INQUIRY-BASED LEARNING: AN INNOVATIVE PROPOSAL FOR EARLY CHILDHOOD EDUCATION

APRENDIZAJE POR INVESTIGACIÓN: UNA PROPUESTA INNOVADORA PARA EDUCACIÓN INFANTIL

Caballero García, Presentación Ángeles
Universidad Camilo José Cela, Spain
pcaballero@ucjc.edu

Díaz Raña, Paloma
Colegio Brains, Spain
diazranapaloma@gmail.com

Resumen

En un mundo en constante cambio, las jóvenes generaciones necesitan desarrollar habilidades científicas como competencias básicas para la escuela y para la vida. El trabajo que presentamos tiene como objetivo promover que estas habilidades se trabajen en niños de edades muy tempranas. Hace una revisión sistemática de la literatura y desarrolla una propuesta innovadora basada en aprendizaje por investigación para niños de 5 años. Supone un avance revolucionario en la educación de los estudiantes hacia un pensamiento autónomo y crítico. Los alienta a convertirse en buenos comunicadores y personas reflexivas, dispuestas a desempeñar un papel activo y diferenciador en el mundo. El enfoque por investigación que proponemos para educación infantil está alineado con las competencias que el alumno debe tener en el siglo XXI, asegura el aumento de la motivación del estudiante para aprender, el desarrollo de habilidades de observación e indagación. como un cambio positivo en las actitudes del estudiante hacia

el aprendizaje. Nuestros resultados señalan que los beneficios de su implementación superan los inconvenientes y que las escuelas tradicionales podrían ser más sostenibles y efectivas con esta forma de trabajo y arriesgarse a desarrollar actividades de investigación por el potencial individual y social que generan.

Palabras clave: aprendizaje por investigación; educación infantil; innovación educativa; aprendizaje basado en proyectos; competencias educativas**.**

Abstract

In a constant changing world, young generations need to develop scientific skills as basic competence for life and school. The work we present aims to promote that these skills can be applied on children of very young ages. It makes a systematic review of the literature and develops an innovative proposal for children of 5 years old, based on inquiry-based learning. It represents a revolutionary advance in autonomous and critical thinking student's education. It encourages them to become good communicators and reflective people, willing to play an active role and make a difference in the world. The inquiry approach that we propose for children´s education is aligned with the competencies that the student must have in the 21st century, ensures the increase of their motivation to learn, the development of observing and inquiry skills, as well as a positive change on the student's attitudes towards learning. Our results indicate that the benefits of its implementation exceed the drawbacks and traditional schools must develop inquiry activities, by individual and social potential they generate.

Keywords: Inquiry-based learning, early childhood education, educational innovation, project-based learning, learning skills.

Introducción

In a constantly changing world, where every day more and more things are managed by technology, the young generations have the necessity to acquire during their childhood science skills (Njagi, 2016). There are currently many studies which claim the importance of the first years of life of any human being, since those are decisive for their future personality and learning abilities. It has also been proved that children are born with an innate curiosity to learn and understand the world around them. Therefore, taking into account that scientific learning has its roots in the innate curiosity, it is important to take advantage of the questions they wonder at this age to initiate them in the scientific literacy (Garzón & Martínez, 2017).

Meléndez (2014) talks about the necessity of having the right attitude to study science. Early Years teachers are lucky to have curios students who wonder why things happen the way they do. Thus, they should take advantage of this innate curiosity. Moreover, Meléndez claims how important it is for teachers to give students time to reflect on the questions they wonder, instead of giving them the solutions. At school it is essential to teach children the scientific way to look at the world, wondering everything rather than giving them simple facts and knowledge.

Many scholars have realized the disconnection between what is being taught at school and the reality of the students out of the school. The Inquiry-based learning (IBL) methodology bases its teaching on the student's previous knowledge and experiences. When learning is isolated and the students do not see a connection between what is happening at school and the real world, concepts are easily forgotten once they leave the classroom. Furthermore, Short (2009) claims that "how we teaching influences students as much or more than what we teach" (p.11).

The main goal of this project is to make a rigorous literature review and develops an innovative proposal for early childhood education based on IBL, in order to increase the student's autonomy, creativity (Njagi, 2016), critical thinking (Edelson, Gordin & Pea,

1999) reduce the number of worksheets and table time, provide the students with a more significant and motiving learning experience and improve their communicative skills (Harwood *et al.,* 2015). In the same line, this proposal pretends to inspire early childhood educators, who work in traditional schools, to implement this methodology, little by little, to promote active and successfully learning.

1. Theoretical framework

1.1. Children's thinking and knowledge acquisition

The scientific knowledge is part of the human knowledge, and it is directly linked to investigation. According to McGuigan (1983) and Quine (2001) the scientific knowledge is rational, factual, objective, comparable, methodical, analytic, communicable, and, at the same time it is used to develop a knowledge which meets all these characteristics (Quintanal, García, Riesco, Fernández & Sánchez, 2012).

Children manifest an innate curiosity to observe and learn from everything they have around. They are born with motivation to explore and experience in order to make sense of the world that surrounds them. It is this curiosity, which carries questions such as "why" and "how", what leads to the scientific learning. The development of a scientific mind in the students from the early years helps them to promote the capacity to predict, observe and experiment, in order to formulate hypothesis that should be tested afterwards (De la Blanca, Hidalgo & Burgos, 2013). For a teacher applying the scientific method in the classroom, it is indispensable to take into account the previous knowledge of the students and the process they follow to achieve something, since it has a considerable impact on their learning (Campanario & Otero, 2000).

In 1929, Jean Piaget believed that infant's thinking was irrational, illogical and pre-causal. Nevertheless, Gopnik (2012) claimed that children have an inductive scientific thinking; they formulate and test hypotheses, learn from statistics and learn from the interactions with the people who are around them, the same way as scientists do. Hence, teachers should be ready to exploit all these capacities children are born with. Educators might sustain the curiosity the youngest students have and provide them with the tools to

develop other skills related to inquiry and the scientific method (National Research Council, 2000). What has then been proposed in the last years is an inquiry-based science education, where students get involved on active inquiry.

1.2. Inquiry-based learning: conceptual aspects

IBL is a conceptual based approach to curriculum (Short, 2009) that has some antecedents on Ernest Boyer, who questioned the lack of opportunities provided to students to actively participate on inquiry activities in the classroom (Torres, 2012; cited by Peñaherrera, Chiluiza, & Ortiz, 2014). Vygotsky highlighted in 1979 the special role of social interaction in developing new knowledge, and Bruner claimed in 1969 that students build new learning either individually or interacting socially, based on previous knowledge they have. Besides this, other authors such as Kilpatrick, Freinet and Decroly have contributed to the support of a teaching methodology based on investigation and inquiry (Peñaherrera *et al*., 2014).

In 1938 Dewey claimed many years ago that traditional teaching created passive learners, and that instead of memorizing facts students should learn how to think scientifically (MacDonald, 2016). In order to avoid these traditional methods, students should be actively involved in the process of learning and teachers should become guides. This would lead to a child-centered philosophy (Varela & Costa, 2015) and more practical work into education. Besides this, Schwab, also believed that students should be given the opportunity to understand the nature of the inquiry.

Today, inquiry is a methodology that situates learning in questions (Abd-El-Khalick, Lederman & Schwartz, 2015), involves a lot of experiential and hands on activities (MacDonald, 2016), has both teachers and students assuming different roles than those that are typical in a traditional classroom (Chichekian & Shore, 2016) and combines uncertainty and invitation (Short, 2009). According to Peñaherrera *et al*., (2014) IBL can be defined as the intentional process of having students building their own knowledge based on practical experiences, individual and group work, searching for information and

planning of investigations and debates with peers which lead to the development of positive attitudes to the scientific, technological, social and humanistic innovation.

In the United States, the National Research Council identified in 2000 five main characteristics for classroom inquiry: engaging by scientific questions, giving priority to evidence, formulation of explanations from evidence, self-evaluation of their own explanations and communication and justification of the explanations. Furthermore, it fosters the development of self-regulation and metacognitive strategies, which are useful to promote autonomous and life-long learning. Inquiry-based also promotes reasoning and enables the understanding of the scientific phenomenon. Making possible for the children to learn concepts and acquire different skills during the process (Varela & Costa, 2015), such as problem-solving, communication and thinking skills, that are going to be useful for their future.

IBL is a constructivist methodology. The constructivism approach implies for the teacher to act as a guide and a role model for the students (Byrne, Rietdijk & Cheek, 2016), giving them a lot of freedom to interact (MacDonald, 2016). IBL is a methodology where students use scientific investigations to construct new knowledge, being one of the main goals to preserve the gift of natural curiosity children are born with. This approach aims to teach students how to pose questions and how to investigate to find out responses, at the same time that it encourages them to communicate their results with others and learn from what others do (Njagi, 2016).

Inquiry-based tasks have to challenge the students, but they should not be very difficult that they demotivate the students. It has also been proved that students like clear instructions and that their involvement decrease with unclear instructions (Riddle, 2016). This process is facilitated by the use of a framework as a guide, the inquiry cycle (Short, 2009).

1.2.1. *Inquiry cycle*

In accordance with Pedaste, *et al*. (2015), five general phases, some of them divided in sub-phases, can be differentiated and are described right below.

1. Orientation: On this first phase, the topic is either introduced by the teachers or chosen by the student. After that, the student's curiosity in relation to a problem is stimulated.
2. Conceptualization: On the second stage it takes place the understanding of concepts related to the problem previously selected. Furthermore, it is divided in two sub-phases which are based on theoretical justification. The first one, questioning, makes reference to the process to arrive at the research questions. And, the second one, hypothesis generation, makes reference to the process to arrive at the hypothesis.
3. Investigation: It is the phase where the action takes place and it is divided in three sub-phases. Exploration encompasses the design of hands-on activities to observe and explore. Experimentation focuses more on applying a strategic plan. And finally, data interpretations make reference to making meaning out of the data which have been previously gathered.
4. Conclusion: It is the phase where the students go back to the research questions and hypothesis and drawn their own conclusions to justify them.
5. Discussion: This final stage is divided in two sub-phases which are communication and reflection. Communication is seen as the sub-phase where students share their findings with others and are willing to receive feedback. Reflection is seen as the process in which the student has the chance to personally reflect on the IBL process.

In Pedaste`s opinion, the first approach to this methodology can cause a lot of stress and demotivation. However, with the proper teacher training teachers can learn how to implement IBL effectively and they realize that the benefits exceed the drawbacks.

1.2.2. *Roles in the inquiry-based learning approach*

Applying an inquiry-based pedagogy requires teachers to pay a lot of attention to the children's interest and the questions they wonder. The teacher's role includes, among others, being a co-learner, a facilitator and an observer (Harwood *et al.,* 2015). With the inquiry-based methodology teachers have the challenge to ask good questions to the students. They must reduce the amount of time they speak and give students more time to talk to each other, take into account the student's curiosities and provide them with opportunities to explore by themselves. Furthermore, it is indispensable to design a classroom environment that supports inquiry, enhances the importance of sharing ideas, listen to others perspectives and collaborating, allowing the teacher to actively listen as well as observe the student's actions (National Research Council, 2000).

Self-efficacy is also indispensable to become a good inquiry teacher. According to Vygotsky, the teacher has the responsibility to guide and scaffold the students, which makes possible to ensure younger children are learning (Byrne *et al.,* 2016). Thus, teachers need to receive training to properly apply this methodology. Dejonckheere, Van de Keere, De Wit & Vervaet (2016) suggest the implementation of scientific courses into the teaching degrees. The courses should include, among other things, ways to stimulate children's scientific thinking, strategies to scaffold student's interactions to promote learning and to motivate students to move forward in their inquiries (Chichekian & Shore, 2016).

IBL is an active and student-centered learning technique (Kang & Keinonen, 2017). The student's role includes being active observers and explorers, asking constant questions to the teachers, playing with possibilities and getting involved in discussions and reflections (Harwood et al., 2015). Moreover, this methodology is based on the student's interest, children are called to speak up about their personal curiosities (Chichekian & Shore, 2016). One of the biggest challenges for students applying the scientific method is to differentiate between their personal beliefs and the empirical evidences (Abd-El-Khalick, et al., 2015).

In 2012, the University of North Carolina, carried out a study which encompassed 104 first-year students aspiring to become teachers who were taught using the inquiry-based methodology. It was concluded that, besides of the general outcomes which inquiry–based learning implies, such as improving critical thinking, enhancing motivation and causing a positive impact on the development of higher-order thinking skills, students benefited from the experience as future teachers as well. The inquiry approach allows students to work on their curiosity and creativity which are essential features of teachers. Moreover, it was found that these students were more willing to use an inquiry-based approach in their classroom practices. The students claimed at the end of the pilot study that they have learnt how meaningful IBL is, that they now have a deeper understanding of the inquiry process, that questions are the key element of the inquiry approach and that they have discovered the importance of collaborating as part of the inquiry process (Byker et al., 2017).

It could then be said that the methodological change we are aiming for should start from the university training future teachers receive. This would be setting the consistent basis for an alternative method to the traditional system (Serret, Martí & Corbatón, 2016) and providing the teachers with the necessary tools to deal with the challenges this methodology might mean.

1.2.3. *Benefits and challenges of the inquiry-based learning approach*

According to Edelson *et al.* (1999), IBL gives students the opportunity to learn how to formulate questions and use critical thinking[2] to solve problems. Besides this, they develop investigative and analytic strategies at the same time that they improve their social and communicative skills (Harwood *et al.,* 2015). Among many other outcomes of the inquiry-based methodology, it is important to highlight the development of abilities such as problem-posing, gathering and interpreting data, and building arguments and negotiations before drawing conclusions (Abd-El-Khalick *et al.,* 2015).

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[2] The Bloom's Taxonomy, which identifies six types of cognitive reasoning, is used to classify critical thinking skills. The six categories are: remembering, understanding, application, analysis, evaluation and creating. (Anderson & Krathwohl, 2001, cited by Riddle, 2016).

The IBL approach also has an impact on the students' interest towards science and the development of math concepts (MacDonald, 2016). Also, students involved in inquiry investigations develop creative thinking, autonomy, self-regulated learning skills from an early age and learn to work cooperatively (Njagi, 2016). On top of that, the freedom students are provided with for their explorations, give them the possibility to develop physically and mentally (Byrne *et al.*, 2016). Moreover, since the students are presented with real-world challenges they are usually highly motivated (Riddle, 2016).

This methodology implies many benefits and challenges for the students, the teachers and the families. They make reference to the application of the inquiry methodology in all ages in general. Nevertheless, in order to implement this learning approach with the youngest students many considerations need to be taken into account to ensure the success of the methodology and the enjoyment of it.

1.3. Inquiry-based learning in Early Childhood Education

Even though infants need more time and guidance in order to carry out an inquiry-based activity, they can also perform well with the adequate support (Byrne *et al.,* 2016). The youngest students are the perfect candidates for this experiential style of learning due to the fact that it involves active explorations that awaken their interest for learning such as: observing, touching, listening, smelling, comparing, sorting, classifying, ordering and so on (MacDonald, 2016). Dejonckheere *et al.* (2016) propose four tips for applying the inquiry-based methodology in the early years: using scientific activities that are meaningful for the students, challenge students with questions appropriate for their age, give children the opportunity to interact and encourage the students to search for evidence and collect data.

It is commonly believed that most children think like a scientific, but it is school which kills that innate curiosity and interest in the world around. Therefore, associations like the Consejo Superior de Investigaciones Científicas (CSIC) have developed programs to offer teachers adequate training to teach science from the early years. "*El CSIC en la Escuela*" is a program where investigators, scientists and teachers work together in order to find out

different methodologies to teach science to the youngest students (CSIC en la escuela, 2017). It offers among other things, training for teachers and classroom resources. It is important to highlight that IBL consolidates from an early age scientific concepts, which are going to be very useful for the students in the primary years, as well as inquiry skills that are needed to create the appropriate basis wto later develop more complex science skills (Njagi, 2016).

Cremin et al. (2015), highlighted some characteristics of teaching and learning in the early years in the revision of the work of different authors, such as: Barrow, (2010); Carlsen, (2008); Kramer & Rabe-Kleberg (2011); Larsson & Halldén (2010); Rojas-Drummond & Zapata (2004); and Torbeyns *et al., (*2002).

- Play and exploration: by nature, children love playing and use it as a learning tool. Playful experiences help the youngest students to stablish connections between scientific concepts and the world around them.
- Motivation and affect: it is indispensable for early years' educators to arise interest in their students and awaken their curiosity.
- Dialogue and collaboration: encouraging conversation among the students is very positive for teaching science, due to the fact that it promotes sharing information and the development of their thinking, reflecting and communicative skills.
- Problem-solving and agency: when the children are provided with the adequate environment to learn and inquiry, they are able to use their problem-solving skills easier.
- Questioning and curiosity: in order to keep awaken the children's innate curiosity, it is important for the teachers to ask open questions.
- Reflection and reasoning: children are born with the innate capacity to reason scientifically, however, teacher's support is indispensable to develop their metacognitive skills.
- Teacher scaffolding and involvement: the efficacy of the IBL methodology deepens on the quality of the scaffolding provided by the teacher.

According to Garzón & Martínez (2017), the scientific content infants are exposed to should align with the following requisites:

- Teachers have the responsibility to provide the students with significant learning.
- The activities must encourage students to be active learners, stimulated and supported by their teachers.
- There must be a relation between the content and the children's daily life.
- The activities must encourage students to be active learners, stimulated and supported by their teachers.
- Teachers have to take into account the diversity of students they have in the class and how different they all approach learning. Therefore, they have to ensure they offer different activities that motivate all the students.
- The activities have to ensure that the students get involved physically as well as mentally.
- Teachers have to keep in mind what motivates students in order to awaken their curiosity to learn and investigate.

Nevertheless, there is still a small percentage (17%) of teachers who support the introduction of new methodologies to teach science at school. While, 86% of the teachers still believe in memorization and traditional methods, which do not support significant learning to teach science (Gil, González & Santos, 2006).

IBL has its roots in the theories of John Dewey (1859-1952), who put heightened emphasis on scientific thinking from the early ages. Since then, many researches have been carried out in this field in order to analyze the consequences of applying inquiry learning strategies in the classroom (Lazonder & Harmsen, 2016). Nevertheless, most of the studies focus either on primary years' students or teenagers, but unfortunately, there are not many studies which have addressed the impact of this methodology in early childhood education.

After reading different meta-analysis which have compared studies related to IBL, the following conclusions have been drawn in relation to teaching and learning applying the inquiry methodology:

- Developmental differences

Teachers who apply inquiry activities in a classroom need to take into account the differences among the students. Developmental differences in scientific reasoning have been claimed by authors such as Piekny & Maehler (2013), who stated that it is not until students reach elementary school that they are able to formulate hypotheses. Moreover, they claimed that it is not until the age of five that children have the capability to evaluate evidence, and not until they are six that children acquire the capability to differentiate between testing a hypothesis and generating and effect (Lazonder & Harmsen, 2016). For teachers who want to apply the scientific method in early childhood education it is essential to understand that even the oldest kindergarteners are going to need a lot of support formulating hypotheses, hence, this step of the scientific method should probably be done all together and with the help of the teacher.

- Student support and guidance

Although so far there is any clear study highlighting what kind of support might be needed to use inquiry with different age groups, it has been proved that the inquiry which is supported by teachers leads to better results in all ages.

A meta-analysis of Alfieri, Brooks & Aldrich (2011), which included a sample of 164 studies, showed that giving students the right guidance previous to let them carry out an activity by themselves, give them the possibility to later fully develop certain skills by themselves while carrying out an activity independently. Therefore, early childhood educators have to assume the responsibility to scaffold students learning, provide them with the adequate guidance to successfully achieve their goals and show availability for them to ask questions if they want children to make the most of the time they dedicate to the activity

Other meta-analysis which included 72 studies, showed that scaffolding and guided inquiry causes a better use of inquiry skills in all age students, especially in young children, whose performance is immensely affected by specific types of guidance. Learning outcomes are positively affected by the presence of particular types of guidance. Teacher's guidance is essential to ensure that the students achieve the goals of every task and that they are learning from every experience (Lazonder & Harmsen, 2016).

- Impact on student understanding of concepts and active engagement

Inquiry-based methodology promotes active thinking in the students as well as the ability to draw conclusions from data. Due to the fact that both skills are needed to understand scientific concepts, it could be concluded that IBL leads to a more proficient understanding of science concepts. Another key element of IBL is its hands-on approach to teaching and learning. IBL implies learning by doing and experiencing. The meta-analysis previously mentioned showed the benefits of this approach, highlighting benefits in the conceptual level of students receiving this type of instruction (Minner, Levy & Century, 2009).

As a consequence of all this, early childhood educators must be aware of the importance of using this engaging methodology to teach science, due to the fact that through active participation it enables students to visualize abstract concepts. During the first stages of life it is essential to provide children with the opportunity to deepen understanding of science concepts (Harwood *et al.,* 2015) which will be the basis for the following years of education.

- The role of discussion

Dalton et al., stated in 1997 that discussion was also a key aspect of inquiry-based methodology. Giving students the possibility to debate is essential in order to allow them to process all the information they are being exposed to (Minner *et al.,* 2009). In the case of early childhood teachers, they have to keep in mind that when applying an IBL approach in the classroom, children are going to come up with many questions and they are going to start different discussions. Therefore, the teacher's role is to guide those discussions and

debates so that students can benefit from them. According to Wright and Gotwals (2017), with appropriate support, students in the early years can engage in science talk, which eventually leads to a positive impact on science learning.

- Student-centered versus teacher-center approach

Most of the studies from the same meta-analysis which has been already cited, show better results when the student is responsible of a big part of the instruction. Which means that the teacher uses a student-centered approach giving them the opportunity to lead their learning process (Minner *et al.,* 2009). In the last decades it has been proved that some strategies to stimulate student's learning are to use topics of interest for the children, in order to take into account what is relevant for the students and to encourage them to discuss and wonder new questions. All this different approaches share the common idea to center the learning on the student and not on the teacher, and that they all have proved to have a positive impact on student's academic success (Kang & Keinonen, 2017).

- Creating teaching materials

According to a meta-analysis carried out in 2011, which included a sample of 164 studies, cognitive skills such as memorization benefit from activities where the students have the challenge to create their own learning materials. It has been proved that students remember more details of materials that have been created by themselves. Besides this, both comprehension and retention of new concepts benefit from the creation of these learning materials by the students (Minner *et al.,* 2009). In early childhood education students are very willing to help teachers creating materials and decoration for the classroom. Therefore, it is essential to take advantage of this energy and willingness they show.

It has then been theoretically proved that inquiry-based methodology has more advantages than disadvantages and that it can be applied in Early Childhood education. Nevertheless, there is still a lot to investigate on this field and there are still many schools which support traditional methodologies.

2. Educational innovation

After reviewing the literature, our goal is to offer guidelines for their development in early childhood, based on our experience developed in the classroom with children of 5 years, which we describe below.

2.1. Methodological considerations

IBL will be a new approach to learning for the student's families. Therefore, at the beginning of the academic year, the headmaster of the school, the infant coordinator and the teachers who are going to apply this new methodology, will prepare a family-friendly presentation to introduce them to this methodology and to remind them the necessity of their engagement to succeed.

Due to the fact that the IBL methodology situates learning in engaging questions (Abd-El-Khalick *et al.,* 2015), involves a lot of experiential activities (MacDonald, 2016), encourages students to self-evaluate their explanations and share them (National Research Council, 2000), and has students building their own knowledge searching for information individually and in group (Peñaherrera *et al.*, 2014), the following methodological strategies have been proposed: Visible Thinking Routines.

Visible Thinking is a flexible framework which fosters abilities, attitudes and alertness. Thinking routines have the goals of making thinking visible for the students, motivate them, provide deeper understanding and help students develop thinking skills and positive attitudes towards learning. Moreover, it implies a positive change into the classroom environment (Visible Thinking, 2017). In the last decades, many positive effects of routines in early learning experience have been highlighted. Thinking routines have also been proved to engage children in thinking activities, help them develop metacognitive and critical thinking skills, make students alert to situations where they have to think and promote student's construction of knowledge (Salmon, 2008).

Due to the fact that applying an IBL methodology implies a lot of thinking that can be very abstract for young students, visible thinking routines are the perfect tool to get started with

this new approach in order to provide them with the visual help they might need. Among the innovative schools which support the use of visual thinking routines we find: Reggio inspired, International Baccalaureate, public and private centers which applied the inquiry or project-based methodology and schools which work with cooperative strategies.

2.1. Participants

The context in which the educational proposal has been implemented are two five-year-old classrooms of a private school, where only girls attend, 58 in total, in a working-class neighborhood of Madrid, in the southern district of Puente de Vallecas (Madrid, Spain). The all-girls school was founded in 2007, it covers education from the first year of Infant education (3 years) until 2º *de Bachillerato* (18 years) and it was accredited in 2008 as a Bilingual Charter School by the Autonomous Region of Madrid. It is important to highlight that the ratio per class in the third year of Infant education is 29 girls per classroom and that the teacher is always alone with the group in the classroom, having no assistant teacher.

2.3. Procedure

2.3.1. *Timing and general procedure*

The duration of the proposal involved an entire academic year. The first term they had a forty-five-minutes session based on the inquiry methodology and ten minutes per day during a period of a month designated to inquiry about the weather. On the second term the students enjoyed four forty-five-minutes sessions of inquiry activities and four short periods of fifteen minutes. The third term the students enjoyed five forty-five-minutes session in addition to the fifteen minutes per day that they will have to carry out a short inquiry activity related to the sensory table.

2.3.2. *Activities and Resources employed*

On the first term, the students were gradually introduced to the inquiry-based methodology. We carried out two activities with this methodology in order to awaken the curiosity for this new way of learning. On the second term, we developed three activities

based on this approach to study the animals. On the third term, we made four different activities based on the topic food. Finally, on the last term, the activities will take place in collaboration with the English teacher (see activities in annex 1).

2.3.3. *Assessment: instruments and criteria*

As well as the teaching methodologies, the assessment methods are also very traditional at the school where we developed our experience. Currently, all the assessment which is carried out by the Infant teachers is summative. They are given a list of items and they check whether the girl does “very good”, “good” or “in process” on each one. Nevertheless, as the International Baccalaureate Organization (2007) claims, assessment is an essential tool to guide the students learning. Therefore, this innovative proposal has the aim to develop a new assessment policy.

The assessment will be composed by an initial assessment, an assessment of the process and a final assessment of the students. The initial assessment, which allows teachers and students to know the reality of their knowledge at the beginning of the school year, will consist on an assessment of their autonomy, critical thinking, involvement and enjoyment of their process of learning through the teacher observation. The assessment of the process, which is useful both for the students and the teachers to improve, will take place daily through personal reflections and the feedback received by the teacher after the activities. Lastly, the final assessment, which makes possible to know what the students have learnt, will take place again through observations and one-to-one conversations between the teacher and the student.

One of the main changes is that students, as well as teachers, will be involved in the assessment process. Visual thinking strategies promote self-assessment themselves and most of the other portfolio activities will imply a self-assessment reflection as well. Moreover, on top of that there will be a final student-friendly self-assessment activity at the end of the school year. Peer-evaluation will be also introduced in the classroom dynamic, in spite of the difficulty to apply it with the younger students. Especially on the activities

where girls are going to be working in groups, they will be asked at the end to explain how they felt in the group and how the other components of the group worked. Finally, teachers and families will have a chance to evaluate the student's experience with the inquiry-based methodology.

The new policy will emphasize the importance of using formative assessment, personal reflections and the involvement of families and the students on the assessment process. The assessment which is going to be applied for this proposal will have as a main goal providing feedback on the learning process to the girls, due to the fact that this will help them improving knowledge and understanding, they will feel more willing to learn, they will know what are the goals we are aiming for and they will develop self-assessment skills.

In order to achieve all that has previously been mentioned the assessment strategies put in practice will be daily observations and open-ended tasks, due to the fact that they perfectly fit in an Infant classroom. The assessment tools which will be necessary are rubrics, checklists, anecdotal records and continuums. Furthermore, every girl will be given a teacher-made portfolio, which will have the goal to show evidence of the student process of learning as well as the development of knowledge and the conceptual understanding the girls has reached. After every inquiry activity the girls will go to the portfolio and reflect about it. Families, teachers and students will have access to it, and they will have their personal space to reflect on this first experience with a portfolio at the end of the school year. On the portfolio, students are expected to accompany their drawings with some words towards the end of the school year, as they get started with the writing.

The assessment criteria will be based on the conceptual, procedural and attitudinal contents that have previously been described. In addition to this, some relevant characteristic for an inquiry methodology, such as student's autonomy, critical thinking, involvement and enjoyment of their process of learning will be assessed. The teacher will also set some goals for himself as a professional. He will have a formal observation in one

of his classes and he will have to reflect on his performance thorough the school year in a personal interview with the Infant coordinator.

3. Discussion and results

The theoretic revision of literature published in the last years related to inquiry-based methodology has made possible to verify that inquiry helps students to increase their creativity, autonomy (Njagi, 2016), critical thinking (Edelson et al., 1999) and communicative skills (Harwood et al., 2015).

According to Edelson et al. (1999), we found that the IBL gives students the opportunity to learn how to formulate questions and use critical thinking to solve problems. Besides, they developed investigative and analytic strategies, at the same time that they improved their social and communicative skills (Harwood et al., 2015). Among other outcomes, our students developed abilities such as problem-posing, gathering and interpreting data, and building arguments and negotiations before drawing conclusions like Abd-El-Khalick et al. (2015).

The IBL approach also had an impact on the students' interest towards science and the development of math concepts (MacDonald, 2016). Students were involved in inquiry investigations developed creative thinking, autonomy, self-regulated learning skills from an early age, learnt to work cooperatively (Njagi, 2016) and were faced with real-world challenges who increased their motivation (Riddle, 2016).

In the long-term, and taking into account that these students would be continuing with the inquiry-based methodology in Primary, introducing this student-centered methodology will help them to increase their creativity, ability to observe, autonomy, experiencing skills, critical thinking, and communicative skills. Furthermore, they will be enjoying more learning, which is essential for their future, since their personal interest would be taken into account more.

In order to evaluate the proposal, the student's autonomy, critical thinking, involvement and enjoyment of their process of learning will be assessed at the beginning of the school year. Then, the same items will be assessed again at the end of the school year to see if the girls have improved. Autonomy will be basically assessed by the main teacher during the first weeks through observation. Critical thinking will be assessed though conversations with the girl individually and within the group. Also through observation, the teacher will take notes of the student's creativity at the beginning of the school year, not just in art but also in other subjects and in the resolution of conflicts. And finally, the student's attitude towards school and learning will be assessed by observing them in the school setting.

4. Conclusion

Society is changing high-speed, and as a consequence, the concept of education has changed a lot in the last decades. As a result of all this evolution the teaching methodologies have varied a lot in the last years. Currently there are many innovative methodologies, and many schools where children learn in very different ways can be found around the world. Also, in the last years there has been an emphasis on the necessity to teach science properly to the younger students, transmitting them the right attitude to study science and giving them time to think by themselves.

In relation to the theoretical part of this article the first conclusion is that, inquiry-based methodology can be perfectly applied in the Early Years, having actually many benefits for the students. The second one is that, although there are many challenges in applying this methology, the benefits exceed them. Regarding the practical section, it has been proved that with some variations, the inquiry approach can be even applied in a traditional Infant classroom if the teacher provides the students with the right support and guidance.

However, some limitations arose during the time the project was carried out. It is a fact that there is a lack of literature in relation to infant education and the inquiry–based methodology, having most of the investigations focused on its impact in higher levels of

education. Another limitation was that due to the fact that the inquiry activities were created towards the end of the school year they could not be put in practice in the real classroom to observe the results.

Therefore, thinking about prospective projects, it would be great to implement this education innovation proposal in the classroom and observe the changes the student's thinking and attitudes towards learning undergo. Another option would be to combine activities for each learning style that allow us to improve achievement in a general way (Calvo, 2017; Guerra Pulido, Pérez Cuta & Martínez Geijo, 2016) or motivation (Aguado & Falchetti, 2009). Moreover, it would be good to promote more experimental investigations in the field of inquiry in the early years in order to go in depth on its benefits, drawbacks, challenges, teacher role and put in practice. It would also be very useful to carry out a comparative study between two classes, one using a more traditional methodology and the other one using the inquiry approach. Finally, it could be interesting to observe a group of students receiving this type of education from their childhood in order to observe their progress.

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APPENDIX. Inquiry-based methodology activities

Activity 1: "What does a scientist do?"

Taking into account that the target group has never been exposed to the inquiry methodology, which is based on the scientific method, it is important to start with an activity to awaken their curiosity for this new approach and to help them understand the new role they are going to assume in their process of learning. This goal will be achieved rough the use of the Visual Thinking routine "*Creative Questions*. To explain the routine, the teacher will say that it is a tool for asking good questions.

In order to achieve this, the teacher will bring a test tube (like the ones scientist use) to the classroom. The object will be shown to the girls without giving any explanations, and they will be asked to brainstorm a list of questions, which will be written on a big piece of paper. The teacher will have to play an active role encouraging the students to formulate questions due to the fact that they are not used to do it. Once all the questions are on the list, the girls as a group will transform some of the questions to develop creative questions along the lines of: what would it be like if, how would it be different if, suppose that and what would change if. After this, the class would choose a question to explore in depth by writing a story and drawing its pictures. At the end, the students would reflect during the assembly on what new ideas they have about what a scientific does and what have they learnt that they did not know before.

Resources: A long sheet of white paper, test tube and a marker.

Activity 2: "The weather forecast"

Once the girls have been explained the new methodology that we are going to gradually implement in the classroom and they are already willing to become scientists, it is the moment to introduce a daily activity which will last a month, and that will only take a few minutes of every morning. First of all, with the help of the students, the teacher will draw a big map of Spain and hang it on a classroom wall. After that, the students will create flashcards with symbols of different weather conditions (sunny, cloudy, windy, etc.). As it

has previously been mentioned, the fact that the students are going to get involved in the preparation of the teaching materials will make them better remember the content.

Once the map and the symbols are done the material is ready to start the activity. Every day, the girls will put the corresponding symbol according to the weather in Madrid. Moreover, they will check the weather forecast on three other areas of Spain that they will freely decide, and will place the right symbol on the corresponding area. Besides this, they will keep a record of the weather in Madrid on a "Weather Journal", which will be included on their portfolio. This way, at the end of each month, the students will have a look and see what´s the weather condition that predominates in their city. The children are expected to easily get involved in this activity since the weather is part of their daily life and younger students are always fascinated by weather conditions.

During the second term the students will carry out a one-month project based on the IBL methodology. The girls will work on the unit "Animals" from a scientific point of view.

Resources: Big sheet of white paper to draw the map, laminating machine, markers and white cardboards.

Activity 3: "See, Think, Wonder"

The unit will start with a warming up activity, the thinking routine "*See, Think, Wonder*". The students will be shown a poster and they will be successively asked the following questions: What do you see? What do you think about that? And what does it make you wonder? The teacher will record the replies to the three questions on a chart that will be drawn on a big sheet of paper, where all the students can see it. The goal of having the questions always visible for the rest of the unit is that they can go over them and ensure they are answered at the end of the project. With this activity the girls are encourage by the teacher to play an active role in their learning.

Resources: Big sheet of white paper, a marker and the animal's poster.

Activity 4: We become animal experts!

For this activity the girls will be working on four groups (farm, ocean, jungle and forest). The teacher will previously survey to see what the girl's preferences are and what are the

animals that motivate every girl the most. Once the groups are set, every group will have to decide one animal to investigate about.

The next step consists on encouraging the girls to bring to the school any picture, magazine, book, toy or other type of information about the animal. It is important to make girls understand that scientists search for information everywhere, and that is what they are going to do. Once all the sources of information have been collected, every group, with the help of the teacher, will start analyzing what they have and making conclusions about their animal.

The final step of the activity is a presentation. This way all the girls will have the chance to learn about the four animals which have been selected, even though they have been working in depth just on one of them. Every group will summarize what they have learnt on a big cardboard, adding some words and pictures. This way, the girls who are better at writing will use this ability and the ones who love drawing will take advantage of it to contribute to the group's presentation.

Resources: 4 big cardboards, scissors, glue, pencils, markers and pencil colors.

Activity 5: Mystery reader

In order to involve families in the project, each one of the Fridays that we will be working on this project (4 Fridays) we will receive mystery readers. The readers will be voluntary relatives of the students who will be welcome to bring books about animals. In order to make if more exciting for the students, the girls will not be told whose relatives are coming every Friday.

On the third term, the girls are expected to be used to the inquiry-based methodology. Therefore, they will start a project combining science and English.

Resources: A list for the families to sign in and books about animals to provide the families with, in case they want to participate but they do not have the materials.

Activity 6: Think, Puzzle, Explore

This unit will start with another thinking routine called "*Think, Puzzle, Explore*", which will help students to connect to prior knowledge and develop their questions of investigation.

The students will be asked the following questions: What do you think you know about this topic (food)? What questions or puzzles do you have? How can you explore this topic? Again, the teacher will record the replies to the three questions on a chart that will be drawn on a big sheet of white paper, where all the students can see it. The goal of having their thinking always visible is that they can go over them and ensure their questions are answered at the end of the project.
Resources: A big piece of paper and a marker.

Activity 7: Sensory Table
A sensory table will be set in the classroom through the whole project. Students will have the chance to explore and play on the sensory table with the Spanish and the English teacher, so that they acquire the vocabulary in both languages. Due to the fact that the unit they will be working on is Food, the sensory table will be filled in every week with some food. The students will be explained that the food on this table is not ready to eat, and that it is there to touch it, feel it, have fun and learn with it. Furthermore, the students will be given kitchen supplies to play with the food, such as a funnel, a whisk, a spatula and spoons.
The first week there will be uncooked legumes such as lentils, peas and chickpeas on the sensory table. The second week the teacher will put color rice on it. The rice will be previously colored by the teacher using vinegar and food coloring. The third week the table will be filled with whipped cream. And, the last week the children will enjoy a sensory table filled with water.
Resources: A sensory table, food to fill in the table and kitchen supplies.

Activity 8: The Recipes' Book
This activity will be carried out with the help of the families. Every student will prepare a dish or dessert at home with her family. The girl will be in charge of recording and explaining the ingredients she used, the time she spent cooking and the different steps she followed on an A4-cardboard. They can use pictures, drawings, words or anything they need to ensure somebody else would be able to prepare the same dish following their

instructions. Moreover, there will be a day where half of the class will bring their recipes to share with the classmates and another day when the other half will bring theirs and everybody will have a small portion of every dish or dessert.

Once the girls have their recipe cardboard ready, they will bring it to the school and the teacher will bind them all together. After that, every student will have a turn to bring the Recipe's Book home, have a look at their classmates' recipes and even try some of them.

Resources: A4-cardboards.

Activity 9: Book diary: What do I eat on a day?

All the children together will choose a day of the week to write down everything they eat on their Portfolio. That day, as soon as they arrive to the classroom, they will write down and draw what they had for breakfast. After the morning snack that most of them eat during the break, they will have time to write again what they brought. Most of the girls have lunch at school, so again, when they come back from the canteen they will have time to draw what they ate. Then, since they have the afternoon snack and dinner at home, they will complete that the following day at school.

Resources: Pencils and colored pencils.

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