test	32.9	2.013	32.4	2.400
Post-test	44.0	6.373	40.8	6.627

One t-test for two independent samples was used to detect any significant difference between the treatment group and the control group on the pre-test scores. No significant violation was found. The analyses revealed no statistically significant differences in prior achievement of the students in mathematics [$t(51)= -.705$, $p= .484$].

For inferential statistics were used analysis of variance (ANOVA) and analysis of covariance (ANCOVA). We used an alpha level of 0.05 for all statistical tests. For assumptions ANCOVA were conducted: normality (Shapiro–Wilk Test, $p= .052$ and $p= .109$), equality of variances ($F(1,51)= .002$ and $p= .963$), homogeneity of regression slopes ($F(1,49)= 1.499$ and $p= .227$) and linearity. No significant violation was found. In order to make clear these scores we accompany them with the figures 1,2.

Figure 1 shows the histograms with normal curves related to 1-experimental group and 2-control group with respect to pre-test.
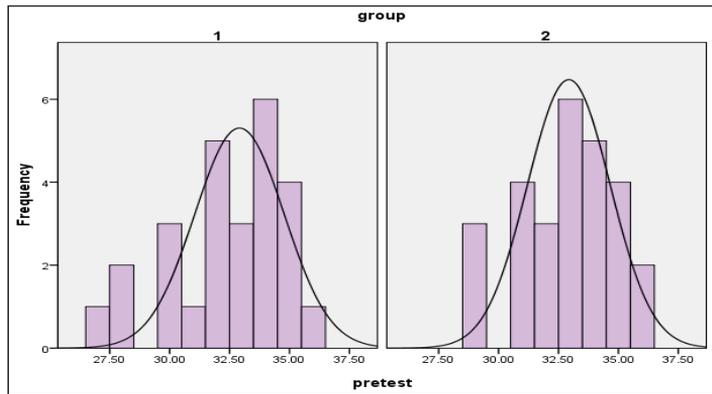

Fig 1. Histograms of pre-test scores with respect to pre-test

The slopes of the regression lines should be roughly parallel, that is the relationship between the covariate (pre-test) and the dependent variable (post-test) should be similar for all two groups (the assumption of homogeneity of regression). From Figure 2 we see that the slopes are parallel.
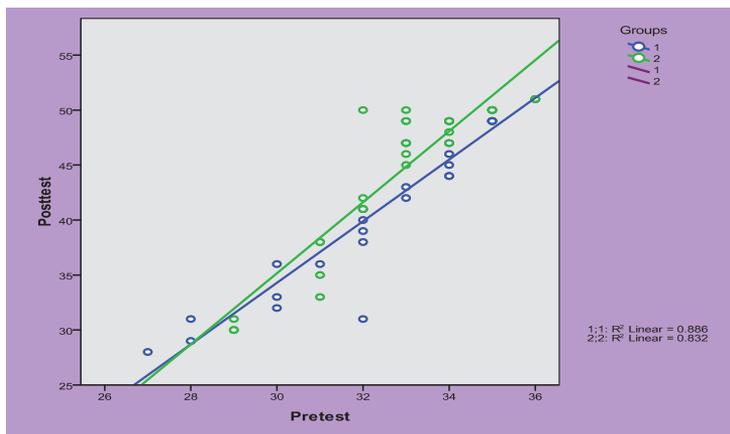

Fig 2. Linear relationship between the pre-test and the post-test Here appears to be a linear relationship.

Now we can continue with the ANCOVA test. In Table 4 the result from an ANCOVA analysis includes data on the posttest for the successful thinking in mathematics for the experimental and control groups after using the pre-test results as covariates.

Table 4. Tests between subjects effects

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1959.284[a]	2	979.642	148.550	.000	.856
Intercept	409.604	1	409.604	62.111	.000	.554
Pretest	1824.304	1	1824.304	276.632	.000	.847
Group	35.424	1	35.424	5.372	.025	.097
Error	329.735	50	6.595			
Total	97723.000	53				
Corrected Total	2289.019	52				

According to the Table 4, there was a significant difference between the results of control group and experimental group ($F_{(2,50)}$=5.372, p=.025<.05, partial η^2=.097). The difference between groups in the mean score (40.81, 44.0) also shows that dual treatments are understood and applied easily by the students. So the hypothesis Ho1: Teaching through dual treatments will not have significant differences according to groups (experimental and control), in successful thinking, is refused. This means that teaching through dual treatments raised significantly successful thinking of the students. Distribution of values according to four levels for the successful thinking is shown in the Graph 1.

Graph 1. Successful thinking according to four levels
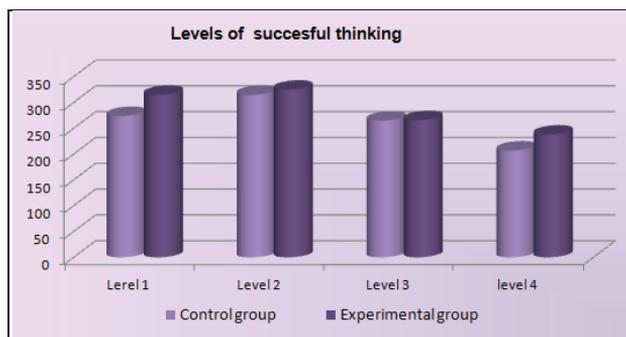
Depending on the fulfillment of data for the graph, the number of tested students is 26 for the experimental group and 26 for the control group. The 1st level – comprehension had a significant increase, which was increased with 41 (from 274 in 315) points, and the 4th level – critical thinking, which was increased with 31 points (from 207 in 238).

There are shown the results related to the hypothesis Ho2 below. Table 5 shows the data about the male and female groups for the total number of cases (N) in the groups, the arithmetic means (M), standard deviations, (SD) and standard error (σ).

Table 5. Strategy Group Statistics

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Gender	Male	14	43.0000	6.90596	1.84570
	Female	13	45.0769	5.82325	1.61508

A t-test for independent samples (Table 6) was administered to the test scores to determine whether there was any statistical significance between boys and girls in the overall test scores. The Levene's Test for Equal variances yields a p-value of .96. This means that the difference between the variances is statistically insignificant.

Table 6. Independent Samples Test Results

	Levene's Test for Equality of Variances		t-test for Equality of Means				
	F	Sig.	t	df	Sig. 2-tailed	Mean Difference	Std. Error Difference
Equal variances assumed	.638	.432	-.841	25	.408	-2.07692	2.46857
Equal variances not assumed			-.847	24.787	.405	-2.07692	2.45256

From the Table 6, it is evident that the t-value (t= -.841, p< .408) is not significant at 0.05 significance. So there is no significant difference between boys and girls of the first grade in the successful thinking. So the hypothesis Ho2 is accepted.

4. Discussion and conclusions

The successful thinking scores of students were significantly different in the experimental group after the treatment and it indicates that the dual treatments have firmly effect in the successful thinking. Although each of two groups has got increasing scores in successful thinking, the successful thinking scores of students in experimental group after treatment have shown much higher scores of students in control group. This means that dual treatments influence in the effectiveness of teaching mathematics. The answers of students of experimental class are characterized by the easiness of expressing being out from the boundaries which characterize the students of the control class. For giving an example we mention answers of the students for the exercise eight of the post-test. Exercise eight was: Mark each of five index cards with one of the numbers 3, 12, 4 or one of the marks >, +. Form an inequality with these five index cards. Form another one. In the answers of students of the control class we find combined two of the cases 3+12>4, 12+4>3, 12+3>4, 4+12>3. In the answers of the students of experimental class there are also the cases 3+4<12, 3<12+4, 4<12+3, 12>4+3. This shows that for the students of experimental class was clear the fact that the index card which has been marked with the mark > being a mobile figure, can be put in two positions: in the position showing the mark > or in the position showing the mark <. Meanwhile the students of the control class haven't shown any sign about knowing this fact.

Discussions about the ways of solving problems showed that students of experimental class express themselves easily and their answers were often astounding. In many cases they gave right argumentations that we haven't thought about. The students' answers have helped us to think that even in the models that teacher has used about the concreteness of mathematical problems exist situations which can be interpreted in duality. From the testing resulted that students of experimental class interpreted, solved and analyzed in the right way the dual situations. Based also in the surveys that we have done during classes we conclude that the students of experimental class are characterized by flexibility in thoughts, by critical and creative thinking.

The results have shown that there is no significant difference between girls and boys in successful thinking after treatment and it indicates that both have got higher scores in successful thinking which means that dual treatment has equally affected boys and girls and the gender factor does not have its effectiveness on successful thinking of the students.

The active methods of elementary education which have dual treatments at their basis can be applied except in mathematics even in other subjects by the teacher. Although dual treatments was designed to be applied in teaching mathematics in elementary education (see Gjoci, 2011, 2012a,b; Gjoci & Kërënxhi, 2010, 2012; Kërënxhi, 2011, 2012a,b; Kërënxhi & Gjoci, 2010, 2011), we think as well, that there exist all possibilities that dual treatments to be method of thinking and reasoning for students, in all subjects beginning in the lower grades of elementary education. When the students study language, literature, natural sciences, history or any other subject, the students should be urged to make dual interpretations, dual analysis and to describe in two different ways the same situation. It is entirely possible due to the dual nature of these sciences. Dual treatments are applicable in languages and literature. During the object's study students become known with its dual features: concrete or abstract, impersonal or general, singular or plural, feminine or masculine. We think that during the study of a certain noun, the student should make the dual analysis why this noun is for example specific and not general, why this noun is singular and not plural and further. In textbook often we encounter verbs with opposite meanings as dress-undress, like-dislike, wrap-unwrap, spell-misspell; adverbs with opposite meanings correctly-incorrectly, fairly-unfairly, quickly-slowly, shortly-mostly; names with opposite meanings as pleasure-

displeasure, ability-disability, responsibility-irresponsibility, joy-sadness; adjectives happy-unhappy, complete-incomplete, honest-dishonest, dependent-independent that are reflected even in opposite sentences for example, the boy climbed the stairs - the boy went down the stairs. We think that the rules about the formation of new words are understood and acquired if the students make dual interpretation of the words and the dual analysis of its formation. The study of transitive and intransitive verbs should be accompanied also with the analysis of changing the structure of the word, for example locomotives pull wagons - wagons are pulled by locomotives. In legends, fairy tales, fables the dual analysis should be done to indicate how are faced the evil with good, the truth with false, wisdom with ignorance, beautiful with ugliness. In classical myths are used dual interpretations where is shown that Gods get angry and joyful, cry and laugh, get bitter and get happy, revenge and make kindness, love and hate, just like human beings. In order to make obvious the contrast between two figures of speech, the student should make the dual analysis. Dual treatments can be applied in history analyzing together concepts of war and peace, victory and defeat. An event is always associated with the date on which it occurred, for example: Albania was declared an independent state on 28th November 1912 – 28th November 1912 reminds us of the fact that Albania was declared an independent state. Dual treatments are applicable in natural sciences. When we talk about the life of living things on Earth, the students have a clear understanding of the fact that living things are born and that they can't live forever, so there comes a day when they die. According to Gao (2000) "Duality in nature is amazingly beautiful, for it is the way nature was created. … If we are not confused very often about the duality of natural phenomena, we do not really understand what it is." (p. xiii), that's why it is the education's job to realize the right formation of the students related to these dual phenomena. In explaining the concept: solidification-liquefaction, evaporation-condensation, push-tow, day-night, light-shade, ebb and flow which can't be understood without each other is dual analysis.

Except achievements reached so far about the dual treatments model has still some issues that need to be studied. A study that will give detailed answer to the issue of effectiveness of dual treatments model in the teaching of mathematics in the other grades of elementary education will be field of our future studies.

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