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Claudia Lichene

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EVALUATION AS A RESEARCH PROCESS. REFLECTIONS STARTING FROM RESEARCH ON SCIENTIFIC EDUCATION IN NURSERY SCHOOL.

Claudia Lichene
ORCID: https://orcid.org/0000-0001-7687-4845

ABSTRACT

Some documents *(Proposal for key principles of a Quality framework for Early Childhood Education and Care,* 2014, National Guidelines for the Curriculum, 2012) establish the importance of formative evaluation as a research and innovation process. The educational evaluation, through the observation and analysis of the educational documentation allows the teacher to evaluate his educational proposal and improve it to promote learning. To develop this topic, I will refer to research on scientific education in nursery school. This research refers to the theoretical contribution of Dewey (1933;1938), Vygotsky (1930; 1934), Wood, Bruner, Ross (1976), to the psychoanalysis regarding the psychic processes as the base for curiosity and to the experience of Susan Isaacs (1930; 1933) at the Malting House. The main objective of the research is to highlight the conditions (space, material, adult approach) which best promote a scientific investigation of the children. The approach of 'promoting from within' (Bondioli, 2008; Bondioli, Savio, 2009; Bondioli, 2015) as a useful reference for designing and setting up adult intervention aimed at promoting the development of a scientific attitude. I collected the data through videotapes, observation protocols and I elaborated two analysis grids: one related to the epistemic conduct of the children and the other concerning the strategies and functions of the adult. The first analysis highlighted some interesting suggestion regarding the conditions of the educational context (adult intervention strategy, material, space) that best promote the development of a scientific attitude in terms of the acquisition of critical thinking.

Key words: Evaluating process, scientific thinking, early childhood education, scientific curriculum, 'promote from the inside'.

O PROCESSO DE AVALIAÇÃO COMO PESQUISA. REFLEXÕES A PARTIR DE UMA PESQUISA SOBRE A EDUCAÇÃO CIENTÍFICA NA ESCOLA DA INFÂNCIA.

RESUMO

Alguns documentos (*Proposal for key principles of a Quality framework for Early Childhood Education and Care,* 2014, Indicazioni Nazionali per il curricolo della scuola dell'infanzia e del primo ciclo di istruzione, 2012) estabelecem a importância da avaliação formativa como processo de pesquisa e inovação. A avaliação educacional, por meio da observação e análise da documentação pedagógica, permite ao professor avaliar a sua proposta educativa e melhorá-la para favorecer o aprendizado. Para isso, a pesquisa se detém sobre o ensino de ciências na pré-escola. Toma como referência teórica os estudos de Dewey (1933; 1938), Vygotsky (1930; 1934), Wood, Bruner, Ross (1976) e, em especial, o que tange a psicanálise

sobre os processos psíquicos como base da curiosidade e a experiência de Susan Isaacs (1930; 1933) na Malting House. O principal objetivo da pesquisa é destacar as condições (espaço, material, abordagem adulta) que melhor promovam a investigação científica das crianças. A abordagem "promover a partir de dentro" (Bondioli, 2008; Bondioli, Savio, 2009; Bondioli, 2015) como referência útil para o planejamento e ações dos adultos com o objetivo de promover o desenvolvimento de uma atitude científica. Coletei os dados por meio de observação e registro em vídeo e caderno de campo e elaborei duas grades de análise: uma referente ao comportamento epistêmico das crianças e outra referente às estratégias e funções do adulto. A primeira análise destacou algumas sugestões interessantes sobre as condições do contexto educativo (estratégia de intervenção adulta, material, espaço) que melhor favorecem o desenvolvimento de uma atitude científica em termos de aquisição de pensamento crítico.

Palavras-chave: processo de avaliação, pensamento científico, educação e cuidado infantil, currículo científico, 'promoção de dentro'.

EL PROCESO DE EVALUACIÓN COMO INVESTIGACIÓN. REFLEXIONES A PARTIR DE UNA INVESTIGACIÓN SOBRE LA EDUCACIÓN CIENTÍFICA EN LA ESCUELA DE INFANCIA.

RESÚMEN

Algunos documentos (*Proposal for key principles of a Quality framework for Early Childhood Education and Care,* 2014, Indicazioni Nazionali per il curricolo della scuola dell'infanzia e del primo ciclo di istruzione, 2012) establecen la importancia de la evaluación formativa como proceso de investigación e innovación. La evaluación educativa, a través de la observación y análisis de la documentación didáctica, permite al docente evaluar su propia propuesta educativa y mejorarla para facilitar el aprendizaje. Para desarrollar este tema, me referiré a investigaciones sobre la enseñanza de las ciencias nela guardería.
Esta investigación hace referencia al aporte teórico de Dewey (1933; 1938), Vygotsky (1930; 1934), Wood, Bruner, Ross (1976), al psicoanálisis sobre los procesos psíquicos como base de la curiosidad y a la experiencia de Susan Isaacs (1930; 1933) en la Malting House. El objetivo principal de la investigación es resaltar las condiciones (espacio, material, enfoque adulto) que mejor promueven una investigación científica en niños. El enfoque de "promover desde dentro" (Bondioli, 2008; Bondioli, Savio, 2009; Bondioli, 2015) como referencia útil para para la planificación y las acciones adultas con el objetivo de promover el desarrollo de una actitud científica. Recolecté los datos a través de video, protocolos de observación y elaboré dos grillas de análisis: una referida al comportamiento epistémico de los niños y otra referida a las estrategias y funciones de los adultos. El primer análisis destacó algunas sugerencias interesantes sobre las condiciones del contexto educativo (estrategia de intervención adulta,

material, espacio) más favorecen el desarrollo de una actitud científica en términos de adquisición del pensamiento crítico.

Palabras clave: proceso de evaluación, pensamiento científico, educación y cuidado infantil, currículo científico, 'promoción desde adentro'.

SCIENTIFIC EDUCATION AND EVALUATION: A PREMISE

In this paper, scientific education and evaluation are given a peculiar meaning, correlated with the equally peculiar nursery school environment, where this research was carried out.

In particular, scientific education is defined as the promotion of critical and reflective thinking, and it is focused on the development of knowledge relating to things that are animated and not of the natural environment. These competences are promoted in the subject through an inquiry process carried out, according to Dewey, through the uncovering and highlighting of issues. In this type of process, it is essential to observe and bring forward hypotheses, solutions, and their verification.

Evaluation is a widely debated and controversial topic in the educational field. On the one hand, it appears that a general agreement has been reached, according to which evaluating is a complex action and it requires observation, documentation, and consideration to improve the educational approach. On the other hand, there are objections related to a more traditionalist perspective, which still considers evaluation as a mere practice aimed at judging the performances (Vertecchi, 2016).

Some European documents (*Indicazioni Nazionali per il Curricolo della Scuola dell'Infanzia e del Primo Ciclo di Istruzione*, 2012; Quality Toolbox: Executive Summary, 2012; *Proposal for Key Principles of a Quality Framework for Early Childhood Education and Care,* 2014) categorically refuse the idea of evaluation as a mere classification and judgment. On the contrary, the evaluating action carried out by the teacher has the purpose of recognizing, describing, and promoting growth and development. The previously cited documents convey a central role to professional strategies such as observation and documentation, also stressing the importance of the auto evaluation both of the child and the teacher. Analyzing the previously collected documents in teams is helpful because it leads to the recognition of the coherence between pedagogic concepts, cultural choices, and actions taken to carry them out (Raso, Lampugnani, Marone, Lichene, 2020). From this perspective, evaluation is a fundamental tool in the constant improvement of the schools' educational offer, aimed at handling the educational act that promotes the children's development. According to this concept, the *Proposal for Key Principles of a Quality Framework for Early Childhood Education and Care* (2012) conveys to evaluation the purpose of recognizing, accompanying, describing, and documenting the processes of development without classifying and judging the performances.

This type of evaluation requires a careful and systematic observation in order to distinguish the abilities and skills the child already possesses from those he is acquiring. These potentials need to be acknowledged and consolidated to orient the choices and educational intervention necessary to

encourage their already-in-motion growth within the children. The teacher has the duty to support (*scaffolding*), encourage, and facilitate their harmonious development. These evaluation procedures need to consider the children's ordinary experiences and convince the teacher to focus on the process while taking responsibility for their chosen educational method, recognizing the successes and failures. The meaning of educational evaluation regarding the developmental processes and progress made by the children is explained from this perspective.

In this research, focused on the concept of scientific education as previously described, evaluation is considered a process that "regulates", guides, and orients the educational effort, the researcher's procedure, and the teachers' actions.

The research is carried out on an explorative basis and aimed at acknowledging and analyzing the best contexts – space, time, educational approaches – to encourage and promote the development of scientific thought in kindergarten. The initial project, monitored by a team of researchers and supervisors, underwent slight modifications due to findings that emerged during the observation of the children and the revision of the documents collected during the process. The final considerations regarding the experience contemplate the children's progress in the scientific field. This progress is closely connected with the contexts in which it was analyzed – tools, time, educational approaches –, intentionally chosen by adults, documented, monitored, and evaluated from different points of view to offer the best experience not only for the children but also for the teachers and families.

SCIENTIFIC EDUCATION AS "ENCOURAGMENT" OF THE LEARNING PROCESS.

The scientific literature on the topic (Giordano, 2010; Andersson, Gullberg, 2014; Bertolino, Guerra, Schenetti, Antonietti, 2017) maintains that scientific education cannot be limited to the transmission of contents. Every child is born with plenty of curiosities, questions, and interests that the adult needs to recognize - even when they begin their journey in education -, support and enhance through a specific approach. This approach must be aimed at promoting and supporting their interests and discoveries in order to encourage further investigations and learning processes (Bondioli, Savio, 2014). Considering this point of view, even the *Indicazioni Nazionali per il curricolo* of 2012 (updated in "*Nuovi scenari*", 2018) deal with scientific education in "*La conoscenza del mondo*" with a particular focus on the child's curiosity, his interest in the phenomena he observes, his ability to ask questions about them and investigate further, and his eagerness to share his discoveries with his classmates and teachers.

These considerations represent the framework necessary to interpret the "heart" of the research I carried out: how to implement a scientific knowledge not only aimed at the transmission of concepts, but also at the development of

> "…ability and willingness to use the body of knowledge and methodology employed to explain the natural world, in order to identify questions and to draw evidence-based conclusions. Competence in technology is viewed as the application of that knowledge and methodology in response to perceived human wants or needs. Competence in science and technology involves an understanding of the changes caused by human activity and responsibility as an individual citizen." (Recommendation of the European parliament and of the council on key competences for lifelong learning, 2006, p. 15).

FROM THE CONCEPTUAL FRAMEWORK TO THE RESEARCH PLANNING

The research planning – briefly described here – and the educational strategies performed by the adult are connected to John Dewey's (1933; 1938) theoretical contributions regarding the inquiry process, to Vygotsky's (1930; 1934) concept of "zone of proximal development" and Bruner's *scaffolding*. Moreover, the contribution of Susan Isaacs (1930, 1933) was particularly useful because, with her experience at *Malting House*, she effectively interpreted Dewey's theory and the psychoanalytic one in an expressly pedagogical sense.

The 'promotion from within' approach was adopted (Bondioli, 2008; Bondioli, Savio, 2009; Bondioli, 2015a e b, Savio, 2003; Bondioli, Savio, 2012; Savio, 2013) in order to maintain a close connection between the theories and sources previously mentioned. This approach is included in the previously outlined conceptual framework and it is characterized by a participative strategy, even because the planning of the educational actions originates from the child's curiosity, and it welcomes its suggestions.

Procedure ideas, intervention styles and implementation

One of the main aims of this research, following the previously mentioned studies, was identifying the best environment to promote and favor a scientific analysis of the natural behaviors in children of preschool age. In particular, it refers to kindergarten children. The educational styles proposed by the teachers strongly influence the environmental factor, therefore, they are also examined in the research. This also has the secondary aim of studying if and in what measure children belonging to the same educational context, age group (4- and 5-year-old), and subject to the same free experimentation of 'stimulating tools' manifested the same set of skills and range of scientific attitudes, after experiencing different teaching styles.

The educational styles proposed by the teachers in the three different groups of children are divided in:

laissez faire. The adult maintains an observer role, does not intervene with the intention of promoting exploration activity, but only if particular practical problems arise. Adopting this approach, we intend to verify if and to what extent the condition of full freedom and autonomy, without interference from the adult, affects the manifestation of conduct of scientific exploration by children;

promotion from within (Bondioli, 2008; Bondioli, Savio, 2009; Bondioli, 2015a e Savio, 2003; Bondioli, Savio, 2012; Savio, 2013). The adult intervenes by promoting and favoring the explorative action, following the 'promotion from within' model. In this scenario, the teacher waits for and welcomes the child's initiative, encourages questions, and 'reflects' the scientific attitude manifested by the children in relation to the materials, either verbally or non-verbally. He also expands the children's initiatives by 'showing how it is done', and elaborates and amplifies their explorative and inventive efforts. The above-cited aspects define the participative attitude of this approach, which is concerned with the child's interests and entitles him to participate actively in the learning process. This approach aims to investigate if and to what extent the intervention of an adult who wants to stimulate the child's interests and curiosity, without controlling his ideas, can influence the manifestation of scientific attitudes.

promotion from within + final conversation. This educational approach is similar to the above-cited, but, at the end of the activities, the researcher encourages the children to revisit and reflect on the experience by discussing it. In this scenario, the adult must favor the discussion, confrontation, and reflection through specific questions: what did we do today? What did we observe? How can we continue the experience? In this case, the purpose is to analyze if and how this approach from the adult, who not only promotes from within but also favors a participative reflection on the experience, can influence the manifestation of scientific attitudes. Moreover, this approach also investigates the impact of the metacognitive dimension.

The implementation

Children between the ages of 4 and 5 were involved in this research. They were later divided into three groups, balanced in age and gender. Each group had the same number of meetings, in the same place, using the same materials, but with different approaches, associated with the three groups randomly. The presented scenario was:

- Group A would test the 'promotion from within' approach
- Group B would experience the combination of 'promotion from within' and guided discussion on the activities
- Group C would have the adult as an observer who does not intervene to encourage the thinking process

The research was carried out in the span of three months, and the meetings took place in a classroom equipped as a laboratory. In particular, the table reported below shows the different types of encounters the groups participated in. All the meetings with the groups of children were recorded and transcribed to monitor the process and analyze it later.

MEETINGS WITH GROUPS PARTICIPATING IN THE RESEARCH	GROUP A	GROUP B	GROUP C
Pre-Observation	2	2	2
Promoting Scientific education	(promotion from within) 4	promotion from within + conversation) 4	(laissez-faire) 4
Post-observation	2	2	2

Table 1. Type and number of meetings held by each group participating in the research.

DATA ANALYSIS: IDENTIFICATION OF THE 'EPISTEMIC' CATEGORIES AND INTERVENTION STRATEGIES OF THE ADULT

The audio-visual materials were fundamental because they allowed the researchers to re-watch the meetings numerous times and notice more and more peculiarities each time. Moreover, they facilitated the inclusion of other observers in the analysis phase, especially the process supervisors. The involvement of the supervisors aimed both at avoiding any subjectivity influence and including different perspectives that enriched the analysis of the materials collected. The documentation of the process and its re-examination *in itinere* allowed the researchers to identify critical points and the necessity, sometimes, to take a step back and reflect on the intervention. The study on the materials also permitted the outlining of analysis tables to describe the scientific attitudes shown by the children, and the strategies and actions perpetrated by the adult to develop thinking processes, coherently with the 'promotion from within' approach. The above-cited actions are part of the idea of evaluation explained in the premise, a sort of evaluation that "*procede, accompagna e segue*" *(Indicazioni Nazionali*, 2012, p.19) the learning process. The researchers and supervisors analyzed the recordings, following this perspective, and they managed to describe some scientific attitudes shown by the children and some of the strategies implemented by the adult.

The identified scientific attitudes

The organization of the categories in the following list is not dictated by a sequential order of manifestation, but it highlights the complexity and articulation of the different approaches.

1. Detection of the phenomenon. These are all those situations in which children interact with the materials by perceiving some characteristics without continuing further investigation. An example is represented by Leonardo who looks at the plastic bottles, lies down on the ground, takes aim, blows on one of the standing bottles. He repeats the action a couple of times by blowing harder and harder until he manages to make it fall.
2. Assembly and construction. The behaviours that have been considered concern situations in which the children, individually and / or in groups, look for objects with the intention of

building something on the basis of a project, a goal that they achieve without meeting particular "hitches". Some examples are represented by the construction of a marble track and the assembly of different materials to create a wigwam.

3. Exploration. This category includes all the behaviours with which a child not only detects and briefly observes a phenomenon but explores it by activating behaviours that indicate the intention to deepen the knowledge, to understand "how it works"; this, too, in view of the achievement of an objective outside the cognitive one. An example is Alice trying to get a piece of cellotape but can not tear it. She tries pulling harder and observes that the tape stretches but does not tear. Try to rip it off with your teeth (if I pull harder or bite with my teeth, it will tear) but she realizes it fails and puts it back in the box holding the roll of cardboard in her hand.

4. Experimentation. This category includes all the conduits through which the child acts and interacts with the material available on the basis of a hypothesis to be verified. The discriminating aspect in this category consists of the verbal explanation of the hypothesis in mind and of the implementation of the actions useful to put it to the test by observing the effects that follow. This type of conduct develops along a process that falls within Dewey's theory of the investigation process. For example, Leonardo is working in a pool of water and suddenly says: *"Look! This float (indicates a piece of wood) but if I put this on it* (a plastic bottle full of water) it *will all go down*".

5. Detection of the problem. This category is very similar to the previous one because it implies a process that falls within the frame of Dewey's investigation process. The aspect that characterizes the behaviours that fall into this category is represented by the fact that the children, during their explorations on the material available, encounter a problem that puts them in front of a 'hitch' or a dilemma. This condition puts the child in front of a frustrating situation because his research remains 'blocked' by a problem 'imposed' by external reality. The problematic situation is such when the child explicitly identifies the hitch that puts him in difficulty and tries to overcome it. An example is shown below.

> " Leonardo notices a piece of cardboard from the broken kitchen paper roll. After a few moments, Leonardo says: "Here it is broken". He looks around, approaches a box and takes a roll of blue tape. He shows it to me and shows me the corner that has been raised in the cardboard roll and says: "I have to fix it!". Looking at the roll of tape he tries to find the point where you can lift it to get a piece. Peter and Alice approach him. Leonardo starts to pull the piece of cellotape, he pulls hard, looks at the cardboard roll of and that of the cellotape and says: "How do you do it... how do you do it?". Alice proposes: "If we take scissors, we can cut it."

Strategies and functions in the adult's intervention

Regarding the analysis of the adult's intervention, I will cite an example from the table below to demonstrate how the researcher performed support actions and strategies to promote and develop the scientific attitudes in children after they solicited him. Even in this scenario, the choice of strategies and functions performed by the adult was influenced by the idea of evaluation intended as an instrument to "control" the coherence between pedagogical basis, objectives to achieve, and educational choices.

THEME	CATEGORY	MATERIAL	VERB/N.VERB	IND/SOC	ADULT
Ingrand/acqua	Detecting of the phenomena Exploration	Plastic bottle water, marbles, metal rings	Verbal ("Guarda, messe così, sembrano più grandi") Verbal ("se le tiri fuori…") Non verbal (actions) Verbal **"**Siii, vedi! É vero, sembrano più grandi se messi qui"	Social (Alice, adult) Social (Elena, adult, alice) Social (Elena, Alice) Social (Elena, Alice, adult)	Open questions (consolidate e relationship) Reflects. (consolidate).

Table 2. Example of analysis grid of the scientific conduct of children, of the strategies and functions performed by the adult to support them

In particular, in order to identify educational strategies and functions performed by the adult that are coherent with the 'promotion from within' approach, Bondioli's and Savio's (1996, 2001) categories were considered. They highlighted the importance of an intervention style that does not prevaricate but enhances the child's interests and perspectives instead. In particular, the adult 'reflects' of the child's verbal and non-verbal behaviors without judging. He also asked open questions that allowed a vast range of possible answers and introduced new elements (materials or activities) coherent with what the child or group was doing.

The above-cited strategies have specific functions[1] - belonging to the tutoring theory – in relation with the cognitive, emotional, and social spheres.

CHILDREN'S SCIENTIFIC ATTITUDES AND THE ADULT'S ROLE

The data processed in the above-cited schemes were analyzed quantitatively and qualitatively. In particular, the former analysis allowed specific considerations regarding the manifestation and development of scientific categories, communication methods, and socialization connected to these attitudes. Moreover, the study conducted on the schemes regarding the adult's role permitted the opening

[1] The functions related to the cognitive dimensions are: Consolidate, Focus the attention, Solicit and expand; while those connected to the emotional and social sphere are: regulating the emotional intensity, containing the frustration, the 'emotional bridge'.

of an investigation on the strategies and functions that can best favor and promote learning processes in children.

The tables (Table 3, 4, 5) describing the manifestation of scientific behaviours in children during the encounters prove that groups A (promotion from within) and B (promotion from within and later discussion) appear different from group C (no intervention to promote the scientific attitude), especially when it concerns the experimentation category (A=6, B=10, C=1) and the detection of the problem (A=10, B=5, C=0). Instead, the differences appear to be minimal in the detection of the phenomena and in the exploration categories. This suggests that providing children with stimulating materials and letting them explore said materials freely, although fundamental, is not sufficient to activate more articulated and complex scientific attitudes. Essentially, these attitudes, belonging to Dewey's inquiry process, were manifested in the groups where the materials were provided and explored freely but also followed by the support of an adult, who planned interventions embodied in the theoretical and methodological framework of Bruner's *tutoring* (1967) and Vygotsky's zone of proximal development (1934; 1938). Therefore, these interventions aimed not only at furthering the manifestation of scientific attitudes but also at developing and enriching them by promoting learning processes.

GROUP A Promotion from within	**Pre-observation**	**1**	**2**	**3**	**4**	**Post-observation**	**TOT**
Detecting of the phenomena	**4**	**-**	**-**	**-**	**1**	**3**	**8**
Assembly/construction	**1**	**1**	**1**	**1**	**-**	**2**	**6**
Exploration	**3**	**4**	**2**	**3**	**4**	**4**	**20**
Sperimentation	**-**	**-**	**2**	**1**	**2**	**1**	**6**
Problem Identifying	**2**	**2**	**1**	**2**	**1**	**2**	**10**

Table 3. Detection of the scientific conduct of the children of group A, in the various meetings carried out.

GROUP B Promotion from within+final conversation	**Pre-observation**	**1**	**2**	**3**	**4**	**Post-observation**	**TOT**
Detecting of the phenomena	1	1	2	-	1	-	**5**
Assembly/construction	2	-	-	1	-	2	**5**
Exploration	3	3	2	4	4	4	**22**
Sperimentation	2	2	-	1	2	3	**10**
Problem Identifying	2	-	1	1	-	1	**5**

Table 4. Detection of the scientific conduct of the children of group B, in the various meetings carried out.

GROUP C Laissez-faire	**Pre-observation**	**1**	**2**	**3**	**4**	**Post-observation**	**TOT**
Detecting of the phenomena	1	2	1	1	1	2	**8**
Assembly/construction	2	-	-	1	1	1	**5**
Exploration	4	4	1	2	2	2	**15**
Sperimentation	-	1	-	-	-	-	**1**
Problem Identifying	-	-	-	-	-	-	**-**

Table 5. Detection of the scientific conduct of the children of group C, in the various meetings carried out

Observing and analyzing the children's experiences, the researcher and supervisors identified some elements that they deemed worthy of investigation; for instance, for how long the children from the three groups were manifesting scientific attitudes and the use they made of them to investigate a specific "theme" or observed phenomenon. In particular, groups A and B, working with and adult who 'promotes from within', focused on their scientific attitudes for a longer period (from 37% during the first encounter to 42% during the last) compared to group C (from 24% in the first meeting to 12% in the last), where the adult did not emphasize or favor the children's interests and did not willingly intervene to promote the learning process.

Similar considerations can be made regarding the identification of articulated[2] epistemic behaviour: complex attitudes perpetrated by the children to investigate an observed phenomenon. In particular, the analysis of the data collected highlighted that children belonging to groups A and B ('promotion from within' approach) had different epistemic behaviour (A and B=11) – connected with the scientific investigation – (exploration, experimentation, identification of the issue) to deepen their knowledge concerning the same phenomenon. Once again, group C showed less quantity (C=4) and complexity (constructing and exploration) regarding behaviors aimed at learning following a scientific investigation method. The tables reported below show the quantity and quality of the articulated epistemic behaviours to investigate the different phenomena observed.

[2] Different scientific behaviours used to depeen the knowledge on an observed phenomenon

	Pre-observation	1	2	3	4	Post-observation	**TOT**
Articulated epistemic behaviours	1	2	1	3	2	2	**11**
Frequency of articulated epistemic behaviours and categories involved	5 articulated conducts Construction, Exp., Sperim. and detect.of the problem	2 articulated conducts Construction and detecting of the problem 2 articulated exp., and sperim.	2 artic. conducts Exp. And detect.of the problem; 2 artic. Exp., and sperim.	2 artic. conducts Exp. and detecting of the problem	3 artic. conducts Exp. And Sperim. 2 artic. Conducts exp. and Sperim.	3 artic. Conducts Exp., Sperim., Exp. 5 artic. conducts Construction, Exp., detecting of the problem, construction and exp.	

Table 6. Articulated epistemic conducts (to deepen a "scientific" theme) in group A – promotion from within

	Pre-observation	1	2	3	4	Post-observation	**TOT**
Articulated epistemic behaviours	1	2	3	2	1	2	**11**
Frequency of articulated epistemic behaviours and categories involved	2 articulated conducts Exp.and detect.of the problem	2 articulated conducts Construction and detecting of the problem 3 articulated exp., detecting of the problem and exp.	2 artic. conducts Exp. and sper; 2 artic. Construction and detecting of the problem 3 artic. Exp., and sper.	2 artic. conducts Exp. and sper.; 2 artic. Construction and detecting of the problem 3 artic. Exp., and sper.	2 articulated conducts Sper. and exp.	2 articulated conducts Construction and exp.	

Table 7. Articulated epistemic conducts (to deepen a "scientific" theme) in group B – promotion from within and final discussion

	Pre-observation	1	2	3	4	Post-observation	**TOT**
Articulated epistemic behaviours	1	1	-	-	1	1	**4**
Frequency of articulated epistemic behaviours and categories involved	2 articulated conducts Construction and experimentation	2 articulated conducts Experimentation and sperimentation	-	-	2 articulated conducts Construction and detecting of phenomena	2 articulated conducts Construction and experimentation	

Table 8. Articulated epistemic conducts (to deepen a "scientific" theme) in group C – leissez-faire

In summary, from the considerations made up to this point, differences emerge between the groups in relation to:

- the epistemic behaviour. Groups A and B differ from group C and in particular are more active in conducts that fall into the scientific categories of experimentation and problem identification.

- times dedicated to epistemic activities. Groups A and B record a greater percentage of time, compared to C, in relation to the time that children engage in carrying out activities that require

the activation of epistemic behaviour. The deepening of this aspect, through the analysis of the 'non-scientific' activities carried out by the groups in the residual time will be able to provide further information.

- "characteristic" situations and meetings due to the presence of data that deviate from the general trend of a certain group. In groups A and B there are meetings in which particular situations emerge from some data. In group B, for example, there was a sharp drop in the second meeting in the manifestation of verbal communication methods, in the social dimension and in the percentage of time dedicated to scientific conduct. Likewise, another fact that is highlighted is represented by a very high percentage of time devoted to scientific activities in the fourth meeting (B = 87%) which will be analyzed in relation to the role of the adult. In group A, starting from the second meeting, there are more complex scientific behaviours (see section 4.2). This situation is not observed in group C because the children seem to remain in a situation in which they do not activate more complex epistemic behaviours, verbal communicative modalities and more collaborative social interactions.

From these considerations emerge the first elements that could make one think of an influence that the intervention approach proposed in groups A and B has on the possibility of supporting and promoting cognitive attitudes in relation to the observed phenomena. This, at the moment, is a hypothesis that needs to be deepened to collect further elements that can support it taking into account any alternative work runs.

Strategies and functions of the adult

The analysis of the strategies performed by the adult proves how many interventions are coherent with the 'promotion from within' approach adopted by groups A and B (mirroring, in particular). In these two groups, the purpose of the adult was soliciting further insights, the continuation of the experience, or the reflection on it (A=35 and B=36). In comparison to the other groups, group C is characterized by more interventions to secure the functioning of the social factors (C=13). This functioning was activated through accommodating strategies (the adult agrees to play with the children to establish some rules) or through more specific guidelines ("Let's take your kit and see what's inside? Is there anything interesting? *Let's try to divide the floating objects from the sinking ones?").*

The data concerning the encounters where the adult 'unintentionally' performed more direct interventions, showing the children what to do instead of considering their suggestions, and presenting them with straight answers to their questions, caused a decrease in the amount of time spent engaging in scientific activities, in the communications of the manifested attitudes, and in the availability to interact in the group. All this confirms what was previously stated regarding the effects of the promotion from within. This aspect suggests that, by proposing activities that do not coincide with the children's interests, the adult becomes a substitute to them, making it more difficult for the children to interact, advance theories, verify them and share them with their classmates. The children in an environment where the

adult did not listen or consider their curiosities showed difficulties both in performing scientific attitudes and handling the interactions within the group. This led the researcher to intervene multiple times in order to secure a harmonious context where the activities could continue. This type of issue did not manifest itself during the encounters of the other two groups, who followed the promotion from within approach.

FINAL CONSIDERATION AND OPEN ISSUES

The richness of materials collected during the research and its quantitative and qualitative analysis provided fundamental data to identify the parameters of an educational approach sustaining a favorable context for the development of scientific attitudes. In this scenario, these attitudes refer to an active investigation that leads to an autonomous and participative construction of knowledge and a scientific understanding (Andersson, Gullberg, 2014; Onida, Salvadori, 2020). The analysis of the materials also provided indications regarding how to support the development of a science-oriented behavior, which furthers the reflection on issues and the comprehension of how this complex world and the entanglements and relations that characterize it work (Arcà, Mazzoli, 1995; Bertolino, Guerra, Schenetti, Antonacci, 2017).

The exploratory level of this research also allowed to identify matters to consider when planning educational interventions aimed at developing critical thinking processes. In particular, this opportunity can highlight questions that must have answers and orient educational and didactic choices. What strategies are more efficient in the favoring of more complex scientific attitudes? What are the most indicated choices to encourage the children's verbalization and their cooperation in the investigation of a phenomenon? How to notice and avoid the daily routine to cause automatisms that lead to non-mirroring answers where the adult substitutes himself to or does not welcome the child's inputs?

Again. What are the suggestions to consider in order to organize and handle an experience similar to that described in the previous paragraph, adapting in the everyday work at school? In particular, how to create small groups of children at a specific time of the day and collect the proper documentation through video recordings or old-style observation with paper and pen to later analyze it with colleagues? The reflection on what needs to be done should not depend on the data collected on the experience nor on the planning intention. This process of contemplation of the action (Schön, 1993) that holds together the planning intention, its perpetration, and its documentation, aimed at evaluating its unfolding and the possible corrections, implicates specific choices from the teacher. In particular, these decisions concern both the organization of the activities and the use of the "evaluation" tool. Therefore, the evaluation process aims to "regulate" the learning process and gather inputs in order to sustain them by improving the context, instead of judging the children's performances.

The above-cited concepts allow considering evaluation as a research process where teachers, sharing values and pedagogical principles, theorize development paths that observe, document, and evaluate. These processes aim at permitting to re-analyze the experience and identify improvements both in the methods (observation, documentation) and the different perspectives. From this point of view, evaluation is not a unidirectional process (the teacher judges the children, or the researcher evaluates the results of his inquiry), but it is characterized by an intertwining of layers that influence one another. This idea of evaluation as a research process requires the teacher to adopt flexible and participative strategies of intervention, not based on preconceptions but on the possibility to question their educational and didactic approach while furthering the children's everyday experience, their curiosity, differences, and variety of personal answers. The opportunity to discuss the adult's choices to offer an educational environment that promotes thinking processes requires the ability to abandon certainties and expose oneself to the emotionally challenging situation of uncertainty (Bion, 1973). This aspect involves a certain amount of anxiety that must be managed in order not to give in to the temptation to find 'pre-packaged' solutions.

Similarly, in this perspective, the researcher and supervisors must be willing to welcome hypotheses that emerge from the analysis of the data collected, though always maintaining the scientific coherence of the project. This consideration leads to reflecting on and enhancing the workgroup intended as an organism able to welcome new hypotheses by promoting confrontation. Obviously, each workgroup has to undergo a proper professional training that enhances dialogue, confrontation, auto-evaluation as a fundamental instrument to "rule" and guide the educational act. Therefore, the training has to prepare teachers capable of conducting research with the children, willing to face the emotional challenge and uncertainty that this process entails and able to handle the doubts and waiting without giving in to the desire to explain, transmit concepts, and suggest specific activities that do not consider the children's interests.

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Affiliation: Istituto Comprensivo Statale di Carcare, Savona, Liguria, Italy

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