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Childhood Education Dossier

ARTICLE - EVALUATION AS A RESEARCH PROCESS. REFLECTIONS FROM RESEARCH ON SCIENCE EDUCATION IN EARLY CHILDHOOD EDUCATION.

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ABSTRACT

Some documents (Proposal for Key principles of a Quality Framework for Early Childhood Education and Care, 2014, Italian National Guidelines for the Curriculum, 2012) establish the importance of formative evaluation as a research and innovation process. Through the observation and analysis of educational documents, the educational evaluation allows teachers to evaluate their academic proposal and improve it to promote learning. To develop this topic, we will refer to research on science education in Early Childhood Education. This research uses the theoretical contribution of Dewey (1933;1938), Vygotsky (1930; 1934), Wood, Bruner, and Ross (1976), and the psychoanalysis regarding the psychic processes as the basis for curiosity and 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 children's scientific investigation. The 'promoting from within' (Bondioli, 2008; Bondioli, Savio, 2009; Bondioli, 2015)approach is a valuable reference for designing and setting up adult interventions to promote the development of a scientific attitude. We collected the data through videotapes and observation protocols, creating 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 suggestions regarding the educational context conditions (adult intervention strategy, material, space). Some situations would best promote the development of a scientific attitude and critical thinking, considered an active investigative attitude to build knowledge and scientific understanding, both independent and shared (Andersson, Gullberg, 2014; Onida, Salvadori, 2020). Data gathering and categorization allowed us to create two evaluation charts: one to analyze the children's scientific behaviors, and the other to explain the adult's functions and strategies. In conclusion, the investigative approach of the research allowed us to formulate two hypotheses (Lumbelli, 1980) that should be further analyzed. 1) Children and their creativity are not too influenced if the adult intervenes through an internal approach. Furthermore, scientific attitudes are developed if the teacher suggests a discussion and confrontation within the group. 2). If the adult does not interfere or they do it imposing a specific direction, the investigative attitude is not encouraged.

Keywords: Evaluating process, scientific thinking, early childhood education, scienc e curriculum, promote from the inside.

ARTIGO - 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 italiana,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 pesquisase 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 pelas crianças. A abordagem "promover a partir de dentro" (Bondioli, 2008; Bondioli, Savio, 2009; Bondioli, 2015) como referência útil para o planejamentoe ações dos adultos com o objetivo de promover o desenvolvimento de uma atitude científica. Os dados foram coletados por meio de observação e registro em vídeo e caderno de campo, foram elaboradas duas grades de análise: uma referente ao comportamento epistêmico das crianças e outra referente às estratégias e funções doadulto. 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, entendida como uma como atitude de pesquisa ativa que leva à construção, de forma autônoma e participativa, de conhecimento e compreensão no campo científico (Andersson, Gullberg, 2014; Onida, Salvadori, 2020). A coleta e organização dos dados possibilitou a construção de duas grades de análise: uma para analisar a conduta científica das crianças, outra para destacar as estratégias e funções do adulto. A dimensão exploratória que caracteriza a minha pesquisa permitiu-me, em conclusão, levantar duas hipóteses (Lumbelli, 1980) que devem ser melhor investigadas. 1) Se o adulto intervém com uma abordagem que promove a partir de dentro, deixa espaço para a criança e sua curiosidade e oferece momentos de discussão e discussão no grupo, então ele promove a conduta científica. 2) Se o adulto não intervém ou o faz por meio de diretrizes, não favorece o desenvolvimento de uma atitude de pesquisa.

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 DEINFANCIA.

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 italiana, 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 aldocente 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, entendida como actitud de investigación activa que conduce a la construcción, de forma autónoma y participativa, del conocimiento y la comprensión en el campo científico (Andersson, Gullberg, 2014; Onida, Salvadori, 2020). La recolección y organización de los datos permitió construir dos grillas de análisis: una para analizar la conducta científica de los niños, la otra para destacar las estrategias y funciones del adulto. La dimensión exploratoria que caracteriza mi investigación me permitió, en conclusión, formular dos hipótesis (Lumbelli, 1980) que deberían ser investigadas más a fondo: 1)Si el adulto interviene con un enfoque que promueve desde dentro, deja espacio para el niño y su curiosidad y ofrece momentos de discusión y discusión en el grupo, entonces promueve la conducta científica. 2)Si el adulto no interviene o lo hace a través de directivas, entonces no favorece el desarrollo de una actitud investigadora.
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, correlatedwith the equally peculiar nursery school environment where we carried out this research.

In particular, science education is defined as the promotion of critical and reflective thinking (Dewey, 1949; Vygotskij, 1960; 1978; Bruner, Wood, Ross, 1976) and focuses on developing knowledge relating to animated things and not of the natural environment. According to Dewey, the subject promotes these skills through an inquiry process by uncovering and highlighting issues. In this process, it is essential to observe and bring forward hypotheses, solutions, and their verification.

The analysis of national and international scientific literature on science education has highlighted aspects that can be traced back to three main lines of investigation.

1. Sensitization towards environmental issues (Environmental Education) (Duhn 2012; Erdogan et al. 2012; Cutter-MacKenzie et al. 2014).

2. The rediscovery of the natural world through a direct relationship with plants and animals (experience of the agri-nursery school, school in the woods) (Faber Taylor et al. 1998; Louv 2005; Peta, Ventura, and Savarese 2013).

3. The importance of initiating children to an investigation method of the natural world phenomena. (Inan, Trundle, and Kantor 2010; Giordano 2013; Andersson and Gullberg 2014).

Only this last investigation line explicitly focuses on a science education intended to support the relationship between child and nature in cognitive terms. In particular, it emerges from the fact that science education in Early Childhood Education cannot be reduced to the simple transmission of scientific notions. It is essential to propose paths to support scientific processes of relating and

experiencing the world, knowing that children, even embryonically, spontaneously activate these processes from early childhood.

Evaluation is a widely debated and controversial topic in the educational field. On the one hand, it seems that a general agreement has been reached, according to which evaluating is a complex action requiring 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 a mere practice aimed at judging the performances (Vertecchi, 2016).

Some European documents (Indicazioni Nazionali italiane 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 simple classification and judgment. On the contrary, the evaluation carried out by the teacheraims to recognize, describe, and promote growth and development. The previouslycited documents convey a central role in professional strategies such as observation and documentation, stressing the importance of children's and teachers' self-evaluation. Analyzing the previously collected papers in groups helps us recognize the coherence between pedagogic concepts, cultural choices, and actions taken to implement them (Raso, Lampugnani, Marone, Lichene, 2020). From this perspective, evaluation is a fundamental tool in improving schools' education and handling the educational actions that promote children's development. According to this concept, the Proposal for Key Principles of a Quality *Framework forEarly Childhood Education and Care* (2012) states that evaluation should recognize, follow, describe, and document the developmental processes without classifying and judging the performances.

This type of evaluation requires careful and systematic observation to distinguish

the abilities and skills the child already possesses from those he is acquiring. These potentials must be acknowledged and consolidated to guide educational choices and interventions to encourage children's ongoing growth. The teacher has to support (scaffolding), encourage, and facilitate children's harmonious development (Bruner, Wood, Ross, 1976). These evaluation procedures need to consider 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. This perspective explains the meaning of educational evaluation regarding the developmental processes and children's progress.

In this research on science education, evaluation is considered a process that "regulates", guides, and orients the educational effort, the researcher's procedure, and the teachers' actions. (Bondioli, Ferrari, 2006; Gariboldi, 2007; Bondioli, 2015; 2015b).

We carried out an exploratory study aimed at acknowledging and analyzing the best contexts

– space, time, and educational approaches – to encourage and promote the development of scientific thought in Early Childhood Education (Dewey, 1933; 1938; Isaacs, 1930, 1933; Bruner, Wood, Ross, 1976). The initial project, monitored by a team of researchers and supervisors, underwent slight modifications due to findings that emerged when observing the children and the documental review. The final considerations regarding the experience contemplate children's progress in the scientific field. This progress is closely connected with the contexts analyzed – tools, time, educational approaches – intentionally chosen by adults, documented, monitored, and evaluated from different points of view to offer the best experience for the children, teachers, and families.

SCIENCE EDUCATION AS "ENCOURAGEMENT" OF THE LEARNING PROCESS.

The scientific literature on the topic (Giordano, 2010; Andersson, Gullberg, 2014; Bertolino, Guerra, Schenetti, Antonietti, 2017) maintains that science education cannot be limited to the transmission of contents. Every child is born with plenty of curiosities, questions, and interests that adults need to recognize - even when they begin their journey in education -, support, and stimulate through a specific approach. This approach must promote and support children's interests and discoveries to encourage further investigations and learning processes (Bondioli, Savio, 2014). Considering this point of view, even the Indicazioni Nazionali per il curricolo in Italy of 2012 (updated in "Nuovi scenari", 2018) deals with science education in "La conoscenza del mondo". It mainly focuses on children's curiosity, interest in the observed phenomena, their ability to ask questions and further investigate, and their eagerness to share their discoveries with their classmates and teachers.

These considerations represent the necessary framework to interpret the core of the research we carried out: how to implement scientific knowledge not only aimed at the transmission ofconcepts but also the development of

"…ability and willingness to use the body of knowledge and methodology employed to explain the natural world, to identify questions and to draw evidence-basedconclusions. 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 adultare 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,Susan

Isaacs's (1930, 1933) contributions were particularly useful because she effectively interpreted Deweyian and psychoanalytic theories into a pedagogical purpose with her experience at Malting House.

We used the 'promotion from within' approach (Bondioli, 2008; Bondioli, Savio, 2009; Bondioli, 2015a e b, Savio, 2003; Bondioli, Savio, 2012; Savio, 2013) to keep a close connection between the theories and sources previously mentioned. We included this approach in the previously outlined conceptual framework. It is characterized by a participative strategy, asthe planning of the educational actions originates from children's curiosity and welcomes their suggestions.

Work hypothesis and research plan

The research is part of the author's PhD at the University of Pavia, in Italy. Its publication is authorized in compliance with ethical principles.

Following the previously mentioned studies, one of the main aims of this research was to identify the best environment to promote and favor a scientific analysis of children's natural behaviors at preschool age. In particular, nursery school children. The educational styles teachers propose strongly influence the environmental factor. Therefore, they are also examined in theresearch. Our secondary aim was to study if and in what measure children in thesame educational context, age group (4 and 5-year-old), and subjected to the same free experimentation of 'stimulating tools' manifested the same set of skills and range of scientific attitudes, after experiencing different teaching styles.

To this end, we conceptualized the following investigation plan:

engagement of 3 groups of 4 and 5- year-old children attending the same section of a nursery school, balanced by age and gender;

- to each group, in parallel, we proposed a pathway with the same number of meetings, in the same space, and with the same materials, but with a different adult role. In particular, each group would have a different adult intervention:

- group A: an adult who promotes from within;
- group B: an adult who promotes from within and supports the conversation about what has been done;
- group C: an adult who observes and lets children act (laissez-faire);
- before and after the course, we held two meetings for each group where children could freely move with available materials. Adults observed and only intervened in the case of emergencies or practical needs.

Context and subjects.

We conducted the research considering a natural/ecological life context, such as the nursery school. Referring to the nursery school and educational services, in terms of context means adopting an ecological perspective (Bronfenbrenner, 1979) and reflecting on the fact that people, in this case,

children, behave differently depending on their environmental situation. Choosing to conduct the research in the natural environment of the nursery school has allowed us to observe children's behaviour within a context familiar to them, considering the roles, activities and relationships of all participant people.

The choice of a nursery school assumes an added value connected to the research objectives: to develop a modality of educational and didactic intervention which, based on the considered literary review, allows a scientific attitude about knowledge in the world of animate and inanimate natural things.

As subjects, we chose only four and 5-year-olds in the exploratory research because they share a common educational past, interacting for two or three years.

The three groups were randomly composed, guaranteeing a balance of gender and age. We also considered friendship ties, keeping friends in the same groups.

Each group had seven to eight children, allowing us to give attention to the groups and the individual activities. Groups that were not numerous would also facilitate interactions between peers and adults.

The research experience was conducted in the city of Mallare[1], where one of the five nursery schools of the Istituto Comprensivo di Carcare (SV) is located. In particular, the school where we conducted the research welcomes 29 children and is run by two teachers assisted by non-teaching staff.

We collected information on the school through two sources: direct observation and interviews with teachers, conducted according to a 'near' approach to the non-directive guided by Roger's approach (Lumbelli, 1981, 1990; Mignosi, 2002; Rogers, 1989; Bondioli, Gusmini, Schietroma, 2006).

The nursery school is located in the same building as an elementary school, which works 27 hours a week (from Monday to Friday from 8:15 am to 1 pm and one afternoon until 4:15 pm). The nursery school works 40 hours per week (from Monday to Friday from 8:15 am to 4:15 pm) in a single section attending children from 2 and a half to 6 years old. The outdoor areas are a cemented courtyard and a green space with a greenhouse, which is part of the laboratories that characterize the Institute's Educational Offer Plan.

The Material

The project envisaged preparing a set of materials and objects to be proposed to children, demanding observations and 'scientific' explorations.

These are the materials chosen and prepared: large tanks of transparent plexiglass of different sizes, flours (white, yellow), sand, stones, caps (metal, plastic, cork), containers, funnels, strainers, bottles of different materials and sizes, ladles and cutlery of varying materials, bolts, rings (wood, metal, plastic), crepe

[1], The city of Mallare has 1,300 inhabitants. It is located in the hinterland of Savona but is part of the Diocese of Mondovì and belongs to the Mountain Community of Alta Val Bormida. The main economic activities are agriculture, woodworking, and the furniture industry. The tradition of the territory is wood - abundant in the surrounding woods. This was emphasized in the school project, leading to a wood museum in the school building. As for the city population, 149 people are between 0 and 18 years. Among these, 33 are included in the nursery school age group.

paper, tissue, cardboard, dried vegetables, seeds, coloured adhesive tape, sellotape, glass marbles, ping pong and rubber balls.

Each child was provided, from the first meeting, with a kit consisting of a magnifying glass, ruler, notebook, pencil and torch to incentivize children to adopt an "explorer" behaviour, thus immediately calling upon the behaviour proposed during the journey.

To keep the children's curiosity alive and not introduce too many variability elements, we planned to use the same set of materials for two successive meetings and then partially change it by introducing new objects.

The different types of adult intervention.

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

laissez-faire. The adult maintains an observer role and does not promote the

exploration activity, only intervening if particular practical problems arise. Adopting this approach,we intend to verify if and to what extent the condition of total freedom and autonomy, without adult interference, affects the conduct of children's scientific exploration;

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 exploration, following the 'promotion from within' model. In this scenario, the teacher waits for and welcomes children's initiative, encourages questions, and 'reflects' their scientific attitude concerning the materials, either verbally or non-verbally. The adult 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, concerned with children's interests and actively participating in the learning process. This approach aims to investigateif and to what extent the intervention of an adult who wants to stimulate children's interests and curiositywithout controlling their ideas can influence scientific attitudes.

promotion from within + final conversation. This educational approach is similar to the previous one. However, at the end of the activities, the researcher encourages children to discuss the experience, revisiting, and reflecting on 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 continuethe experience? In this case, the purpose is to analyze if and how an approach that promotes from within and favors a participative reflection can influence scientific attitudes. Moreover, this approach also investigates the impact of the metacognitive dimension.

The implementation: the times and the encounter

The research lasted three months, with meetings held in aclassroom equipped as a laboratory. The box below shows the different types of group encounters. All the meetings with the children groups were recorded andtranscribed to monitor the process and analyzed later.

BOX 1. Type and number of meetings held by each participating group.

SESSIONS WITH PARTICIPATING GROUPS	GROUP - A	GROUP - B	GROUP – C
Pre-Observation	2	2	2
Promoting Science Education	(promotion from within) 4	promotion from within + conversation) 4	(laissez-faire) 4
Post-observation	2	2	2

In all three groups, the path would be preceded and followed by two meetings in which the adult would maintain an observer role, intervening only for a practical need emerged or to guarantee the safety needed to continue the experience. The two preliminary observation sessions aimed at detecting children's exploratory behaviour before they were subjected to an intentionally-designed intervention to support and promote scientific conduct.

The final observation sessions intended to detect differences in children's scientific conduct compared to the two initial observations.

Between the two preliminary and final observation sessions, four others were planned for each group, characterized by the adult's different approach, as previously described. The meetings of the three groups, the two initial ones, the four central ones, and the last two, occurred in parallel to ensure that the experience took place for all in the same period.

The four central sessions (intervention phase) were scheduled so that each group participated in the experience once a week, with a similar time interval between one session and the other. The survey plan included eight sessions (4 observations and 4 interviews) for each group of children.

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

Methodological considerations

Before continuing to describe the steps to elaborate the grids to analyze the data qualitatively, we should reflect on the data collection method.

The audio-visual materials were fundamental because they allowed researchers to re-watch the sessions numerous times and notice more peculiarities each time. Moreover, they facilitated the inclusion of other observers in the analysis phase, especially the process supervisors.

The supervisors ' involvement aimed to avoid any subjectivity influence and include different perspectives to enrich the analysis of the materials collected (Lucisano, Salerni, 2002).

The documentation of the process and its re-examination allowed the researchers to identify critical points and, sometimes, the need to take a step back and reflect on the intervention.

The study on the materials also permitted outlining analysis tables to describe children's scientific attitudes and the strategies and actions perpetrated by the adult to develop thinking processes, following the 'promotion from within'approach. The above-cited steps are part of the idea of evaluation explained in the premise, which "*procede, accompagna e segue*" *(Indicazioni Nazionali*, 2012, p.19)[procedes, accompanies, and follows] the learning process. Following this perspective, the researchers and supervisors analyzed the recordings and managed todescribe some children's scientific attitudes and some strategies implemented by the adult.

The identified scientific attitudes

The sequential order of the categories in the list does not follow their manifestation sequence, 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. For example, Leonardo looks at the plastic bottles, lies down on the ground, aims, and blows on one of the standing bottles. He repeats this actiona couple of times by blowing harder and harder until he manages to make it fall.

2. **Assembly and construction**. The behaviours considered 'concern situations' in which the children, individually and /or in groups, look for objects aiming to build something for a project, a goal they achieve without particular "hitches". Some examples were constructing a marble trackand assembling different materials to create a wigwam.

3. **Exploration.** This category includes all the behaviors in 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"; towards achieving an objective outside the cognitive one. For example, Alice tries to get a piece of sellotape but cannot tear it. She tries pulling harder and observes that the tape stretches but does not tear. She tries to rip it off with her teeth ("if I pull harder or bite with my teeth, it will tear"), but she realizes it does not work and puts it back in the box, holding the cardboard roll in her hand.

4. **Experimentation**. This category includes the behaviors through which children act and interact with the material available based on a hypothesis to be verified. The discriminating aspect in this category consists of the verbal explanation of the hypothesis in mind and implementing practical actions to test them by observing theeffects. 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 andsuddenly says: *"Look! This floats (indicates a piece of wood), but if I put this on it* (a plastic bottle fullof water), it *will all go down*".

5. Detection of the problem. This category is quite similar to the previous one, implying a process that falls within the frame of Dewey's investigation process (Dewey, 1933, 1938). In the

behaviours of this category, when children explore the available material, they are confronted with a dilemma. In this condition, children are frustrated because their research is 'blocked' by a problem 'imposed' by external reality. It is a problematic situation when children explicitly identify the hitchthat puts them in difficulty, and they try to overcome it. We show an example.

"Leonardo notices a piece of cardboard from the broken 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, pointing out the raised corner in the cardboard roll and says: "I have to fix it!". Looking at the tape roll, he tries to find the edge to lift it to tear a piece. Peter and Alice approach him. Leonardo starts to pull the piece of sellotape. He pulls hard, looks at the cardboard roll and the sellotape and says: "How do you do it... how do you do it?". Alice proposes: "If we take scissors, we can cut it."

Adults' strategies and functions

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

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

THEME	CATEGORY	MATERIAL	VERB/N.VERB	IND/SOC	ADULT
Magnified/water	Detecting the phenomena	Plastic bottle water, marbles, metal rings	Verbal ("Look, put it like this, they look bigger")	Social (Alice, adult)	Open questions (consolidate e relationship)
			Verbal ("if you remove them…")	Social (Elena,adult, Alice) Social	
			Nonverbal (actions)	(Elena,Alice)	Reflection
	Exploration		Verbal **"**Yes, look! It's true. They look bigger when placed here."	Social (Elena,Alice, adult)	(consolidate).

In particular, to identify educational strategies and functions performed by the adult that are coherent with the 'promotion from within' approach, we considered Bondioli's and Savio's (1996, 2001) categories. They highlighted the importance of an intervention style that does not hinder but enhances the child's interests and perspectives. The adult 'reflects' on children's verbal and non-verbal behaviors without judging. He also asked open questions that allowed many 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.[2] - belonging to the tutoring theory (Bruner, Wood, Ross, 1976)– in relation with the cognitive, emotional, and social spheres.

CHILDREN'S SCIENTIFIC ATTITUDES AND THE ADULT'S ROLE

We analyzed the data processed in the above-cited schemes quantitatively and qualitatively. 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 on the schemes regarding the adult's role permitted the opening of an investigation into the strategies and functions that best favor and promote learning processes in children.

The tables (Table 1, 2, 3) describing the manifestation of children's scientific behaviours during the sessions prove that groups A (promotion from within) and B (promotion from within and later discussion) seem different from group C (no intervention to promote the scientific attitude), especially regarding the experimentation category (A=6, B=10, C=1) and the detection of theproblem (A=10, B=5, C=0). The differences appear minimal in detecting the phenomena and the exploration categories. This suggests that providing children with stimulatingmaterials and letting them explore freely, although fundamental, is insufficient to activate more articulated and complex scientific attitudes. Essentially, these attitudes, belonging to Dewey's inquiry process (Dewey, 1933, 1938), appeared in the groups where the materials were provided and explored freelybut also followed by the support of an adult, who planned interventions grounded on the theoretical and methodological framework of Bruner's tutoring (1967) and Vygotsky's zone of proximal development (1934; 1938). Therefore, these interventions aimed to further scientific attitudes and develop and enrich them by promoting learning processes.

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

Table 1. Detection of children's scientific conduct in group A, in the various sessions carried out.

GROUP A Promotion from within	**Pre-observation**	**1**	**2**	**3**	**4**	**Post-observation**	**TOTAL**
Detecting the phenomena	4	-	-	-	1	3	**8**
Assembly/construction	1	1	1	1	-	2	**6**
Exploration	3	4	2	3	4	4	**20**
Experimentation	-	-	2	1	2	1	**6**
Identifying problem	2	2	1	2	1	2	**10**

Table 2. Detection of children's scientific conduct in group B, in the various sessions carried out.

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

Table 3. Detection of children's scientific conduct in group C, in the various sessions carried out.

GROUP C Laissez-faire	**Pre-observation**	**1**	**2**	**3**	**4**	**Post-observation**	**TOTAL**
Detecting the phenomena	1	2	1	1	1	2	**8**
Assembly/construction	2	-	-	1	1	1	**5**
Exploration	4	4	1	2	2	2	**15**
Experimentation	-	1	-	-	-	-	**1**
Identifying problem	-	-	-	-	-	-	**-**

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

Similar considerations can be made regarding the identification of articulated[3] epistemic behaviour: complex attitudes perpetrated by the children to investigate an observed phenomenon. In particular, the analysis of the data collected highlighted that children from 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 about the same phenomenon. Once again, group C showed a smaller amount (C=4) and complexity (constructing and exploration) regarding behaviors aimed at learning following a scientific investigation method. The boxes below show the quantity and quality of the articulated epistemic behaviours to investigate the different phenomena observed.

Box 3. 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 behaviors	1	2	1	3	2	2	**11**
Frequency of articulated epistemic behaviors and categories involved	5 articulated conducts Construction, Experimentation and detection of problem	2 articulated conducts Construction and detecting problem 2 articulated exp., and experimentation.	2 artic. conducts Exp. And detect. of the problem; 2 artic. Exp., and experimentation.	2 artic. conducts Exp. and detecting of the problem	3 artic. conducts Exp. and experim. 2 artic. Conducts exp. and experim.	3 artic. Conducts Exp., experim., Exp. 5 artic. conducts Construction, Exp., detecting of the problem, construction and exp.	

[3] Different scientific behaviours to deepen the knowledge of an observed phenomenon

Box 4. 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	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 2 articulated exp., detecting ofthe problem andexp.	2 artic. conducts Exp. and sper; 2artic. Construction and detecting ofthe 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 Experimentation	2 articulated conducts Constructionand exp.	

Box 5. Articulated epistemic conducts (to deepen a "scientific" theme) in group C – laissez-faire

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

Summing up, differences emerged betweenthe groups regarding

- epistemic behavior. Groups A and B differ from group C. In particular, they are moreactive in conducts that fall into the scientific categories of experimentation and problem identification.

- times dedicated to epistemic activities. Groups A and B record a more significant percentage of the time, compared to C, concerning the time that children engage in activities that require the activation of epistemic behavior. 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 data deviating from a certain group's general trend. In groups A and B, there are meetings in which particular cases emerge from some data. In group B, for example, there was a sharp drop in the second session in verbal communication, in the social dimension

and in the percentage of timededicated to scientific conduct. Likewise, another fact to be highlighted is the very high percentage of time devoted to scientific activities in the fourth session (B = 87%), which will be analyzed concerning the adult's role. In group A, starting from the second session, there are more complex scientific behaviours – for example, experimentation and detection of the problem - (see paragraph about 'The identified scientific attitudes'). This situation is not observed in group C (laissez-faire) because the children seem to remain in a condition where they do not activate more complex epistemic behaviors, verbal communicative modalities, and more collaborative social interactions.

From these considerations emerge the first elements of an influence of the intervention approaches proposed in groups A and B – promotion from within (Bondioli, 2008; Bondioli, Savio, 2009; Bondioli, 2015a e Savio, 2003; Bondioli, Savio, 2012; Savio, 2013) - on the support and promotion of cognitive attitudes concerning the observed phenomena. This hypothesis needs to be deepened at the moment through additional elements that can support it.

Strategies and functions of the adult

The analysis of adult strategies performed proves how many interventions arecoherent with the 'promotion from within' approach (Bondioli, 2008; Bondioli, Savio, 2009; Bondioli, 2015a e Savio, 2003; Bondioli, Savio, 2012; Savio, 2013) adopted by groups A and B (mirroring, in particular). In these two groups, the adult's purpose was to solicit further insights, the continuation of the experience, or the reflection on it (A=35 and B=36). Compared 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 (adult agreed 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 sessions where the adult 'unintentionally' performed more direct interventions, showing 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 communication of manifested attitudes, and group interaction. 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 children's interests, the adult becomes a substitute, making it more difficult for the children to interact, advance theories, verify, and share them with their classmates. In an environment where the adult did not listen or consider their curiosities, the children showed difficulties in performing scientific attitudes and handling the interactions within the group. The researcher had to intervene multiple times to secure a harmonious context where the activities could continue. This type of issue did not appear during the sessions of the other two groups, who followed the 'promotion from within' approach.

Assuming that this is an exploratory study, the richness of the material produced and its quantitative and qualitative analysis has provided some valuable data to outline the characteristics of an educational and didactic approach that seem to contribute to structuring a favourable context for the development of a scientific attitude as defined in the paragraph dedicated to the literature review and to the theoretical and cultural frame of reference (Dewey, 1933, 1938; Isaacs, 1930, 1933; Vygotskij, 1960; Bruner, Wood e Ross, 1976). In short, it is essential to offer children different and mindful materials (in the experience conducted, water, wooden planks, and plastic bottles were the most used objects), and allow children to move freely and explore the space and the objects. For example, let them notice the different colours produced by sunlight or a flashlight. These conditions, although fundamental, are not sufficient to explain the differences observed in the three groups of children for which the conditions were the same except for the intervention style proposed by the researcher.

We observed the consolidation and strengthening of the experimentation and identification of research behaviours in those groups that could explore the material freely and were supported by an adult who proposed interventions. These interventions were grounded on the theoretical and methodological framework of Bruner's tutoring (1976), Vygotsky's zone of proximal development, and the "promotion from within" approach (Bondioli, 2008; Bondioli, Savio, 2009; Bondioli, 2015a e Savio, 2003; Bondioli, Savio, 2012; Savio, 2013). An adult who observes, listens, and accepts children's initiatives through stages aimed at amplifying their value and encouraging the group to share and ask for contributions. This attitude helps to create the appropriate conditions to deepen the knowledge of a phenomenon based on increasingly articulated behaviours. This seems to be confirmed by the fact that the 'promotion- from-within' groups presented more situations in which a theme was deepened because of behaviours of different epistemic categories. In various cases, these categories belong to a complex cognitive level which seems to follow similar steps to those of Dewey's (Dewey, 1933, 1938) inquiry process (experimentation and problem identification).

FINAL CONSIDERATION AND OPEN ISSUES

The rich materials collected during the research and its quantitative and qualitative analysis provided fundamental data to identify the parameters of an educational approach sustaining afavorable context for developing 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 these issues and the understanding of the complex world, entanglements and relationships that characterize this work (Arcà, Mazzoli, 1995; Bertolino, Guerra, Schenetti, Antonacci, 2017).

The exploratory perspective of this research also allowed us to identify issues to consider

when planning educational interventions to develop critical thinking processes. In particular, this opportunity can highlight questions that must be answered and guide educational and didactic choices. What strategies are more efficient in favoring more complex scientific attitudes? What are the most indicated options to encourage the children's verbalization and cooperation when investigating a phenomenon? How does one notice and avoid the daily routine which causes automatisms that lead to non- mirroring answers (where the adult ignores or does not welcome the child's inputs)?

What are the suggestions to organize and handle an experiencesimilar to the previous paragraph, adapting to everyday work at school? In particular,how do we create small groups of children at a specific time of the day and collect proper documentation through video recordings or old-style observation with paper and pen to analyze later with colleagues? The reflection on what needs to be done should not depend on the data collected on the experience nor 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 evaluationprocess aims to "regulate" the learning process and gather inputs to sustain it by improving the context instead of judging the children's performances.

The above-cited concepts allow for considering evaluation as a research process where teachers, sharing values and pedagogical principles, theorize development paths that observe, document, and evaluate. These processes aim to re-analyze the experience and identify improvements 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). It is characterized by an entanglement 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 of questioning their educational and didactic approach while furthering children's everyday experiences, curiosity, differences, and a 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 exposeoneself to the emotionally challenging situation of uncertainty (Bion, 1973). This aspect involves a certainamount of anxiety that must be managed to avoid the temptation to find 'pre-packaged' solutions.

Similarly, in this perspective, the researcher and supervisors must be willing to welcomehypotheses 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 intendedas an organism able to welcome new hypotheses by promoting confrontation. Certainly, each workgroup has to undergo professional training that enhances dialogue, confrontation, self-evaluation as a fundamental instrument

to "rule" and guide the educational act. Therefore, the traininghas to prepare teachers able to research with the children, willing to face the emotionalchallenge and uncertainty of this process. Furthermore, the teacher has to handle doubts and be able to wait withoutgiving in to the desire to explain, transmit concepts, and suggest specific activities that ignore children's interests.

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