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Scientific articles

Desarrollo de habilidades científicas en preescolar con el tema de las leyes de movimiento mediante una secuencia didáctica basada en indagación

Development of Scientific Skills in Preschool Using the Topic of the Laws of Motion Through an Inquiry-Based Didactic Sequence

Desenvolvimento de Habilidades Científicas na Educação Infantil com o Tema das Leis do Movimento por Meio de uma Sequência Didática Baseada em Investigação

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Resumen

Este estudio analiza el desarrollo de habilidades de pensamiento científico en niños de educación preescolar mediante la implementación de una secuencia didáctica basada en el método de indagación, en concordancia con el enfoque de la Nueva Escuela Mexicana. Partiendo de la premisa de que la educación preescolar debe ir más allá del juego, se diseñaron actividades experimentales centradas en las leyes del movimiento, con el propósito de estimular la curiosidad y el razonamiento crítico desde edades tempranas. Además, se elaboró una rúbrica para evaluar el desarrollo de habilidades. La metodología aplicada se fundamentó en las teorías de Piaget y Vygotsky, priorizando el aprendizaje significativo, cooperativo y la mediación del docente dentro de la zona de desarrollo próximo. La secuencia didáctica incluyó actividades prácticas y contextualizadas que facilitaron la interacción activa de los niños con los conceptos científicos.

Los resultados mostraron un avance significativo en el desarrollo de habilidades científicas, especialmente en la formulación de hipótesis y la capacidad de explicar fenómenos. La evaluación mediante rúbricas permitió cuantificar el progreso de los estudiantes al comparar los resultados de la sesión inicial con los de la sesión final, evidenciando un incremento notable en dichas habilidades. Estos hallazgos confirman que es posible fomentar el pensamiento científico en el nivel preescolar a través de estrategias de enseñanza basadas en la indagación. La implementación de actividades experimentales y prácticas no solo facilita la comprensión de conceptos científicos, sino que también contribuye al desarrollo integral de los niños, promoviendo el pensamiento crítico y la curiosidad como bases para futuros aprendizajes.

Palabras clave: Aprendizaje por Indagación, Educación preescolar, Enseñanza de las ciencias, Nueva Escuela Mexicana

Abstract

This study examines the development of scientific thinking skills in preschool children through the implementation of a didactic sequence based on the inquiry method, aligned with the New Mexican School approach. Starting from the premise that preschool education should transcend play-based activities, experimental activities focused on the laws of motion were designed to foster curiosity and critical reasoning from an early age. Additionally, a rubric was developed to assess the development of these skills. The applied methodology was grounded in the theories of Piaget and Vygotsky, emphasizing meaningful and cooperative learning, as well as the teacher's mediation within the zone of proximal development. The didactic sequence included practical and contextualized activities promoting active interaction between children and scientific concepts.

The results demonstrated substantial progress in the development of scientific skills, especially in hypothesis formulation and the ability to explain phenomena. Evaluation through rubrics allowed for quantifying students' progress by comparing the initial and final sessions, indicating a marked improvement in these skills. These findings demonstrate that it is possible to foster scientific thinking at the preschool level through inquiry-based teaching strategies. The implementation of experimental and practical activities not only enhances the understanding of scientific concepts but also contributes to the holistic development of children, promoting critical thinking and curiosity as foundations for future learning.

Keywords: Preschool Education, New Mexican School, Inquiry-Based Learning, Science Teaching.

Resumo

Este estudo analisa o desenvolvimento de habilidades de pensamento científico em crianças da educação pré-escolar por meio da implementação de uma sequência didática baseada no método de investigação, em conformidade com a abordagem da Nova Escola Mexicana. Partindo do pressuposto de que a educação pré-escolar deve ir além do brincar, foram elaboradas atividades experimentais focadas nas leis do movimento com o objetivo de estimular a curiosidade e o raciocínio crítico desde a infância. Além disso, foi desenvolvida uma rúbrica para avaliar o desenvolvimento dessas habilidades. A metodologia aplicada fundamentou-se nas teorias de Piaget e Vygotsky, priorizando a aprendizagem significativa, cooperativa e a mediação do professor dentro da zona de desenvolvimento proximal. A sequência didática incluiu atividades práticas e contextualizadas que facilitaram a interação ativa das crianças com os conceitos científicos.

Os resultados mostraram um progresso significativo no desenvolvimento de habilidades científicas, especialmente na formulação de hipóteses e na capacidade de explicar fenômenos. A avaliação por meio de rúbricas permitiu quantificar o progresso dos alunos ao comparar os resultados da sessão inicial com os da sessão final, evidenciando um aumento notável nessas habilidades. Esses achados confirmam que é possível promover o pensamento científico no nível pré-escolar por meio de estratégias de ensino baseadas na investigação. A implementação de atividades experimentais e práticas não apenas facilita a compreensão de conceitos científicos, mas também contribui para o desenvolvimento integral das crianças, promovendo o pensamento crítico e a curiosidade como bases para futuras aprendizagens.

Palavras-chave: Educação Pré-escolar, Nova Escola Mexicana, Aprendizagem por Investigação, Ensino de Ciências.

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Introduction

Teaching science in preschool education represents a significant challenge when trying to introduce scientific concepts that, by their nature, can be complex for children. This requires adapting the content to their cognitive abilities in the early stages of development. In this context, the inquiry-based approach has emerged as an effective strategy to involve children in active and participatory learning, where exploration and discovery constitute central axes of the educational process (Harlen, 2004).

This article addresses the implementation of an inquiry-centered teaching sequence designed specifically to develop scientific skills through the laws of motion, that is, children will not conceptualize, but will develop fundamental scientific skills such as observation, hypothesis formulation and experimentation (Harlen, 2011).

Preliminary results suggest that this teaching sequence enhances skills such as observation, question formulation and the ability to hypothesize. It is concluded that the development of scientific skills in preschool education is essential to establish a solid foundation for future learning. Likewise, the integration of inquiry strategies in educational programs is recommended .

This study contributes to the discussion on the importance of science education in childhood and suggests directions for future research in the field of science education.

In the context of Mexican schools, the Ministry of Public Education (SEP, 2020) emphasizes the importance of inquiry as a key method in teaching science, especially in basic education. The 2020 educational model promotes experiential and inquiry-based teaching from preschool to high school, taken up in the New Mexican School through the training field Scientific Knowledge and Thought. This approach highlights the relevance of science from the earliest years so that students perceive it as a natural and useful part of their daily lives.

Therefore, implementing a didactic sequence based on inquiry, with experiments that reflect everyday situations using common materials, allows to systematically influence the development of critical thinking skills such as observing, questioning, explaining and hypothesizing in preschool children.

Design of the teaching sequence based on inquiry

In this study, the didactic sequence constitutes a fundamental component of the methodology, providing an organized structure for the development of scientific thinking skills in children in preschool education in Mexico. This sequence, based on the inquiry approach proposed by Harlen (2011), takes advantage of children's natural curiosity and their desire to explore the world around them.

The sequence is based on the principles of cognitive development described by Piaget and Vygotsky. According to Piaget (1986), meaningful learning occurs when children actively interact with their physical environment, which facilitates practical and contextual exploration of natural phenomena. Therefore, each activity includes accessible materials, such as balls and cars, that promote direct observation and experimentation.

On the other hand, Vygotsky (1979) highlights the importance of social interaction in learning and the role of the teacher as a mediator in the zone of proximal development. In this context, the teaching sequence incorporates moments of reflection and group discussion, allowing children to exchange observations, formulate hypotheses jointly and receive feedback guided by the teacher. This approach encourages both collaborative learning and the construction of individual and group knowledge.

The sequence consists of six interrelated sessions, designed to address the laws of motion and develop specific scientific skills such as observing, hypothesizing, explaining, and reflecting. The first and last sessions have a diagnostic purpose, while the middle sessions focus on concrete skills to avoid overloading students.

The complete teaching sequence can be seen in the following link https://sites.google.com/view/rededucativakanaj/inicio which shows how it is structured and which responds to the current study plans and programs of Mexico, within the framework of the New Mexican School.

The sequence consists of six interrelated sessions, designed to address the laws of motion and develop specific scientific skills such as observing, hypothesizing, explaining, and reflecting. The first and last sessions have a diagnostic purpose, while the middle sessions

focus on concrete skills to avoid overloading students.

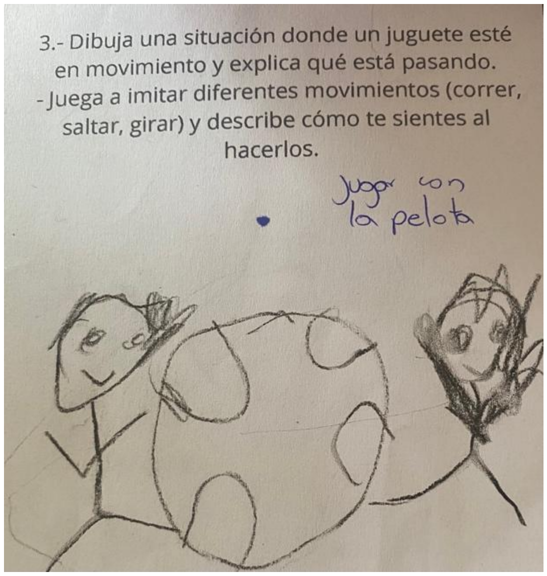
A key aspect of the sequence is the connection between scientific concepts and everyday situations, using common materials to facilitate understanding and motivate active participation. Each activity includes moments of collaborative reflection, fostering a meaningful and contextualized learning environment.

The sequence is assessed using a rubric that measures progress in the development of scientific skills, ensuring that each child receives constructive feedback. This comprehensive approach lays the foundation for critical and scientific thinking in childhood, aligning with the principles of the New Mexican School (SEP, 2019).

The teaching sequence not only organizes learning activities, but also creates a framework that facilitates the acquisition of scientific knowledge in a meaningful and contextualized way. This comprehensive approach is essential to cultivate critical and scientific thinking in children, laying the foundation for their future education. It has been designed in such a way that students progress from the simplest ideas to the most complex ones, with each session in the sequence focusing on the development of one or two scientific skills.

The teaching sequence is divided into six sessions, of which the first and last serve as a diagnosis that evaluates the level of performance achieved based on the operational definitions that were made for this work. It is taken from the model of the New Mexican School (SEP, 2019), taking into account the formative fields of Knowledge and scientific thought and making a transversality of knowledge with other formative fields such as Languages.

Figure 1. Student representation of the first law of motion



Source: Own elaboration

In session 1, which was used for the diagnosis, a situation is presented about the laws of motion, taking up Newton's first law on inertia, as the students observe how toys move and what happens when no force is applied to them. The idea is being explored that an object at rest will remain at rest and an object in motion will remain in motion unless an external force acts on it. In this way, the students record, in the form of a drawing, those situations that illustrate the first law of motion (see image 1).

For this first session, the scientific skills of observing, questioning, hypothesizing and explaining are assessed through drawings made by the girls and boys and at the same time audio recordings in order to be able to capture the most relevant ideas that the students have.

For sessions 2, 3, 4 and 5, the scientific skills that are evaluated are one or two, since the development of these was progressive, as can be seen in the didactic sequence, each session is focused on one or two specific skills in order to give a more comprehensive approach and that at the time of applying them the students are not saturated with information.

The following image shows the scientific skills that were developed in each session of the implementation of this teaching sequence:

Figure 2. Scientific skills developed in the teaching sequence.

Source: Own elaboration

This study is based on a methodology focused on inquiry. Novak (1964) defines inquiry as "a series of behaviors involved in human beings to find reasonable explanations for a phenomenon about which they want to know something." This approach guides the development of scientific thinking skills in childhood, allowing them to explain phenomena related to the laws of motion. Recognizing the importance of fostering curiosity from an early age (Dewey, 1960), a didactic sequence is implemented that integrates experimental activities related to these laws.

Anderson (2007) defines inquiry from three perspectives:

1. What scientists do: Practices and methods that include asking questions, conducting experiments, and analyzing data.
2. What students do and learn: Activities that promote questions and knowledge construction through experience.
3. What teachers know and can do in the classroom: Pedagogical strategies needed to guide students in a collaborative and active environment.

In this study, perspectives two and three are mainly worked on, aligned with the model of the New Mexican School (SEP, 2022) and the expected learning in the formative field of Knowledge and Scientific Thinking (Díaz Barriga, 2013). The method encourages meaningful learning, allowing children to interact with their environment through observation, questioning, and experimentation.

Methodology structured in three key stages

1. Design of the didactic sequence: Experimental activities with everyday materials related to the laws of motion.
2. Implementation of activities: Promotion of scientific skills through exploration and experimentation.
3. Assessing learning: Using a rubric based on operational definitions to measure progress in scientific skills.

The inquiry approach allows for the development of critical thinking and problem-solving skills. Bybee (2000, 2004) highlights that this method not only seeks correct answers, but prioritizes learning during the process, with key components such as inquiry skills, process knowledge, and pedagogical strategies.

In short, the didactic proposal incorporates playful and relevant activities, related to daily life, to make science teaching an attractive and meaningful experience in preschool education (Tembladera, et al., 2013).

Bybee (2004) also mentions that inquiry should be a central focus of science teaching and that it should include three key components:

1. Inquiry skills: These are the actions that students must perform such as observing, asking, experimenting and analyzing data, the same skills that in this research have been evaluated in early childhood education.
2. Knowledge about inquiry: this process must be known by the students, in this research work within the didactic sequence, (which will be emphasized later), the steps that the students followed are defined and in each activity they themselves carry out the observation, formulation of hypotheses, asking questions and explaining the results obtained.
3. Pedagogical approach: Teachers should adopt pedagogical strategies that facilitate inquiry, which includes creating a learning environment where curiosity is fostered, questions are encouraged, and the opportunity to explore concepts through practice is provided. All of the above will be defined in the teaching sequence for the development of scientific skills in preschool through inquiry.

For her part, Harlen (2012), who is one of the main advocates of teaching science through inquiry, argues in her work that inquiry should allow students to develop a deep understanding of scientific concepts by actively involving them in the learning process, since children participate in the exploration of phenomena, posing questions, hypothesis, experimentation and analysis, which helps them build their own knowledge. Harlen (INNOVEC, 2016) emphasizes that inquiry should be related to questions that students do not really know the answers to, which makes learning more attractive and relevant to them.

With this proposal, it becomes necessary to have a connection with daily life, since the didactic sequence is based on inquiry, making the teaching of science attractive, playful and with situations from the daily life of children.

Different investigations such as the one carried out by Olvera Aldana, M., Pérez Trejo, L., Méndez Sánchez, AF, & Ramírez Díaz, MH (2018) propose a methodology based on constructivism, which will allow students to build their learning through exploration and manipulation of objects with physics themes, it is important to mention that inquiry and constructivism are related concepts, they are not exactly the same, on the one hand inquiry refers to a pedagogical approach to learning based on research and constructivism on the other hand maintains that people build their own knowledge through experience and reflection.

Inquiry is a method that fits very well with constructivist theory, as both promote the idea that knowledge is actively constructed rather than simply transmitted.

Implementation of the inquiry-based teaching sequence for the development of scientific skills through the laws of motion

Working on inquiry from the preschool stage is essential to foster the development of scientific skills for various reasons, among which the following stand out:

1) Early cognitive development: Introducing inquiry from an early age encourages scientific thinking, curiosity, and establishes the foundations for structured logical reasoning (SEP, 2019).
2) Early cognitive development: Children can begin to develop skills such as observation, hypothesis formulation, experiment design and explanation of phenomena, which are essential for scientific learning (Cuevas et al., 2016).
3) Promoting active and meaningful learning: Actively participating in the learning process allows children to associate what they learn with their daily experiences (Cuevas et al., 2016).

The design of the teaching sequence arises from the need to foster these scientific skills by exploring the laws of motion. Since children do not focus on memorizing concepts, the sequence seeks to make them, through experiments, make observations, formulate hypotheses, generate questions and explain their experiences.

The implementation took place in a preschool education setting, with inquiry as the central methodology. During the sessions, priority was given to fostering children's innate curiosity, allowing them to explore and develop scientific skills at their own pace. Each session began with a review of previous learning, following the meaningful learning approach (Ausubel, 1968). Practical activities, such as observing the movement of cars under different conditions, reinforced their understanding of the laws of motion and promoted problem solving.

In addition, formative assessment techniques, such as open-ended questions and group discussions, were implemented to monitor progress and adjust activities to the needs of children. This flexible approach allowed the teaching sequence to be adapted to different learning paces, ensuring an inclusive and meaningful experience for each student.

Scientific inquiry offers specific benefits over other learning methods, as it promotes critical thinking, problem solving, and the development of analytical skills. Unlike traditional approaches (Freire, 1970) based on memorizing content, inquiry encourages the active participation of the individual in formulating questions, experimenting, and interpreting results. This process not only facilitates a deeper understanding of scientific concepts, but also stimulates creativity and the ability to adapt to new situations. In addition, by involving the researcher in the search for evidence-based solutions, essential skills such as logical reasoning and informed decision-making are strengthened, aspects that are less developed through passive or repetitive teaching methods.

In this sense, this inquiry-based study with preschoolers, practical activities enhance cognitive development by stimulating curiosity, attention and logical thinking. Active exploration allows children to build knowledge, solve problems and develop causal reasoning. This approach fosters autonomy, creativity and the ability to formulate hypotheses, strengthening scientific thinking from an early age.

Method

To assess the scientific skills described in Table 1, it was necessary to conduct an exhaustive bibliographic review with the aim of generating operational definitions that would allow this study to be quantified and the learning progression to be assessed according to the defined criteria.

In this work, the operationalization of variables was designed to ensure their validity and relevance in the educational field. This process was validated with the participation of experts through the following steps:

1. Selection of experts: Specialists in preschool education, exact sciences and methodological design, with experience in educational evaluation and in the implementation of the New Mexican School, were called upon. They reviewed both the operational definitions and the evaluation rubrics.
2. Validation process: Experts analyzed the instruments in individual and group sessions, providing feedback on the clarity, relevance, and consistency of the rubrics and assessment criteria. This process ensured that scientific skills such as observing, questioning, explaining, and hypothesizing were clearly defined and objectively measurable. Observations were incorporated through successive iterations until consensus was reached.
3. Alignment with the current curriculum: During the validation, the coherence of the instruments with the expected learning of the training field "Knowledge and scientific thinking" and their integration with the pedagogical principles of the New Mexican School was verified.

The New Mexican School (NEM) perspective emphasizes practical and meaningful teaching from an early age. The validated rubrics allowed measuring scientific skills aligned with this model, highlighting its transversality with other formative fields such as "Languages".

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Figure 3. Conceptual and operational definitions of the variables

VARIABLE	DEFICINIÓN CONCEPTUAL	DEFINICIÓN OPERACIONAL
OBSERVAR	RAE (2024). acción y efecto de observar. Sierra (1984). Examen y análisis que se raliza un investigador utilizando sus sentidos.	Capacidad del niño para dirigir su atención hacia objetos, eventos o personas especificas, tomando en cuenta tres dimensiones como: atención y enfoque, capacidad de registro e interpretación de la observación.
PREGUNTAR	Zalueta (2005) Interrogar o hacer preguntas a alguien para que diga y responda lo que sabe sobre algo. Freire (1970)Las preguntas ayudan a iniciar procesos interactivos de aprendizaje y solución de problemas	Capacidad del niño para iniciar y participar en interacciones donde se fomrulan preguntas de manera independiente, clara y comprensible, tomando en cuenta cuatro dimenciones: iniciativa, claridad y comprensipon, variedad y participación e interacción de peguntas y respuestas.
HIPOTETIZAR	RAE (2024), soluciones probables, previamente seleccionadas, al problema planteado que el científico propone a través del proceso de investigación para confirmar o no los hechos.	Capacidad del niño para imaginar y proponer soluciones o respuestas creativas a preguntas o problemas considerando diversas posibilidades, tomando en cuenta cuatro dimensiones: creatividad en la generación de hipótesis, exploración de las posibilidades, explicación y participación activa.
EXPLICAR	Paz (2009) Conjunto de afirmaciones del que se describe la condición del asunto que hay que explicar. RAE (2024) Declarar, manifestar, dar a conocer lo que alguien piensa.	Acción de comunicar información de manera clara y comprensible, utilizando ejemplos, tomando en cuenta cuatro dimensiones: comunicación de ideas, uso del lenguaje adecuado, claridad y comprensión y participación activa en el proceso de explicación

Source: Own elaboration

In the conceptual definition of explaining, Paz (2009) takes up a set of statements that describe a condition of the matter in contrast to the operational definition where it is taken up that the information must be clear and understandable within four dimensions such as communication of ideas, use of language, clarity and understanding.

In the table above you can see the conceptual definitions and the operational definitions that were validated by experts. Based on this table and taking into account the dimensions to be evaluated, the evaluation guide is developed, where it is observed that each dimension will have a level of development that will be used for the evaluation.

The New Mexican School (NEM) perspective is strongly related to the conceptual definitions of the variables in this study, especially in its focus on relevant, experiential, and contextual learning. PDAs [1], defined within the NEM framework, promote students to develop competencies through observation, analysis, reflection, and action. These dimensions directly match the scientific skills defined in the study, such as observing, questioning, explaining, and hypothesizing. For example:

Observe: Linked to the PDA "Exploring the environment", where children interact

[1]The PDAs are the learning development processes that depend on the educational level within the framework of the New Mexican School.

with their physical environment to identify patterns and phenomena. Ask and hypothesize: Related to the PDA "Formulating questions and solving problems", promoting curiosity and anticipating well-founded answers. Explain: Connected to the PDA "Communicating learning", prioritizing the clear and well-founded expression of ideas.

In session 2, entitled *Discovering Movement* , concepts observed in the previous session about the state of rest and movement were revisited. Activities included hypothesis formulation and questions related to observations. During each session, children carried out practical activities, analysed results and explained their findings, fostering metacognition and collaboration.

The four rubrics designed (observe, question, explain, and hypothesize) were key to assessing each session. Through audio recordings and written records, the children's responses and observations were captured (Díaz, 2001). The clear structure of the rubrics allowed for objective assessment of individual performance, as well as providing specific feedback.

Figure 4. Evaluation criteria for the ability to observe.

HABILIDAD DE OBSERVAR										
Indique del 1 al 3 el nivel de habilidad que se desarrolla con la secuencia didáctica, en donde 1 es el mas bajo y 3 el más alto										
	Atención y enfoque			Capacidad de registro			Interpretación de la observación			
Nombre del alumno	Se distrae fácilmente y tiene dificultad para enfocarse en lo que se le pide observar	Muestra cierto nivel de atención, pero puede distraerse ocasionalmente	Demuestra una atención constante y enfocada en lo que se le pide observar	Olvida rápidamente lo que ha observado	Recuerda algunas situaciones vividas de lo que ha observado, pero no todo.	Recuerda con precisión la mayoría de todas las cosas de lo que ha observado.	Tiene dificultad para comprender lo que ha observado	Comprende algunas partes de lo que ha observado, pero no todo.	Comprende completamente lo que ha observado y puede hacer conexiones con su conocimiento previo	Total de puntos sumados
Estudiante 1	0	0	0	0	0	0	0	0	0	0
Estudiante 2	0	0	0	0	0	0	0	0	0	0
Estudiante 3	0	0	0	0	0	0	0	0	0	0
Estudiante 4	0	0	0	0	0	0	0	0	0	0
Estudiante 5	0	0	0	0	0	0	0	0	0	0
Estudiante 6	0	0	0	0	0	0	0	0	0	0
Estudiante 7	0	0	0	0	0	0	0	0	0	0
Estudiante 8	0	0	0	0	0	0	0	0	0	0
Estudiante 9	0	0	0	0	0	0	0	0	0	0
Estudiante 10	0	0	0	0	0	0	0	0	0	0
Estudiante 11	0	0	0	0	0	0	0	0	0	0
Estudiante 12	0	0	0	0	0	0	0	0	0	0
Estudiante 13	0	0	0	0	0	0	0	0	0	0
Estudiante 14	0	0	0	0	0	0	0	0	0	0

Source: Own elaboration

As can be seen in the table above, the operational definition of observing has 3 evaluation criteria, which in turn have 3 levels of development that were evaluated numerically, where 1 is the lowest and 3 the highest.

The following table presents the evaluation resulting from the operational definition of the variable "asking," which takes into account the initiative to ask questions, the clarity and understanding when formulating them, the variety and depth of the topic, and the participation in the questions and answers. Each of these criteria has three levels of performance, which take into account aspects such as whether or not to start the process of asking questions, whether the questions are clear and understandable to others, whether the questions are superficial or varied, and participation when asking questions.

Figure 5. Assessment criteria for questioning skills

HABILIDAD DE PREGUNTAR													
Indique del 1 al 3 el nivel de habilidad que se desarrolla con la secuencia didáctica, en donde 1 es el mas bajo y 3 el más alto													
	Iniciativa para formular preguntas			claridad y comprensión al formular preguntas			Variedad y profundidad de las preguntas			ipación en interacciones en preguntas y respu			
Nombre del alumno	No inicia el proceso de hacer preguntas	Hace preguntas solo cuando se le anima	inicia activamente el proceso de hacer preguntas sin necesidad de uqe se le anime a realizarlas	Formula preguntas poco claras o no comprende las preguntas de los demás	Formula preguntas claras pero puede necesitar aclaraciones ocasionalmente	Formula preguntas claras y comprende las preguntas de los demás sin dificultad.	Hace principalmente preguntas simples y superficiales	Hace preguntas variadas y algunas muestran el nivel de profundidad	Hace preguntas variadas, algunas de ellas exploratorias y que invitan a la reflexión.	Participa poco en conversaciones de preguntas y respuestas	Participa de manera limitada en conversaciones, mostrando interés ocasional	Participa activamente en conversaciones de preguntas y respuestas, haciendo preguntas pertinentes y respondiendo a las preguntas de los demás	Total de puntos sumados
Estudiante 1	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 2	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 3	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 4	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 5	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 6	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 7	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 8	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 9	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 10	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 11	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 12	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 13	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 14	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: Own creation

In the table above you can see the evaluation criteria for the variable of asking, there is also the operational definition, which was divided into three criteria and these in turn into three levels of performance within which we can find capacities such as being able to communicate one's thoughts based on what was observed in a clear and coherent manner, the correct use of language, and active participation.

Figure 6. Assessment criteria for the ability to explain .

HABILIDAD DE EXPLICAR													
Indique del 1 al 3 el nivel de habilidad que se desarrolla con la secuencia didáctica, en donde 1 es el mas bajo y 3 el más alto													
	Comunicación de ideas			Uso del lenguaje adecuado			Claridad y comprensión			Participación activa en el proeso de explicación			
Nombre del alumno	No logra comunicar sus pensamientos de manera clara	Logra comunicar algunas ideas, pero de manera confusa.	Comunica sus pensamientos de manera clara y coherente.	Utiliza un lenguaje adecuado, pero con limitaciones .	Utiliza un lenguaje apropiado y comprensible para su edad.	Utiliza un lenguaje comprensible y adecuado para su edad e incorpora un leguaje científico en lo que quiere comunicar	Sus explicaciones son vagas y poco coherentes con respecto a lo que vio	Da una explicación de manera breve sobre el tema visto	Explica de manera clara lo que ha entendido	No participa activamente en el intercambio de ideas durante la explicación	Participa de manera limitada o pasiva	Participa activamente, haciendo preguntas y contribuyendo con sus propias ideas.	Total de puntos sumados
Estudiante 1	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 2	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 3	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 4	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 5	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 6	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 7	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 8	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 9	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 10	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 11	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 12	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 13	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 14	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: Own elaboration.

Finally, the evaluation criteria for the variable hypothesize are presented. Like the previous ones, it takes into account three criteria which are subdivided into the expected performance levels. In this variable, it is taken into account whether the students generate a hypothesis or not, whether they consider one or more alternatives, whether they manage to explain their ideas clearly taking into account various scenarios and whether they demonstrate interest in creating their hypotheses.

Figure 7. Assessment criteria for the ability to hypothesize

HABILIDAD DE HIPOTETIZAR													
Indique del 1 al 3 el nivel de habilidad que se desarrolla con la secuencia didáctica, en donde 1 es el mas bajo y 3 el más alto													
	Creatividad en la generación de Hipótesis			Exploración de posibilidades			Explicación de las hipótesis			Participación en actividades de hipotetizar			
Nombre del alumno	No genera hipótesis o propone respuestas	Propone algunas hipótesis simples o evidentes	Propone varias hipótesis creativas y originales	no desarrolla aún la capacidad de considerar múltiples posibilidades, enfocándose en una única opción	Considera algunas alternativas, pero de manera limitada.	Explora activamente diferentes posibilidades y escenarios.	No puede explicar sus ideas o lo hace de manera confusa.	Explica algunas ideas de manera básica.	Explica claramente sus hipótesis y las justifica con razonamientos.	Se muestra desinteresado/a o pasivo/a en las actividades de hipotetizar.	Participa de manera limitada o superficial en las actividades.	Participa activamente y con entusiasmo en las actividades de hipotetizar. .	Total de puntos sumados
Estudiante 1	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 2	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 3	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 4	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 5	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 6	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 7	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 8	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 9	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 10	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 11	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 12	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 13	0	0	0	0	0	0	0	0	0	0	0	0	0
Estudiante 14	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: Own creation

The four evaluation matrices were used to create an evaluation of each of the sessions in the teaching sequence. Although the rubric did not change, the activity to be carried out did, and it was necessary that, in addition to the records of the children, audio recordings were made for the collection and analysis of data (Sierra, 1984) to capture as faithfully as possible what the children say about the activity and what is specifically asked of them.

The rubric is designed to have a clear structure, as it is well organized, allowing the person evaluating to assign scores clearly and directly based on the performance that has been observed in each boy and girl. In the same way, this rubric is not only useful for evaluation, but can help provide specific feedback to students about each of the skills that are intended to be developed.

At the end of the implementation of the teaching sequence, through the scores obtained, remembering that they will range from 1 to 3, where 1 is the lowest level of performance and 3 the highest, it was possible to obtain an average of the 14 students who participated in this study, and from there the levels achieved by the group in general were visualized. All of the above will be described in the following section.

Results

The following graph (Figure 8) presents the level of achievement of each scientific skill assessed in the first and last sessions. This comparative diagnostic analysis shows significant progress in the development of scientific skills throughout the implementation of the inquiry-based teaching sequence. During the intermediate sessions, experiments designed to strengthen these skills were carried out.

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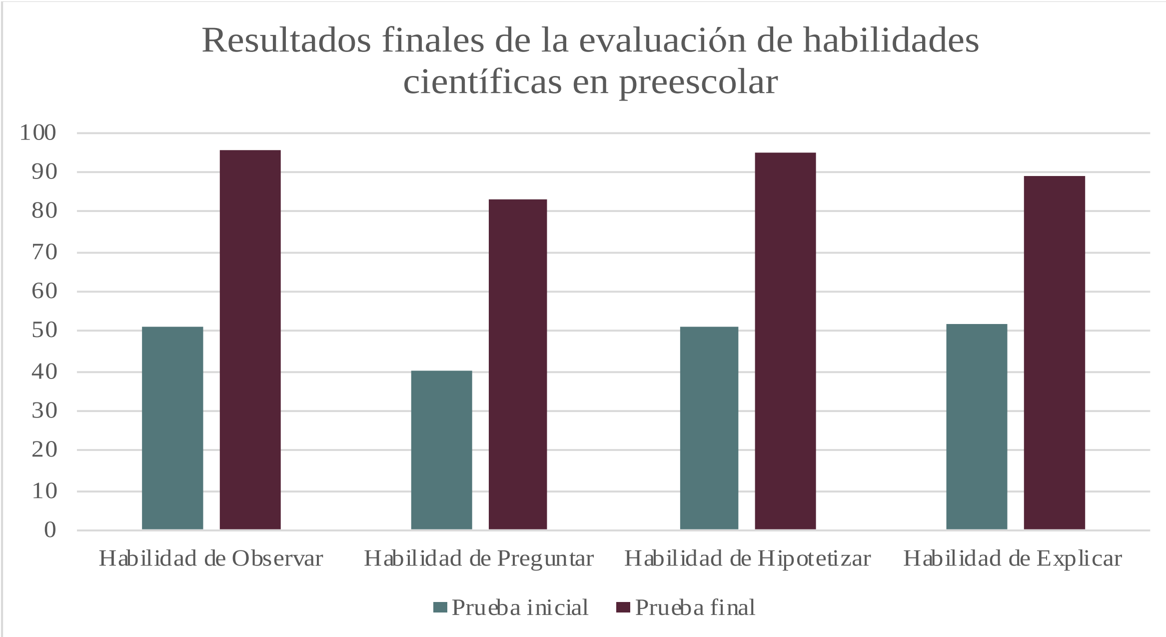
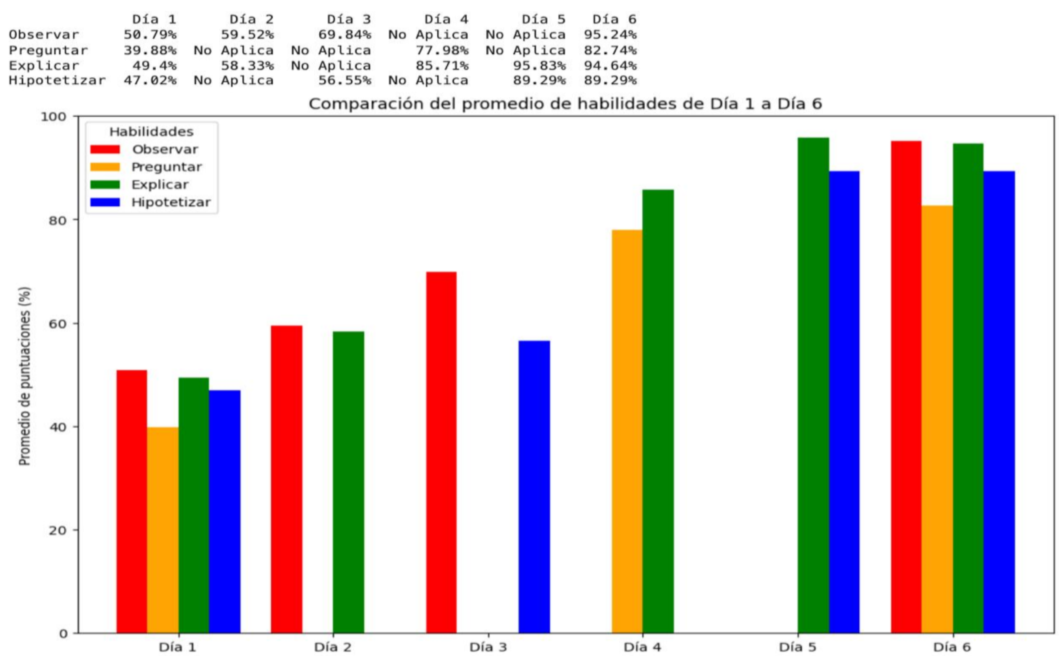
Figure 8. Comparison of the level of development of scientific skills, Day 1 vs Day 6.



Source: Own creation

A significant increase is observed in skills such as explaining and hypothesizing, especially towards the end of the process (Day 6), while observing and asking questions show a more gradual improvement. A more detailed analysis of the daily progression is presented below.

Figure 9. Average comparison of initial and final skill development.



Source: Own elaboration.

In the graph, the average scores reflect the evolution of the skills assessed. It should be noted that skills not assessed on certain days are not included in the graph. The results show a more pronounced development in explaining and hypothesizing, reaching a performance above 80% towards the end of the process.

The most important findings in this study are: a significant increase in scientific skills, since when comparing the evaluations carried out in the initial session and in the final session, a notable progress was observed in the scientific skills of each of the students, specifically in:

1. Observe and ask questions: These skills showed gradual improvement, highlighting the children's ability to identify phenomena and plan related questions.
2. Hypothesizing and explaining: the greatest improvements were observed in these skills, where girls and boys made progress in formulating more structured hypotheses and in the ability to express coherent explanations about the observed phenomena.

The implementation of the inquiry-based teaching sequence showed that children can actively participate in scientific processes, linking the laws of motion with practical and contextualized activities. This allowed the development of critical thinking skills from an early age. Likewise, throughout the six sessions, the skills were developed progressively, which shows significant learning when the activities are designed gradually and focused on clear objectives.

Discussion

The validation of the teaching sequence highlighted the importance of linking experiments with everyday situations to facilitate understanding in preschool. A recurring observation was the need to extend the duration of the teaching sequence to consolidate learning and to carry out longitudinal monitoring to assess the impact of these skills in later educational stages.

Although previous studies, such as those by García, Ramírez, and Arriaga (2022), address scientific competencies at higher educational levels, this work represents a significant contribution by demonstrating that scientific skills can be developed and measured in preschool children. The operationalization of concepts made it possible to evaluate specific skills, which reinforces the feasibility of working with this approach from an early age.

While the thematic focus was on the laws of motion, the method of inquiry is transferable to other disciplines. The rubrics designed in this study could be adapted to explore biological phenomena (such as plant growth) or mathematical phenomena (such as patterns and measurements), opening up lines of research for future studies.

Conclusions

The development of scientific skills from an early age represents a major challenge for teachers, especially in physics subjects, given that preschool curricula in Mexico do not broadly cover these areas. The incorporation of these topics depends on the curricular autonomy of the teacher, who may choose to include them or not in his or her educational practice.

The inquiry method is a key tool for teaching science, as it encourages scientific thinking through play and exploration, allowing children to discover the world through observation and experimentation with everyday phenomena. This approach facilitates the development of skills such as observing, asking questions, explaining and hypothesizing, which are essential for understanding the environment.

Although the New Mexican School and its 2022 reform represent a significant advance by including formative fields such as "Knowledge and Scientific Thinking", it is essential that these topics are systematically integrated into classrooms. This will require a joint effort between schools and teachers to transcend traditional practices and implement innovative strategies that strengthen science teaching from an early age.

Future lines of research

It is essential to further develop scientific skills in preschool education, exploring other areas of the exact sciences, such as mathematics, biology and engineering. In addition, priority must be given to the design and implementation of well-founded teaching sequences that take advantage of educational technologies and address the demands of the current context.

Longitudinal monitoring could assess the impact of these strategies on the educational trajectory of girls and boys, identifying their influence on the choice of careers related to the exact sciences. This would allow for the design of more robust educational programs that promote interest in science from early childhood.

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