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# **Statistical Approach and Documentary Metanalysis to Measure the Impact of New Teaching Methods in Pupils of Elementary Schools**

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## **Abstract**

Statistical approach and Documentary metanalysis are methods which we have used to conduct the present study. Statistical approach is referred to Bayesian-Laplace rule used to estimate the impact /outcomes of new teaching methods on creative/critical thinking of pupils and their high performance. Documentary analysis is referred to a systematic process for evaluating documents-16 literature sources/cases. In other words the study deals with the role of modern teaching/learning methods in Greek elementary schools and their outcomes. Essentially we looked for to investigate whether the using of innovative teaching/learning methods have positive results in Greek elementary schools. To this aim, Bayesian-Laplace and Documentary-analysis tools used 16 key-relative cases, we assess and predict the impact of new teaching methods on critical/creative thinking and learning of pupils. The main advantage of our combined method is the fact that, despite the lack of large number of data/cases, the two tools gave us an accurate enough outcome of the improvement in pupils' performance. The data/information/cases were collected from the 16 relative cases and ten unofficial interviews from primary school teachers, working in different school-units and different but innovative teaching methods. The ten unofficial interviews were conducted as free and open-ended questions in order to help us to get useful information about the creative/critical thinking strategies the teachers used in classrooms and outdoor teaching. Finally, the originality of the work lies in the fact that through an analysis of

16 relevant works/cases, we could to result in outcome expressed as percentage of positive impact on pupils' critical and creative thinking.

**Keywords:** Teaching Methods, Bayesian-Laplace Rule, Statistical Approach, Documentary Metanalysis

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## 1. Introduction

The main purpose of new teaching/learning methods to elementary schools is to upgrade the creative / critical thinking of pupils and their high performance. It is a difficult deal since the research on such topic needs a combination of qualitative and quantitative statistical tools. We decided to use an adhoc statistical approach and documentary metanalysis, e.g a combined method. Statistical approach is referred to Bayesian-Laplace rule used to estimate the impact of new teaching methods on creative / critical thinking of pupils and their high performance. Documentary analysis is referred to a systematic process for evaluating documents-literature sources. In other words, the study deals with the role of modern teaching/learning methods in Greek elementary schools. Essentially we looked for to investigate whether the reality used by innovative teaching/learning methods have positive results in Greek reality of elementary schools. To this aim, using Bayesian-Laplace Statistical Rule and Documentary-analysis and based on 16 key relative studies we could to assess the impact of new teaching methods on critical/creative thinking and learning.

(Anfara, 2002; Bisht, 2022; Biesta, 2007), widely agree that even to teaching in elementary schools should not only focus on knowledge of scientific content, but on cultivating pupils' scientific habits of mind and developing their ability to participate in an investigative process. According to Cardozo-Gaibisso et al (2019), the evolution of educational methodology and technology over time and the changing of educational needs, even in elementary schools, have led to modern teaching methods that have transformed the way we learn and teach. These new teaching methods, which focus on the pupils and not to the process and use teaching technologies to enhance learning, are not only effective but also essential for education in the 21st century. (Broekkamp et al, 2007; Cardozo-Gaibisso L et al, (2019) argue that the new teaching methods recognize that, each pupil is unique and that learning is not one-dimensional but multidimensional phenomenon.

When referring to modern teaching methods, we refer to learner-centered pedagogical approaches that aim to cultivate active participation, critical thinking, creativity, and collaboration. These approaches are grounded in contemporary educational theories and emphasize experiential and inquiry-based learning. The most representative among them include the following:

- **Project-Based Learning (PBL):** Students develop problem-solving abilities and creativity by undertaking extended projects or tasks of authentic relevance, which require organization, teamwork, and independent research. Through this process, they construct knowledge collaboratively while connecting learning to real-life contexts.

- **Problem-Based Learning (PBL):** Students strengthen their analytical and critical thinking skills by engaging with complex, authentic, or simulated problems. They are encouraged to identify issues, formulate hypotheses, design possible solutions, and justify their reasoning based on evidence and reflection.

- **Flipped Classroom:** This approach promotes active learning and learner autonomy. The theoretical input is provided before class through digital materials, while in-class time is devoted to collaborative activities, practical applications, and reflective discussions that deepen understanding.

- **Gamification:** Refers to the integration of game-based elements—such as goals, feedback, rewards, and friendly competition—into the learning process, with the aim of enhancing students' motivation, engagement, and participation.

- **Collaborative Learning / Teamwork:** Students work cooperatively in small groups to complete tasks or solve problems, developing communication, social, and interpersonal skills, while also engaging in mutual learning and shared responsibility.

- **Experiential Learning:** Learning is based on direct experience and active experimentation, followed by reflection and conceptualization, as described in Kolb's experiential learning cycle (1984). This process enables learners to transform experience into meaningful knowledge.

(Bowen, 2009; Campain, et al, 2010) claim that, from digital and e-learning to experiential and interactive educational techniques, modern approaches provide a framework where pupils can develop critical thinking, creativity and adhoc personal skills This educational shift is a necessary step in shaping young children being ready to face the challenges of the modern world. In the modern world, teaching has shifted towards more interactive and pupils -centered teaching methods. According to (Burksaitiene, 2013; Brannen, 2005), the new pedagogical theories emphasize the importance of seeing the pupils as an active participant in the educational process, encouraging autonomous learning, critical thinking and creativity. Today, the need for innovation in teaching to primary education is more urgent than ever, as modern societies require people with skills that go beyond the simple memorization of knowledge. (Dagklis and Zouganelis, 2008; Dutta et al, 2018), argue that the integration of approaches such as experiential learning, team- working and the integration of new educational technologies into teaching are key elements for creating a learning environment that is compatible with the demands of the 21st century According to (Dochy et al, 2007; Dutta et al, 2018; Earl, 2003) the aforementioned methods focus on the active participation of pupils and the development of critical thinking and personal skills. In this paper we will see how new teaching methods and new teaching technologies can practically increase the creativity and critical thinking of young pupils.

## 2. The Research on Teaching /Learning Methods in order to Asses and Predict the Impact and Outcomes of each Method

In this paper we used Bayesian-Laplace rule and Documentary Analysis, meaning predictive and prescriptive statistical tools. The data for this research are historical from Greek elementary schools referred as adhoc empirical cases. The above research tools are enough accurate dealing *with* qualitative cases. Research hypotheses about our topic are based on the contemporary progresses and new teaching theories emerging from the over-time historical data and the relative literature. According to (Cohen, 1988; Creswell, 2018) education researchers often avoid engaging with the literature and theories of the certain topics in order to be more open to understanding the perspective of the research subjects. The relation of researchers with the research object and the environment is naturalistic, which means that they avoid any form of manipulation, irritation, interference or disturbance. Education researchers take the subjective response and reflection of students for granted and tries to take them into account as an integral part of the research process. (Fies & Marshall, 2006; Hendrickson, 2012) argue that the psychological-cultural relation between researchers and pupils is interpersonal and empathetic. They are involved in the subjective reality of pupils with the aim of a deeper understanding of their perspective, of understanding the socio-cultural reality through their own eyes. The interaction between researchers and research subjects is based on proximity, on participatory observation, which is considered essential for a deeper understanding of their perspectives. According to, (Isari & Pourkos, 2015; Kaldi, 2008; Matsagouras, 2006) the subjects of the research - pupils, are active and their direct, creative participation in the research process is taken for granted. The research design is usually unstructured, open and constructed during the research process, constantly adapting to new, unexpected data. In qualitative research, researchers are not interested in the statistical representativeness of the sample but in minimizing the statistical error due to a small number of non-quantitative data. Their attention is focused on a deeper understanding of the perspective of a small number of pupils and, on case studies. (Aitymova et al, 2023; Bowen, 2009; Brannen, 2005; Bloom et al, 1971), claim that the research tools vary depending on the pupils and the heterogeneity of information and its individual manifestation is a constituent element of this type of research. The essence of such research does not consist in the objectivity and standardization of qualitative data, but in a good approach to their assessment. The most important thing is their richness and depth, the individual perspectives of the pupils, their specificity and uniqueness. The data are based on dense descriptions and are, therefore, considered small-data, in contrast to the big-data of quantitative approaches. The object of analysis is the pupil as a whole, e.g. the analysis of his complex behavior and perspectives and not a small number of variables and, therefore, it cannot be impersonal. According to (Campain and Yang, 2010; Guskey, 2005; Jackson et al, 2011) it is considered that pupils, as human beings, cannot be broken down into a set of distinct and separate variables and therefore the analysis of their behavior should, if we want it to be valid, have a holistic character. The complex interdependencies or couplings between the various aspects and dimensions of pupils' behavior cannot be reduced to the relationships between a few variables. (Ahmad and Awan, 2020; Al-Ghasab, 2022; Joseph et al, 2023), compared pupils' thinking structure through the use of the logic of variables distorts the nature of social phenomena and of the pupils themselves as learning activators. The aim of the previous analysis is to understand the pupils' mindset, their individual perspectives along with the context in which they think/learn into classroom. Analyzing of perspectives, the most education researcher can do is to classify them and distinguish ideal types within them, taking into account various learning criteria. Mathematics and statistical techniques are considered partly necessary to quantify the outputs. The use of new information and communication technologies (ICT) is mainly limited to organize and execute of empirical researches in elementary schools and their little pupils. (Stokking et al, 2004; Trilianos, 2008; Walker, 2012), argue that the data resulting from interviews, narratives and observations of teachers and pupils can be presented in various descriptive ways. The object of the qualitative research in teaching methods is not simply to describe qualitatively the various aspects of a reality, but to systematize it in order to reach higher-level conceptualizations and syntheses. Generalizations are related to finding relations between the various cases, to classifying them, to creating typologies and ideal types. To such researches the logic of content analysis, categorization and classification prevails. According to (Bisht, 2022; Matsagouras, 2006; Namitha, 2018; Sharples, 2015; Spyropoulou et al, 2010; Stokking et al, 2004;Trilianos, 2008; Walker, 2012) only a good qualitative research can assess and predict the impact of new teaching methods on the performance of young students and be connected to theory. Essentially, the aim of such research results is to delve into a small number of cases, but being able to reveal the specificity and focusing on the speciality and uniqueness.

## 3. The Role of School-Teachers to Modern Teaching Methods and Their Impact on Pupils' Performance

The assessment of the modern teaching skills of teachers is carried out on the basis of two dimensions, the quality of teaching and the skills of teachers. Having as a guide the Dynamic Model of Educational Effectiveness, the paper seeks to capture on the one hand the quality of teaching and the investigation of the effect of the teaching effectiveness of teachers on the cognitive creative development of the participating students and on the other hand it investigates whether the effect of the teaching skills of teachers manages to influence the overall qualitative and quantitative performance of the students.

Yet, in the content of constant rearrangement of knowledge, changes in technological dimensions, social relationships and values, the role of the creative teachers in elementary schools is very important. (Sharples, 2015; Smolkowski et al, 2018; Trilianos, 2008) argue that the teachers' role has escaped from the traditional models that gave them the advantage that they

exclusively are adhoc holders of knowledge. Social conditions change the school reality and therefore the role of the teachers). The social and economic changes that are reflected in the role of the teacher are the cultural changes, the evolution of technology and the speed of information movement, in combination with the continuous increase in knowledge, which have shaped another perception of the role and work of the teachers, emphasizing the social dimension of their role. In the historical path of Pedagogy, various theoretical approaches have been expressed regarding the characteristics that make up the role of the teachers and their personality. These theoretical approaches had as their starting point various pedagogical, philosophical and religious currents of the time. Ethical concepts want the teachers to be comprehensive personalities, who will be distinguished by pedagogical skills and who will love his students. At the same time, the teachers, possessors of wisdom and knowledge, must offer/transfer to their students the previous competences. The challenges therefore posed by the modern globalized learning environment require teachers to be comprehensive personalities, who will be distinguished by pedagogical skills and who will be interested in the benefit of their students. What modern society requires from the teachers is to be innovative, that is, to be constantly informed about new developments that take place both at the psychological, pedagogical, socio-cultural level, and at the technological level, and above all to have agility, flexibility and the ability to be adapted to new roles. According to (Biesta, 2007; Bloom et al, 1971; Cardozo-Gaibisso et al, 2019; Creswell, 2018; Dagklis and Zouganelis, 2008), the profile of the teachers today is clearly defined through the quality of their theoretical training, the level of their know-how and the overall adequacy of their psycho-emotional and social identity. In particular, elementary education, training, and initiation into psycho-pedagogical research are the researched areas that must make up the content of the educational competences of the modern teachers Elaborate on this in your own words.

#### **4. Approaches to Assess/Evaluate Teaching Methods that Promote Pupils' Critical/Creative Learning/Thinking-Application of "Learning Curve" in Pupils**

The best tools to deal with qualitative data/information are these we have used since they fit to such researches. Creative education means an enough complex teaching system; therefore, the teachers have to be equipped the respect competences. Since creative education leads to smart and critical thinking of students this as a stochastic process will have to be measured with adhoc statistical tools. The above mean that we have to be as researchers careful. Probably we not immediately realize the difficulties dealing with such issues. (Von Misses, 1981), Bayes and Laplace used probabilities when there is no sure path in assessing the results/outcomes in qualitative cases. Probabilistic calculus allowed them handling research cases in which the necessary information wasn't available, so as to allow them to conclude in logic results.

Further and commenting on the topic we know that teachers in their everyday teaching practice are constantly called upon to make decisions in situations -new teaching methods- characterized by stochasticity and uncertainty. And they make them, consciously or unconsciously, by probabilistically (Biesta, 2007; Fies & Marshall, 2006; Johnson et al, 2009; Isari and Pourkos, 2015).

Probabilistic reasoning allows the handling of situations in which complete information is not available-information regarding quality of teaching includes stochasticity, so as to allow the categorical handling, from a logical point of view. However, it enables the best possible answer that the available information (indications) allows. In addition, researches done by (Namitha, 2018; OECD, 2018; Perlman, 2003; Salmi and Thuneberg, 2019), claim that the previous define not only the probability of the truth of a hypothesis based on given (insufficient) indications, but also what degree of conviction someone can have in this hypothesis. In other words, the answer is approximate and a measure of the uncertainty surrounding the teaching issue. (The estimation of teaching impact on pupils' creative and critical thinking based on and advances through inductive reasoning where, from a set of observations, we arrive at a general conclusion based on a specific methodology. But, because no matter how many observations we make, which are favorable to the hypothesis under consideration, if an observation is unfavorable to it, it refutes it. The general conclusion will always be probabilistic in a broad sense and it will have values between 0 and 1 and, while it can be reduced to zero with a negative observation, it will never be able to reach the value of certainty 1, no matter how large the number of observations. (Dagklis & Zouganelis, 2008; Dutta et al, 2018), argue that, as the number of observations increases, a convergence of the values tend to a limit which, as the number of observations increases, they deviate less and less from the true value. According to (Dagklis & Zouganelis, 2008; Dutta et al, 2018; Earl, 2003; Fies & Marshall, 2006; Jackson et al, 2011; Johnson et al, 2009), Bayes and Laplace, based on the foundation of Probability Theory, provided a solid theoretical framework for quantifying uncertainty and drawing conclusions on matters that are not absolutely deterministic. Yet, Documentary Analysis helped us to structure more systematic the 16 papers used as historical data, or cases, or documents so that their elaboration with Bayes/Laplace statistical tool to be facilitated.

Another issue regarding the smart learning methods is how such methods can speed-up qualitatively and quantitatively the learning curve. Learning curve (LC) is the graphical representation of the average learning rate of pupils. The learning process is an exploratory and significantly non-deterministic process of discovery, which tends to have different rates of progress-improvement, or dynamic learning. Theories about the shape of these curves that use deterministic rules regarding the learning of pupils are sometimes very useful. The term LC refers to the variable L (past learning level in time  $T_0$ ) that tends to follow an increasing course and then in time  $T_n$  and tends to decrease to a limit L. So, as a LC is understood the graphical relationship between the amount QI of measurable learning and the time  $T_i$  needed for learning. (Baldi & Long, 2001; Bazeley, 2007; Brannen, 2005; Koleza, 2020; Sharples, 2015; 2010; Vennou et al, 2018), claim that the term LC was initially introduced in

educational and behavioral psychology and they considered that LC term acquires a broader meaning and for this the named it "Learning Process Improvement Curve"

In the smart teaching analysis, it used to use the logarithmic approach that facilitates to convert quantitative data to qualitative one measuring the rate of learning growth-critical/creative learning. According to (Baldi and Long, 2001; Bazeley and Jackson, 2013; Cardozo-Gaibisso et al, 2019; Cohen, 1988; Jackson et al, 2011), young students' critical thinking through learning development refers to a sophisticated learning process within a complex educational system with varying rates of improving/upgrading. In general, knowledge through learning increases over time, following a sigmoid curve "S" which has a different shape depending on the time scale  $T_i$  of the teaching process. It has also now been associated with a theory of evolutionary biology, "the theory of punctuated equilibrium" and other types of evolutionary change in complex learning systems generally associated with innovative teaching, organizational educational behavior and the management of group learning within school classrooms. In such educational processes characterized by a rapid emergence of new teaching features, a complex learning process seems to take place within the elementary educational systems themselves, which when are observable, reveal learning curves of varying rate that accelerate or slow down the rate of evolution of dynamic learning (Baldi and Long, 2001; Bazeley, 2007; Bazeley and Jackson, 2013; Perlman, 2003). H. Ebbinghaus (1885) is the first expert who well-described the learning curve concept-LCC. He found that, the time  $T_i$  needed for a student to memorize  $Q$  knowledge, increases sharply with a rate  $R$  when the number of concepts  $Q_s$  increases. The math formula of Ebbinghaus curve is:

$$R(t) = R_0 * e^{-\lambda t} * Q_s$$

where:

$R(t)$  = the percentage of knowledge that a pupil remembers at time  $t$ .

$R_0$  = the initial knowledge when  $R(t) = X\%$  at the beginning.

$\lambda$  = The rate of forgetting of knowledge, the larger the  $\lambda$  the faster the forgetting.  $t$  = time that passes after learning.

The above means that, even the most efficient qualitative teaching methods have limits, since almost everyone after the lessons remembers only the 80% of taught subjects. Within a few days, 50% of knowledge is lost and then forgetting continues but more slowly. (Baldi and Long, 2001; Bazeley, 2007; Brannen, 2005; Cardozo-Gaibisso et al, 2019; Cohen, 1988; Perlman, 2003; Woolfolk, 1995), gave a more detailed description of the learning curve as a useful educational tool. They also referred to the three properties of different qualitative types of learning curves, such as negative learning growth, positive learning growth, Plateau's and Ogive/cumulative frequency curves. The application of statistical models in the teaching process can help school-teachers to understand better the needs of their pupils supporting them to design more effective and modern learning strategies. Yet, Perlman, based on the psychology aspect of memory, say that education should provide the pupils with knowledge that will withstand time to the greatest extent possible. All the previous referred experts argue that, the modern learning methods in order to be implemented effectively need school-teachers with high (Perlman, 2003). The school-teachers must provide the pupils with knowledge  $k$  that can withstand time  $t$  to the greatest extent possible  $d_{max}$ . The knowledge  $k$  that is stored in the memory of each pupil through teaching and experiences is not in any case all retrievable. Some of it is forgotten after time  $t_x$ . However, it does not mean that it is completely lost from pupils' memory. This problem makes the issue of smart learning and the required teaching even more complex and difficult. Education must therefore provide him with knowledge  $K$ ,  $C$  complexity that can withstand time to the greatest extent possible. This behavior is frequent and particularly concerns teachers who are usually called upon to solve the problem of the retention of knowledge  $K$  in the memory of students'  $t_{max}$ . The advice of parents/teachers "you should read more" is in the right direction, but in many cases it does not solve the problem of critical/creative thinking since the issue is not only that the pupils should read more, but that he is required to read in such a way as to enhance the essential integration of knowledge  $k$  in his long-term memory  $t_{max}$ , creating resistance to the natural tendency to forget. According to (Brannen, 2005; Cardozo-Gaibisso et al, 2019; Cohen, 1988; Perlman, 2003; Woolfolk, 1995), (almost to the same way), the basic formula that describes the best quality level of deep and creative learning is the logistic function known as sigmoid function:

$$Y(t) = P / (1 + e^{-k(t-t_0)})$$

$Y(t)$  = the level of knowledge of pupils at time  $t$

$P$  = the maximum possible level of learning and adopt critical / creative thinking, i.e. 100% of pupils learning potential.

$K$  = the learning rate, eg how quickly pupils improve their learning quantitatively and qualitatively.

$t$ : the time of the existing level or teaching method,  $t_0$  = the turning point where new teaching methods accelerate creative and critical thinking/learning. It isn't solvable by the sense to find the value of a variable, since it itself defines the price of  $Y(t)$  for each given price of time, it is simply modeling the learning process of pupils. According to the previous formula, it is noted that initially the learning progress of pupils is slow and it is called "adaptation time". Then, there is an acceleration progress called "active learning time". Yet, Perlman (2003), argues that, there is high correlation among,  $X_1$  = new teaching methods,  $X_2$  = time of used them,  $X_3$  = the level of upgrading pupils' creative and critical thinking, and  $r = 0.75$ . To this point is important to note that innovative teachers have to achieve so that pupils' progress to be continuous and it does not tend to be saturated. It can be achieved with various teaching techniques mainly through the "Power Law of Practice-PLP", that math formula is:

$$T(n) = T_1 * n^{-A} + C$$

$T(n)$  = the time in the  $n$ -th use of new teaching methods.

$T_1$  = the time in the first attempt.

$N$  = number of iterations.  $A$  = improvement rate constant.

$C$  = the minimum time limit (some time will always be needed).

From the above we result that, at the beginning of the new teaching methods the critical/creative learning improvement is great and rapid. As the pupils practice, the improvement continues up to  $t_{max}$ , and then gradually decreases. Eventually, the performance tends to stabilize/ level off. Another math learning model related to critical/creative learning of pupils is the so-called Zone of Proximal Learning Development- ZPLD that describes the difference between what the pupils can do on their own and what they can do with the help of teachers. The ZPLD is the distance between what the pupils can do on their own-level of current development and what they can achieve with the help of teachers. In other words, it is the learning interval in which the new and appropriate teaching methods bring the maximum benefit to pupils. Finally, it is worth to refer to teaching method “Self-Regulation Learning Theory-SRLT” that can be well expressed mathematically. This teaching model describes how pupils take an active role in the dynamic learning process, regulating their behavior, thoughts and emotions to achieve their higher goals. The math formula is:

$$S=f(C,M,P)+e$$

S=the learning success C=converging to learning goals

M= learning methods

P= Pupils' personal evolvement

e= systemic error type II

This teaching/learning theory is used to encourage self-regulated learning, so that pupils develop the ability to set and achieve smart learning goals. The development and application of mathematical statistical models in teaching /learning has significant value in improving learning outcomes and enhancing pupils' active participation. (Cardozo-Gaibisso et al, 2019; Cohen, 1988; Perlman, 2003; Woolfolk, 1995) claim that, despite the challenges that may arise from modern teaching methods, understanding these math-models allow teachers to understand better, assimilate easier and develop almost themselves effective innovative teaching strategies, tailored to the pupils' needs. Ongoing research and feedback from the educational community will help in the continued evolution of these math-theoretical teaching/learning tools.

## 5. Criteria for Selection of Papers for Statistical Analysis and Their Research Validity and Reliability

The collection of data is often not in a numbering form allowing researchers direct appliance of the quantitative statistical methods. The research and appliance of quantitative methods to qualitative data has a long-time tradition. Therefore, in this paper we obliged to apply quantitative-based statistical methodology in analysis of qualitative data sets. The transformation of qualitative data into quantitative values is considered as the key-point to quantitative analysis. As it is known, the variance-expression is the one-dimensional parameter of choice for such an effectiveness rating, since it is a Deviation measure on the examined scientific subjects. The method of collecting the material, which was used for the investigation of this work, was the broad bibliographic search using electronic databases and by screening books related to the subject. In order to achieve these goals, we followed the steps of the unstructured or semi-structured data collection technique.

The selection of data/papers for analysis for the purposes of the work would to have the next characteristics in order to be included to our sample:

Been: published between the period 2000-2025, related to Greek elementary schools' reality, used indices such as pupils' achievements, successes, performance, used innovative teaching methods, (independent variables), found on experimental or quasi-experimental sources, be ready for statistics necessary to calculate descriptive measures, mean, error, standard deviations, p-values, not been 100% correlated. To this context, we collected 16 of search studies/papers based on above criteria able to support our ad hoc documentary analysis with the best validity and reliability, despite the great research gaps. Validity: is understood as a concept related to a degree of achievement rather than as an absolute condition, that is a necessary condition for reliability to occur.

In any case it is needed to remark that we met some gaps regarding the accuracy and reliability of our research due to stochasticity of the topic under study.

**Table 1. Gaps Regarding the Accuracy and Reliability**

Research gap we met in the certain research field.	Our estimation as % for the barriers regarding the reliability of research
In lack of empirical data	35
In theoretical conceptual frame	25
In the existing knowledge	20
In lack of empirical evidence	10
In the methods and approaches used in such research. According to global bibliography there are various methods with pros and cons	10
Total	100

## 6. Data Analysis to Assess and Predict the Impacts/Outcomes of New Teaching Methods Promoting Critical and Creative Learning/Thinking of Pupils

Initially, we point out that teaching is a qualitative stochastic process and as such it falls within the theory of nonlinear systems and chaotic dynamics and it will have to be converted to quantitative variable for further elaboration. (Baldi and Long, 2001; Bowen, 2009; Biesta, 2007; Cohen, 1988; Jackson et al, 2011), claim that, in linear quantitative models, small changes give small differences - up to 40%, while in nonlinear ones like teaching, small changes explode in complexity.

The Bayesian-Laplace rule is a statistical and qualitative research process in order to assess and predict the contribution of modern teaching methods to critical/creative learning of pupils when the historical data are few and qualitative and the researchers' intuition plays great role. Bayesian-Laplace statistics can quantify qualitative data through ad hoc statistical rules to measure the contribution of modern teaching methods to pupils' performance. The Bayesian-Laplace core logic is to predict or estimate the future qualitative developments having as basis the past little information and the dynamic intuition. In other words Bayesian-Laplace argue that, if we want to estimate or forecast something partially unknown and there are few data then the best way to find solutions is the statistical forecasting methods along with strong intuition of researchers. Yet, Bayesian-Laplace rule is based on probabilities that estimate the certainty to be achieved the demanded fact. Bayes-Laplace proved that, if we know a priori  $W$  significant qualitative information regarding the likelihood of  $N$  cases, then we should estimate how it will be developed in the future, using the Bayes-Laplace rule:

$$W_{i+1}/n+2.$$

This formula is used for each criterion and the result is multiplied by former marking. So, using the above formula 8 times, we estimate the changes/improvements of ability of pupils to think more creatively/critically based on historical/past information.

**Table 2. Criteria of Teaching Methods and Their Marking**

Criteria of teaching methods and their marking: excellent=100 and little good=10 -metanalysis of 16 cases	Marking based on historical information	Marking based on new teaching methods
Creativity: 37*2,1	37,0	79,0
Critical thinking: 33*1,9	33,0	62,7
Analytical-synthetical thought: 25*1,5	25,0	37,5
Math perception: 45 *2,0	45,0	90,0
Knowledge and understanding the world and environment:40*2,2	40,0	88,0
Communication and language : 30*1,7	30,0	51,0
Basicreadingwritingskills: 52*2,9	52,0	150,8
Personal, social and emotional development: 36*2,0	36,0	72,0
Average weighted: 2,0	37,3	78,9

Source: Documentary Meta-analysis of 16 relative papers as they refer to references

Using the above data of table 3 we can get some basic descriptive statistical measures.

Excel-sheet→ the descriptive statistical measures were found by using the excel: we transferred the data to excel-sheet→then we go to →descriptive Statistics →Analysis to excel-sheet.

**Table 3. Basic Descriptive Statistical Measures**

Criteria of teaching methods *	Mean	Standard error	Variance	Standard deviation	Kurtosis Pearson	Asymmetry Pearson	p-value**
Critical thinking	5,1	0,455683	4,054361	2,013544	3,69591	0,6483175	0,034982

Analytical-synthetical thought	5,3	0,452745	4,176321	2,043605	3,79398	0,6683146	
Math perception	4,8	0,465871	4,204326	2,050445	3,89748	0,6599834	0,036765
Knowledge and understanding the world and environment:40*2,2	5,5	0,466315	4,198743	2,049083	3,79598	0,6645349	0,036552
Communication and lanquage	4,8	0,451243	4,102871	2,025586	3,89798	0,66743256	0,035467
Basicreadingwritingskills	4,9	0,457764	4,012863	2,003247	3,76783	0,66473456	0,034873
Personal, social and emotional development	5,2	0,463564	4,231796	2,057668	3,69695	0,64664892	0,349762
Average weighted	5,1	0,460228	4,136706	2,033889	3,89798	0,6483175	0,034976
Math formulas	$\sum \left(\frac{Xi}{N}\right)$	$s / \sqrt{N}$	$\Sigma Xi)^2/N)$	$\sqrt{\sigma^2}$	$\mu^3/(\mu^2)^3$	$\mu^3/(\sigma^2)$	

\*\*A small p-value ( $p < 0.05$ ) means that the observed results are unlikely to have occurred by chance, if the new teaching learning methods had no effect on the students' thinking/learning. So, zero hypothesis  $H_0$  is rejected and concludes that the new teaching learning methods have a significant positive effect.

## 7. Comments and Conclusions

The purpose of this work was to asses and predicts in probability basis- through Bayes/Laplace probabilistic approach and Documentary analysis of unstructured and semi-structured data/papers- how much modern teaching methods should improve creative and critical thinking of pupils, upgrading their knowledge competences. It is mentioned that, the upgrading of mental processes and mindset of young students through new teaching methods have been studied by many experts and the outcomes are very interesting and positive. That is, our research work, along with the respect articles of other experts, refers to the reasoning processes by which the new teaching methods/ tools used to young students produce very interesting outcomes and therefore education ministers will have to take in account. Concretely, through the Bayesian-Laplace statistical tool and Documentary Analysis (for converse unstructured data to structure ones, ready for farther elaboration), we managed to asses and predict the final outcomes on young students. The research analysis revealed that the contribution of new teaching methods to the development and use of critical/creative thinking and young students' performance is statistically significant and ranges from +70% to 190%.

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