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Light and Color in Preschool: A proposal for teacher training based on the New Mexican School

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Abstract

This article presents a continuing education experience for preschool teachers in Mexico City, developed within the framework of the New Mexican School. The teaching proposal focused on teaching preschool teachers about the concepts of light and color through an interdisciplinary approach that combined science, art, and pedagogy. Through experimental activities, artistic creation, and critical reflection, the program promoted the meaningful construction of knowledge and scientific thinking aligned with the principles of inclusion, collaborative work, and community context required by the Mexican curriculum. The methodological design combined problem-based learning, action research, and the use of low-cost materials, distributed in three phases: face-to-face sessions, virtual sessions, and asynchronous work, all under the STEAM approach. The results show that the participating teachers reevaluated science as an accessible and creative field for preschoolers and art as a means of enhancing the understanding of complex phenomena from an emotional, cognitive, and aesthetic perspective.

Keywords: *Preschool education, Light and color phenomena, New Mexican School, Teacher training, STEAM*

Introduction

In the context of educational transformation, characterized by the search for more comprehensive, inclusive, and contextualized approaches, the need to rethink the teaching of phenomena such as light and color from a perspective that goes beyond the traditional limits of each discipline (Fragkiadaki, Frangedaki, Zachariadi, & Christidou, 2024) takes on special relevance. This shift is not accidental; it responds to a historical process of critical review of education that, since the late 20th century, has questioned disciplinary fragmentation and promoted interdisciplinary and transdisciplinary pedagogical models (Delors, 1996).

In Latin America, these trends are linked to the thinking of Paulo Freire (1970), who emphasized that education should be a liberating and contextualized process, and to recent educational reforms that seek to consolidate a paradigm centered on comprehensive learning (SEP, 2013). Preschool education, as the foundation of the educational process, offers a privileged scene for promoting learning experiences that articulate different areas of knowledge, thus fostering a richer, more meaningful understanding that is closer to the everyday reality of children (SEP 2023). In this sense, the teaching of light and color should not be restricted solely to the scientific realm (the physics of optics), but should also be open

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to the sensory, aesthetic, and cultural, which allows for the simultaneous development of cognitive and creative skills (Eisner, 2002, Serón et al, 2024). From a historical- pedagogical perspective, recognition of the importance of perceptual phenomena in comprehensive education has its roots in the active pedagogy of the early 20th century, with authors such as Maria Montessori and John Dewey, who defended the value of experimentation and art in the early school years (Dewey, 2008; Montessori, 2019). These visions already raised the need to overcome disciplinary isolation by promoting experiences that integrated science, art, and everyday life. The training experience developed with preschool teachers in Mexico City, within the framework of the New Mexican School (NEM), takes up this legacy and updates it in the face of contemporary challenges (SEP, 2023). The NEM seeks to ensure that education responds to principles of equity, inclusion, and social justice, promoting critical and situated teaching (Martínez, 2023a). Within this framework, the pedagogical value of breaking with monodisciplinary approaches that tend to treat school content in a fragmented and decontextualized manner (Serón et al, 2024) is highlighted. Instead, it proposes a teaching-learning model that encourages the integration of scientific and artistic knowledge, recognizing that knowledge is constructed in an interrelated manner and that educational processes must reflect this complexity from the earliest stages of school development (Serón et al, 2024). Thus, working on phenomena such as light and color from an interdisciplinary approach not only strengthens cognitive skills, but also aesthetic sensitivity, cultural appreciation, and the capacity for wonder, which are fundamental dimensions for comprehensive early childhood education (Glauser-Abou, Pahl, & Tschiesner, 2022). Furthermore, it offers a pedagogical path consistent with the Latin American critical educational tradition and with UNESCO's global demands for education for the 21st century, which emphasize the importance of "learning to know, learning to do, learning to live together, and learning to be" (Delors, 1996).

Justification

The monodisciplinary approach to scientific content has been a constant in school curricula for decades, even in teacher training (Bybee, 2013). This fragmentation has limited the potential of the topics covered and has made it difficult to create meaningful connections between what is taught and the everyday lives of students. In the case of phenomena such as light and color, this separation between disciplines prevents recognition of their presence in different branches of knowledge such as physics and chemistry, but also in biology, psychology, art, and culture (Serón, 2024).

From the perspective of the New Mexican School, which proposes a comprehensive education with an emphasis on interdisciplinarity, inclusion, critical thinking, and community engagement, it is essential to generate educational experiences that allow teachers to redefine their role as designers of diverse learning environments that are relevant and sensitive to the social and cultural contexts of their students (SEP, 2023, SEP, 2024, García, Ramírez, and Maffey, 2025).

In this sense, the experience developed demonstrates that it is possible and desirable to design educational proposals where art and science meet, creating a didactic space that stimulates curiosity, exploration, and creativity. By integrating experimental activities with processes of artistic expression, not only is the understanding of phenomena enriched, but also the emotional, aesthetic, and communicative development of children. This disciplinary synergy thus becomes a powerful way to strengthen teaching skills and expand teaching possibilities

from an early age, as proposed by the NEM pedagogical framework (Ramírez, Olvera, & Aguirre, 2025).
This paper proposes an innovative path for curricular integration, in which scientific and artistic knowledge converge to enrich educational practice from the earliest school levels. This integration not only enhances the development of cognitive and creative skills in students but also allows teachers to redefine their role as mediators of knowledge, capable of designing contextualized, sensitive, and culturally relevant learning experiences, as shown in the following sections.

Theoretical Foundations and Interdisciplinary Approach

Light and color are phenomena that transcend the boundaries of physics, also involving biological (vision), chemical (light-material interaction), psychological (color perception), and artistic (visual expression) dimensions (Cetto, 2019). This conceptual richness requires an integrative approach, consistent with the pedagogical principles of the NEM (García, Ramírez, and Mafey, 2025), which value the transversality of knowledge. Therefore, from an interdisciplinary approach, we must seek to overcome the fragmentation of traditional school knowledge, generating didactic proposals that allow teachers to construct explanatory models based on their experience, articulating empirical observation with aesthetic reflection. This also implies the recognition of art as a vehicle for knowledge construction and as a space for the development of sensitivity, e creativity, and a deep understanding of natural phenomena, for which the STEAM approach is ideal (Serón et al., 2024; Bybee, 2013).

Methodological Design and Development of Experience

This project was structured in three phases (Figure 1): A face-to-face session focused on experimental activities with low-cost materials; a synchronous session of theoretical support and critical reflection; and an asynchronous phase in Moodle, where teachers will develop a teaching sequence and implement it in the classroom, documenting their results (Ramírez, Olvera, Aguirre, 2025).

Fig. 1. Phases of the teacher training proposal**.**

Phase one, face-to-face session

First, a face-to-face workshop-style session was held, focusing on experimental activities with low- cost materials, which allowed teachers to explore basic physical phenomena such as the decomposition of light, the mixing of colors, and the formation of shadows (Figure 2).

Fig. 2. Example of a face-to-face session with activities on light and shadows**.**

This phase promoted hands-on manipulation, experiential learning, and the recognition that physics can be approached using accessible, everyday resources.
Six experiments were designed and implemented for preschool teachers: three related to the use of magnifying glasses and three to color mixing. The proposal was based on the principle that a single experiment is insufficient to promote knowledge construction; therefore, a sequence of activities was proposed that would allow optical phenomena to be addressed in a progressive and meaningful way (Harlen, 2015). Optics was chosen because this field provides an accessible route for early immersion in science, as a lens is one of the simplest and safest scientific devices that a preschool-aged child can handle (García-Carmona, 2019). Finally, the experiments proposed in the course are intended to be included by teachers in a teaching plan to be developed directly in the classroom (as will be seen later).

Experiments in the face-to-face phase

In the first experiment, the teachers observed a drawing of insects through a magnifying glass, bringing the lens close to the paper to obtain an enlarged image, and then focused on a distant scene. At the end, they described details of the insects and drew a picture of the scene seen from a distance (Figure 3). The objective was to differentiate between the perception of near and distant images (Eshach, 2006).

Fig. 3. Use of magnifying glasses to observe insects.

In the second experiment, the magnifying glass was used as an optical projector. One teacher stood in front of the window with a sheet of paper, while another held the lens to try to form a real image of the scene outside (Figure 4). The purpose was to understand the formation of real images using converging lenses (Driver et al., 1994).

Fig. 4. Use of a magnifying glass as an optical projector.

In the third experiment, a glass was used as a lens. Behind the empty glass, a drawing with two horizontal arrows pointing in opposite directions and different colors (red and blue) was placed (Figure 5). The teachers observed the image first with the glass empty and then filled with water, which allowed them to see how the medium modifies the trajectory of light and, consequently, the perception of the image (Gil-Pérez & Vilches, 2001).

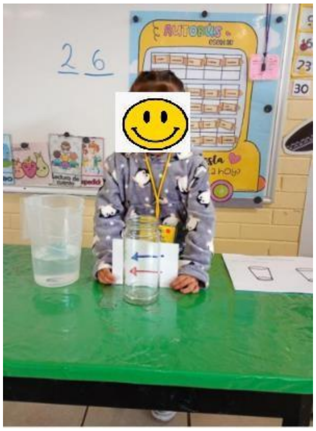


Fig. 5. Use of glasses as a lens.

The next section of experiments focused on color mixing, a classic topic for children. In this case, cyan, magenta, and yellow dyes were introduced using droppers to promote both color exploration and counting. The first activity consisted of placing drops of color in different proportions on sheets of paper to observe the resulting combinations. In the second activity, the teachers solved a tangram: first they looked at a colored model and then had to recreate it in white using only the three primary colors, which involved applying what they had learned in the previous activity (Figure 6) (Piaget, 1973). Finally, in the third activity, the teachers cut out and assembled colored geometric shapes, which they then observed through paper glasses with different color filters in each eye (Figure 7), with the aim of highlighting the effects of vision under varying color conditions (Siraj-Blatchford & MacLeod-Brudenell, 2003).

Fig. 6. Color experiments.

Fig. 7. Color filters with paper glasses.

Together, these experiences constituted a teaching resource to encourage exploration, observation, and the active construction of knowledge in science at the preschool stage, linking experimental practice with the principles of the New Mexican School (SEP, 2023).

Second phase, synchronous sessions via Zoom

The second phase consisted of a synchronous session of theoretical support and critical reflection, conducted virtually. In this space, participants were able to talk with trainers, resolve doubts that arose from the experimental practice, and deepen their conceptual understanding of the phenomena studied (Figure 8). This exchange fostered the collective construction of knowledge and critical thinking, reinforcing the teachers' confidence to subsequently implement the activities in their own school context.

Figure 8. Example of a synchronous session via Zoom.

Third phase, work on the Moodle platform.

Finally, the third phase was carried out asynchronously through the Moodle platform. Here, teachers accessed specialized readings, interactive simulations (PhET), and self-assessment activities that broadened the conceptual dimension of the phenomena. As an integrative product, each participant developed a teaching sequence linked to the training field of Scientific Knowledge and Thinking, which was implemented in the classroom and documented with evidence (rubrics, observation guides, checklists, and children's work). This conclusion allowed not only to consolidate learning, but also to evaluate the relevance and effectiveness of the strategies designed (Figure 9).

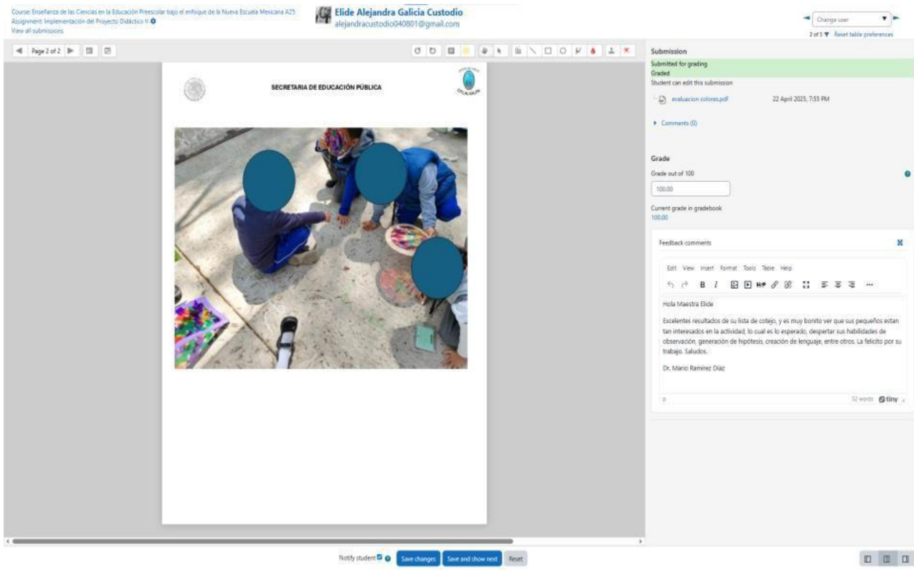


Fig. 9. Example of work on the Moodle platform.

METHODOLOGICAL INTEGRATION

The methodological approach that underpinned this experience combined the principles of action research, understood as a cyclical process of planning, action, observation, and reflection aimed at transforming teaching practice (Flemate, 2022), with the fundamentals of problem-based learning (PBL), which promotes the resolution of real situations through inquiry, collaborative work, and the autonomous construction of knowledge (Barrows, 1986; Savery, 2006). This methodological integration ensured an active, reflective, and situated training process in which teachers did not simply reproduce experimental activities but rather reinterpreted them in terms of their immediate educational context, linking theory and practice in a continuous cycle of improvement.

In this sense, action research allowed participants to be simultaneously researchers of their practice and agents of change in the classroom, documenting evidence, identifying problems, and designing strategies to address them critically (Kemmis & McTaggart, 1988). For its part, PBL fostered the development of scientific skills such as observation, hypothesis formulation, and argumentation by placing physical phenomena within problematic scenarios close to the children's reality (Hmelo- Silver, 2004).

Likewise, the incorporation of artistic reinterpretation exercises—particularly through plastic expression—broadened the epistemological horizon of the proposal, promoting interdisciplinary learning in which science dialogues with art. This perspective responds to able to reinterpret the phenomena of light, color, and shadows not only from a conceptual level, but also from an aesthetic and cultural dimension, enriching the construction of meanings and enhancing pedagogical creativity in the classroom.

Results and Assessment of Learning

As mentioned in the introduction, this work is a case study derived from a course entitled

"Science teaching in preschool with a focus on the New Mexican School." A comprehensive case study approach is used because its main objective is to conduct a study on the results of the impact of teaching situations that introduce experiments with light, color, and shadows on preschool teachers who took the course. The sample selection is based on an intentional sample of the total group of participating teachers (Merriam and Tisdell, 1998). Furthermore, this is a specific case of preschool teachers in a region of Mexico City, and not of teachers in general throughout the country's education system (Coller, 2000). The context of the case focuses on a group of preschool teachers in the Mexican education system who took the course between July and September 2024 in five municipalities in southern Mexico City.

The evidence gathered shows that teachers highly value practical experiences, highlighting their potential to spark curiosity, critical thinking, and creativity in children. At least 70 teaching situations were analyzed, showing how teachers, when implementing these activities, took on a role similar to that of researchers of their own practice, promoting processes of critical reflection and change in the classroom. Although no formal action research process was formulated, the activities showed characteristics of this methodology, as teachers documented evidence, identified issues related to children's understanding of scientific phenomena, and designed pedagogical strategies to address them. Likewise, the activities promoted the placement of physical phenomena in scenarios close to children's everyday lives, encouraging active exploration, hypothesis formulation, and argumentation, in line with the principles of Problem-Based Learning (PBL). These approaches contribute to the development of scientific skills in children and, in turn, encourage teachers to transform their teaching practice in line with the objectives of the New Mexican School (SEP 2024). Taken together, these findings show how the teaching situations (see Figure 10) analyzed strengthen the reflective, problem-solving, and participatory nature of preschool teaching, supporting the training of teachers who act as agents of change in their educational environment.

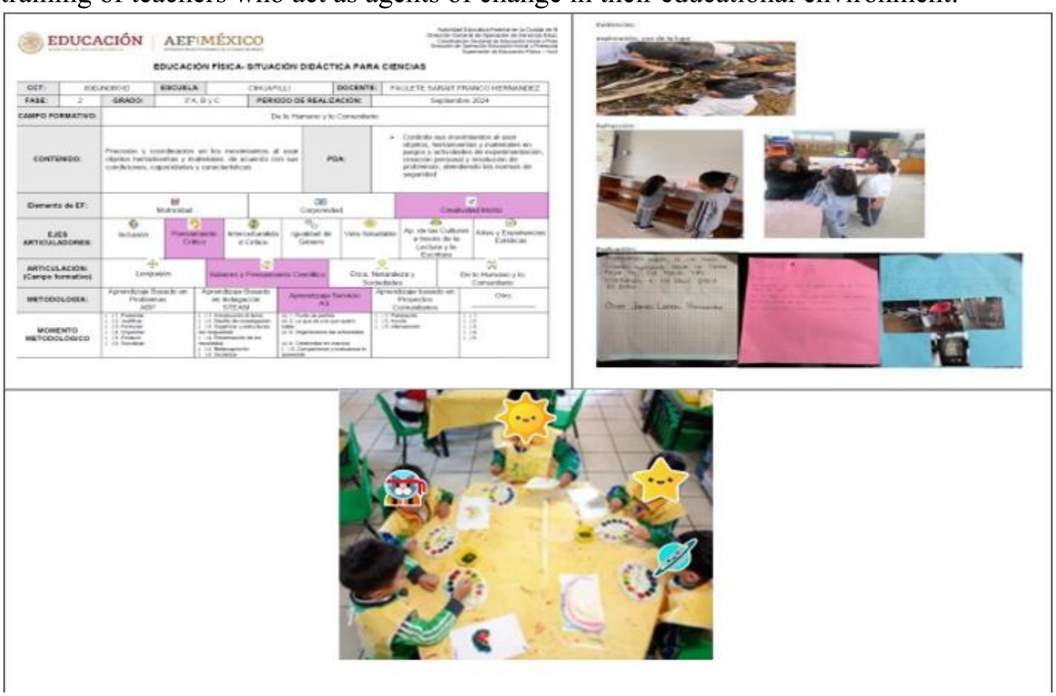


Fig.10. Examples of classroom implementation of light and shadows.

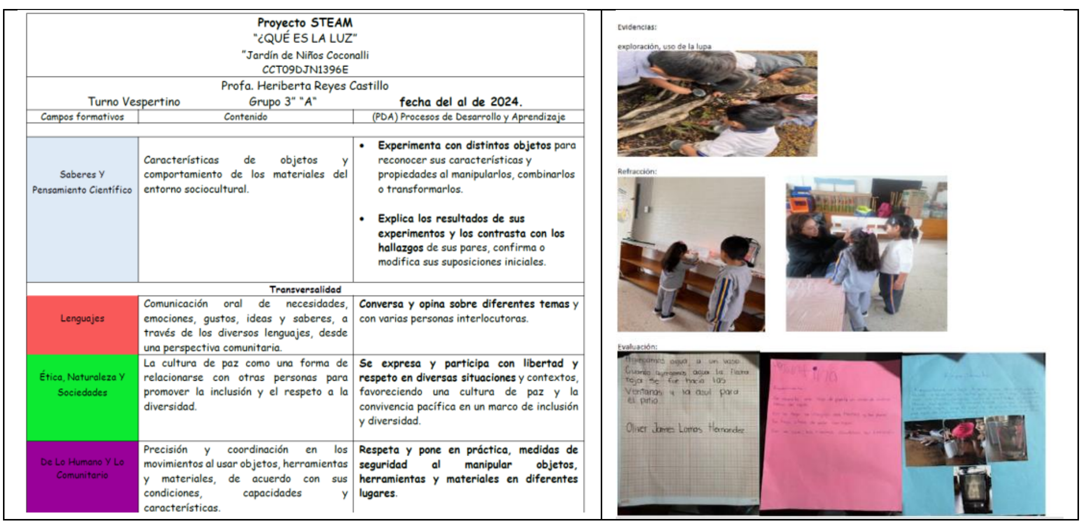
Likewise, the participants identified new strategies for explaining complex concepts using visual analogies, light games, and sensory explorations.
Another significant finding was the recognition among teachers of a comprehensive learning process that transformed their scientific understanding and enriched their teaching practices, promoting active, exploratory, and meaningful learning in the classroom. The results of the following activities are highlighted:

Results of the teaching situations

To evaluate the teaching situations presented by the teachers in the course, different items were assessed using a checklist (Appendix 1). The aspects evaluated are discussed below.

Deep Understanding of the Phenomenon

From the review and analysis of the teaching situations submitted by the teachers, it can be inferred that they acquired a solid knowledge of light (natural and artificial), reflection, refraction, and shadow formation, understanding that it is vital for children to experience the phenomenon directly to learn actively, not just passively. To illustrate, an example of a teaching situation is shown in Figure 11.



Proyecto STEAM
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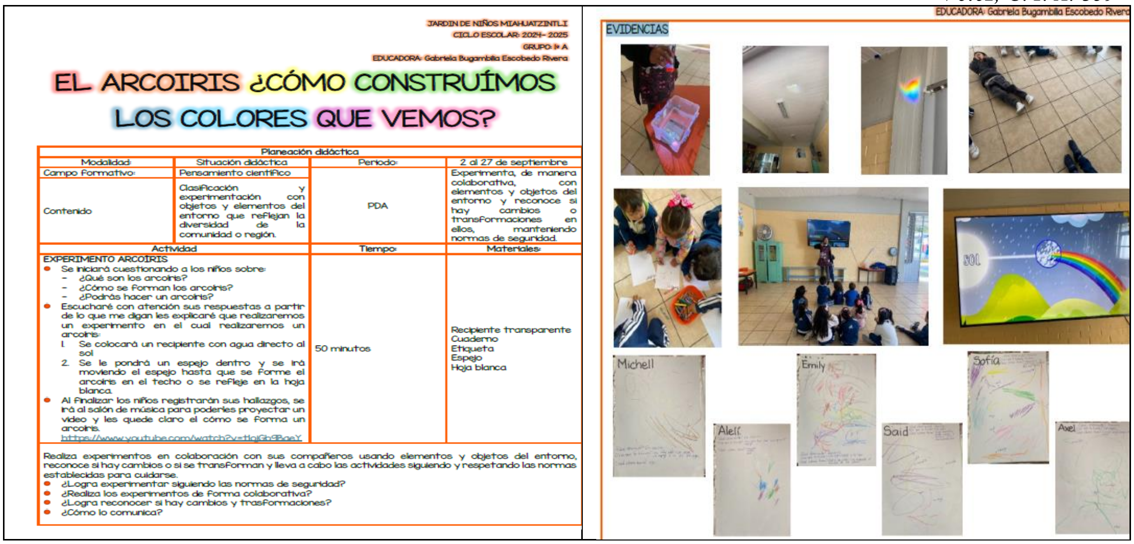
"Jardín de Niños Coconalli
CCT09DJN1396E
Profa. Heriberta Reyes Castillo
Turno Vespertino — Grupo 3° "A" — fecha del al de 2024.

Campos formativos	Contenido	(PDA) Procesos de Desarrollo y Aprendizaje
Saberes Y Pensamiento Científico	Características de objetos y comportamiento de los materiales del entorno sociocultural.	• **Experimenta con distintos objetos** para reconocer sus características y propiedades al manipularlos, combinarlos o transformarlos. • **Explica los resultados de sus experimentos y los contrasta con los hallazgos** de sus pares, confirma o modifica sus suposiciones iniciales.
Transversalidad		
Lenguajes	Comunicación oral de necesidades, emociones, gustos, ideas y saberes, a través de los diversos lenguajes, desde una perspectiva comunitaria.	**Conversa y opina sobre diferentes temas** y con varias personas interlocutoras.
Ética, Naturaleza Y Sociedades	La cultura de paz como una forma de relacionarse con otras personas para promover la inclusión y el respeto a la diversidad.	**Se expresa y participa con libertad y respeto en diversas situaciones** y contextos, favoreciendo una cultura de paz y la convivencia pacífica en un marco de inclusión y diversidad.
De Lo Humano Y Lo Comunitario	Precisión y coordinación en los movimientos al usar objetos, herramientas y materiales, de acuerdo con sus condiciones, capacidades y características.	**Respeta y pone en práctica, medidas de seguridad al manipular objetos, herramientas y materiales en diferentes lugares.**

Fig. 11. Examples of classroom implementation of light and shadows.

In the case of color, although students express hypotheses and show interest (enhanced by symbolic play and homemade materials), they have not yet fully consolidated their observation and understanding of scientific concepts. To illustrate this, an example of a teaching situation is shown in Figure 12.



JARDIN DE NIÑOS MIAHUATZINTLI
CICLO ESCOLAR: 2024- 2025
GRUPO: 1º A
EDUCADORA: Gabriela Bugambilia Escobedo Rivera

EL ARCOIRIS ¿CÓMO CONSTRUÍMOS LOS COLORES QUE VEMOS?

Planeación didáctica			
Modalidad:	Situación didáctica	Periodo:	2 al 27 de septiembre
Campo formativo:	Pensamiento científico	PDA	Experimenta, de manera colaborativa, con elementos y objetos del entorno y reconoce si hay cambios o transformaciones en ellos, manteniendo normas de seguridad.
Contenido	Clasificación y experimentación con objetos y elementos del entorno que reflejan la diversidad de la comunidad o región.		
Actividad		Tiempo:	Materiales:
EXPERIMENTO ARCOÍRIS • Se iniciará cuestionando a los niños sobre: - ¿Qué son los arcoiris? - ¿Cómo se forman los arcoiris? - ¿Podrás hacer un arcoiris? • Escucharé con atención sus respuestas a partir de lo que me digan les explicaré que realizaremos un experimento en el cual realizaremos un arcoiris: 1. Se colocará un recipiente con agua directo al sol 2. Se le pondrá un espejo dentro y se irá moviendo el espejo hasta que se forme el arcoiris en el techo o se refleje en la hoja blanca. • Al finalizar los niños registrarán sus hallazgos, se irá al salón de música para poderles proyectar un video y les quede claro el cómo se forma un arcoiris. https://www.youtube.com/watch?v=tIqjGb9BaeY		50 minutos	Recipiente transparente Cuaderno Etiqueta Espejo Hoja blanca

Realiza experimentos en colaboración con sus compañeros usando elementos y objetos del entorno, reconoce si hay cambios o si se transforman y lleva a cabo las actividades siguiendo y respetando las normas establecidas para cuidarse.

- ¿Logra experimentar siguiendo las normas de seguridad?
- ¿Realiza los experimentos de forma colaborativa?
- ¿Logra reconocer si hay cambios y trasformaciones?
- ¿Cómo lo comunica?

Fig. 12. Examples of classroom implementation of light and shadows.

Active and Exploratory Teaching Strategies

Most teachers incorporated methods focused on practical exploration (use of magnifying glasses, everyday materials) and discovery guided by questions that stimulate critical thinking, as well as outdoor activities that encourage children's curiosity and autonomy. However, there were cases where some of the above elements were not introduced. It can be inferred that, for example, questions that stimulate critical thinking were not included due to the teachers' lack of confidence in their ability to answer them for the children.

Stimulation of Critical Thinking and Oral Expression

It was found that, for the most part, the teaching situations proposed by the teachers promote scientific language from an early age, encouraging children to express their observations and questions, which favors metacognition and the appreciation of diversity of ideas, also strengthening coexistence and a culture of peace in the classroom.

Use of Contextualized and Accessible Materials

Teachers learned to take advantage of everyday resources (LED lights, glasses of water, leaves, etc.) to carry out simple experiments that facilitate understanding and motor skills, adapting activities to the context and focusing on resource efficiency, as illustrated in Figure 13.

Fig. 13. Examples of classroom implementation of light and shadows.

Family-School Linkage

The teaching situations showed that family participation in learning was encouraged by assigning tasks to be done at home with family support, strengthening school-home communication, and expanding the child's meaningful learning environment, which is very important for the NEM (SEP 2024).

Formative and Reflective Assessment

In general, teachers incorporate constant reflection and formative assessment during activities to identify students' incorrect prior ideas and adjust their teaching, thereby improving their teaching practice by incorporating observation and description of phenomena. Different assessment tools were proposed in the teaching situations, such as rubrics with performance categories (excellent, good, fair, poor), checklists, observation guides, and narratives. On the other hand, enthusiastic participation in practical activities (painting, experiments with flashlights and cellophane, collaborative mural, among others) stands out. Among the aspects that teachers proposed to evaluate in their different instruments are linguistic skills, scientific, mathematical, and reflective thinking, observation, manipulation of materials, and behavior.
The checklist also recorded as an observation that scientific and experimental competencies were developed. This implies that the course curriculum guides teachers to develop competencies in observation, question formulation, manipulation of instruments, and playful activities, integrating cognitive, socio-affective, and physical aspects from preschool education.

CONCLUSIONS

The results shown in this experience demonstrate that interdisciplinary work, when placed in real contexts and linked to the training needs of teachers, can be highly transformative. The course reported on succeeded in integrating science with art in preschool education, promoting

a more complete understanding of natural phenomena (Ramírez, Olvera, & Aguirre, 2025), as well as enhancing the development of fundamental skills for teaching in the 21st century.
Furthermore, the proposal is aligned with the humanistic vision of the NEM (SEP, 2024), promoting a pedagogical practice that respects teachers' knowledge, recognizes their creative capacity, and supports them in the construction of relevant, meaningful, and culturally relevant knowledge.
This approach opens up new avenues for further exploring the integration of disciplinary fields in teacher training, with an emphasis on the STEAM approach and the use of accessible resources that democratize science learning from the earliest levels of education.
By addressing physics phenomena from an interdisciplinary perspective, a more holistic, motivating, and meaningful education is promoted, in line with the principles of the NEM, which uphold the right of children to explore the world through multiple languages and dimensions of knowledge.

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