

## Building precursor models of buoyancy: a review of current knowledge and future directions

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### ABSTRACT

*This review examines the literature on the development of precursor models of floating in children aged 3 to 6 years. The studies analyzed were conducted in a variety of cultural and educational contexts. From a methodological standpoint, qualitative approaches predominate. The results show that research on the formation of precursor models of buoyancy in early childhood has focused primarily on the construction of a precursor model based on the nature of materials. Teaching strategies are generally grounded in socioconstructivist theories of learning that emphasize the importance of dialogic teaching and inquiry-based activities. The importance of teacher interventions in guiding children's inquiries and discussions is highlighted. Further research is needed on the most effective teaching strategies to promote progress in students' models and forms of reasoning, as well as on the progression of these models. Teaching strategies based on precursor models also constitutes a privileged pathway for linking epistemic knowledge and critical thinking.*

### KEYWORDS

*Precursor models, early childhood education, science education, flotation, literature review*

### RÉSUMÉ

*Nous passons en revue la littérature consacrée à la construction de modèles précurseurs chez les enfants âgés de 3 à 6 ans concernant la flottabilité. Les études analysées ont été menées dans divers contextes culturels et éducatifs. En ce qui concerne la méthodologie, les approches*

*qualitatives prédominant. Les résultats montrent que la recherche sur la formation de modèles précurseurs de la flottabilité dans les premières années s'est principalement concentrée sur la construction d'un modèle précurseur basé sur la nature des matériaux. Les stratégies didactiques s'appuient généralement sur des théories socio-constructivistes de l'apprentissage qui mettent l'accent sur l'importance d'un enseignement dialogique et d'activités d'exploration. L'importance des interventions de l'enseignant pour guider les explorations et les discussions des enfants est soulignée. Des recherches supplémentaires sont nécessaires sur les stratégies didactiques les plus efficaces pour favoriser le développement des modèles et des modes de raisonnement des élèves, ainsi que sur la progression de ces modèles. Le travail didactique avec des modèles précurseurs constitue en outre une voie privilégiée pour articuler les connaissances épistémiques et la pensée critique.*

## **MOTS- CLÉS**

*Modèles précurseurs, éducation de la petite enfance, éducation scientifique, flottaison, revue de la littérature.*

## **INTRODUCTION**

Science education is an essential component of informed public participation in contemporary society. Adequate scientific literacy enables people to critically assess the reliability of information, thereby helping to prevent misinformation and pseudoscience. Furthermore, high-quality science education provides a conceptual framework that enables the formation of well-founded opinions and informed decision-making. Although there is broad consensus on the need for science to be accessible to all, debate persists regarding the appropriate age at which science education should begin.

In recent years, research in science education has focused on the processes through which young children construct scientific knowledge. Various studies emphasize that science teaching in early childhood education plays a key role in the development of critical thinking and basic scientific skills (Bargiela et al., 2022; Maraisane et al., 2024). In this regard, it is now recognized that, from early childhood, people construct mental models of the world around them and progressively revise them as they incorporate new information (Kuhn & Pease, 2006).

The concept of a mental model refers to an internal representation constructed by individuals based on their innate predispositions and prior experiences, with the aim of describing, explaining, or predicting phenomena (Greca & Moreira, 2000). In the field of education, the concept of precursor models is introduced to refer to those models that can be constructed from an early age under certain teaching conditions. The purpose of these models is to promote early scientific literacy.

From an educational perspective, precursor models form the core of scientific learning in the early years of education, as they engage pupils in an activity akin to modelling that requires them to attempt to explain, justify and revise their own initial models of phenomena. The construction of precursor models also represents a way of understanding scientific knowledge. By comparing alternative models, analyzing their limitations and reviewing their assumptions, children begin to develop initial epistemic knowledge, linked to criteria of validity, internal consistency, explanatory power, and consistency with the evidence. Thus, the construction of precursor models is linked to the development of critical thinking which, in this context, is not conceived as a general skill, but as a cognitive practice situated within the activity of modelling, since thinking critically means thinking with and about models, evaluating their consistency and explanatory power (Kuhn, 2019).

Precursor models thus constitute a first step in the construction of more sophisticated models (Ravanis, 2000). Precursor models are compatible with scientific models, as they are built based on certain elements included in the scientific model, but they have a limited scope of application (Ravanis & Boilevin, 2022). These are models that form the basis for subsequent constructions (Weil-Barais, 2022). Furthermore, teaching strategies based on precursor models can provide an excellent opportunity to link epistemic knowledge and critical thinking.

When selecting scientific content suitable for early childhood education, as well as for the construction of preliminary models by pre-school pupils, it is appropriate to adopt the criterion that teaching proposals should focus on phenomena familiar to children about which they have already developed preliminary ideas and explanations (García-Carmona et al., 2014; Harlen, 1989). A second criterion for selecting science topics suitable for teaching in schools from an early age is that the concepts to be covered must be within the children's grasp, taking into account their experience and intellectual maturity (Harlen, 1989).

Numerous studies have analysed the explanations children offer regarding the buoyancy of objects, identifying different types of reasoning depending on age and level of cognitive development. These studies describe a wide range of responses, from animistic explanations to reasons related to the properties of objects such as shape, size, weight, hardness or material (e.g. Butts et al., 1993). According to the studies by Piaget (1934) and Inhelder & Piaget (1972), it is not until the age of nine that children conceptualize the idea of density.

Thus, Piaget (1934) described children's explanations of why boats float, in children aged between 4 and 12, as a four-stage progression. In the first stage, around the ages of 4-5, animistic and moral explanations predominate. In the second stage, around the ages of 5-6, children attribute floating to the weight of the object, arguing that ships float because they are heavy. In the third stage, which occurs approximately between the ages of 6 and 8, this explanation is reversed, so that children state that ships float because they are light. From the age of 9 onwards, a fourth stage emerges in which explanations refer to the weight of the object in relation to the weight of an equivalent volume of water, which represents a functional approximation of the concept of density.

This progression in the understanding of buoyancy has been reviewed and refined in subsequent research. For example, in a study of children aged 3 to 9, Smith et al. (1985) concluded that the youngest children (aged 3-4) operate with an undifferentiated concept that conflates characteristics such as size, weight, and material. Subsequently (5-7 years), a process of conceptual differentiation emerges in which size is distinguished from weight, weight from material, and an incipient concept of density appears.

Kohn (1993) challenges the classical Piagetian interpretation according to which children cannot understand concepts such as density until more advanced cognitive stages. Instead, the author proposes that 4- and 5-year-olds possess partial and intuitive knowledge, albeit not yet formally or scientifically integrated. The study shows that many children distinguish weight from material, although they are often confused when the two dimensions conflict. In other words, their reasoning reveals early conceptual structures that can serve as a basis for later acquiring more formal learning. Furthermore, explanations such as those described by Piaget have also been observed in subsequent research (Butts et al., 1993; Ioannides & Kakana, 2001; Paños et al., 2022; Pramling & Pramling-Samuelson, 2001; Selley, 1993).

As noted in a previous paragraph, precursor models represent a first step in the construction of more elaborate conceptual models (Ravanis, 2000). In this context, we consider what precursor model might fulfil this initial function in the specific case of floating. The concept of density, which is required to understand how an object floats, cannot be grasped by young children, although it appears that an intuitive idea of density begins to develop after the age of 5 or 6 (Kohn, 1993; Smith et al., 1985).

The aim of this study is to identify, describe, and synthesize the main findings regarding a fundamental area of research in early science education: the formation of precursor models of floating in children aged three to six.

## METHODOLOGY

The following section describes the methodological framework used to conduct the review. A literature search was carried out in March and April 2026, using the following databases: Google Scholar, Dialnet, ERIC, SCOPUS, and Web of Science.

The search strategy in databases involved creating an algorithm combining the following keywords and Boolean operators: ‘precursor model’ AND (flotation OR buoyancy) AND ‘early childhood education’. The search time frame spanned from 1990 to the present. Once potential publications had been identified, the results were refined by applying the inclusion and exclusion criteria set out in Table 1. As shown in Table 1, only articles from peer-reviewed journals were considered. Conference proceedings were also included.

Furthermore, only studies examining the development of early models of floating in children aged three to six were included. It should also be noted that articles referring to the same research or lacking empirical evidence were excluded. For the selection of publications, titles, abstracts, keywords, and content were reviewed. Once the publications meeting the inclusion and exclusion criteria had been identified, the objectives, the participants in the sample, the type of intervention, the methods of data collection and analysis, and the main findings were analysed for each one.

**TABLE 1**  
*Inclusion and exclusion criteria used in the literature search*

Category	Inclusion criteria	Exclusion criteria
<b>Research objective/Keywords /Topic</b>	Studies focusing on the development of early concepts regarding buoyancy.	Studies that do not focus on the development of preliminary concepts regarding flotation.
<b>Age</b>	3-6 years old	Other age groups
<b>Type</b>	Peer-reviewed journal articles and conference proceedings	Books, book chapters, non-academic articles
<b>Language</b>	Spanish, English, Portuguese	Other languages
<b>Access</b>	Accessible through USC	Not accessible through USC

## RESULTS

This section provides a summary of the main findings and the various methodological approaches used to study the formation of precursor models of scientific concepts relating to buoyancy in the studies included in the review. Eight studies were selected following the application of the inclusion and exclusion criteria (see Table 2).

A pioneering study on the formation of early models of buoyancy is that of Koliopoulos et al. (2004), who analysed the representations and explanations developed by 20 pre-school children (average age 5.6 years) from a school in Greece regarding the phenomenon of objects floating and sinking. The aim of the research was to understand children’s reasoning regarding these phenomena and to examine whether the participants were able to construct a coherent precursor model based on density. The study adopted a qualitative approach based on individual interviews. In the first phase of the research, the aim was to familiarize the children with the

concepts of floating and sinking through a group activity, in which they made predictions about the floating behaviour of 15 familiar objects. However, at this stage, the reasons why these objects floated or sank were not addressed. In the second phase of the research, the children were asked to predict whether various cubes, made of different materials and of varying sizes, would float or sink. After the experiments were carried out, they were asked to compare the results obtained with their initial predictions and to explain their conclusions. The results showed that many children started with intuitive ideas, based mainly on the weight or size of objects. Following the experiments, several participants were able to revise their explanations, taking the nature of the material into account as a relevant factor (a step towards the scientific concept of density). Analysis of the responses revealed that some children managed to develop a preliminary model based on the nature of the material and qualitatively improved their reasoning about buoyancy. The authors considered that the results would be better with a more structured intervention.

**TABLE 2**  
*Studies on the construction of precursor models for flotation*

Author/ year	Objective	Country/ Participants	Methodology	Intervention	Findings
Koliopoulos et al. (2004)	To understand how they form a precursor model based on density perception when predicting and describing the behaviour of the flotation of solid geometric objects.	Greece/ 20 children. Mean age was 5.6 years	Qualitative approach. Recordings of group activities. Individual interviews. All interviews were video recorded	Phase 1: The children were introduced to the concepts of floating and sinking and to the properties of different materials. Phase 2: Individual interviews were conducted in which the children explained their predictions and observations regarding the buoyancy of different buckets	On analysing the children's responses, it was observed that some children developed a preliminary model based on an intuitive concept of density derived from the nature of the material, and that their reasoning improved qualitatively.
Canedo- Ibarra et al. (2010a)	To describe and characterise the construction of a preliminary model of flotation based on the nature of the material.	Spain 20 children (aged 5-6)	Qualitative approach. Participant observation. Pre and post-intervention individual interviews. Data collection: audio and video. Analysis of discursive interactions	A dialogic context focusing on collaborative interaction, conceptual change and guided discovery, using a modelling teaching strategy.	Some children were able to build a preliminary model of flotation based on the properties of the material, and overall, they all made significant improvements in their reasoning.
Canedo- Ibarra et al. (2010b)	To investigate how children's ideas about buoyancy change following a period of instruction	Spain 24 children (aged 6)	Qualitative approach. Participant observation. Pre and post-intervention individual interviews. Data collection: audio and video.	A dialogic context with a focus on collaborative interaction: a teaching strategy based on modelling.	The results show how 6-year-olds construct a preliminary model based on density. The children showed improvements in their reasoning.

<p>Hsin &amp; Wu (2011)</p>	<p>To examine children’s explanations of floating and sinking, and to investigate how scaffolding strategies provided by a tutor might improve their scientific understanding</p>	<p>Taiwan (China)/ 15 four-year-olds and 15 five-year-olds</p>	<p>Qualitative approach. Pre and post-intervention children’s interviews. The interviews and the intervention were recorded.</p>	<p>During the experiment, the children handled objects made of different materials and were assigned to one of three experimental groups: 1. With instructional scaffolding and the opportunity to see the materials the objects were made of; 2. Scaffolding only; 3. The opportunity to see the materials only.</p>	<p>The study provides significant evidence regarding the role of scaffolding in science teaching in early years education and the teaching conditions that promote the development of initial explanatory models.</p>
<p>Schneider et al. (2017)</p>	<p>To investigate how children form concepts of floating and not floating</p>	<p>Brazil 15 children (aged 5-6)</p>	<p>Data collection: audio and video. Observation log.</p>	<p>Dialogic approach. A practical activity in which the children experimented with fruit to see if it floats. Explicit teaching on the relationship between density and buoyancy.</p>	<p>The results of the data analysis showed that the activity helped to develop the children’s understanding of buoyancy.</p>
<p>Elmalı &amp; Laçın Şimşek (2021)</p>	<p>To investigate how children construct concepts of floating and sinking, and the influence of peer interactions in these ideas</p>	<p>Turkey 20 children (66-73 months) (5-6 years)</p>	<p>Qualitative and interpretative study. Semi-structured interviews. Data were collected via audio and video recordings during experiments.</p>	<p>Preliminary interviews with five children The 20 children then made predictions and observations, explaining their answers. Follow-up interviews were conducted with six children. No instructions or guidance were provided.</p>	<p>In subsequent interviews and when describing their experiences, they used terms similar to those in the earlier interviews— ‘heavy-light’, ‘soft-hard’, ‘big-small’ and ‘thin-thick’—to explain the concepts of floating and sinking. Two children referred to buoyancy.</p>
<p>García-Rodeja et al. (2022)</p>	<p>To describe children’s explanations of the buoyancy of solid objects and how these develop during the implementation of an activity.</p>	<p>Spain 7 four-year-olds</p>	<p>Data were collected through semi-structured interviews that were recorded on audio and video.</p>	<p>Dialogic context using a teaching strategy based on the construction of a preliminary scientific model. Intervention based on POE-type activities.</p>	<p>By the end of the sequence, they became better at making predictions, and some children began to use more relevant characteristics in their explanations, such as weight or the material the objects are made of.</p>
<p>García-Rodeja et al. (2023)</p>	<p>To describe how they construct models relating to the buoyancy of solid objects</p>	<p>Spain (4 children aged 6)</p>	<p>Data collection: audio and video. Analysis of discursive interactions.</p>	<p>A dialogue-based context using a teaching strategy centred on the construction of a preliminary scientific model. An intervention</p>	<p>At the end of the series of activities, the children draw on ideas from an earlier model of</p>

				based on POE-type activities.	buoyancy based on the material from which the objects are made.
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The studies by Canedo-Ibarra et al. (2010a) and Canedo-Ibarra et al. (2010b) describe how, through carefully designed and structured experimental activities based on Koliopoulos et al. (2004) and Havu-Nuutinen (2005), following an approach of collaborative interaction, conceptual change and guided discovery, some children were able to construct a precursor model of buoyancy based on the nature of the material. In particular, the study by Canedo Ibarra et al. (2010a) presents results obtained with 5- and 6-year-old children from a school in Catalonia (Spain), whilst Canedo Ibarra et al. (2010b) describe the process by which a group of 6-year-olds developed a precursor model of flotation based on the concept of density. Both studies are exploratory in nature and adopt a qualitative approach to data collection and analysis, following a design that included a pre-interview, an instructional process, and a post-interview. The children made predictions about how different objects would behave in water and wrote down their predictions. They then tested how the objects floated in water, discussing and evaluating their predictions. The results showed that, following the instructional period based on experimentation and dialogue, several participants were able to construct a preliminary model of floating, and that, in general, the children showed improvements in their reasoning, both in describing the phenomenon based on the events observed and in reformulating their explanations in terms closer to those used by scientists.

The study by Hsin & Wu (2011) examines children’s explanations of buoyancy and investigates how scaffolding strategies can improve children’s scientific understanding. The research was conducted with 30 pre-school children (15 aged 4 and 15 aged 5) from a state nursery school in northern Taiwan. During the intervention, the children handled objects made from different materials and were assigned to one of three experimental groups. In the scaffolding-material group, the tutor used scaffolding strategies to support the children’s learning process, and the children could see the materials from which the objects were made. In the scaffolding group, the teacher also used scaffolding strategies, but the children could not see what the objects were made of because they were covered. Objects made of the same material were covered with strips of the same colour. All three groups were allowed to handle the objects. The objects were carefully selected, all being solid objects with different volumes, weights and materials. The instructional scaffolding took the form of sixteen teaching strategies based on six principles of scaffolding, such as directing pupils’ attention, asking guiding questions, and encouraging reflection on experimental results. The children were interviewed before and after the intervention.

Analysis of the interviews showed that, prior to the intervention, 4-year-olds appeared to have varied and inconsistent explanations for sinking and floating, whereas most 5-year-olds explained the phenomenon primarily in terms of weight. After the intervention, 4-year-olds tended to use the weight and volume of objects to explain buoyancy, whilst some 5-year-olds were able to use the materials of the objects to explain it. Following the intervention, the results showed significant improvements in the understanding of floating and sinking in the groups that received scaffolding. However, this study also highlights that not all scaffolding strategies were effective for all children. The authors conclude that teachers should employ different scaffolding strategies depending on the children’s varying initial levels of understanding. The results indicate that hands-on experience by itself is not sufficient to promote scientific understanding. Instead, combining hands-on experiences with intentionally designed teaching scaffolding strategies are particularly effective in supporting the construction of models more consistent with scientific knowledge.

The study by Schneider et al. (2017) describes how 20 Brazilian children (aged 5–6) develop their conceptions of buoyancy and how they are able to construct a preliminary model based on an intuitive concept of density. A practical activity was designed in which the children experimented with different fruits, and the participants' interactions during the activity were recorded on audio and video. The results of the experiment were evaluated by analyzing the discursive interactions that took place between the teacher/researcher and the children during selected teaching episodes. The results showed that the activity provided opportunities for the children to develop and transform their initial conceptions. Initially, the children believed that large, heavy fruits sank because, in general, they tend to weigh more than small, light fruits. By the end of the activity, the five- and six-year-olds were able to construct a preliminary model based on an intuitive concept of density. The experiment allowed for the observation of knowledge-building processes, revealing progress in understanding why some objects float and others do not, as well as in their ability to reason and reflect based on experimentation.

The study by Elmalı and Laçın Şimşek (2021) aimed to identify pre-school children's ideas about the concepts of floating and sinking, as well as to analyse the effect of classroom interactions on these ideas. The research adopted a qualitative and interpretative approach, based on individual interviews and the analysis of interactions during experimental activities. The sample consisted of 20 children aged between 66 and 73 months (5-6 years) attending a state-run early years education centre in Turkey. The research design included initial interviews with five participants and final interviews with six, as well as an interview with one of the parents. The data were collected through semi-structured interviews and video recordings during experiments involving the floating and sinking of objects and analysed using content analysis. The data collected in the pre-study interviews showed that, whilst the children used terms such as 'heavy-light', 'soft-hard', 'big-small', and 'thin-thick' to explain the concepts of floating and sinking, the post-study interviews showed that they continued to use similar terms after the study had finished. It is important to note that in this study, the objects used were of different shapes and materials, both solid and non-solid (plastic balls of various sizes, a pencil, paper, an eraser, a balloon, a metal marble, expanded polystyrene, a plastic fork and spoon, glass and plastic bottles, and bottle caps with and without holes). Furthermore, no explanation or guidance was provided. The only progress made in relation to the conceptual model was that some children used the term 'thrust' in the discussion. This seems to highlight the importance of the teacher's role as a guide, as hands-on activities and dialogue amongst the children alone were not sufficient to facilitate conceptual progress towards a precursor model.

The study by García-Rodeja et al. (2022) describes the explanations given by seven four-year-old children from Galicia (Spain) regarding the buoyancy of solid objects during the implementation of a teaching activity, and analyses whether there are changes in their explanations as they carry out the tasks. The intervention presented here employs the Prediction-Observation-Explanation strategy (White & Gunstone, 1992), in which children are encouraged to make predictions about a phenomenon that they will then have the opportunity to observe and test experimentally. Various studies have shown that, although very young children tend to use a single property or characteristic of the object (e.g. weight, size or shape) to explain floating, interventions can be successful in that children may combine more than one property or characteristic (Havu-Nuutinen, 2005). In this study, at the outset of the experiment, four-year-olds begin by offering explanations that refer to an object's strength, size, or the presence of air to account for why objects float. In some cases, these experiences lead to a diversification of criteria, introducing contradictions and resulting in the adoption of incompatible explanations—a phenomenon that has already been described in other studies (Inhelder & Piaget, 1972). By the end of the sequence, they improve at making predictions about the buoyancy of objects, and some children begin to use more relevant properties such as weight, and even the 'weight of the material' or the material from which the objects are made;

these latter explanations are based on concepts that can be understood as approximations to the concept of density. The study demonstrates how, even at a young age, it is possible to encourage the development of more well-founded explanations through appropriately designed inquiry activities. Furthermore, it illustrates the transition from intuitive ideas to more elaborate models of buoyancy.

Finally, in the study by García-Rodeja et al. (2023), the authors describe in exhaustive detail how four six-year-old children from Galicia (Spain) construct models and explanations relating to the buoyancy of solid objects during an educational activity on floating. The session was audio-recorded to collect data and study the development of their ideas. The results showed that, at the start of the sequence, some children were unable to justify their predictions about the buoyancy of certain objects, whilst others used different criteria for each object, such as size, hardness or weight. During the sequence, the prediction–observation–explanation process enabled the children to revise their prior conceptions. By the end, the children had constructed a preliminary model of buoyancy, incorporating the idea that it depends on the material the object is made of, demonstrating a more coherent understanding that is closer to the scientific model.

## FINAL CONSIDERATIONS

This article reviews the scientific literature on the development of early models of buoyancy in children aged between 3 to 6 years old. The studies analysed were conducted in a variety of cultural and educational contexts, specifically in countries such as Greece, Spain, China, Brazil and Turkey. Although a complete understanding of flotation would not be an appropriate objective for this age group, it has been shown that it is possible to design interventions on flotation that lead to some form of development in children's conceptual understanding (Canedo-Ibarra et al., 2010b; Kallery, 2015). Other researchers (Hsin & Wu, 2011; Koliopoulos et al., 2004) also point out that linking the idea of 'material' with the concepts of density and buoyancy is a first step towards explaining the buoyancy of objects. Clearly, the scope of this concept is limited to solid objects, that is, objects without any holes. The findings of this review show that research at this stage of education has focused primarily on developing a preliminary model based on the nature of materials as a first step towards a density-based model.

In terms of methodology, qualitative approaches predominate, with data collected through individual interviews in pre-test–post-test designs, and through recordings made during the implementation of the teaching interventions.

The teaching strategies described in the studies are generally based on socioconstructivist theories of learning, which emphasise the importance of dialogic teaching and inquiry-based activities. In this type of approach, children are given the opportunity to make predictions, carry out observations, experiment with different materials, and construct progressively more thorough explanations.

The reviewed literature agrees that pre-school children are capable of constructing scientifically coherent preliminary models of buoyancy when engaged in learning contexts that activate their initial models, allow them to test their ideas through experimentation, and encourage the development of new explanations. In this process, the systematic use of dialogue and guided reflection is key to moving beyond initial intuitive models and progressing towards models that more closely resemble scientific models.

Furthermore, the studies highlight the importance of carefully selecting the materials and objects used in the activities. In particular, when constructing a precursor model based on the nature of the material, the use of solid objects is crucial, as they enable children to make inductive generalisations in line with the intended precursor model: 'floatation depends on the

nature of the material'. This model constitutes a first step towards more complex understandings, such as a model based on the density of the material and the density of the fluid.

Teacher intervention emerges as a decisive factor in pupils' conceptual progress. Teachers' guidance in inquiries and discussions is essential for promoting significant advances in children's initial models and reasoning. Studies such as one by Hsin and Wu (2011) show how scaffolding strategies help to move beyond intuitive explanations based solely on weight and encourage a shift towards explanations grounded in relevant physical properties. The findings of Hsin and Wu (2011) and Elmalı and Laçın Şimşek (2021) suggest that hands-on experiences, on their own, may not be sufficient to deepen understanding of the phenomenon.

Finally, the review highlights the need for further research into the construction and development of precursor models of buoyancy in early childhood education. More studies are required to describe in detail the learning environments, the processes involved in constructing precursor models during specifically designed scientific activities, and individual conceptual progress. Furthermore, it is necessary to deepen the analysis of effective teaching strategies that can adequately support scientific learning at an early age. In particular, more research is needed to identify which types of teaching interventions promote significant progress both in children's explanatory models and in their ways of reasoning about phenomena, as well as in the progression of these models over time. Within this framework, the didactic approach to precursor models emerges as a particularly relevant pathway for articulating the epistemic knowledge inherent to school science by more clearly defining the models that children are expected to construct. Furthermore, the didactic approach to precursor models is particularly relevant for the development of critical thinking, as it promotes argumentation, metacognitive reflection, and the progressive revision of one's own explanations.

## FUNDING

This research was funded by the Consolidation and Structuring of Competitive Research Units Programme 2025, GRC GI-1667 Razoamento, Discurso e Argumentación–RODA (2025-PG015-1), Ref. ED431C 2025/48; by MCIN/AEI/10.13039/501100011033/FEDER, UE, grant number PID2022-138166NB-C21.

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