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RESEARCH ARTICLE

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Attitude toward informal science in the early years and development of Leisure Time in Science (LeTiS), a pictographic scale

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Abstract

Attitude toward science has been recognized as highly influential in students' engagement with science and future career choices. Science is important in our everyday lives as well, in a society demanding more scientific vocations and higher levels of scientific literacy. There is little research on how attitudes develop and evolve at early ages, which may be due to a lack of appropriate measurement tools. The objective of this study is to design and validate a tool to measure attitude toward informal science in 5 to 6-year-old children, who are not yet familiarized with "formal science." Rather, these children are constantly interacting and learning about their surrounding world. These early experiences are important for future science engagement. The Leisure Time in Science (LeTiS) scale consists of eight pictures representing science learning activities in informal environments. Children's intentions of performing the activities shown in the LeTiS pictures are measured by comparing them with other leisure non-scientific activities. We also analyze parents' views on their children's leisure interests for comparison. The relationship among attitudes, intentions, and interests is also analyzed as part of this study involving

387 children and 188 parents. LeTiS is a pictographic scale, which is easy to interpret, with reliable psychometric properties, Oω = .88, and a unidimensional factorial structure. The results show that participants, aged 5–6, have a very positive attitude, with no gender-based differences. Nevertheless, their intentions to perform the activities are less promising, as nonscientific activities are consistently the first choice. Although parents' views report considerable science interest in their children, there is a low correlation with attitudes and intentions. The findings may offer clues on the relationship between children's attitudes toward science and their actual behavior. The study may also contribute to planning science curriculum in the early educational years.

KEYWORDS

attitude toward science, behavioral intention, early childhood education, informal science, science interests

1 | INTRODUCTION

For several decades, science educational research has focused on the study of student attitudes toward science, the relationship to children's interest and engagement in science, and the influence of these factors on school performance and career choice (Ball, Huang, Cotten, & Rikard, 2017; Koballa, 1988; Leibham, Alexander, & Johnson, 2013; Potvin & Hasni, 2014; Schibeci, 1984; Simpson & Oliver, 1990). This focus is justified by a social context that increasingly demands higher levels of scientific and technological competence in citizens. Today's society requires not only new, well-prepared generations of scientists, but also everyday people who can make informed decisions about their immediate environment and other global concerns (Wagner, 2014). In the modern world, everyone is expected to play an active and critical role in economic, technological, and environmental progress.

This everyday participation in science contrasts with reports and research from around the world that highlight the decline of scientific vocations and a general lack of interest in science by average citizens (Avargil, Kohen, & Dori, 2020; Blotnicky, Franz-Odendaal, French, & Joy, 2018; COSCE, 2011; European Commission, 2004; FECYT, 2018; National Research Council, 2012; OECD, 2017b). This decline is partially justified by the development of negative attitudes toward science in school (Desy, Scott, & Brockman, 2006). Analyses of science education report low propensity of students toward science careers (Aydeniz & Kotowsky, 2014; Sithole et al., 2017), and a negative correlation between interest in science and a country's level of human development (Osborne & Dillon, 2008; Sjøberg & Schreiner, 2010). The concern is further accentuated in the case of women, who are underrepresented in scientific departments and even more so in the job market, especially in the physical sciences (Funk & Parker, 2018; OECD, 2008, 2017a).

An improved scientific culture requires promotion of science in young children (COSCE, 2011; Eshach & Fried, 2005; National Research Council, 2007; OECD, 2016; Spektor-Levy, Baruch, & Mevarech, 2013), and therefore political and educational efforts have been aimed at stimulating effective actions that enhance science engagement (Osborne & Dillon, 2008). These efforts have analyzed the quality of science education and provided new learning methods that are expected to be more effective. Nonetheless, trends in academic achievement in science are not positive. For example, almost none of the 79 countries participating in Program for International Student Assessment improved in performance from 2006 to 2015 (OECD, 2016). Other actions have focused on affective variables such as attitudes. Most countries have even included the development of positive attitudes toward science as a specific learning objective in their science curricula (Sjøberg & Schreiner, 2010). Despite this revision to curricula, trends in attitudes are not showing improvement, and research finds declines from the middle years of formal education through the end (Christidou, 2011; Said, Summers, Abd-El-Khalick, & Wang, 2016).

It is necessary to emphasize that there is little information about how attitudes toward science develop and evolve in the early years, which can be due to a scarcity of appropriate measurement tools. Research in this area has been focused on students of age 8 and older (Kerr & Murphy, 2012; West, Hailes, & Sammons, 1997). In addition, research has targeted interest in science as a school subject, neglecting to consider that children and science have a strong connection that begins well before they start school (Brown, 1991; Trundle, 2015). Early science experiences and the development of positive attitudes in these years can be a precursor of future engagement in science (Jones, Corin, Andre, Childers, & Stevens, 2017).

Thus, in an attempt to fill this gap, this study develops and validates an instrument to measure attitude toward informal (out-of-school) science in students aged 5–6. We examine children's attitudes and relate them to behavioral intentions (BIs) in choosing between scientific and nonscientific alternatives in different informal environments, and parents' information on their children's interests.

2 | EARLY SCIENCE EXPERIENCES. DEVELOPMENT OF ATTITUDES AND SCIENCE ENGAGEMENT

Throughout childhood, children are exposed to a great amount and variety of informal learning situations about the natural world, a fresh scientific frame for which they have an inherent proclivity (Worth, 2010). Furthermore, from an early age they possess the cognitive abilities to establish cause-and-effect relationships (Greenfield et al., 2009), a basic competency for proper scientific thinking.

Children are innately curious and enjoy observing, exploring, handling objects, and asking questions to make sense of the world around them (Trundle, 2015). Common children's activities in natural environments are a clear example of their great desire to learn (Eshach & Fried, 2005), for instance observing ants marching in a line, viewing the stars at night, and collecting shells, stones or leaves. The curiosity that a child shows about natural phenomena covers life, physical, and Earth and Space science disciplines (Patrick & Mantzicopoulos, 2015). All of these initial informal science learning experiences lay the foundations for attitude toward science, which develops early (Bruce, Bruce, Conrad, & Huang, 1997), and relates to later interests throughout their education (Jones et al., 2017; Regan & DeWitt, 2015). Research indicates that if childhood interests are sustained, that may stimulate science engagement in the long term and even the choice of a professional future linked to science (Crowley, Barron, Knutson, & Martin, 2015). Jones et al. (2017) show that childhood experiences of science learning were a determinant of lifelong science interests. The positive effects of these experiences can be attributed to being guided by the learner's interests, the personal and voluntary nature, and being contextually relevant, among other reasons (Falk, 2001).

Parents play a prominent role in attitude development by identifying and supporting children's interests (Leibham et al., 2013). Parental attitudes toward science are also strongly related to their children's attitudes (Papanastasiou & Papanastasiou, 2004).

3 | REVIEW OF TOOLS TO MEASURE ATTITUDE TOWARD SCIENCE IN THE EARLY YEARS

Measurement of attitude toward science in the early years may offer several clues on how the relationship with science will evolve throughout a child's education. We carried out a systematic review of the available measures through 2018, identifying those available for ages 5–8. To enhance the review, a similar construct, such as motivational beliefs (which embraces children's science affinity), has been included as well.

There are only eight available measurement tools for the defined age range (see the supplementary material, Table S1 for a summary), and only five are specific to preschool or kindergarten. Six of the self-reported measurement tools contain the word "science" in some or all items, mostly referring to general science and science as a school subject. In an attempt to adapt the ATSSA scale to young children (*Attitude toward Science in School Assessment*), Reid (2014) changed the wording of the questions to adjust them to the childhood curriculum, replacing the term "science" or defining the scientific activity. For example, "I would like to learn more about science" is replaced by "I would like to learn more about insects," and "I like observing like a scientist" becomes "I like observing plants." Although this measure shows good reliability and validity, the study is a Master's thesis and therefore has not been peer reviewed.

Research by Oppermann, Brunner, Eccles, and Anders (2018), focused on motivational beliefs, shows potential for the *Young Children's Science Motivation scale*. The authors note that "science" as a concept might not be suitable for preliterate children. Thus, the term "science" is replaced by early science learning experiences from the research literature and the preschool science curriculum in Germany. They include items such as: "Please, show me how much you would enjoy learning more about plants." Although the scale consists of 28 items on self-confidence and enjoyment of physical and life sciences, there is a short version of the scale with good psychometric properties.

With respect to the questionnaire format, most of the eight measures employ between 4- and 5-point Likert scale questionnaires completed through personal interviews or with the guidance of the teacher. In two of the tools puppets are used to guide the interviews (Mantzicopoulos, Patrick, & Samarapungavan, 2008; Oppermann et al., 2018). For most questions, respondents are asked to select smiley faces (Jaus, 1977; Mulkey, 1989; Pell & Jarvis, 2001) or other levels of response choices (Oppermann et al., 2018; Peleg & Baram-Tsabari, 2011; Reid, 2014).

Andre, Whigham, Hendrickson, and Chambers (1999) developed the only tool that uses three graded options with the youngest students. This study assesses attitudes toward mathematics, reading, life science, and physical science, according to students' perceived self-competence, degree of liking for the subject, and degree to which respondents perceived related jobs as male or female dominated. Response choices consist of a smiling, neutral, and frowning face, except for the questions about jobs, where there is an icon of a male, a female and an icon including both. The authors assumed that students are able to conceptualize not only the term “science” but also physical and life sciences, an assumption that is no longer justified in the research. Furthermore, the reliability and validity of the data are not reported. Only the *Puppet Interview Scales of Competence in and Enjoyment of Science* scale is applied in a dichotomous format when interviewing respondents (Mantzicopoulos et al., 2008). This instrument provides valuable information about children's motivation toward science, but it draws from participants' concept of the word “science.”

Five of the eight measures present a multidimensional structure, and the most common dimensions under study are self-competence in science and science enjoyment (although they are represented with different wording). For instance, the instrument developed by Pell and Jarvis (2001) includes five attitudinal scales named: enjoyment of school, independent investigator, science enthusiasm, social context of science, and science as a difficult subject; it is therefore a long questionnaire comprised of 43 items. Three studies are focused on a single dimension. Jaus (1977) called it attitude toward science, and although it appears to refer to science as a school subject, the construct is not clearly defined.

Several aspects of this review deserve emphasis. First, despite the child-science connection described, and the fact that official national curricula in preschool are increasingly committed to addressing science (Broström, 2015; Greenfield et al., 2009), the lack of formal exposure to this discipline makes it difficult for children to comprehensively understand the term “science.” In this respect, the research conducted by Mantzicopoulos, Samarapungavan, and Patrick (2009) with 193 kindergarteners provides evidence that children could only begin to conceptualize science as an independent academic domain after participation in a specific program of integrated science inquiry and literacy activities. Additionally, even when a formal science education is established at this early stage, little instructional time is dedicated to it (Kinzie et al., 2014; Saçkes, Trundle, Bell, & O'Connell, 2011; Tu, 2006). Learning is mainly focused on basic skills of literacy, numbers, and socialization (Nayfeld, Brenneman, & Gelman, 2011; Worth, 2010). Thus the term “science,” included in most of the scales, may not be properly developed in preliterate children, as other authors have suggested (Mantzicopoulos et al., 2009; Oppermann et al., 2018; Reid, 2014).

The attitude–behavior relationship has been a topic of discussion for several decades, since attitudes fail to predict behavior under certain conditions (Gaviria, López, & Cuadrado, 2013). Although attitude is an affective variable determining behavior, there are additional situational factors that mediate between attitude and behavior (Ajzen, 2002), which provide very relevant information in predicting children's engagement in science. None of the available tools includes information on other indicators for establishing a model to predict science behavior more accurately.

Some of the tools assess several dimensions of attitude, which has received criticism because the tools cannot provide a clear idea of what is really being measured (Gardner, 1975). This issue can also make questionnaires too long, and although some of them include supporting material, such as puppets, or employ a visual response format, none of them incorporates a pictographic design. When using only formats that are written or read to them, young children are assumed to have a level of abstraction perhaps not available at their developmental stage (Berger, 2007). Research with children may require innovative techniques or the adaptation of traditional approaches to use child-centered approaches that facilitate the communication process (Pridmore & Bendelow, 1995; Punch, 2002a), especially when their reading skills are still limited. Pictures play a leading role in the teaching-learning process in the early educational years, and children use them to communicate (Brooks, 2005). Therefore, the use of pictorial representations in interviews of students under 9 years old may put them at ease (Cameron, 2005), make them feel confident with the questions, focus their attention, and stimulate their interest in the questionnaire (Valla, Bergeron, Bérubé, Gaudet, & St-Georges, 1994). Providing easy-to-understand questions and answers that are simple to complete is necessary to reduce responses that reflect their desire to show a perfect vision of themselves to please the interviewer (Read, 2008).

This research fills a gap in terms of tools for the pre-elementary period, with an instrument focused on the attitudes toward informal science learning experiences during the early years, and a goal of offering information on the science-child relationship. The employment of an innovative and child-centered interviewing format is needed to accomplish this goal.

4 | THEORETICAL FRAMEWORK

4.1 | Attitudes toward science

Social psychology defines attitude as a psychological tendency expressed by evaluating a specific entity with some degree of favor or disfavor. It is thus an internal state, which is not directly observable, but inferred from expression of approval or disapproval, approach or avoidance, and like or dislike (Eagly & Chaiken, 1998). Attitudes are learned, predispose to action, influence behavior, and are relatively stable, although they can be modified (Fishbein & Ajzen, 1975; Gaviria et al., 2013).

When extrapolating this construct to the field of science education, the literature shows some vagueness on delineation of attitude toward science, making it difficult to conceptualize (Osborne, Simon, & Collins, 2003). It is initially necessary to differentiate two main categories: scientific attitudes and attitudes toward science. The scientific attitude of an individual is characterized by the cognitive features of scientific thinking, such as skepticism, mental openness, and impartiality, among many others. Attitude toward science implies a favorable or unfavorable evaluation of an attitudinal object linked to science. It would be defined as "a learned disposition to evaluate objects, people, actions, situations, or propositions related to the learning of science" (Gardner, 1975, p. 2). These attitudes, the focus of this study, underline the affective aspect of the attitudes and not the more cognitive character of "scientific attitudes" (Vázquez & Manassero, 2009).

Past research exploring attitudes toward science reflect a lack of clarity on their theoretical formulations (Tytler, 2014). There is disagreement on the nature of the science definition, which is the concept being measured (Blalock et al., 2008). Science has been assigned different meanings (Krynowsky, 1988), making it difficult to compare and generalize results. In the assessment of attitudes toward science it is therefore necessary to delimit the attitudinal object, distinguishing between attitudes toward general science, science as a school subject, a profession, or informal science, among other definitions (Aydeniz & Kotowsky, 2014).

Informal science refers to science learning experiences that take place outside of formal educational contexts. According to Dierking, Falk, Rennie, Anderson, and Ellenbogen (2003), learning in general, and particularly science learning, is cumulative, and emerges from different daily experiences. These authors emphasize that there are many real-world situations that influence an individual's knowledge, attitudes, and behaviors: reading, playing, watching TV, traveling, browsing the web, and so forth, in addition to experiences in formal contexts. For several decades, informal experiences have been considered relevant in studying the affective domain in science education (Klopfer, 1976). According to the scientific literature, there are positive relationships between informal science, science interest, and learning achievement (Bakoban & Aljarallah, 2015; Sha, Schunn, & Bathgate, 2015); however, these studies have mainly focused on students in middle school and older.

4.1.1 | Attitudes toward science in the early years. Gender differences

Although the affective variables toward science in the early educational years, especially attitudes, are described as very positive, this statement must be qualified by some aspects previously described throughout this study: the lack of research in pre-elementary years, the scarcity of stable tools, the inability to compare across studies because of the different dimensions analyzed, and the imprecision when defining the studied constructs. Despite these gaps, observations can be extracted from various studies that help us better understand the affective relationship of the child with science.

Research with the youngest students generally reflect encouraging patterns. For instance, Mantzicopoulos et al. (2008) report that kindergarten students are quite positive about science, and consider that they are good at learning this subject. Moreover, results showed that integrated science inquiry improves children's opinions on science. Oppermann et al. (2018) reported higher science motivation in children attending preschools with a science focus, and also that age 6 children were more motivated than age 5 from analyses of self-confidence and enjoyment of science learning experiences. Mulkey (1989) finds that attitudes toward women in science are neither positive nor negative, although from the 791 participants only 69 are pre-elementary students. In a study on attitudes of children from 5 to 11 years of age, Pell and Jarvis (2001) show a decline in enthusiasm for science, and consider the primary years of schooling the most significant to reverse the rejection of science.

For decades, gender has been considered one of the most significant variables in the analysis of attitude toward science (Gardner, 1975). Early reviews of the scientific literature on the topic emphasize that gender differences are identified early (Gardner, 1975; Munby, 1983; Schibeci, 1984). The overall trend found was that boys have greater interest in science than girls do in upper primary and secondary school years, although this finding could be qualified by subdisciplines, with boys more interested in physical sciences and girls in biological sciences (Gardner, 1975; Schibeci, 1984). However, the latest research with primary school students reflects contradictory results: some do not find gender differences (Eren, Bayrak, & Benzer, 2015; Sagir, 2012; Simpkins, Davis-Kean, & Eccles, 2006), while others do report them (Hacieminoglu, 2016).

In general, the limited studies in pre-elementary education have not found gender dissimilarities. For example, Andre et al. (1999) did not find differences in K-3 students' affinity for life and physical science. Mantzicopoulos et al. (2008) reported similar positive feelings toward science for boys and girls, although all the topics were related to life science. The results of Oppermann et al. (2018) are consistent with Mantzicopoulos', and topics on physical and life science were considered.

Although there is not a clear tendency, current data reflect gender disparities in career choices in the area of science (OECD, 2016; te Wang & Degol, 2013). Despite efforts to reduce these disparities, research finds that males have a higher affinity for science career options starting in middle school (Dorph, Bathgate, Schunn, & Cannady, 2018). The paucity of data in the early educational years and the impact that early science experiences can have in future choices make it necessary to perform studies to identify the origin of these observed differences.

4.2 | Attitude–behavior relationship

The study of attitude toward science is mainly justified by students' interest and engagement with science, which means with children's real science behaviors. This attitude–behavior relationship reflects certain inconsistencies that have been approached with different theories, such as the behavioral theory of reasoned action (TRA). This theory proposes that investigating attitudes toward specific actions is a better predictor of behavior than studying general attitudes (Ajzen & Fishbein, 1980). Thus, the attitude of an individual is represented by the sum of his/her attitudes toward each of the specific behaviors.

The TRA also emphasizes the value of other variables when predicting behavior, such as BI. According to the TRA, attitudes are evaluative responses to performing specific behaviors, and these attitudes influence BI, which is the antecedent of an individual's behavior. Measuring attitudes toward specific activities related to science learning and students' intentions to participate in such activities would offer information closer to behavior than measures focused on general attitudes. The TRA also includes a variable influencing BIs, the subjective norm (social context influence on the specified behavior). Considering the young age of the children in this study, and in order to avoid creating a long and heavy instrument, we have not examined this variable.

In an attempt to deepen our understanding of children's science behavior, this research also takes into account the influence of the strength of attitudes (Andre et al., 1999). Children's leisure or free time is full of options, making attitudinal objects overlap and compete with each other. The activity that generates the greatest emotional intensity will determine the child's behavior (Shrigley, 1983). According to this idea, and following other research (Jones et al., 2017; Sha et al., 2015), offering children a choice between science and nonscience content activities may be an appropriate and valid indicator to predict children's tendencies to engage in science learning activities.

4.3 | Science behaviors: Children's interests

Although affective variables such as attitudes have received special attention according to the influence they exert in children's behavior, researchers have focused mainly on the study of academic science learning outcomes (Bidegain & Lukas, 2020; Crouch, Wisittanawat, Cai, & Renninger, 2018) and career or subject choice (Andre et al., 1999; Dorph et al., 2018; Tytler & Osborne, 2012). However, the early years contain a number of environments and opportunities where children can express their interests in science (Dierking et al., 2003). Children's leisure time can offer additional information about the role of attitudes toward science in predicting science behavior.

Children can develop scientific interests before entering formal education (Alexander, Johnson, & Kelley, 2012), with their parents as the key to continued interest over time. When parents detect their children's interest in a certain activity, they provide support and help that interest evolve (Leibham et al., 2013). Early interests have a universal nature around 3 years old and become more differentiated around the age of 4 (Todt & Schreiber, 1998). At the age of 3–4, children have developed the necessary attention and memory skills to maintain interest for a period of time and to retain knowledge on their own interests (Leibham et al., 2013; Renninger, 2000; Todt & Schreiber, 1998). Besides satisfying the cognitive curiosity of children, science learning experiences start accumulating in their memories (Alexander et al., 2012). The level of cognitive development at the age of 4–5 allows children to identify their own values and attitudes (Garaigordobil & Berrueco, 2007). Information from parents on the real interests of children could enrich attitudinal data and offer clues to the origin of gender differences, considering research that finds parents reporting more science interests in boys than in girls (Leibham et al., 2013).

In summary, according to the model that this research proposes, attitude toward science is a unidimensional construct defined as the predisposition of children aged 5 and 6 to respond favorably or unfavorably to different science learning experiences that take place outside of formal environments. This attitude influences the intention of students to participate in such science learning activities, and positive correlation is expected between the two variables (Shrigley, Koballa, & Simpson, 1988). Thus, students with a more positive attitude toward informal science should choose more science-based activities as a first option when given a choice. Additionally, very positive attitudes should reflect high levels of science interest in children.

5 | RESEARCH OBJECTIVES

Considering the relevance of early science experiences in future science engagement, and that there are few available instruments to measure pre-elementary school students' attitudes toward science, the main goal of this research is to develop and validate a pictographic scale to measure attitudes toward informal science of preliterate children (5 and 6 years old). The instrument consists of specific science learning experiences in nonformal environments. With the data collected specifically for the tool validation process along with the other data collected for this study, we also examine the following research questions:

1. What are the attitudes toward informal science of students aged 5 and 6?
2. What are children's BIs to participate in informal science learning experiences when compared with nonscientific leisure-time activities? To what extent do these intentions relate to attitudes toward informal science?
3. What are parents' views on their children's leisure time interests? To what extent do these interests relate to attitudes toward informal science and BIs of children?

Within the three questions, the role of gender is considered.

6 | METHODS

6.1 | Participants

All participants were recruited from several schools in Albacete, Spain. Figure 1 shows the development of measures and participants recruitment. As part of the process of the attitudinal scale development, two pilot tests were conducted to check the appropriateness of the visual

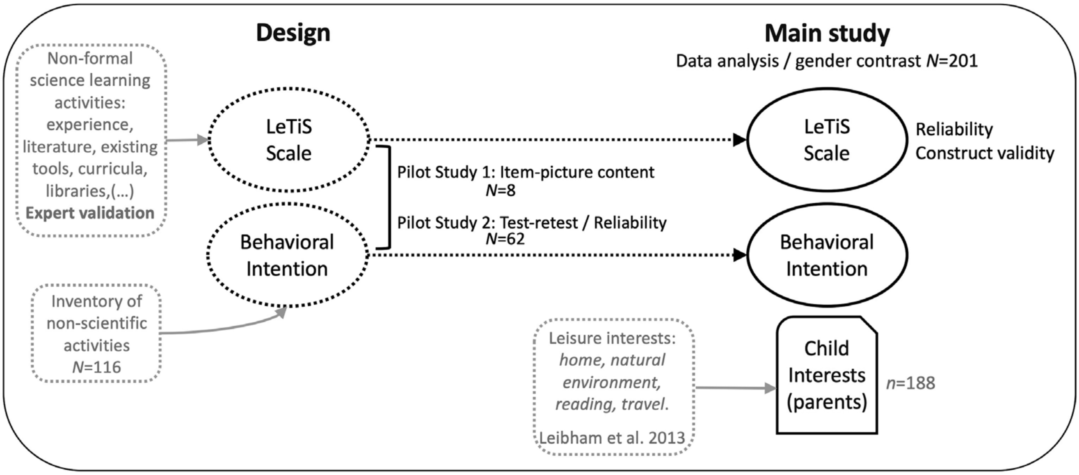

FIGURE 1 Measure development and participants recruitment

material (pilot test 1: $N = 8$, age from 5 to 8 years, mean = 6.5 years) and to evaluate the reliability of the instrument (pilot test 2: $N = 62$ children, age from 5 to 8 years old, mean = 6.11). Three schools participated in this research phase.

To contrast the information about attitudes with BIs, at the beginning of the study an inventory of nonscientific leisure time activities was created by interviewing a different sample of 116 students aged 5–8 (mean = 6.04 years) from two schools. Considering that the format of this information is also pictographic, its appropriateness and reliability were also verified during the pilot tests.

The final version of the attitudinal scale and the complementary information about BI were applied in four different public schools, involving nine third-year childhood classrooms of students aged 5 and 6. Informed consent was obtained from 201 children (99 boys and 102 girls; 146 age 5 and 55 age 6), and 188 parents of the 201 participants provided information on their children's favorite leisure activities.

In all phases, a nonprobabilistic convenience sample was used, as a result of access to participants through established working relationships (Bryman, 2016). The schools participating in the pilot tests and in the inventory of nonscientific activities had collaborated in previous studies. For the main study (201 participants), the researchers contacted the principals of public schools that had shown interest in participating in educational research. All of them agreed after consulting their teachers. Each school involved in the research is located in a different area of the same urban nucleus, and the families whose children attend the schools belong to a middle socioeconomic level, for the most part. The sample is very homogeneous in terms of race (white).

6.2 | Measures

6.2.1 | Attitude toward informal science: LeTiS scale

Design

Taking into account the aim of the instrument, the assigned name was LeTiS. The development of the scale was based on the following requirements:

1. Adequate for ages 5–8. Although the scale will be validated with children aged 5–6 years, its development will consider the possibility of being applied with students as old as 8, provided that appropriate validation occurs in the future. This design may facilitate following a trend in children's attitudes.
2. Not including the word "science," since this term has not been properly conceptualized in all young children, and replacing it with specific science activities in nonformal contexts to be performed during leisure time.
3. Applied through an interview using a pictorial format for the items, to facilitate the interview process with young children. The response format should also be suitable for children in this developmental stage, considering that previous research on children older than 8 found that they have difficulty interpreting formats with more than three response options (Almeida, García, & Strecht-Ribeiro, 2017). Although including four or five options may offer better psychometric properties, we decided to employ three options in order to facilitate children's responses. Participants' answers must be based on an iconic and familiar shape: thumb up, sideways, or down.

The approach of science raised by LeTiS is therefore conceived from a leisure time perspective, so it is limited to science learning activities that take place outside of school for recreation or interest (Trainor, Delfabbro, Anderson, & Winefield, 2010). According to these criteria, and the age of participants, the following context relevant areas were defined: *home*, *natural environment*, *reading*, and *travel*. The first two areas are the most common locations in which children spend their free time (Veitch, Bagley, Ball, & Salmon, 2006). *Reading* was considered specifically because reading books is one of the most popular activities performed at these ages (Sobkin & Skobeltsina, 2014). Travel was included considering leisure trips with relevant science-based learning opportunities. Although travel may happen with the school group (such as visiting a natural area, a science museum, etc.), it is considered a leisure activity because students tend to view it as such.

On this basis, we developed a list of activities involving learning about science in the defined areas, according to our teaching experience and from our analysis of the literature on early nonformal science experiences, existing measures of science interests, national childhood and elementary curricula, teaching materials, and the libraries of early childhood and primary school classrooms. Following the criteria of content relevance and representativeness of items suggested by Messick (1995), we focus on the most common contents and processes related to the scientific practice for this age range. We obtained a list of 21 activities, five in each area, and 6 reading topics. To select the activities that would be part of the scale, a group of five experts rated them on a 1–5 scale according to their relation to science and the feasibility of children imagining themselves taking part in them (1-very low relation/feasibility; 5-very high relation/feasibility). The experts included two science education professors, two childhood education teachers, and one elementary teacher. The first and second highest rated activities within each leisure time area were chosen. The LeTiS scale consists of eight item-pictures (LTS1-8), two in each of the predefined leisure-time areas (Table 1). The first item is mainly connected to physics (LTS1). Others combine contents of Earth and Space and life sciences (LTS2 and LTS3). Three items are directly related to life sciences (LTS4, LTS5, LTS6), one to science as a whole (LTS7), and one to Earth and Space (LTS8).

A professional illustrator, following our guidelines, transformed the activities into drawings for children. An essential requirement was to include a boy and a girl in all the activities to avoid bias due to gender (the entire LeTiS scale is available in Supplementary Materials online).

TABLE 1 LeTiS description

Item	Description of the activity	Leisure-time area
LTS1	Throwing objects of different sizes and materials. Time calculation.	Home
LTS2	Observing rocks, minerals, leaves,... through magnifying glasses.	
LTS3	Collecting rocks, leaves, pine cones,...	Natural environment
LTS4	Looking at insects.	
LTS5	Books about animals and plants.	Reading
LTS6	Books about the human body, five senses.	
LTS7	Trip to a zoo and science museum.	Travel
LTS8	Trip to the planetarium.	

Abbreviation: LeTiS, Leisure Time in Science.

Pilot studies

The first pilot study was used to examine whether children understood the general content of the drawings. Participants were interviewed individually by a researcher and they were required to describe the eight item pictures (with support questions such as: "What can you see?," "What are they doing?," "Where are they?"). They easily interpreted general information, such as location and general activity (e.g., they are looking at..., collecting things, etc.), and the content of books. Next, the interviewer described the pictures and highlighted specific details to verify that children understood the vocabulary, for instance magnifying glass, planetarium, and so forth. Two pictures were slightly modified according to participants' feedback (a drawing was resized and some background elements that did not provide relevant information were removed). This version of the LeTiS scale was the one that we validated.

The reliability of the instrument was analyzed in a second pilot study ($N = 62$). We performed a test–retest with an interval of 2 days between the two tests. Students were individually interviewed in both tests, according to the interview process that will be described below. The researcher in charge of data collection reported that participants easily understood the items and identified their answers. After analyzing the reliability of the instrument in terms of temporal stability, the data collection to validate the scale began with interviews of 201 children.

Interview process

Interviews start with some warm-up questions about the like or dislike of food and sports. The interviewer asks the child to grade the response with the thumb up (if s/he likes), down (if s/he dislikes) or sideways (neither like nor dislike), showing the gestures with the instructions. After some trials and when the interviewer notices that the child has understood the process, she describes the item-picture of LeTiS and asks him/her to grade how much s/he likes the activity. If the respondent shows a thumb up, three points are assigned, two if the thumb is sideways and one for thumbs-down. The scale ranges from 8 to 24 points. The interviewer records data on an individual sheet and digitizes them later on. Here is an item sample:

> "*Look at this* (interviewer shows student item-picture 3), *these children are in the park/countryside, and they are collecting rocks, leaves, pine cones,... How do you rate this activity? Do you like it?* (showing the thumb up), *Do you dislike it?* (thumb

down) *Or do you neither like or dislike it?* (thumb sideways). *Please, put your thumb up, down or sideways to express your opinion.*

6.2.2 | Behavioral intentions

Design

An inventory of common nonscientific leisure activities was developed to complement attitudinal data provided by LeTiS with students' BIs. For the inventory, 116 children were individually asked about their leisure activities, with the following questions: (a) what do you prefer to do during free time at home?; (b) what do you like to do in a natural environment/park?; (c) what book topics do you like the most?; and (d) if you could choose a trip, where would you prefer to go? Interviews were given by the students' teachers, who transcribed the answers. The process took place in the regular classroom. The answers were analyzed and coded by two researchers: for each area, the researchers assigned answers to the subcategories they established after examining and re-examining the whole list, using an inductive process. For instance, many answers about leisure time at home mentioned play with specific toys (dolls, teddy bears, toy cars, etc.), and they were categorized as "play with toys." Some activities referring to the natural environment were: "I like playing hide-and-seek," "I always play catch with my friends," "I play racing games with my sister." All of these were subcategorized as "active games." When mentioning reading topics, participants' answers included "pirates," "knights and swords," or simply "adventures," for instance, labeled as an "adventures" subcategory. For case of traveling, answers describing specific cities to visit were grouped as "visit cities or countries." The four main subcategories in each of the areas (see Table 2) were selected and transformed into a pictorial format by a professional illustrator, to be shown to the respondents after completing the LeTiS. Each pair of activities was assigned to the different LeTiS items (first with fourth and second with third, therefore distributing their weight in a balanced manner). The final product is in Table 2. This list was used to make sure that the activities were attractive to children when comparing them with the item-pictures of the attitude scale.

Pilot studies

The content of drawings and the reliability of the information were assessed in the same two pilot studies described above, following the same process. Only one picture was slightly modified (the spatial distribution of the elements). In the second pilot study, the researcher emphasized the ease with which students adapted to the response format when putting their preferences in order from most to least.

Interview process

Once the attitudinal information is obtained (LeTiS scale questionnaire), the participant is asked about his/her intentions toward the activities shown previously. Instead of asking them to grade their intention to perform the activity, and as a way to prevent repetition of the initial response, the interviewer sets three cards on the table: one LeTiS item picture and the two alternative common leisure activities, inviting the interviewee to choose the card s/he would do first. Next, the interviewer withdraws the first choice and asks him/her to point to the card for the activity they would choose second. The process is repeated with the remaining items. A total of three points are assigned to the first activity selected, two to the second, and one for the last.

TABLE 2 Four main subcategories of common leisure-time activities. Number of students mentioning activities of the subcategory (). Item of LeTiS with which they are compared ()

Leisure time areas			
Home	**Natural environment**	**Reading**	**Travel**
Play with toys (34) (LTS1)	Active games (24) (LTS3)	Adventure (32) (LTS5)	Visit cities, countries (46) (LTS8)
Play on the tablet, computer games (26) (LTS2)	Ride a bike, skate (16) (LTS4)	Mystery, magic (21) (LTS6)	Go to the beach, swimming pool (23) (LTS7)
Do crafts, paint (14) (LTS2)	Play with a ball, jump-roping (15) (LTS4)	Cartoon stories (19) (LTS6)	Theme parks (19) (LTS7)
Watch TV (13) (LTS1)	Play on slides and swings (11) (LTS3)	Classic tales (18) (LTS5)	Camping activities/sports (9) (LTS8)

Abbreviation: LeTiS, Leisure Time in Science.

Data are collected on individual sheets which are digitized by the interviewer. A sample statement is:

> "*Imagine next time you go to the park/countryside*, *you can*: *go to collect rocks*, *leaves*, *pine cones*,*…*; *play games such as: catch*, *hide-and-seek*, *races*; *or go the swings* [interviewer shows student the three pictures one by one as she describes the activity: the one with children collecting natural objects, other with children playing active games, and a last one where children are playing in slides and swings (see the example BI3, BI section, in Supplementary Material)]. *Which activity would you do? And then*, *if you could choose another one*, *which would it be? (…)* The respondent takes the chosen card.

6.2.3 | Parents' information about leisure activities

We provided parents of 201 participants a five-question written survey on their children's preferences of leisure time activities: (a) what does your child prefer to do during free time at home; (b) in a natural environment/park?; (c) what book topics does your child like the most?; (d) if your child could choose a travel/trip where would s/he prefer to go?; and (e) do you think your child seems to have a focused interest? For each of the questions, parents were asked to give details in order to avoid ambiguity when identifying science interest in the activities, topics, or places described. They were asked specifically to fill in the questionnaire in their own, without consulting their children. The survey is based on the research about science interests in preschool kids carried out by Leibham et al. (2013).

Two researchers analyzed the questionnaires independently and codified the information of each of the leisure areas in nonscience interest or science-interest, assigning 1 and 0 points respectively, then summing the four areas for the final rating. Scientific interests were considered those related to life, physical, Earth and Space science, mechanics or technology. For instance, answers such as "he likes to play with the tablet" or "ride his bike," were codified as nonscience interest, while others such as "he looks for bugs, snails and stones," were included in the science-interest group. Ambiguity was resolved by considering the details specified by parents. The agreement between both researchers was almost perfect in all areas (Landis & Koch, 1977): $\kappa = .887$ (home); $\kappa = .914$ (natural environment); $\kappa = .986$ (reading); and $\kappa = .967$ (traveling). The few disagreements were resolved in discussions between the researchers.

6.3 | Procedure

The research was approved by the Province's Educational Inspection Service. All families read and signed informed consent for participation in the research. This process meets the ethical principles of information to participants, autonomy, respect for privacy and confidentiality.

The LeTiS scale was developed and piloted during September 2016 and February 2017. At the beginning of this period, the inventory of nonscientific leisure activities was developed. The main data collection started in March 2017, and information on children's interests was requested from parents at the same time. Before carrying out interviews, the researchers in charge of data collection were introduced to children through their teachers, in their regular classrooms, so that they would feel comfortable being individually interviewed later. The researchers spoke to the whole group about their job, the need for collecting reliable information, and the structure of the interview. To avoid any implication of pressure to give correct answers, the researchers stressed that there were no right or wrong responses and that questions would only be focused on their interests or preferences (Punch, 2002b). It took 3 weeks to collect the information from the 201 children. Personal interviews, including attitudinal (LeTiS) and intentional information, were conducted in separate rooms, with an average duration of 15 min each.

6.4 | Data analysis

The test–retests carried out in the second pilot study ($N = 62$) allowed us to evaluate the consistency of the scale. Spearman's *rho* was calculated to determine the correlation between the two tests, and the Wilcoxon signed-rank test was used to identify possible differences between children's answers on the two dates.

Next, the scale factor structure and its reliability were evaluated, using the sample of 201 children. An exploratory factor analysis (EFA) was carried out with the software Factor 10.7.01 (Lorenzo-Seva & Ferrando, 2006, 2013). Due to the ordinal nature of data, the dispersion matrix used was polychoric correlations. The optimal implementation of parallel analysis (PA) was the procedure for determining the number of dimensions, based on the proposal of Timmerman and Lorenzo-Seva (2011). The method used for factor extraction was minimum rank factor analysis (Ten Berge & Kiers, 1991). To test the reliability of the scale, the coefficients ordinal alpha (Oα) and ordinal omega (Oω) recommended by Gadermann, Guhn, and Zumbo (2012) were used. Both coefficients were calculated using the following R packages: Rcmdr, psych, and GPArotation.

The analysis of the scale was complemented with a contrast of gender results. These data were also related to BIs and information from parents on leisure time preferences of their children. The Kolmogorov–Smirnov test showed that the data do not follow a normal distribution, and considering their ordinal nature, we applied nonparametric statistics: the Wilcoxon test to contrast related groups and the Mann–Whitney test (U) in the case of independent groups. Effect size analysis (r) and Spearman correlation (*rho*) was also included. The Spearman correlation of the scores in the LeTiS with the eight types of BIs was employed to verify the validity of external criterion of the scale. The analyses were performed with SPSS v22. Despite working with ordinal data, some information on average values and standard deviations is included merely for reference.

7 | RESULTS

7.1 | Validation of the LeTiS scale

7.1.1 | Test–retest

The correlation in the pilot sample ($N = 62$) between the two applications of the tool was very high, with coefficients over .7 for all items above, except LTS7 (.546, $p < .001$; Table 3). The Wilcoxon test shows no statistically significant differences between children's answers in the two tests for any of the eight items of the LeTiS.

7.1.2 | Factorial structure and reliability of the ATS scale

The adequacy of data to perform an EFA was previously evaluated, based on the examination of the matrix of polychoric correlations. Barlett's statistic = 208.7 ($df = 2$, $p < .001$) and the Kaiser–Meyer–Olkin (KMO) test = .798 [BC bootstrap 95% CI of KMO = (.791, .837)], have values greater than .7, indicating that the correlations between the items of the LeTiS scale were high enough to perform an EFA.

Using a PA, we determined that the optimal number of factors or dimensions was 1. The unidimensionality measures proposed by Ferrando and Lorenzo-Seva (2017) provided additional evidence pointing to the unidimensionality of the scale. Values of unidimensional congruence larger than .95 (.965) and mean of item residual absolute loadings lower than .3 (.260) suggested that data can be treated as essentially unidimensional.

TABLE 3 Test–retest for the LeTiS Scale

		Wilcoxon signed rank test	
Item	**Spearman's *rho***	***Z***	***p***
LTS1	.940***	−1.000	.317
LTS2	.936***	−0.447	.655
LTS3	.849***	−1.000	.317
LTS4	.861***	−0.832	.405
LTS5	.708***	−1.190	.234
LTS6	.944***	−1.000	.317
LTS7	.546***	−1.508	.132
LTS8	1.000***	0.000	1.000

Note: ***$p < .001$ (two-tailed).

Abbreviation: LeTiS, Leisure Time in Science.

TABLE 4 Exploratory factor analysis: loading matrix, model fit, and reliability

Item	Loading	Communality	Corrected item-total correlation	Oα if item deleted
LTS1	.638	.664	.66	.80
LTS2	.716	.824	.70	.79
LTS3	.509	.333	.61	.81
LTS4	.652	.534	.70	.79
LTS5	.645	.478	.71	.79
LTS6	.508	.380	.60	.81
LTS7	.619	.693	.63	.81
LTS8	.692	.605	.72	.79

Note: Model fit: RMSR = .08 and WRMR = .14.
Abbreviations: RMSR, root mean square of residuals; WRMR, weighted root mean square residual.

The EFA results for a single factor are in Table 4. All loadings were high, above .5, ranging from .508 for LT6, to .716 for LTS2. The model fit was also adequate, since the RMSR was at .08, within the maximum acceptable threshold, and the WRMR was less than 1 (.14), the recommended criterion for good fit (Yu & Muthen, 2002). This single factor or dimension explains 69.64% of the total common variance.

Once we determined the factor structure, the reliability of the scale was analyzed. The ordinal alpha (Oα) was .82 and the ordinal omega (Oω) was .88. Both coefficients were well above the recommended value of .7. As shown in Table 4, in general terms, the LeTiS scale is fairly homogeneous. The values obtained by the item-total correlation process make it possible to represent the contribution of each of the items to the common feature measurement, verifying also that the removal of any of items of the scale would not allow to improve its reliability.

7.2 | Attitude toward science, BI, and scientific interests. Group differences

7.2.1 | Attitudes toward science (LeTiS)

Considering that the scale ranges from 8 to 24, attitude toward informal science of participants is high, with an average value of 20.67 ($SD = 2.997$, median = 3 for all items). The percentage of ratings is presented in Table 5. The results show that most students like the activities included in all the items of the scale. The highest valued items are LTS1 (throwing objects: 73.1%), LTS5 (books about animals and plants: 80.1%), LTS7 (trip to zoo and science museum: 84.1%), and LTS8 (trip to planetarium: 84.6%); of them, "science travel" obtain the best results. Although more than half of students like the activity of looking at insects in the countryside (LTS4), 25.4% of participants do not. Total attitude is slightly higher in girls than boys, but there are no statistically significant differences between the two groups ($M = 20.72$, $SD = 2.88$; $M = 20.63$, $SD = 3.13$; $p = .971$). When detailing by item, results show no statistically significant gender differences in any items except item LTS1 (throwing objects) ($p = .007$) (Table 5). This first item represents an activity of physical science related to movement, and boys' rating is more positive.

TABLE 5 Students' maximum and minimum rating in attitude by items. Gender differences

	Total % ($N = 201$)			Girls % ($n = 102$)			Boys % ($n = 99$)			Mann–Whitney		
Item	**1**	**3**	**Me[a]**	**1**	**3**	**Me**	**1**	**3**	**Me**	***U***	***p***	***r***
LTS1	5	73.1	3	9.8	65.7	3	0	80.8	3	4,190.5	.007	−.19
LTS2	16.4	57.7	3	11.8	62.7	3	21.2	52.5	3	4,416	.083	−.12
LTS3	12.9	57.7	3	7.8	59.8	3	18.2	55.6	3	4,641.5	.263	−.08
LTS4	25.4	54.2	3	32.4	50	2.5	18.2	58.6	3	4,398	.080	−.12
LTS5	6.5	80.1	3	4.9	83.3	3	8.1	76.8	3	4,707	.233	−.08
LTS6	16.4	64.7	3	12.7	68.6	3	20.2	60.6	3	4,577	.177	−.1
LTS7	2.5	84.1	3	2.9	80.4	3	2	87.9	3	4,673	.151	−.1
LTS8	4	84.6	3	2	85.3	3	6.1	83.8	3	4,946.5	.692	−.03

[a]Median.

TABLE 6 Test–retest for behavioral intentions

		Wilcoxon signed rank test	
Item	**Spearman's *rho***	***Z***	***p***
BI1	.942***	−0.447	.655
BI2	.782***	−0.577	.564
BI3	.838***	−0.333	.739
BI4	.693***	−0.924	.356
BI5	.800***	−0.265	.791
BI6	.627***	−1.617	.106
BI7	.841***	−0.707	.480
BI8	.721***	0.000	1.000

Note: ***$p < .001$ (two-tailed).
Abbreviation: BI, behavioral intention.

Although without statistical significance, it is noteworthy that 32.4% of girls have recognized they do not like the activity related to insects, versus 18.2% of boys (LTS4).

7.2.2 | BIs toward activities of the LeTiS

Although not presented as a scale but as supporting information, BIs with respect to other leisure time activities were also asked at two points in time ($N = 62$; Table 6). Again, data show a high correlation in all items, with the exception of items BI4 and BI6 (although with values close to .7), and no statistically significant differences. Therefore, this information can be considered reliable.

Data analysis on the intention of performing LeTiS scientific activities compared with other common leisure-time options show that, median values are 1 and 2 in all items, while the

TABLE 7 Students' maximum and minimum scores in behavioral intention by items. Gender differences

	Total % ($N = 201$)			Girls % ($n = 102$)			Boys % ($n = 99$)			Mann–Whitney		
Item	1	3	Me[a]	1	3	Me	1	3	Me	U	p	r
BI1	42.8	27.9	2	56.9	17.6	1	28.3	38.4	2	3,409	.000	−.30
BI2	69.7	4.5	1	69.6	3.9	1	69.7	5.1	1	5,036	.969	.00
BI3	63.7	14.4	1	61.8	13.7	1	65.7	15.2	1	4,907	.687	−.03
BI4	65.7	17.9	1	64.7	17.6	1	66.7	18.2	1	4,977	.835	−.01
BI5	42.8	34.8	2	48	26.5	2	37.4	43.4	2	4,208	.029	−.15
BI6	43.3	32.3	2	39.2	35.3	2	47.5	29.3	2	4,595	.238	−.08
BI7	70.6	10	1	83.3	4.9	1	57.6	15.2	1	3,726	.000	−.28
BI8	42.3	20.4	2	44.1	19.6	2	40.4	21.2	2	4,853	.609	−.04

Note: Scientific activity chosen as first option: 3; chosen as third option: 1.
Abbreviation: BI, behavioral intention.
[a]Median.

scientific activity was 3 (i.e., it was chosen in third place) (see Table 7). Thus, most children prefer doing any of the two nonscientific activities during their free time instead of the ones proposed in the LeTiS scale. In activities 5 and 6, related to reading books, is where science topics obtain the best results, with approximately one third of students choosing them as their first option (34.8 and 32.3%). The least chosen activity was the observation of rocks, minerals, leaves, and so forth with magnifying glasses (BI2: 4.5%). Gender differences were found in items BI1 (throwing objects), with a medium effect size ($r = -.30$), and items BI5 (books about living things) and BI7 (trip to zoo/science museum), the latter two with low effect size ($r = -.15$ and $r = -.28$). More than twice the number of boys than girls selected the activity of physics (BI1) in first place (38.4 vs. 17.6%) and 83.3% of girls chose nonscientific travel instead of visiting a zoo or a science museum (BI7), compared with 57.6% of boys.

Next, the total scores of the LeTiS scale and the results by item were compared with the intention toward them when having the opportunity to choose between other leisure time activities. In both cases the correlation between attitude and intention is positive and, although mostly statistically significant, with low fit (Table 8). When comparing item by item, the most notable correlations are in items 1 (throwing objects: $rho = .366$), 4 (observing insects: $rho = .371$), and 6 (human body books: $rho = .358$). In this case, the Wilcoxon test shows that children's answers were statistically different in all items (Table 8). By gender, the highest values were obtained in items 6 (human body books: $rho = .468$) and 1 (throwing objects: $rho = .404$) in the case of girls, and in activities in the outdoors, items 4 (observing insects: $rho = .397$) and 3 (collecting natural objects: $rho = .269$), for boys. In both cases, the Wilcoxon test reflects statistically significant differences in all items ($p < .001$), and item 7 (visiting a zoo/science museum) presents the highest effect size (girls: $r = -.87$ and boys: $r = -.81$).

The data also allow us to differentiate between the students that score the maximum in the attitude toward an activity, with little intention of actually doing it (3 vs. 1), from those that also have a high attitude and show a higher intention of performing that activity compared to others (3 vs. 3). In all items, the majority of students are concentrated within the group that has a high attitude toward the specific activity, although showing differences regarding intention (Table 9). For instance, items 1 (throwing objects) and 5 (books about living things) were highly

TABLE 8 Correlation and contrast between attitude toward science and behavioral intention. Correlation by gender

Item	LeTiS Total score Spearman's *rho*	LeTiS item by item Spearman's *rho*	*Wilcoxon signed rank test* *Z*	*p*	LeTis item by item girls	Effect size (*r*)	LeTis item by item boys	Effect size (*r*)
1	.104	.366***	9.756	.000	.404**	−.73	.251*	−.64
2	.192**	.239**	−10.622	.000	.313**	−.8	.171	−.7
3	.293**	.213**	−9.715	.000	.148	−.71	.269**	−.66
4	.331**	.371***	−8.870	.000	.368**	−.56	.397**	−.69
5	.180*	.197**	−9.005	.000	.149	−.71	.266**	−.54
6	.197**	.358***	−7.430	.000	.468**	−.55	.249*	−.51
7	.120	.164*	−11.878	.000	.098	−.87	.182	−.81
8	.176*	.203**	−10.509	.000	.154	−.76	.250	−.72

Note: ***$p < .001$; **$p < .01$; *$p < .05$. All cases based on negative ranks: attitude > intention. Item: LTS vs. BI.
Abbreviations: BI, behavioral intention; LeTiS, Leisure Time in Science.

TABLE 9 Contrast of scores by items: attitude versus behavioral intention (%)

Item	1 vs. 1	1 vs. 2	1 vs. 3	2 vs. 1	2 vs. 2	2 vs. 3	3 vs. 1	3 vs. 2	3 vs. 3
1	5	0	0	13.9	6	2	23.9	23.4	25.9
2	13.9	2	0.5	20.9	5	0	34.8	18.9	4
3	11.4	0.5	1	19.4	8.5	1.5	32.8	12.9	11.9
4	22.9	2.5	0	14.9	3.5	2	27.9	10.4	15.9
5	5.5	0.5	0.5	7	2.5	4	30.3	19.4	30.3
6	12.4	2.5	1.5	10.9	4	4	19.9	17.9	26.9
7	2.5	0	0	11.4	1.5	0.5	56.7	17.9	9.5
8	2.5	1	0.5	7.5	3.5	0.5	32.3	32.8	19.4

Note: Item: LTS vs. BI.
Abbreviation: BI, behavioral intention.

valued by students in the LeTiS, and the intentions of performing them were also high in over a quarter of students (25.9 and 30.3%, respectively). In contrast, although nearly 85% of students scored the activity of visiting a zoo as a 3 (item 7), only 9.5% of the group choose it in first place. Instead, they prefer doing other leisure activities related to travel. In relation to the activity of classifying minerals and rocks using magnifying glasses (item 2), nearly 60% of students said they like it, but only 4% choose it in first place, and they prefer using screen devices or doing arts and crafts instead.

These data reflect that participants are coherent when being interviewed, since most of those scoring 1 in attitude toward an activity reflect that they do not like it, and would not perform it in first or second place if they had the option. This finding reinforces the value of the information obtained.

TABLE 10 Scientific (Sc) and nonscientific (Non) activities of children according to parents' information on leisure time activities. Gender differences

	Total % (N = 188)			Girls % (n = 96)			Boys % (n = 92)			Mann–Whitney		
	Sc	Non	Me[a]	Sc	Non	Me	Sc	Non	Me	U	p	r
Home	31.9	68.1	0	14.6	85.4	0	50	50	0.5	2,852	.000	−.38
Natural E.	54.3	45.7	1	57.3	42.7	1	51.1	48.9	1	4,142	.395	−.06
Reading	25	75	0	17.7	82.3	0	32.6	67.4	0	3,758	.019	−.17
Travel	43.1	56.9	0	38.5	61.5	0	47.8	52.2	0	4,006	.200	−.09

[a]Median.

TABLE 11 Correlation and contrast of parents' information with attitude and behavioral intention

	Parent's information—attitude			Parents' information—behavioral intention		
Item	Spearman' *rho*	Mann–Whitney	p	Spearman' *rho*	Mann–Whitney	p
1	.07	3,581.5	.338	.092	3,430.5	.208
2	−.009	3,801.0	.899	.051	3,646.0	.485
3	.203**	3,478.0	.006	.081	4,031.5	.267
4	.141	3,740.0	.053	.138	3,790.5	.058
5	.008	3,288.5	.914	.105	2,880.0	.150
6	.115	2,884.5	.115	−.025	3,212.0	.737
7	.198**	3,697.5	.007	.198**	3,526.5	.007
8	−.029	4,241.5	.687	.168*	3,546.0	.022

Note: $^{**}p < .01$; $^{*}p < .05$.

7.2.3 | Parents' information about leisure interests of children

Parents report considerable percentages of science-content activities in the four defined areas, especially when children are in a natural environment (54.3%) (see Table 10). It is important to note that reading topics were the least linked to science according to parents (25%). There are significant statistical differences in gender when it comes to science at home (14.6 vs. 50%; $p = .000$) and reading topics (17.7 vs. 32.6%; $p = .019$), in both cases in favor of boys, and with a medium effect size in the former ($r = -.38$ and $r = -.17$).

7.2.4 | Correlation of attitude, BI and parents' information

The analysis of the relation between parents' information with children's attitude and BI is detailed in Table 11. In the case of attitude, there are only significant correlations for items 3 (collecting natural objects) and 7 (trip to zoo or science museum) with a low degree of fit (*rho* = .203 and *rho* = .198, respectively); in these items, there are statistically significant differences between children's and their parents' opinions. A similar pattern occurs with intention, where the correlation is significant only in items 7 and 8 (science-content trips) (*rho* = .198 and *rho* = .168 respectively), and the Mann–Whitney test values show $p < .05$ as well.

8 | DISCUSSION

This research provides a validated tool to measure attitude toward informal science in children 5–6 years old, taking into account the developmental characteristics of young learners in various ways. First, this tool includes science learning activities that can take place outside of formal environments, which connect to scientific disciplines and cover several of the main types of science (physical and life science, Earth and Space, and science in general), but are grounded in the child's surrounding world and interests. Past research mainly focused on attitudes toward general science or science as a school subject, and only physical and/or life sciences were considered. Additionally, the activities describe processes which are fully in line with the way children learn science in the early years (Greenfield et al., 2009; Samarapungavan, Patrick, & Mantzicopoulos, 2011).

The approach used to develop the LeTiS scale avoids problems identified by other researchers regarding the use of the term "science," which may be unfamiliar to young children (Oppermann et al., 2018; Reid, 2014), and too many possible answers, which may make it difficult for the child to choose (Almeida et al., 2017). Additionally, the pictographic format of the items, not employed in any of the few scales available for pre-elementary students, helps the interviewee understand the process. If children understand the questions and options, the data gathered can provide a reliable idea of their attitudes toward science. Further, considering interviewers' perceptions, participants feel comfortable identifying their preferences.

The LeTiS scale is an 8-item tool with a unidimensional factorial structure, where all of the items appropriately contribute to measure students' attitude toward science. The scale exhibits good psychometric characteristics, similar to other related scales, although these are not specifically focused on attitude (Mantzicopoulos et al., 2008; Oppermann et al., 2018). The results on reliability are in line with other research covering attitudes of children for the same age range (Jaus, 1977; Reid, 2014). Our work stands out because of the instrument used, and because the only two other studies involving scales that check the validity of the construct, apart from Oppermann et al.'s (2018) study on motivational beliefs, are Mulkey (1989) and Reid (2014), the latter being a Master's thesis. Additionally, the LeTiS scale correlates with a wide range of BIs, which could be considered an indication of criterion validity. Thus, LeTiS fills a gap identified by different authors on a lack of appropriate tools to measure attitudes toward science with evidence in terms of validity and reliability (Blalock et al., 2008; Summers & Abd-El-Khalick, 2018). The limited number of items employed, although enough to measure a psychological phenomenon (Martín, 2004), is similar to what other scales on this topic and age group include (Andre et al., 1999; Jaus, 1977; Peleg & Baram-Tsabari, 2011).

Additionally, the scale could be useful in the educational context to carry out pretest–posttest for contrasting attitude change in children involved in different learning approaches: active versus passive, problem-based learning versus guided instruction, and so forth, or to assess relevant scientific experiences such as visiting a natural environment, a science museum, attending a scientific event, and so forth.

The information on BI is an important contribution of this study. The model proposed allows researchers to go deeper into the study of attitudes and their influence on student behaviors. We have not found research that considers this variable in analyses of attitude of the youngest students. Past literature has only focused on the intention of choosing a professional future related to science on students older than 12–14 (Roberts, 2014). Additionally, the inclusion of choice when studying this variable is a strategy that can help us to better understand the complexity of the attitude–behavior relationship. Very few studies have examined choices that students make regarding daily science learning in formal and informal environments (Sha et al., 2015).

The analysis of the LeTiS scale results shows that 5 to 6-year-old students have a very positive attitude toward science, which agrees with previous studies showing high enjoyment of science in young students (Mantzicopoulos et al., 2008; Oppermann et al., 2018). Scientific activities are very attractive to young children, which is reinforced by the science-child connection highlighted in the scientific literature. Results showing positive attitudes toward science may be a result of a child's curiosity, his/her intrinsic motivation to learn and understand the environment (Brown, 1991; Eshach & Fried, 2005; Worth, 2010). Children's positive view of science can be qualified according to the results of this study. Thus, it is important to note that when offering children aged 5 and 6 the option of the activities proposed in LeTiS or other common nonscientific activities in the same environments, the students choose the nonscientific activities first.

Considering that the main objective in analyzing attitude toward science must be understanding and predicting science-related behaviors in students (Koballa, 1988), our results may be informative for researchers to consider attitude data with care when predicting behaviors. Nonetheless, and according to the proposed model, our research finds that attitudes and BIs tend to be positively correlated, which means that students' attitudes toward informal science are reflected in the choice of scientific content activities. This finding indicates the relevance of reinforcing the affective connection to science learning experiences in the early years, for true science engagement.

Another result of this study is knowledge on which scientific activities from LeTiS are valued the most by children: those related to travel with a scientific context, such as visiting a zoo, a scientific museum, or a planetarium. In contrast, only a small percentage of students said this would be the best option over other nonscientific activities. Research over the past decade has focused on the study of these informal family learning settings (Zimmerman & Mcclain, 2016), and some have found a direct relation to academic success, while only a few parents attended these informal activities with their children (Tárraga, García, & Ruiz-Gallardo, 2018). Although variables should not be taken independently, and knowing that a relationship does not indicate causality, these learning activities in informal settings could be considered important to be fostered particularly by the family, taking advantage of children's positive attitudes.

The activities with the worst results, although still enjoyed by students, were those that can be freely performed in the park or countryside, a finding that aligned with children's BIs. These science activities in a natural environment are mostly chosen as the second and third options, with children preferring swinging, running, or playing with a ball instead. These results could be related to the current disengagement of children from authentic natural environments outlined in recent research (Dunkley & Smith, 2019; von Benzon, 2018). Another reason may be that all participant schools are in an urban environment, and the number of accessible natural areas is limited. Further studies in rural schools are necessary to corroborate this hypothesis. In any case, family and educational agents must encourage real and attractive outdoor experiences, considering their relationship with learning and the acquisition of skills, attitudes and behaviors needed for citizens in the 21st century (Kuo, Barnes, & Jordan, 2019).

Considering the family and home environment, we observed that most of the children choose nonscientific activities as the first option, especially when they involve screen-based devices: video games, tablets, and so forth. Curiously, the activity involving the use of magnifying glasses, which is reported of high interest in other studies with young children (Gomez-Motilla & Ruiz-Gallardo, 2016), does not generate sufficient emotional intensity when competing with the nonscientific activities proposed. Recent research reports widespread use of touchscreen technology by toddlers (Gomez Perez et al., 2019), and that digital experiences have become an integral part of their daily life (Edwards, 2013). Thus, should science activities be adapted to these screen devices in order to be more attractive? This question deserves a discussion that surpasses the objectives of this paper but has important implications in educational planning.

Nonetheless, it is valuable to have found that there is an average of 20% of students that prefer doing activities related to science even when they have the chance to watch TV, or reading books about animals and the human body instead of mystery, magic, or cartoon stories. According to the findings of this research, positive attitudes are closely related to choices. These students may have developed long-term interest in science topics, a phenomenon that in previous research was described as only occurring in a small percentage of children from this age group (about 20%) (Alexander, Johnson, Leibham, & Kelley, 2008). Early interest encourages a person to acquire competency and new knowledge in relation to that area (Kraap, 2002), and can be a predictor of later academic achievement (Leibham et al., 2013). It would be interesting to follow-up with these students along their educational paths and analyze their performance, engagement, and knowledge of science in the future, in contrast to others that were less interested. It is important to verify whether this positive relationship in both attitude and intention continues or if there are variables that cause it to change. In any case, in our opinion, these children should be offered engaging scientific options to avoid any loss in their positive feelings toward science.

Regarding gender, a positive attitude is something that characterizes boys and girls, which is supported by previous studies (Andre et al., 1999; Mantzicopoulos et al., 2008; Oppermann et al., 2018). Results showing no gender differences must be a starting point in the search for and analysis of those factors that lead to differences later on, which must guide the teaching-learning process throughout the educational process, and encourage schools to work on reducing their effects.

When analyzing items individually, the LeTiS topic related to physics scored significantly higher in boys than in girls, which also occurs for intention. This result aligns with the findings of Murphy and Beggs (2003), although these authors focused on enjoyment of school science in children aged 8–11. In contrast, a study on pre-elementary school students by Andre et al. (1999) found that girls like physical activities to a similar degree as boys. In any case, our results match with data about future career selection, with men outnumbering woman in jobs related to physical science and technology. Our results confirm the OECD (2017a) report, which indicates that the differences emerge long before having to choose a career. Considering that LeTiS only includes one item closely related to physical science, to confirm this statement it would be necessary to develop new research or expand the scale with new activities or questions from a different point of view at different times.

Finally, parent surveys reflect that children are interested on science-content activities, especially in open-air environments and travel options. Our results are encouraging, considering the main role that parents have in identifying and sustaining interest, and the influence that these interests exert in future science engagement (Crowley et al., 2015; Jones et al., 2017). Nevertheless, the low correlation between parental information and attitudinal or intentional variables may reflect a lack of knowledge on their children's preferences at these ages. Therefore, an erroneous picture of reality may be provided when only the parents' opinions are considered. This disconnect deserves additional reflection and an extension of the research that could include asking parents to fill in the same questionnaire as their children.

A remarkable observation is that parents reported topics closer to scientific content in the home environment and in relation to reading preferences for boys. This result is similar to Leibham et al. (2013), who identified the same tendency, although with no differences between genders in their subsequent science achievement. This observation has relevant implications on the pivotal role that parents play by generating opportunities for science learning (Alexander et al., 2012).

The information obtained provides clear action items for school professionals and planners since it is necessary to maintain this positive view throughout the school years and through higher education. Further, educators must take full advantage of this very positive attitude, an essential requirement for developing enduring science interests and for students to consider science as a vocation. This positive inclination toward science learning activities shown by young students contrasts with the low BI toward the same activities, when different nonscientific options are offered. Therefore, efforts in formal and nonformal environments must focus on proposing interesting science-based activities as options for young children. This approach to fostering real science interests may be the key to reversing the negative tendency in students' relationship with science, and to enhance science engagement.

Considering all the results, LeTiS scale has the potential to be a reliable and useful tool to assess early science attitude toward informal science, in a child-centered pictographic format that makes it easily applicable in a world that is becoming more and more related to science. The information provided by LeTiS may help complete the framework of attitudes toward science from childhood to high school, filling the current gap in the early years.

9 | LIMITATIONS AND FUTURE WORK

LeTiS provides psychometric evidence on validity and reliability; however, it may be advisable to verify its stability in a representative sample, considering the lack of randomization of the selected participants. The sample of the pilot studies is diverse in terms of age (5 to 8-years old-children), but the validation of the scale includes only students aged 5 and 6. LeTiS was designed to understand how attitudes evolve up to the age of 8, and the pictographic activities have been developed including appropriate science experiences for children in the age range 5–8. Thus, the psychometric characteristics of the scale must be verified with older children (7–8 years). New research would involve more heterogeneous samples in terms of location (city-center, suburban areas, rural schools, etc.), and different ethnicities, cultures, and socioeconomic levels. This heterogeneity would be expected to enrich the inventory of nonscientific activities.

Although the data on intentions can be considered reliable due to its high correlation when applied to the same subjects at two points in time, additional work is needed to include it as part of a stable tool of attitudes and BIs. In relation to the nonscientific activities employed to analyze intention, it is necessary to point out that results may be influenced by the particular activities shown with each item. Different options of offering alternatives must be studied.

Although eight items are appropriate for measuring a psychological trait, considering the ease shown by respondents in interpreting the LeTiS scale, new items could be added that offer more information on contents (life, physical, Space, and Earth science) and processes (measure, hypothesize, etc.).

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