A Basic Competences Assessment through a Multimodal Biopedagogic Classroom Design: Empirical Comparative Study

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The four basic competences according to the theory of “Biopedagogism” presented by Alahiotis and Karatzia-Stavlioti in 2008 (The International Journal of Learning, 15(3), 323-330) are considered to have an hierarchical evolutionary origin and an ontogenetic appearance that is as follows: Technological-T, Socialization–S, Language/Literacy-L and Numeracy/Theorotical-N/T. These are multifaceted with multimodality characteristics that develop in authentic Teaching-Learning-Assessment (T-LA) environments where communication is essential. Appropriate learning activities, including ones with cheiraptic and digital material, based in an analogues hierarchical and interactive cultivation of the four “biopedagogic” competences, could contribute to a more affective learning, through the physical maximization of human brain potential; that is, through the coordination of the pedagogico-educational praxis with the aforementioned considered biological basis of learning. A one school year empirical/experimental design was undertaken to test whether pupils’ learning is promoted by such innovative biopedagogic instruction. The four relative competences were evaluated in two Preschool classes, one Experimental-E (innovative instruction) and one Control-C. The four competences tested, were the basis for E and C teachers’ grading/measuring each pupil performance and also for formulating evaluative/qualitative comments. The methodological design was tested through the contrastive investigation of research tools reliability and validity. Both qualitative and quantitative data analysis showed that the E-class pupils exhibited significantly higher levels of competence acquisition and learning in general. A linear model was also constructed and revealed that the major determinant of all competences’ acquisition was the innovative/”biopedagogic” instruction. This hierarchical, interactive and multimodal form of T-L-A, could lead to a better understanding and application of knowledge construct, and learning; an issue that is already extended to Primary and Secondary school classes, an effort that is already being made, with encouraging initial data, and is expected to reveal

many issues regarding the construction of authentic, multimodal and socially rich learning processes.

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Introduction

Useful traditional educational and learning approaches are currently being under reexamination in an effort to overcome existing difficulties to explain the cognitive processes (Wagner 2010). On this basis, any innovative effective competence T-L-A (Teaching-Learning-Assessment) would be of interest if basic biological levels of knowledge construction are taken into consideration. To this direction, a T-L-A basic competences’ cultivation according to the new theoretical frame of learning, called “Biopedagogism,” could shed more light on the field of learning (Alahiotis and Karatzia-Stavlioti 2008). The meaning given to the term “competence” is considered wider than that of “skill,” more complex and deeper; it refers to the innate capacities of any individual that could be cultivated through proper pedagogico-educational interventions and may be expressed in varied facets of competence related learning such as knowledge content, skills, emotions and behavior (European Commission-EC 2008).

Brief Description of the New Biopededagogic Frame

Within “Biopedagogism”, any proper pedagogico-instructional intervention should be “coordinated” with children’s brain biological phylo-ontogenetic (evolutio-developmental) dynamics; thus, this new theory is based on three axons: The first is the evolutionary one, according to which, during the evolutionary process of the Homo species there was a gradual increase not only of the brain size, but of the complicated way of thinking, which led hierarchically and interactively in time, to cognitive/thinking and cultural changes (Dehaene 2007). This hierarchical construction is considered substantial for the sequential acquisition of human competences (Gärdenfors 2006). Within this evolutionary framework, four basic competences were extracted, with the T (Technological) to be considered that appeared first,

the S (Socializaton) second, the L third and that of N/T (Numeracy/Theorizing) fourth; during the evolutionary origin of each competence the previous reinforced, as a substrate, the evolution of the followed one in an interactive way.

The second axon, the cognitive developmental one, is mainly approached by the recent neuroscientific observations, according to which the developmental/ontogenetic configuration of at least the basic brain neuron networks is hierarchical; with those for attention to be shaped first playing an important role in the configuration of the first competence T through the design-creation-tools use, as well as of the S that is of the sensation and sensible characteristics, those of L to follow and lastly those of N/T (Posner and Rothabrt 2007). This developmental process is in a great analogy to the evolutionary one. The third axon is the pedagogico-educational one, and within the above biological framework, the four competences' relative teaching emphasis has to be of the form T>S>L>N/T in the small ages generally. This approach has to do with competence hierarchical cultivation and the relative instructional time devoted to each one (more time for T than for S, etc.).

The brain is genetically pre-programmed for specific structures that are distributed in different parts and coordinated, a process reflecting the holistic function of the brain (Dehaene 2007; Posner and Rothbard 2007); this calling for a need to have multimodality in both curriculum and classroom practice. Multimodality is a recent term (Kress and van Leeuwen 1996) that highlights the complex combinations between media (e.g. a book a screen), modes (e.g. speech, writing, image, music) and semiotic resources (fonts, intonation, colors. Moreover, the society's multicultural nature, in conjunction with the rapidly increasing diversity in technology, require a new multimodal and multidimensional approach to be understood (Cope and Kalantzis 2000). The present research aimed at investigating whether the pupils taught with the innovative multimodal competences' hierarchical and interactive biopedagogic way of the four basic competences cultivation, became able to learn more effectively.

Research Design and Methodology

The present research applied an experimental design method on the basis that there was a commitment to both conjoint goals (Brown 1992; Terron 2003) of instructional innovation in naturalistic classroom settings on the one hand, and theorizing on biopedagogism, on the other (Alahiotis and Karatzia-Stavlioti 2008).

Sample Choice and Characteristics

Two Preschool classes were used, one experimental (E) and one Control (C), which were in separate school units and areas of a city. The were chosen on the basis that they had

comparable number of pupils (E=20, C=17) at the age of five, with similar Socio-Economic-Status (SES) and general individual characteristics, that were tested for their comparability (see below). The two classes were selected through the study of their pupils' school records. Moreover, two corresponding Preschool teachers, who accepted to participate, had also comparable teaching experience, age and years of appointment in their particular schools.

The Empirical Research Process and Evaluation Design.

Both quantitative and qualitative approaches were used, in which the teachers worked with differentiated methodologies, but observed and evaluated their pupils' progress regarding each of the four basic competences acquisition in a similar frame of assessment, using similar, specific, competence related criteria. These criteria were formed during a prior pilot application (in May, previous school year) in Preschool classes of similar characteristics. The major criteria categories formed were almost the same for each competence, although they were given a varied, competence related content; the comments in these categories were analogous to the degree the pupils acquired the following qualities/characteristics/assessment crieteria: i) readiness/willingness, ii) methodic, iii) collaborative/participating, iv) critical, v) creative and vi) effective (see Appendix).

The duration of the Preschool experiment was planned to be of one school year, in order to have more detailed and longer observations, as well as more feedback from the classroom work, for obtaining increased validity. Five quantitative and qualitative evaluations/measurements of the performance on each competence were made from both teachers at the first, seventh, thirteenth, twenty-first and thirtieth week, respectively. Teachers were provided with evaluation sheets and were asked to use a Likert type scale from one to seven (1-7) scores for the quantitative approach, while the qualitative one was mainly based on teachers' descriptive comments analysis.

Preparation of Classroom Interventions and Implementation

Both teachers were informed on the clarification of the term "competence" as a horizontal, cross-thematic knowledge of expression that may interact with varying specialized skills; they are stable and multi-dynamic cognitive processes that can be reproduced in many places and communication contexts. E and C classes worked on the same themes/topics, the ones that the national CTC (Cross-Thematic-Curricula).

The E class teacher was informed on the innovative biopedagogic cultivation of the four basic competences in an authentic-naturalistic multimodal way within the existing national

CTC (Alahiotis and Karatzia-Stavlioti 2006). The framework of the E Preschool class T-L-A activities (and/or games) would be of technological-kinaesthetic(T) nature mostly (gradually introducing computer/new technology), starting on individual basis, with the group/social(S) element to gradually increase; analogous multimodal and individual-group approach consequently applies with language/literacy(L) and numeracy/theoretical(N/T) cultivation. Moreover, activities in this class could be combined in a synthetic form of T+S or T+S+L or T+S+L+N/T, for their interactive cultivation, but always within the interactive hierarchical biopedagogic framework of T>S>L>N/T.

The C class teacher was expected to simply apply the CTC and advised on isolating the four competences, evaluating them within the Preschool curricula instruction (Alahiotis and Karatzia-Stavlioti 2006), for obtaining comparable data. T-L-A in the C class, in opposite to the E one, was based on the traditional hierarchy of Preschool activities from the beginning of the school year; that is, whole class discussion (S) on language(L) and numeracy(N/T) based activities that are related to the theme under investigation and then, aesthetics and technology(T) on individual and group basis; That is, the general competence hierarchy is of the form S,L,N/T,T and differs seriously from the biopedagogic one (T,S,L,N/T); a situation that leads to additional differences regarding the competences' interactive cultivation and the emphasis given to them.

The researchers visited regularly both schools to observe the relative progress, to have unofficial interviews/discussions with the teachers and pupils and make observations in an evaluative formative way that targeted to the design improvement (Brown 1992); one researcher also participated several times in the T-L-A process in order to become more familiar with the pupils in order to express themselves more freely and comfortably. The information collected was useful in the comparison of the E and C teachers' comments.

Findings and Analysis

Sample Characteristics analysis

The χ^2test was applied to explore whether there are statistically significant differences between the pupils' characteristics of the two classes. As it is shown in Table 1 no such differences were found in terms of their gender, mother's occupation (MOCC) and father's occupation (FOCC), which was grouped into 3 major categories: 1) high professional, 2) professional and 3) manual (Willms 1992).

Table 1

Quantitative Approach

Comparison of the Evaluation Scores' Means

Extracted mean pupil's scores for each competence in every one of the five evaluations/measurements in the E and C classes are shown in Table 2. They were subjected to *t*-test analysis and showed, about after six weeks from the beginning of the experiment, that is after the second evaluations, from the third one, statistically significant differences between the E and C classes in favor of the E for each competence. The relevant pupils' mean score of all the four competences per evaluation/measurement also showed the same pattern (Table 3), that is a significant, much higher competence performance of the E pupils in comparison to the C ones; an issue that is of importance, if we consider these means as a proxy measure of the pupil's learning performance.

Table 2

Table 3

The dynamics of each competence mean pupils' score for each class (E and C) of Table 2 is better represented in Figure 1, showing more emphatically the performance diversion in favor to the E-biopedagogic class pupils. An increase was also found in the C pupils performance, who were taught with the national CTC, which is also considered useful (Alahiotis and Karatzia-Stavlioti 2006); however, the corresponding curve inclination in E pupils is much higher. Analogous situation, in terms of the mean of all competence performance of the E and C pupils, is also shown more clearly in Figure 2, where the numerical data of Table 3 are presented diagrammatically.

Figure 1

Figure 2

Analysis of Variance and Regression Analysis

In order to answer the question whether the quantitative scores for every competence evaluation/measurement, as well as for the mean of the sum of the scores in all competences at every measurement in both classes, were influenced by any of the pupils' personal and SES

characteristics (gender, father's-FOCC and mother's-MOCC occupation), or whether these scores differed between the categories of these characteristics, a series of one-way analyses of variance (ANOVA) were run. From this analysis (data not presented), no statistically significant differences were found between the E and C classes regarding the effect of FOCC and gender on the pupils' mean scores. When we focused our analysis on the mean score of all competences in the last evaluation/measurement (MSCALLCO5), which could be considered as the overall learning effect, the investigation regarding MOCC, the first measurement mean score of all competences (MSCALLCO1) and the groups of pupils of the two classes (CLASS), showed a significant effect on the score configuration of the MSCALLCO5 (Table 4).

Table 4

Given the results of this ANOVA analysis, a first question arises of whether each of those statistically significant factors (CLASS, MOCC, MSCALLCO1) detected in comparison to the dependent MSCALLCO5 variable, had statistically significant effect, in the cases where the rest of the factors were held constant. Moreover, a second question is related to whether all these factors combined produced a satisfactory predicting model, which could better explain the relative quantitative differences detected between the E and C class pupils scores at the end of the school year (MSCALLCO5) In relation to the first question, the estimated model, presented in Table 5, shows that all the independent variables had statistically significant effects after controlling the influences of the other factors.

Table 5

In terms of the second question, our analysis (Table 5) shows that the investigated three factors (MSCALLCO1, CLASS, MOCC) explain around 87 % of the variance of the MSCALLCO5 (R^2=0.87). This value is considered as a high percentage (Willms 1992; Oppenheim 2005), suggesting that the MSCALLCO5 variance can be explained, to a large extent, by the effect of the three referred factors. However, these factors do not contribute equally, with those of the MOCC (B= 0.388) and MSCALLCO1 (B= 0.360) to exhibit much smaller effects in comparison to the third one (CLASS), which has higher coefficient (B = 1.782). When e.g. MSCALLCO1 is excluded from the model, MOCC becomes the second most important factor, but still with very lower effect in comparison to the effect due to the

type of CLASS, that is between the C and E class. In short, both, the MSCALLCO1 and MOCC are interrelated showing that some of the differences in pupils' scores due to these two factors are related to mother's occupation. Moreover, the influence due to the CLASS factor, that is to innovative biopedagogic instruction applied, is the most important factor in raising E and C class pupils' differences (in favor of E) regarding their competence performance.

Qualitative Approach

Teachers' Comments Analysis

In the process of analysing teachers' descriptive comments, (i) our experience from observing and participating in the specific classrooms, (ii) our conversations with the teachers and their previous knowledge on educational goals, as well as (iii) the effective didactic approaches they shared with us, were taken into consideration (Jackson 2010). Additionally, (iv) we also had a feedback from the teachers in cases that the comment they had made needed more clarification, so that the reliability and the validity of the analysis could be increased. Such examples could be:

- the emphasis that was given to a pupil's characteristic,
- whether a conjoined characterisation was implied,
- if the description was very general or very specific.

During this process we finalized the assumptions that we had to make during the qualitative analysis. E.g. it is worth mentioning that:

- When teachers referred to a pupils' characteristic (e.g. methodical) by expressing frequency (e.g. rarely, usually, always) or emphasis (a little, very), we used a reprocical way of coding, i.e. by using numbers in ascending order as codes, such as: 1, 2, 3 and include these as counts of the specific references when counting the number of references made in each category.
- When teachers referred to pupils' performance in a positive or negative way, the counts were grouped accordingly.
- When teachers used a word (noun or adjective) that was very similar to another, wider and very commonly referred characteristic, the reference was counted in the category formed for the wider characteristic (e.g. systematic was counted as methodical).

The analysis of the relative evaluation sheets from both classes, confirmed the mentioned in the methodology criteria categories, as well as their usage from both teachers in all evaluations/measurements. We also extracted the percentages of positive and negative

comments made by each teacher in the first evaluation/measurement in order to explore the correlative validity (Krippendorff 2004), as this is presented below.

We underline at this point that the classroom progress, which was revealed regarding the differences in the frequency of the qualitative comments between the first and the last measurement, is an interesting outcome. As it is shown in Figure 3, a rise in the positive comments is obvious in favor of the E class; a shift is also seen towards the higher cognitive qualitative characteristics, as such of critical thinking and creativity, with this shift to have also a much higher rise in the experimental (E) class.

Figure 3

Additional approaches for research tool reliability and validity

Reliability of the way the teachers evaluated/scored the pupils in the quantitative criteria (see Appendix), was measured using the split-half method and the Cronbach's Alpha coefficient: the items (scores) of pupils at the first measurement, were divided into two halves at random in both classes and, were, then, intercorelated. The Cronbach's Alpha coefficient was more than 0.85, which means that the percentage of shared true variance is more than 72.25% (high intercorrelation). Since Cronbach's Alpha coefficient gives us an estimate of the proportion of the total variance that is not due to error, this represents the reliability of the scale used for measurement/evaluation (Oppenheim 2005).

As regards the research design validity testing, three approaches were utilized referring to:

(1) discussions with the teachers,

(2) discussions with peers-specialists in empirical research/experimental design, and

(3) analysis of the content that the descriptions/comments the teachers made in comparison to the quantitative data produced by the scores.

Apart from the appropriate research tool adjustments, that emerged from the first and second approaches, we also focused on the third one; that is, on the content analysis of teacher's qualitative comments that were made on the first evaluation/measurement for each pupil. More specifically, the teachers' positive and negative references/comments on each competence acquisition of every pupil was extracted, counted and subjected to correlation analysis with the reciprocal quantitative mean scores referring to each competence, through

the proper statistical package (SPSS-19.0). This approach to correlative validity (Krippendorff 2004) was performed to weight the extent to which one measure taken by the qualitative data (method A) can be substituted by another reciprocal quantitative data (method B); a strong correlation could be considered as strengthening both of them and consequently the validity of the data obtained. This aforementioned basic idea of correlative validity is that validity travels along high correlations between the findings of the two methods.

Table 6

The findings shown in the above Table 6, revealed very high, statistically significant, correlation coefficients for the positive comments of all competences, while for the negative ones the correlation coefficients were lower, but also statistically significant; the negative values of these coefficients indicate a negative relationship, that is, the higher scores the pupils the less negative comments obtained. Analogous findings also stand for all evaluations/measurements (data not shown). These findings strongly support the validity of both methods used, the quantitative and the qualitative and consequently that of the research tools applied.

Discussion and Conclusions

The basic competence hierarchical and interactive biopedagogic instruction in a multimodal CTC frame, applied in the E classroom pupils, clearly enhances pupils' general progress, increasing class and school effectiveness in comparison to the C pupils. This conclusion is supported by our findings of both quantitative and qualitative methods, as well as from the ANOVA and the extracted linear analysis model, according to which the most important determinant proved to be the CLASS; that is the innovative biopedagogic instruction. Moreover, the observed, to a great degree, parallel kinetics of the curves regarding the four basic competences' scores in the E and C classes, in combination to their more effective acquisition in the E class pupils, indicate that each competence has been developed more effectively in this class, through the proper hierarchical, interactive and multimodal way of cultivation, as this was expected by the theoretical considerations of biopedagogism (Alahiotis and Karatzia-Stavlioti 2008).

The fact that pupils' four competences performance differences start to appear between the E and C class after the second measurement, indicates that in order to reveal any (biopedagogic) T-L-A influence, a certain time period of its application is needed. This influence in our experiment is obvious in about six weeks' time (after the second measurement) from the initialization of the experiment. Analogous comparable relevant period of time of five weeks was detected through the ERP (Event Related Potential)

technique in an investigation of the systematic changes that took place in neural circuits of the brain as a reflection of vocabulary learning (McCandliss, Posner and Givon 1997).

Moreover, we could underline in brief additional interesting points that emerged in this research:

(1) Learning effectiveness can be influenced by a natural and mild biopedagogic intervention, as it was performed with the E class Preschool pupils; this can be due to the physical strengthening of the biological phylo-ontogenetic cognitive process, which was "parallelized" with the pedagogico-educational intervention/axon; that is, on the hierarchical and interactive cultivation in authentic, multimodal way of the four basic biopedagogic competences, which was of the form T>S>L>N/T. The differences between the E and C class performance, strengthen once more, the importance of the Preschool educational experience and cognitive development in general (OECD-PISA 2004; OECD-CERI 2007).

(2) For the reason that several sensitive–critical periods of learning in the small ages seem to be unknown (Posner and Rothbart 2007), their possible physical strengthening can be better approached by the effective multimodal biopedagogic instruction of Preschool pupils. Within such a frame a possible brain re-programming (Blakemore and Frith 2006; OECD-CERI 2007), through the presented more effective biopedagogic instruction and learning, could help pupils, with "semi-lost" learning opportunities, due to their poor T-L-A; or even pupils with mild learning difficulties, something which is worth investigating.

(3) The biopedagogic T-L-A performed could be also considered as contributing to the better understanding and improving the early development of metacognition, through the competences' instructional relation to critical thinking, to creativity, as well as to the individual and social effectiveness; characteristics observed to be much higher in the E class pupils.

(4) The cross curricular competences promoted in national curricula of several countries, and assessed as literacies (language, mathematical and scientific/technological) in the Program of International Student Assessment of the Organization of Economic Cooperation and Development (OECD-PISA 2004), can be effectively grouped into four categories, which are related satisfactory and match the discussed four basic biopedagogic competences (Karatzia-Stavlioti 2010; OECD-CERI 2007). Thus, the investigations on the effectiveness of the innovative T-L-A, could be extended to isolate from various national curricula possible parameters that relate to biopedagogism and can be used as explanatory factors of the differences of pupils' international performance (OECD-PISA 2004; OECD-CERI 2007).

It must be underlined that many strong claims are also made for the educational potential of new computer /information technologies, but few have been substantiated by research evidence; these technologies, introduced in the schools over the past two decades, did not contribute greatly to either the T-L-A transformation or the productivity expected (Mayer, 2010). Thus, most of the past optimistic predictions in terms of the educational technology impact have failed to be materialized (Mayer 2010), a position possibly due to technology application in the absence of a proper theoretical frame, as it is based on the biopedagogic model of the T cultivation, as well as of the other relevant and interactive to T biopedagogic competences (S,L,N/T) (Alahiotis and Karatzia-Stavlioti 2008) .

The presented research illustrated interesting issues on the way that instructional-learning innovative interventions could be effectively introduced to authentic classroom situations, with the teachers' participation and assistance. More specifically, we could support the view that this research also contributed in:

- substantiating the expected, according to biopedagogic theory, hierarchical and interactive significance of the four basic competences instruction for learning within a cross curricularity and multimodal frame,
- showing the effectiveness of the combination of quantitative and qualitative approach in research taken place in classrooms,
- defining the performed T-L-A techniques and the relevant classroom research based tools, as e.g. is the list of competence assessment criteria,

The assessed T-L-A biopedagogic application, even if it is considered as a first, general and pilotic approach, showed that it is simple, easy to use without difficulties, applicable in any school in the world, even within the frame of the existing curricula; it is also promising for its further improvement with the participation of educational practitioners; an issue that would be a challenge and help them reconceptualize their work in the classroom (Cobb, Zhao, and Dean 2009) and offer valuable feedback towards the refinement and further improvement of T-L-A biopedagogic tools. The discussed approach can be considered as a general educational tool, that can be used flexibly and creatively by the educators, who could exemplify and adapt the competence cultivation according to curricula/pupils/classroom specific characteristics; a situation that is also central to lifelong learning (de Corte 2010).

The outcome of the innovative T-L-A experimental approach encourages us for further research and applications, since many complex issues remain to be illuminated, as e.g. the improvement of the instructional biopedagogic tools or the magnitute of biopedagogic

influence in a following class. Thus, preliminary results from 1st year Primary school experimental classes, already show that pupils who were instructed biopedaggically in Preschool class in the previous school year, exhibit higher performance in comparison to those who were not taught biopedagogically in Preschool. Interesting preliminary results also stand in terms of secondary school E classes. Thus, biopedagism could be already marked out as a relative basic and generally applicable theoretical frame that could contribute to the strengthening of the role of the school, even to the promotion society's goals, that is increase individual, school and social effectiveness.

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Appendix

Teachers' Specific Evaluation Criteria Categories per Competence

i= Ready-willing ii=Strategy- Methodical iii= Collaboration-Participationiv= Analytical- Critical thought, v) imagination Creativity vi= Effectiveness

TECHNOLOGICAL (T)	1	2	3	4	5	6	7
i. The pupil is ready to use all the necessary (technological) materials for the accomplishment of every work/activity and he/she is also motivated and eager to start.							
ii. The pupil works methodologically and systematically for a technological work/activity.							
iii. The pupil can work with other classmates to practice/implement their technological competence related work/activity							
iv. The pupil can use his/her critical thought to make decisions and choices that are more effective in undertaking, organizing and carrying out his/her technological work/activity							
v. During activities of technological nature, the pupil is able to imagine new ways/paths in the creation of an outcome with fantasy							
vi. Pupils are effective when the technological work/construction/activity is actually what they were supposed/expected to accomplish.							
SOCIALIZATION (S)	1	2	3	4	5	6	7
i.The pupil is ready and willing to work in a way that cultivates his/her social competence. He/she does not hesitate to socialize, cooperate, be responsible and have empathy and self-control when working in groups (e.g. is not shy or hostile).							
ii.The pupil works with others and he/she is willing to change roles and/or strategies (and communicate these changes to others) in order to become more effective.							
iii. The pupil may potentially participate in all stages of learning in collaboration with his/her classmates–the class works as learning community.							
iv. The pupil may take simple critical decisions on his/her learning in a collaborative way							
v. When the pupil works together with others and creates innovative learning outcomes in an imaginative way.							
iv. When the outcome of the collaborative work/activity is what was supposed to be.							
LANGUAGE (L)	1	2	3	4	5	6	7
i. The pupil is ready and willing to work in language related work/activities, oral and/or written							
ii. The pupil works methodologically e.g. in oral discussions, in written work/activity.							
iii. The pupil can work individually and together with others in oral language work as well as in written individual and/or group based language related work/activities.							
iv. The pupil can apply his/her critical thought in oral and written language related work/activities.							
v. The pupil is able to apply his/her imagination in oral and written language related work/activities and create individual and/or group innovative oucomes.							
vi. The outcomes of the oral and written language related activities are as supposed and mostly related to the goals/aims set for the specific thematic content.							
NUMERACY/THEORETICAL (N/T)	1	2	3	4	5	6	7
i. The pupil is ready and willing to work in arithmetic related work/activities, oral and/or written							
ii. The pupil works methodologically e.g. in oral discussions, in written arithmetic work.							
iii. The pupil can work individually and together with others in oral arithmetic work as well as in written individual and/or group based related work/activities.							
iv. The pupil can apply his/her critical thought in oral and written arithmetic related work/activities.							
v. The pupil is able to apply his/her imagination in oral and written arithmetic \related work/activities and create individual and/or group innovative outcomes.							
vi. The outcomes of the oral and written arithmetic related work/activities are as supposed and mostly related to the goals/aims set for the specific thematic content.							

Table 1

Display of Cross-tabulation Results between Pupils Sample Characteristics and Type of Class (Control and Experimental) (*N*=37)

Characteristic	Control (*n*= 17)		Experimental (*n*=20)		χ^2
Gender	Frequency	Percentage(%)	Frequency	Percentage(%)	
Boys	10	58,8	10	50	0,591
Girls	7	41,2	10	50	
Mother's occupation (MOCC)					0,743
1. High professional	2	11,8	1	5	
2 Professional	14	82,3	18	90	
3. Manual	1	5,9	1	5	
Father's occupation (FOCC)					0,254
1. High professional	4	23,5	9	45	
2. Professional	12	70,6	11	55	
3. Manual	1	5,9	0	0	

Note: All χ^2 values do not show any statistically significant differences regarding the characteristics tested between the pupils of the Experimental (E) and Control (C) Class.

Table 2

Mean Pupils' Score at each of five Evaluations/Measurements for Everyone of the Four Basic Competences in two Preschool Classes – Experimental (E) and Control (C), and t Test for the Statistical Significance of their Differences (N=37)

Competence	Measurement	Class	Number of students	Mean scores	Standard error of Mean	*t* values and 35 degrees of freedom (df)	95% CI of the Mean Difference
		E	20	2,3	0,14		
Technological	1st	C	17	2,1	0,21	0,75	[-0,32, 0,71]
		E	20	3,0	0,07		
	2nd	C	17	2,8	0,21	0,83	[-0,25, 0,61]
T		E	20	4,6	0,15		
	3rd	C	17	2,9	0,21	6,57*	[1,5, 2,18]
		E	20	5,5	0,25		
	4th	C	17	3,8	0,20	5,18*	[1,03, 2,33]
		E	20	6,1	0,11		
	5th	C	17	3,9	0,22	,99*	[1,68, 2,66]
Socialization		E	20	1,9	0,21		
	1st	C	17	1,8	0,21	-0,15	[-0,46, 0,4]
		E	20	2,7	0,13		
S	2nd	C	17	2,5	0,22	0,47	[-0,39, 0,64]
		E	20	4,0	0,18		
	3rd	C	17	3,0	0,17	4,01*	[0,49, 1,05]
		E	20	5,2	0,20		
	4th	C	17	3,3	0,23	6,4*	[1,3, 2,5]
		E	20	5,8	0,16		
	5th	C	17	3,9	0,28	5,99*	[1,23, 2,5]
Languge/Literacy		E	20	2,3	0,17		
	1st	C	17	2,0	0,27	0,64*	[-0,42, 0,80]
		E	20	3,0	0,12		
L	2nd	C	17	2,7	0,23	1,14	[-0,23, 0,82]
		E	20	4,4	0,21		
	3rd	C	17	2,9	0,20	4,82*	[0,81, 2,00]
		E	20	5,8	0,15		
	4th	C	17	3,7	0,17	8,81*	[1,57, 2,5]

Note: E: Experimental Class. C: Control Class

CI: Confidence Intervals. * $p < .05$. ** $p < .01$ level

Table 3:

Mean Pupils' Score for All the Four Competences at Each of the Five Evaluations/Measurements in two Preschool Classes – Experimental (E) and Control (C), and t Test for the Statistical Significance of their Differences (N=37).

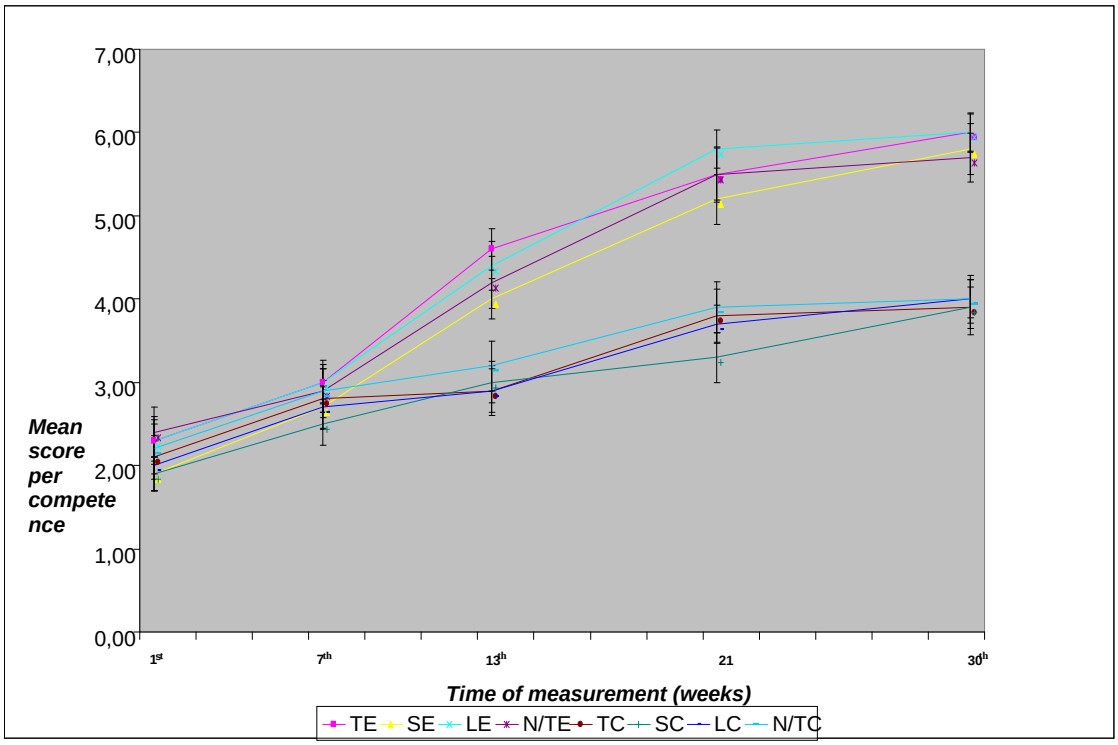
All competences (T,S,L,N/T)	Measurements	Class	Number of students	Mean scores	Standard error of Mean	t values and 35 degrees of freedom (df)	95% CI of the Mean Difference
Mean of T+S+N+N/T score sum per Measurement	1st	E	20	2.16	1,99		
		C	17	2,07	0,20	0,39	[-0,38, 0,56]
	2nd	E	20	2,88	0,09		
		C	17	2,75	0,20	0,58	[-0,31, 0,56]
	3rd	E	20	4,28	0,16		
		C	17	3,00	0,17	5,35*	[0,79, 1,76]
	4th	E	20	5,47	0,17		
		C	17	3,66	0,16	7,70*	[1,33, 2,30]
	5th	E	20	5,86	0,11		
		C	17	3,96	0,18	9,30*	[1,48, 2,32]

Note: E: Experimental Class. C: Control Class

CI: Confidence Intervals. * p < .05 . ** p < .01 level

Figure 1

Diagram Showing the Dynamics of Each of the Four Competences (T-S-L-N/T) During the Experiment in both the Experimental and the Control Preschool Classes; Each Measurement Represents the Pupils' Mean Scores per Competence.



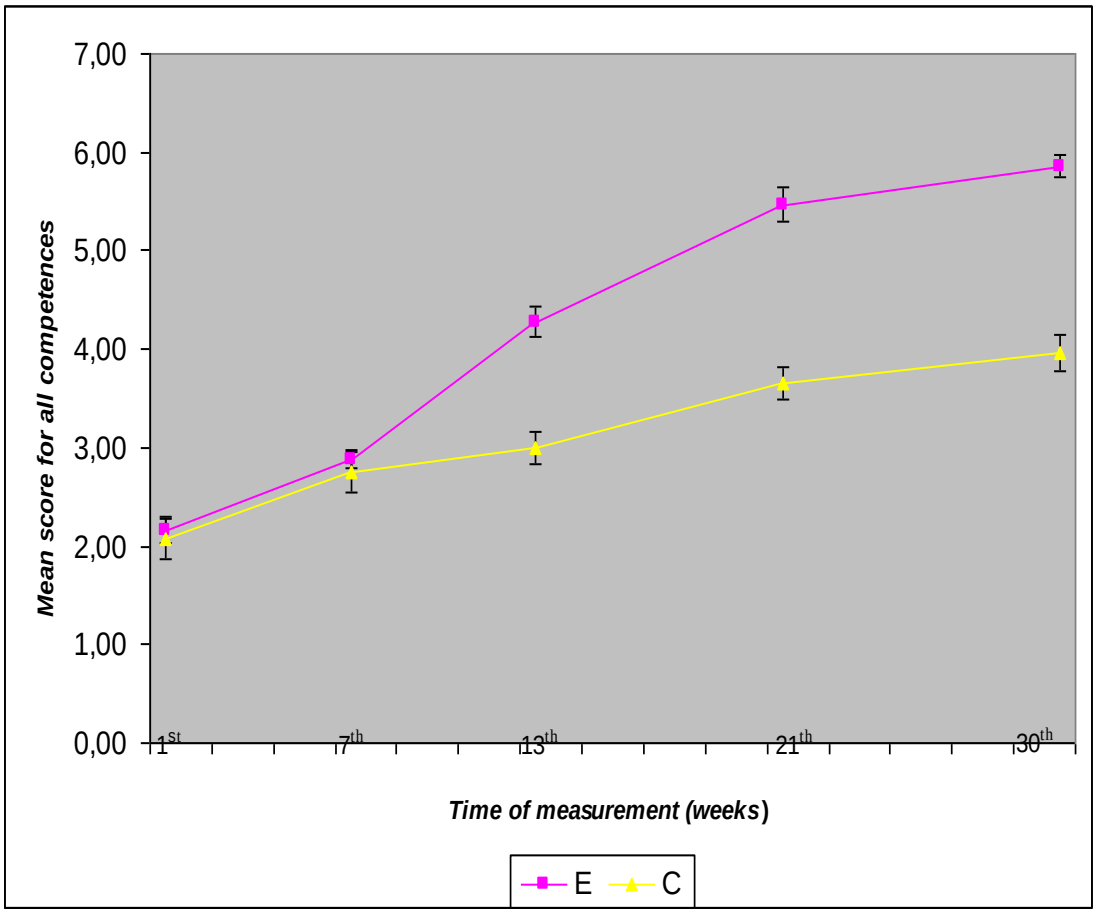
Note: TE-SE-LE-N/TE denote the T-S-L-N/T competence means in the Experimental- E class

TC-SC-LC-N/TC denote the T-S-L-N/T competence means in the Control-C class

Bars denote Standard Errors

Figure 2

Diagram Showing the Mean Scores of All the Four Competences in Both the Experimental (E) and the Control (C) Preschool Classes.



Note: E: Experimental Class, C: Control Class

Bars denote Standard Errors

Table 4

Test of the Statistical Significance of the Differences in the Pupils' Scores Means of all Competences in the Last Measurement (MSCALLCO5)

		Sum of Squares	df	Mean Square	*F*
CLASS	Between Groups	33,147	1	33,147	85,608**
	Within Groups	13,552	35	,387	
	Total	46,699	36		
MOCC	Between Groups	16,666	3	5,555	6,104**
	Within Groups	30,034	33	,910	
	Total	16,432	36		
MSCALLCO1	Between Groups	15,145	9	1,683	2,050*
	Within Groups	31,554	27	1,169	
	Total	46,699	36		

Note: CLASS stands for the two types of classes one Experimental (E) and one Control (C). MOCC stands for mother's occupation, MSCALLCO1 stands for every pupil's mean score for all competences in the first measurement and MSCALLCO5 stands for every pupil's mean score for all competences in the fifth (last) measurement.

CI: Confidence Intervals, * $p < .05$. ** $p < .01$ level

Table 5

A General Linear Model for the Prediction of the Mean Score of all Competences in the Last (fifth) Measurement (overall learning effect) (MSCALLCO5)

MODEL:Variables	*B*	*Beta*	*t*	95,0% *CI* for *B*
(Constant)	0,065		0,153	[-0,802, 0,932]
CLASS	1,782**	0,790	12,302	[1,487, 2, 076]
MOCC	0,388**	0,230	2,869	[0,113, 0,664]
MSCALLCO1	0,360**	0,218	2,742	[0,093, 0,627]

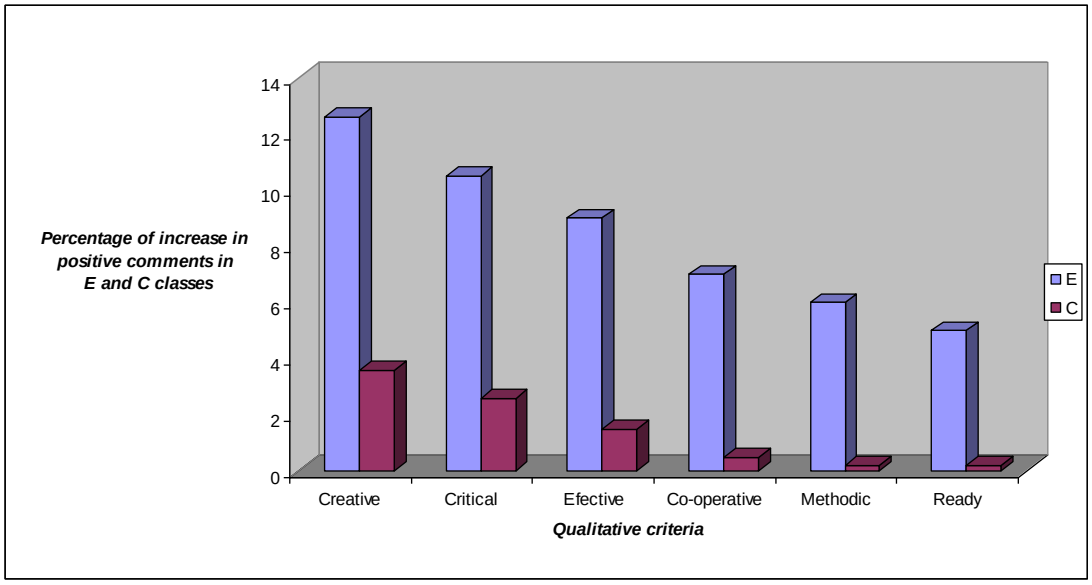
R^2=0,87 (Adjusted R^2=0,86)

Note: CLASS stands for the two types of classes one Experimental (E) and one Control (C). MOCC stands for mother's occupation. MSCALLCO1 stands for every pupil's mean score for all competences in the first measurement, and MSCALLCO5 stands for every pupil's mean score for all competences in the fifth (last) measurement.

CI: Confidence Intervals. ** p < .01 level

Figure 3

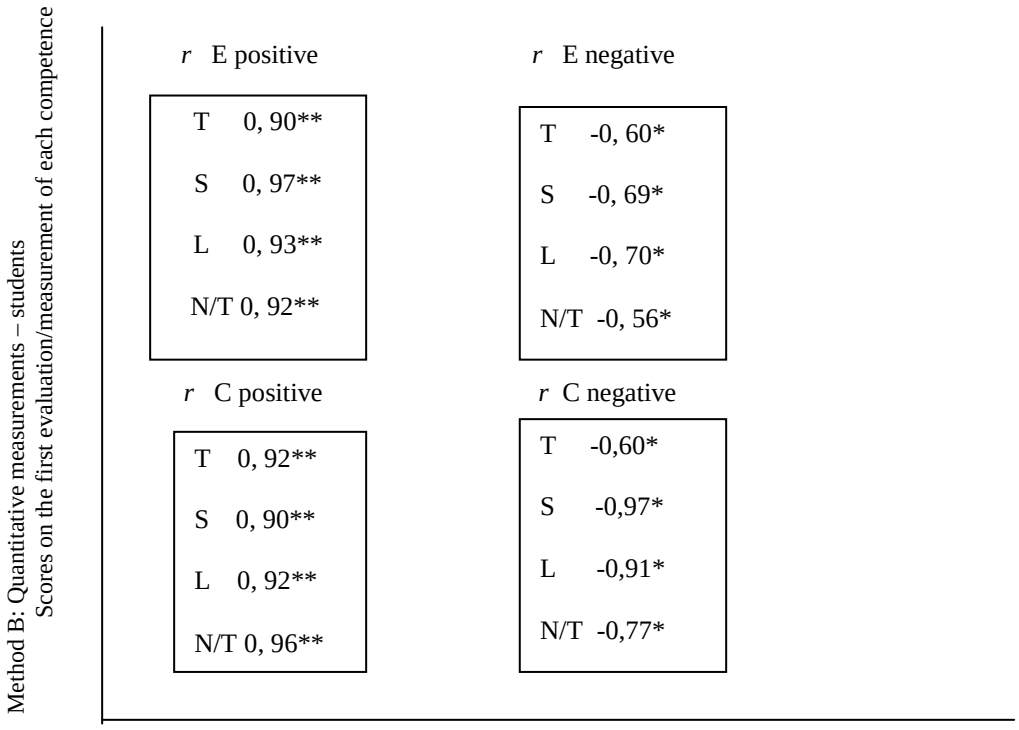
Percentages of the Increase from the First to the Fifth Measurement, of the Number of the Teachers' Positive References, for both Classes E and C, Grouped According to their Relation to the Qualitative Criteria Categories, as these are Presented in Appendix



Note: E: Experimental Class. C: Control Class

Table 6

Correlative Validity as it is Shown by the Correlation Coefficients (r) Between the individual Pupil's Initial Quantitative Measurement Scores per Competence and the Qualitative Content Analysis Findings from the Teachers' Comments (positive and negative) Made at the Same Period



Method A: Numbers of positive or negative teachers' comments from the qualitative

Content analysis per competence on the first evaluation/measurement

Note: E: Experimental Class. C: Control Class

* p < .05 . ** p < .01 level