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The Importance of Educating to Think: Teaching Methodologies and Aids from Cooperative Learning and Problem-Based Learning, focusing on Sciences Education

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ABSTRACT

This paper deals with the theme of educating to think. The education to thought is a highly topical methodology, in terms of critical thinking and doubt, which initiates processes of reflection and moves away from rigid and dogmatic visions. The central point concerns the opportunity to promote a rational activity, not understood as a fideistic attitude towards the great possibilities of reason, but as a desire to direct the educational process on a well-founded scientific basis. There are many formulations in support of educating to think; they have inspired concrete teaching methodologies focused on the development of critical thinking, preferring doubt, research, cooperative activity, problem solving. Among them, a prominent place is occupied by Cooperative Learning and Problem-Based Learning. They are characterized by analogous aspects and by different factors, but are oriented towards a common intentionality related to the development of critical and creative thinking, through the strategy of dialogue. The paper highlights the reasons for the motivated interest in the indicated topic, underlining the need, connected to the current historical-social context, for a review of learning methods. Cooperative Learning and Problem-Based Learning are examined, highlighting the fundamental characteristics and educational objectives. The conditions for creating a suitable climate for effective learning based on skills and competences to be improved are underlined, describing the teaching methods of interest. These are innovative teaching methods capable of involving pupils and students,

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making them interact, aware of their knowledge and acquisitions, trying to develop their critical and creative thinking. Regarding science education, the indications of scientific and pedagogical literature to direct students underline the use of the inquiry-based laboratory teaching methodology, to deal with issues of social relevance and close to students, and the use of an interdisciplinary approach. A detailed example of the application of Problem-Based Learning for science related to mathematics, as its language, for primary school is also provided before the conclusions.

***Keywords*:** Education to think, Cooperative Learning, Problem-Based Learning, Project-Based Learning, Mathematics Education, STEM Education, STEAM Education

1. INTRODUCTION: EDUCATING TO THINK

Educating to think is a topic of great importance; over time, theoretical elaborations have been developed to support the importance of such a model of education and training. Hystorically, John Dewey's thought has a particular relevance in this direction, so as the teaching methodologies of "Cooperative Learning" and "Problem-Based Learning". These methodologies have the central objective of educating, from childhood, the new generations to critical and reflective thinking, giving particular emphasis to the role of dialogue.

Humanity is currently in a historical time of high complexity, great uncertainty and change, in continuous transformation. It is essential to understand how much the creation of an environment able to stimulate the active mind of children and students can produce positive effects in cognitive, emotional, affective, ethical and social fields [1].

The stimulus towards curiosity, creativity, wonder in children and students allows to remove the risk of disconnection between teaching and learning, making ineffective many teaching attempts, and alleviating the feeling of uncertainty and confusion, typical of our era. Beyond the sectorial and specialist knowledge, it is important to acquire a way of thinking that will be only subsequently oriented towards the various fields of knowledge [2, 3].

A central goal of education is also to induce and encourage good thinking habits that lead to the development of a reflective attitude. To achieve these objectives it is necessary to ensure that students are interested and feel involved, to provide them with problematic situations as a stimulus for thinking, with information and data so that they can understand and deal with problems, to offer them the possibility of developing solutions.

The changes in social life that accompanies the progress in science and technology around the world lead to the need for an educational reform to address them. Therefore, it emerges with particular force the need that also educational objectives, in addition to the acquisition of contents, are more oriented to the development of flexible processes and strategies that allow learning and produce new knowledge in a critical and creative way, facilitating functional active and cooperative learning [4].

2. ON RELATED THEORETICAL KNOWLEDGE

The promotion of an education in thinking is decisive for an overall and complete development of people; by failing to do that, there is a serious risk of leaving people in the hand of habits (even and above all negative ones) that humanity took over time and under the

authoritarian control of others. The primary way to a permanent improvement in educational and teaching methods is to focus on conditions that promote and challenge thinking.

Among the first steps in the development of thinking we have the experience; in educational practice it is often believed that thought must develop outside experience, thus distinguishing the material dimension of experience from the spiritual one, proper to reason. The reference to a concrete situation of daily life rather than to a pre packaged information allows to reawaken the thought of the students, due to its close relationship with reality and lived experience; when the link with reality becomes evident, learning becomes natural.

It is therefore important to develop the habit to reflection, starting just by the experience or by problematic situations which, in their close relationship with the experience, become a fundamental opportunity for an effective development of thought. After stimulating reasoning and reflection, it is important to provide students with the information and data that allow them to set up reasoning aimed at tackling the presented difficulties.

Clearly not all difficulties can lead to think, there may be some that are not suitable for children due, for example, to their complexity and therefore bearers of distrust. However, the goal is to encourage the development of a well trained mind in thinking, equipped with a multiplicity of resources and tools to be used when necessary.

The significant idea is to understand the knowledge as a process of continuous acquisition and construction of knowledge, which happens starting from people in constant interaction and contact with reality; it is directed to the attention towards the activity of children, considered by their nature active and dynamic, and who should have the freedom to express their inclinations and attitudes.

They should be able to learn closely with the outer environment, directing their natural curiosity on the surrounding world, in order to combine intellectual and practical activities. Among the criticisms directed to the traditional scholastic approach there is the fact that pupils must attend lessons as if they were theoretical spectators, without having practical opportunities to experience the notions to which the teacher refers; this separation between intellectual and practical activities can cause a series of negative effects [5].

The first of these is related to the bad discipline of the pupils; the more physically active children reproduce attitudes of strong restlessness and malaise, the more responsible ones tend to repress their energies, thus suffocating their freedom. Another negative effect refers to learning to read in the traditional context, which pushes children to mechanical memorization of letters and then of words, leaving out the meaning that will later be required for an expressive reading.

Historically, the contribution coming from the developers of the principles of activism, such as Ovide Decroly, Edouard Claparède, Adolphe Ferrière and Maria Montessori [6,7], has been of considerable importance; they developed a large theoretical work, focusing in particular on some factors:

- the recognition of the essential role of the child;
- the enhancement of practical activities in the training course;
- the promotion of children's interest and curiosity;
- the centrality of the learning environment;
- the importance of socialisation;
- the promotion of a non-authoritarian and hierarchical approach;
- the enhancement of a more free organization of knowledge.

At the end of the 1950s, the activism was criticized in its constitutive characteristics and its supporters were accused of having given excessive space to the manual, practical and social dimension of learning, forgetting the importance of the cognitive dimension. However, the school cannot remain far and extraneous to the dynamics and deep changes taking place in society; it should recreate, on a small scale, the conditions of a community, soliciting dialogue, active participation, and enhancing the democratic function of education and of the scientific method as a useful strategy for the development of a democratic education.

Reasoning is a primary need of the human being; thinking is connected to questions relating to the ethics of existence and therefore to questions of meaning. It is a thought closely connected to experience, with the reality and the contexts within which each of us is inserted, characterized by continuous changing and transitory problems. The thought activity is fundamental for the analysis and interpretation of daily reality with its related problems, even though we know we cannot arrive at definitive answers [8].

The idea that educational processes are fundamental for the structuring of high-level ways of thinking such as to make possible an autonomous and critical management of subjective experiential activity, has acquired growing importance also thanks to scientific acquisitions in the neuro biological field and to the idea of brain plasticity. Consequently, this leads to the search for new educational hypotheses for a global development of thought, a creative thought capable of intertwining cognition and affectivity, reason and imagination, logic and fantasy, art and science [9].

3. REFLECTIONS ON TEACHING METHODOLOGIES TO EDUCATE TO THINK

Educational and didactic practices should therefore be oriented not only to the transmission, but also to the construction of knowledge, to the promotion and development of functional skills to this construction, as well as to the transfer of the knowledge. To the content- and declarative-type knowledge should therefore be added the procedural knowledge, i.e. those that refer to the methods and strategies for making the best use of the pupils knowledge.

In order for the acquired knowledge to help in differentiating an expert thinker from a beginner one, it must first of all be available and transformable. Over the last few years, pedagogical reflection has highlighted the importance of metacognition, understood as the knowledge of one's own cognitive processes and their deriving consequences. The aim is to acquire ever greater awareness of one's own abilities and potential in the cognitive field, together with the components of emotional nature. Metacognition is important for monitoring one's thought processes, reflecting on one's mental activity, and deepening one's ways of knowing. The concept of metacognition is closely linked to the constructivist conception [10, 11].

A particularly useful strategy for a critical examination of thoughts and ideas is that relating to the *dialogue*, through which it is possible to create a comparison and a cooperative exchange aimed at discussion and understanding. Dialogue has a great ethical value; to effectively be able to dialogue, it is necessary to open up to the others with respect, empathy, understanding, attention, listening. However, it often happens that the discussion in the class does not find an adequate place within the teaching activities, as a particular learning strategy [12].

The “Cooperative Learning” and “Problem-Based Learning” educational programs are just characterized by having the common goal of educating to think through cooperative learning strategies centered on the dialogue.

4. THE COOPERATIVE LEARNING

There are many definitions formulated regarding the "Cooperative Learning" methodology, depending on the angle from which the method is viewed; in literature, six main orientations of the Cooperative Learning are usually considered: Learning Together, Student Team Learning, Group Investigation, Structural Approach, Complex Instruction, Collaborative Approach [13, 14]. Generally, even before a specific teaching/learning method, speaking of Cooperative Learning we refer to a vast educational movement which, despite locally different theoretical perspectives, applies appropriate techniques of cooperation in learning in the classroom. A common and determining element is the enhancement of the variable of the interpersonal relationship in learning, around which motivation, cognitive processes, class organization, assessment, etc. rotate [15].

The Cooperative Learning has also been defined as:

1) a set of classroom techniques with students working in small activity groups, being co-responsible for their learning and receiving assessments based on their achievements;

2) a teaching-learning method where the most significant variable is the cooperation between students who help each other, establish the pace of work, correct and evaluate each other.

It is therefore a teaching/learning methodology that involves the acquisition of social and cognitive skills, within a participatory and democratic environment. This methodology is normally implemented with working groups of four/five members, with a positive interdependence of roles, materials, tasks, skills, and requires a distributed responsibility with respect to the development of the task and the relational dynamics, creating a productive context of higher order affective/cognitive processes. This leads students to be more responsible to themselves, to others and to the teacher.

Thanks to the use of cooperative activities in the classroom, it is possible to deal with mental patterns different from the one’s own and education is conceived as an active and constructive process, interesting to be used from childhood in the school context [16].

The development of cooperative learning studies received further positive impetus with the work of Lewin related to the “field theory”. Taking the concept of “field” from physics, it is reused in the psychological sector and applied both to the study of individual actions and to that of groups. From this point of view, it is possible to look at the group and its organization as a dynamic unitary field, where the action of the group expresses a will directed towards an end, on the basis of a common project. Within the group, children learn behavior patterns, specific cognitive and emotional styles [17, 18].

4. 1. PECULIAR CHARACTERISTICS OF COOPERATIVE LEARNING

The peculiar characteristics of Cooperative Learning are as follows:

- *Positive interdependence*: it is verified when a member of the group understands that she/he is connected to the others in achieving the global goal. This one can be achieved through

common goals, division of the work, sharing of materials and information, assignment of different roles, group rewards. The positive interdependence makes use of some organizational strategies: the interdependence of objectives, tasks, roles, rewards.

- *Face to face promotional interaction*: it refers to the atmosphere of collaboration, exchange, respect, trust established among members of the same group, experiencing the school environment with respect and freedom of expression.

- *Individual responsibility*: it is an essential part of the group that aims at a common goal, completing one's own work and facilitating that of the others.

- *Teaching-learning of the use of social skills and the formation of small groups*: it is necessary that the group members learn to effectively communicate, acquiring skills of a social nature to support the interaction, necessary for the management of the cooperative group, to its functioning, to learning and re-conceptualizing what is being studied.

- *Review and control of group behavior*: the teacher is responsible for monitoring the activities both during their development (monitoring) and at the end (processing) [19].

The test consists in collecting the necessary data to formulate a value judgment on the basis of obtained data and information. Through this methodology it is possible to develop numerous skills of a meta cognitive and social nature.

4. 2. SKILLS AND COMPETENCES IN THE USE OF COOPERATIVE LEARNING

Particular attention is devoted to *reflection* and *critical thinking*. The measured skills in this complex mental activity are several: knowing how to focus on a question, analyzing arguments, summarizing, solving problems, asking and answering questions for clarification or challenge, evaluating the credibility of a source, evaluating the relationships among knowledge, deductions, inductions, define terms [20].

Of notable interest is the use of this methodology with pupils who show behavioral problems through participatory teaching in which they are the protagonists. This is especially true when complex and heterogeneous classes have to be managed, for example in which there are foreign pupils, pupils with disabilities, pupils with some difficulties. Considering the team building and the creation of an empathetic environment, the group participants begin to feel involved and to show interest in the proposed activities.

An effective path of Cooperative Learning should have the following effects:

- to decrease behavioral and discipline problems, limiting oppositional attitudes;
- to reduce the isolation of the more shy, lonely, fearful students, through the development of interaction and relationships between peers;
- to limit conflict situations among students;
- to increase the student involvement and commitment;
- to encourage a greater collaboration, ensuring that even the best students achieve better results;
- to ensure that the most listless pupils improve their school performance [21].

4. 3. THE FUNCTION OF THE TEACHER/FACILITATOR IN COOPERATIVE LEARNING

In Cooperative Learning, also the role of the teacher differs, in some respects, from the traditional one. The teacher plays the role of mediator between the student and the context by

defining the stimuli for learning, organizing space and time, using diversified languages and methods, and investigating the student's learning style [22].

The teacher's attention and control are mainly placed on the activity in which students are involved, thus reducing the occasions in which they have to exercise personal authority; activities, in which everyone participates, become the main means of control. Through this type of activity it is also possible to involve those students who may show oppositional and disturbing behaviour.

The planning of the activities must be flexible, to offer some freedom, but also stable, to guarantee the commitment of the involved pupils and so that the correct execution of the task can be monitored, with the teacher in the role of director of the activities, who activates and empowers students in their learning while also achieving cognitive, emotional and motivational goals.

During the Cooperative Learning activity the teacher should:

- plan group work, presenting the learning contents;
- organize the activity;
- decide on the modalities of the groups formation;
- establish the didactic and educational objectives to be achieved;
- prepare the materials to be used;
- establish the evaluation criteria;
- teach the social skills;
- plan the cooperative lesson;
- evaluate learning according to established criteria;
- stimulate discussion on the achieved results and reflection on the used strategies.

Work reviews can occur through observation during the work and with the final review, followed by the discussion of the performed work, having clearly defined the objectives to be achieved, and having organized tests reflecting the performance to be measured.

5. THE PROBLEM-BASED LEARNING

Being able to solve problems by collaborating with the others leads to strong conceptual changes, develops cognitive and metacognitive processes based on reasoning and reflection, activating exploration and evaluation strategies. The resolution process is articulated through a series of stages that start from the definition of the problem to be solved and arrive to the analysis of all possible solution paths [23]. The reasoning used to solve problems can be either inductive or deductive. A problematic situation can represent for pupils and students a way of stimulus to think, in particular with children, if it has a strong connection with reality and with daily experience.

It is therefore important that students are continually stimulated to think and to seek solutions to the assigned problems and tasks, identifying a way out, albeit with the constant support of the teacher and classmates; it is an attitude aimed at problematizing and analyzing which is proper to the method followed by sciences and that promotes a scientific rigor. "Problem-Based Learning" is one of the most interesting teaching methodologies centered on problem solving, where the problem represents the starting point of the learning process [24, 25].

5. 1. PECULIAR CHARACTERISTICS OF PROBLEM-BASED LEARNING

The fundamental characteristics of Problem-Based Learning are as follows:

- student-centered learning;
- learning taking place in small groups of students;
- teacher who plays the role of guide or facilitator;
- problems as organizational device and stimulus for learning;
- problems as vehicle for the acquisition of problem-solving skills;
- self-directed study as one of the methods that facilitates the learning of new knowledge.

At the end of each four or six week module, students are randomly assigned to other groups with the guidance of a new tutor, so that they can fit and interact in various types of groups. Important moments in the process concern the clarification of terms and data that are not immediately understandable, brainstorming, search for explanatory hypotheses, formulation of study objectives, synthesis and evaluation of information, evaluation of personal and group work.

The presented problems have the objective of soliciting a problem-solving activity, formulated in such a way to be concrete and close to the students' daily experience, with a degree of complexity suited to their knowledge, favoring an interdisciplinary approach for their resolution [26].

Problem-Based Learning can be effectively used with all types of students, with heterogeneous classes where there are students with different characteristics and who can pool collaboratively their skills for reaching the solution of the proposed problem during the activity [27].

The methodology is based on an interdisciplinary approach, because it may require the use of information from multiple disciplinary fields, preferring a transdisciplinary rather than a parceled thinking. Children are naturally inclined to make connections rather than to operate disjunctions [28, 29].

5. 2. THE ROLE OF THE TEACHER/FACILITATOR IN PROBLEM-BASED LEARNING

The teacher's role is that of facilitator who must support the students in their research, without providing too many predefined elements and schemes, in order to quickly reach a conclusion.

It is decisive her/his ability to stimulate meaningful questions and to propose problem-situations capable of soliciting in students the identification of adequate strategies to solve the problem; facilitating the learning process, she/he is characterized as metacognitive tutor of the group, planner of the module, evaluator, expert of disciplinary contents [30, 31].

Dialogue is undoubtedly a fundamental element of this teaching methodology; discussion and argumentation activities carried out in the classroom, both among peers and between students and adults, are a powerful tool for developing argumentative, reflective and metacognitive thinking.

The progressive penetration of information and communication technologies (ICT) in all sectors of contemporary society in developed countries is an increasingly established reality. Education systems are becoming fully aware of this evident paradigm shift [32, 33].

6. ON THE TEACHING OF SCIENCES

Sciences intrigue students for the fascination of discovery and the unknown, but their teaching and learning is in trouble at national and international level, especially in secondary school. It is therefore important to reflect on the relative teaching methods and on the role of the student during her/his school experience.

The indications of scientific and pedagogical literature to direct students to appropriate the language and ways of operating in sciences can be summarized in three aspects:

1) adequate use of the inquiry-based laboratory teaching methodology;
2) dealing with issues of social relevance and close to the students' daily life;
3) use of an interdisciplinary approach.

The process of involving students in the sciences must begin at an early age, as early as primary school or kindergarten, and considering that people learn by doing rather than by watching or listening, and they learn better what they want or need to know [34, 35]. In order for students to appropriate the languages and ways of operating in science and its applications, it is decisive to make use of a laboratory teaching and address issues related to everyday reality and to the social context.

6. 1. REGARDING "HOW TO TEACH AND TO EVALUATE"

It is an evident and ascertained fact that knowledge develops by the first months of life through direct experience, which is the first step towards the construction of knowledge, in different forms depending on age and personal education. The concrete and interactive knowledge of natural objects and phenomena has a fundamental role in stimulating cognitive processes and learning [36].

It follows the importance of using laboratory teaching, not intended as a duplicate of what has been learned with the theory, but that raises questions and curiosities making students desirous to know; it is the environment where they learn to look for and to use tools in problem solving situations.

It has been suggested to adopt the "discovery learning", also called "Inquiry-Based Science Education" (IBSE), or "5E method": Engage, Explore, Explain, Elaborate, Evaluate [37, 38]. It is a laboratory approach that can be seen as the didactic version of scientific research. The knowledge deriving from the results of experiments generates amazement, and this hold up new curiosity and new questions. This type of teaching can already be traced in Dewey's pedagogy and is already recommended by kindergarten.

To make laboratory experiences meaningful, careful planning is essential, aware of the objectives to be achieved and of the techniques to be proposed to the students. The final moment is that of reflection, so that students assimilate the concepts, reviewing the covered path, making concrete what has been done, understanding what has been learned and ordering the essential correlations.

As far as kindergarten and primary school are concerned, laboratory activities should involve and be presented in the form of a game, being this one a part of the children's natural approach to reality. The playful-exploratory activities trace the path of scientific knowledge, helping children to acquire a critical capacity of information for the interpretation of the surrounding world.

Regarding the way to evaluate students, considering that the traditional evaluation is essential and has a primary educational role in stimulating them to improve, it is also important to evaluate the involvement of students in informal activities, such as science festivals, exhibits for the dissemination of scientific topics addressed during the school year.

6. 2. REGARDING "WHAT TO TEACH"

Regarding "what to teach", it is appropriate to address issues related to daily reality and the social context; topics such as energy, health, food, water, environment are particularly suitable. These are leading topics of scientific research: alternative energy sources, related nano-technological developments, investigations into climate and environmental changes, innovations in the diagnostic and medical fields. These are motivating themes for students, close to their reality, demonstrating that science involves every aspect of life.

Being complex topics, they require an inter- and trans-disciplinary approach, involving the entire community of teachers in the scientific area, and not only, as they allow ethical and social aspects to be discussed, increasing the students' critical skills. They can be addressed at different levels of detail and are therefore suitable for develop a vertical curriculum. As far as science is concerned, it is not difficult to develop integrated activities with mathematics, physics, philosophy, history, art, music, geography, economics, religion, law [39].

6. 3. THE PROJECT-BASED LEARNING

There is a distinction between "Problem-Based Learning" and "Project-Based Learning", identifying in the second case more structured teaching methodologies, with more care in the procedures of analysis, discussion, problem solving, with a specific focus on the collaborative design of operational and concrete solutions to the problem posed to the students. Project-Based Learning is becoming the way the Problem Solving approach is spreading in schools [40].

Its simplest form is a popular activity in the school, the "Web Quest"; it consists in starting from a search of online resources on a real problem, planning a critical presentation of results obtained by selecting the information [41, 42].

The characteristic steps concern the identification and definition of the problem that the students have to face, the didactic strategy to be implemented, the identification of the prerequisites, preliminary materials that facilitate students in finding solutions, an initial selection of useful resources for better framing the problem, a reasoned list of other usable resources (Internet sites, learning objects, books, multimedia material), the detailed planning of the work to be carried out in the classroom, the definition of the verification tools.

This approach is useful on a motivational level, helping to deal with the risk of early school leaving or critical behavioral issues [43], increasing the ability to deal with and solve problems in physics, mathematics, science and environmental education, technical and technological education projects, helping students to identify them more clearly and to approach them more critically [44, 45].

6. 4. AN EXAMPLE OF APPLICATION OF PROBLEM-BASED LEARNING IN PRIMARY SCHOOL FOR SCIENCE CONSIDERING MATHEMATICS AS ITS LANGUAGE

The complete format of the application of Problem-Based Learning for the topic "Science considering mathematics as its language" in a primary school (2nd/3rd year) context is indicated

below. It derives by a used module for the documentation of the way, where examples, details and particulars are indicated [15, 16, 46, 47].

CHARACTERISTICS OF THE WORK	**DETAILS**
	Title (in canonical form or in the form of a question). Example: The pleasure and utility in sciences of learning mathematics. Is it useful to learn mathematics? Why? What important things about mathematics do you think learned last year? How did you do it, what helped you? What tools or games can we prepare to help first graders to learn mathematics?
Complexity and Novelty The task must be structured in such a way that answers are not immediately and easily identifiable. The situation-problem posed must be unedited, i.e. it must be presented to the pupils for the first time, otherwise the problematic nature is canceled, entering the traditional field of restitution of what has been learned.	*Theme/Problem (Description)* The first class mathematics teacher is interested in knowing which strategies, tools and games were useful for learning mathematics last year, because she/he would like to introduce them to her/his pupils. We must therefore reflect on the taken path, deciding which tools and games have been effective and choose which ones to build for giving to the first class children. It could also be games never used by us before, but resulting from new ideas of second graders, now more experienced. The tools/toys will be presented to the 1st class children at defined times, where the older children can tutor the younger ones. When we say “mathematics in sciences”, what are we talking about?
Skills to be indicated The key skills and that of the pupils profile. The goals for the development of skills.	*Skills* - Mathematical proficiency and basic skills in science and technology The child uses her/his mathematical and scientific-technological knowledge to find and justify solutions for real problems (relationship among Problem-Based Learning and Project-Based Learning). - Learning to learn She/He has a wealth of basic knowledge and understanding and is able to seek out new information.

	- Social and civic skills She/He cares and respects her/himself, the others and the environment. She/He respects the shared rules and collaborates with the others. She/He is committed to completing the work, alone or together with the others. - Spirit of initiative and entrepreneurship She/He demonstrates originality and initiative spirit. She/He is able to carry out simple projects (Project-Based Learning). She/He assumes her/his responsibilities, asks for help when in difficulty and knows how to provide help to those who ask for it. *Goals* - Mathematics She/He moves confidently in written and mental calculation with natural numbers. She/He recognizes and represents shapes on plane and in space. She/He builds reasoning by formulating hypotheses (Inquiry-Based Learning), supporting her/his own ideas and comparing her/himself with the point of view of others. She/He develops a positive attitude towards mathematics through meaningful experiences (Laboratory teaching/learning). - Science and Technology She/He knows and uses simple everyday objects and tools (Laboratory learning). She/He produce simple models or graphical representations of her/his work. - Social and civic skills She/He interacts in the group understanding different points of view, contributing to common learning and to the realization of collective activities. - Learning to learn She/He engages in new learning. She/He transfers learning to other contexts. - Spirit of initiative and entrepreneurship

	She/He takes personal initiatives, completes tasks, also evaluating in a simple way the results of the work (Inquiry-Based Learning). She/He can express simple hypotheses of solution to problems of experience. She/He can use some learned knowledge, with the support of the teacher, to solve problems of experience.
Context, Place, Time In order to be real, a task of reality must necessarily indicate the context, times and places of realization. The principle of reality can also be ensured with the temporal or spatial transposition of the context and therefore with situations imagined as possible.	*Context* - Develop the ability to reflect on one's own learning path to support motivation, tenacity and will, making children perceive that their active, proactive and personal participation is essential for learning and feeling good at school. - Fundamental are also the development of social skills that make possible to achieve objectives, support in difficulties, promote self-esteem and a sense of confidence in one's abilities and the development of a sense of community in which one perceives that by giving something to others (time, resources, energies), she/he gets rich (Problem-Based Learning, Project-Based Learning). *Implementation Time* - Indicate the necessary period of time. *Place of Realization* - The rooms of the primary school. *Sharing Platform* - Indicate the possible sharing platform and/or the ways of sharing.
Disciplinarity/Multidisciplinarity It is preferable that the task of reality be pluri-interdisciplinary, but it is not excluded that it could be disciplinary. The involved disciplines must always be indicated.	*Involved Disciplines* - Sciences - Mathematics - Technology - Art
Final and intermediate Products In a learning unit, in addition to the final reality task which is carried out for the entire duration of the activity, intermediate reality tasks can also be expected, requiring less time to be completed.	*Final Product* - Tools and/or toys to support the learning of sciences using mathematics designed by children. *Intermediate Products* - Sketches of the designs of the products to be made (Laboratory teaching/learning).

Acquired and to be Acquired Knowledge	*Already Acquired Knowledge*
The necessary knowledge for the realization of the reality task can already be fully or partially acquired, or it is acquired along the way.	- Mathematics ● Natural numbers up to 20. ● Addition and subtraction operations and their symbols. ● Simple topological concepts: open/closed, inside/outside, inner/outer. ● The main flat shapes: square, rectangle, triangle, circle. - Technology and Science ● Correct use of tools. ● Use of simple technological and scientific concepts. - Art ● Use of different kinds of colors. *Knowledge to Acquire* Disciplinary ● Mastery of natural numbers up to 100 and of the decimal structure of numbers. ● Mastery of the meaning of the mathematical symbols "+" and "-" and of the operations connected to them. ● Mastery of the recognition of the most common solids (cube, parallelepiped, cylinder, sphere) and flat geometric figures (rectangle, square, triangle, circle, rhombus). ● The characteristics of the most common materials. ● Use of various graphic and plastic techniques. ● Targeted and waste-free use of tools and materials. *Transversal* ● Simple searches for new information or retrieval of previous knowledge. ● The rules of a conversation/discussion. ● The roles in the group and their function. ● Find a common solution to a problem/project. ● Simple strategies for organizing time, tools and materials. ● Simple design tools. ● Share and cure of tools and materials.

Individual/Collective It is preferable for a reality task to be carried out by a small group of pupils, but it is not excluded that in some circumstances it can be carried out individually.	*Large Group Collective Phases and Phases in Small Groups* Together, everyone reflects, ideas are compared, choices are made. In small groups, the artifacts are made to support the first graders mathematics activities (Problem-Based Learning). ➢ First product In the plenary session, after reflection, it is decided what the artefact should be (for example a mathematics placemat or an abacus for science applications), the first "split tree" map is compiled together, planning is done with the feasibility study, then each group passes to the execution phase and realizes the product (Laboratory teaching/learning). ➢ Subsequent products The type of product is decided in plenary session, for example "the mathematics game", then each group defines and creates a different product by experimenting all the phases on their own (Laboratory teaching/learning).
Receiver/Purpose The indication of the receiver and the purpose of the final product to be elaborated represent another inevitable principle of reality.	*Real Receiver* First grade children. *Real Purpose* Reflection on one's own learning path, sharing of ideas, enhancement of everyone's skills, peer tutoring, preparation of concrete tools for first graders pupils to support their sciences activities supported by mathematics.
Evaluation a) of the reality task The reality task usually evaluates a group product and each member of the group will have the same evaluation. Indicate the evaluation tools (rubric, check-list, performance-list). b) of the acquired skills - Systematic observations: table. - Cognitive autobiography (rubric, story-telling, etc).	*a) Reality Task* - Product evaluation rubric. - Social and civic competences rubric. - Learn to learn rubric. *b) Acquired Skills* - Ideation ➢ Social and civic competences rubric. ➢ Split tree map evaluation rubric. - Planning ➢ Learning to learn rubric. ➢ Feasibility plan checklist. - Execution

	➢ Initiative and entrepreneurship rubric. ➢ Performance list on self-assessment group work. - Closure ➢ Product self-assessment checklist. ➢ Mathematics used in sciences skills self-assessment checklist.

The application example has been implemented with success in some Italian schools; used materials are everyday materials as paper, wood, glue suitable for children, colors, markers, colored paper, number tables, multiplication tables, simple tools for measuring lengths.

This example is intended to consider general guidelines for working with children in a context that reflects the issues of Problem-Based/Project-Based/Inquiry-Based Learning and related laboratory/experiential/practical activities. The example must be adapted to the local context of the class, i.e. to the needs of the class-group and the related experience.

7. CONCLUSIONS

Educating to think means promote the development of critical thinking that can look globally towards the multiple dimensions of existence. Education must be democratic and anti-authoritarian, with the task of preparing people for future life, so that they can act with awareness and effectiveness within society.

The use of a pedagogy that attributes importance to dialogue and confrontation is of high importance for any democratic society, especially for those in which there are people of different ethnicity, caste and religion.

Democracy makes aware of how important is for people to flexibly and responsibly think; if this does not happen, they may become victims of propaganda in favor of authoritarianism and conformism.

The Cooperative Learning and Problem-Based Learning teaching methodologies are undoubtedly useful in the direction of the critical development of thinking, starting from an early age, through the responsible involvement of children in the path of human and cultural growth for a democratic and peaceful human future.

It is important to promote initiatives that touch transversal aspects, allowing to see the world in its complexity and globality; this is achieved by adopting inter- and trans-disciplinary teaching in which all teachers, both in the scientific and humanistic areas, are involved. The Inquiry-Based Learning approach, starting from a stimulating question on which to make students able to work both experimentally and conceptually, is particularly favourable.

Laboratory teaching does not specifically concern scientific disciplines only, but is to be understood as an approach aiming at the acquisition of skills, a place from which transversal training opportunities of an observational, logical, linguistic nature can be obtained, useful for producing new knowledge and develop new skills. What has been discussed fits clearly into the educational tasks of the school: promotion of learning (education) and accompaniment to

knowing how to be in the world (education), teaching well some notions rather than many superficially.

The "Project approach" can be very useful for tackling some strategic challenges, such as the recovery of motivation for learning, the usability of knowledge and skills and the enhancement of students' critical skills.

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Biography

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