FACULTAD DE EDUCACIÓN DE PALENCIA

UNIVERSIDAD DE VALLADOLID

DEVELOPING THINKING SKILLS THROUGH STEAM IN INFANT EDUCATION

DESARROLLANDO DESTREZAS DE PENSAMIENTO A TRAVÉS DE LA METODOLOGÍA STEAM EN EDUCACIÓN INFANTIL

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ABSTRACT

The following Final Degree Dissertation poses an activities and strategies design, within a didactic project based on Middle Ages and, more specifically, in castles, to help students to develop Thinking skills in Infant Education. These tools I propose are going to be worked from a double scaffolding to support the methodological structure: The Project Based Learning and the STEAM methodology. This union provides the acquisition of view in which scientific, technological, and artistic knowledges are integrated.

School must foster the multiple intelligences in students. Moreover, the key is to make the thinking visible. Children need to learn to think and to be conscious of this process. Through STEAM, I provide students of tools and methods to explore new and creative ways of problem-solving, innovating, and linking multiple fields. Projects facilitate the building of knowledge, fostering the comprehension of the world and the capacity to act in it in a responsible and solidary way.

RESUMEN

El presente Trabajo de Fin de Grado (TFG) se plantea una planificación de actividades y estrategias, dentro de la programación de un proyecto didáctico basado en la Edad Media y en los castillos, para ayudar a desarrollar las habilidades de pensamiento del alumnado de Educación Infantil. Estas herramientas que se van a trabajar se van a apoyar en un doble andamiaje que sustenta toda la estructura metodológica: el aprendizaje basado en proyectos y la metodología STEAM. Esta unión facilita la adquisición de una perspectiva que integra conocimientos científicos, tecnológicos y artísticos.

La escuela debe fomentar las inteligencias múltiples en el alumnado. La clave es conseguir hacer visible el pensamiento. Necesitamos que aprendan a pensar y a ser conscientes de este proceso. Por medio de la metodología STEAM, se ofrece al alumnado de las herramientas y métodos para explorar nuevas formas y creativas de resolver problemas, innovar y conectar diferentes disciplinas. Los proyectos facilitan la construcción del aprendizaje impulsando la comprensión del mundo y la capacidad de participar solidaria y responsablemente.

KEY WORDS

Thinking Skills, STEAM, Project Based Learning, Middle Ages, castles, infant education, multiple intelligences, problem-solving.

PALABRAS CLAVE

Habilidades de pensamiento, STEAM, aprendizaje basado en proyectos, Edad Media, castillos, Educación Infantil, inteligencias múltiples, resolución de problemas.

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1. INTRODUCTION

This TFG is legislatively justified following the guidelines defined in the following laws:

> **ROYAL DECREE 1393/2007**, of October 29, which establishes the regulations regarding Official University Education will conclude with the elaboration and public defense of a TFG, which must be part of a syllabus.
>
> At section 3 shows that the purpose of the TFG is to demonstrate the competences associated to the Degree and let the acquired skills by the student.
>
> **ORGANIC LAW 8/2013**, of December 9, for the improvement of the quality of Education (LOMCE).
>
> **DECREE 122/2007,** of December 27, which establishes the curriculum of the second cycle of pre-school education in Castilla y León.

Through the experience obtained in different schools I have developed my teaching career and from my teacher peers, I consider I have adapted several methodologies with the aim of getting children enjoy learning.

Teaching a creative and critic thinking is applied in a transversal way. In LOE, 14.4 section we found that "The educative contents in Infant Education will be organized in respective areas to experience and infant development through globalised activities of children's meaning and interest."

2. OBJECTIVES

The proposed objective to elaborate this TFG is to check teachers' capacity to confront the educative system challenges and to adapt the learning process to the new educational needs in a collaborative and teamwork environment. Students have to:

- Analyse the context and to plan properly the educational activity
- Act as mediator, fostering coexistence inside and outside the classroom.
- Act as a tutor and orientate students
- Do a formative assessment of learnings
- Elaborate curricula documents adapted to students' context and needs.
- Design, organize and evaluate disciplinary and interdisciplinary works in diversity contexts.
- Collaborate in educative activities with families.
- Apply the ITCs in classroom activities.

The main objective of the designed and implemented project is to put into practise a methodology in which children develop Thinking skills through STEAM and project work.

As specific objectives:

- To analyse the educational intervention initiative based on thinking skills focusing on a meaningful learning.
- To develop creativity and critical sense in school.
- To generate, to analyse and to evaluate ideas.
- To design and put into practice an educational intervention initiative based on STEAM methodology.
- To offer children tools of coding to develop their knowledge through different tasks.
- To provide different possibilities to introduce STEAM in daily class.

Project objectives:

- To demonstrate the existence of questions in our daily life and to solve them through reflection and thinking schemas application.
- To plan and order actions using the previous analysis, thinking on the effects and the consequences.
- To recognise in the heritage the history the cultural and artistic events, showing interest and respect.

- To know the main characteristics of people who lived in castles.
- To identify the basic elements of a castle
- To use different techniques and strategies to build a castle.
- To identify the way of life and traditions in Middle Ages.
- To show interest in investigation and in sharing their knowledges.
- To establish similarities and differences between objects, buildings, and cultures.
- To defend their proposals.

3. JUSTIFICATION

This TFG is aimed to work with four core issues: multiple intelligences, visible thinking, STEAM and project-based learning. I consider that the school must foster the multiple intelligences in students. Moreover, the key is to make the thinking visible. Children need to learn to think and to be conscious of this process. Through STEAM, I provide students of tools and methods to explore new and creative ways of problem-solving, displaying data, innovating, and linking multiple fields. Projects facilitate the building of knowledge, fostering the comprehension of the world and the capacity to act in it in a responsible and solidary way.

4. THEORETICAL FOUNDATIONS

4.1. METHODOLOGICAL PRINCIPLES

As established in DECRETO 122/2007, of December 27, the purpose of Infant Education is to contribute to the physical, affective, social and intellectual development of boys and girls. The experience that children receive in the second cycle of Infant Education will influence their perception about the school, about homework and ways of learning.

Moreover, it establishes the following methodological principles:

The educative intervention will be adjusted to the children's level of development and learning pace, focusing on the individualization of the education and enabling children meaningful learnings establishing connections between what they know and what they are going to learn.

The intervention will incorporate globalization proposals using the game as the main educative resource and facilitating the manipulation of objects. Children build their knowledge of things and establishing cause-effect relations. Providing flexible grouping to let children gather autonomously in big group, small groups, in pairs or individually is essential.

4.2. VISIBLE THINKING

Following Ritchhart and Perkins (2008) the main problem of thinking is invisible and happens "under the hoods of our mind". We cannot observe our own or each other's thought and cognitive processes.

Perkins (2010) suggests that routines and habits have a main role in space and time organization in learning, because they produce confidence, coherence and security in children. Thinking routines are structures which help students to manage their thinking.

To learn to think and to be conscious of this process, the key is to make the thinking visible.
This approach (Perkins, Swartz, Ritchhart, Gardner, Tishman) tries to incorporate the contents of all the curricular subjects into two main objectives: foster thinking skills and enhancing resultant learnings.
The goals reached through visible thinking are understanding of contents; motivation for learning; development of learners' thinking, learning abilities and attitudes; development opportunities for thinking and learning.

4.2.1. Thinking Routines

These thinking routines were organized in nine broad areas that describe the types of thinking they facilitate: core thinking routines; possibilities and analogies; perspectives, controversies and dilemmas; object and systems; perspective taking; with art or objects; digging deeper into ideas; synthesizing and exploring ideas; introducing and exploring ideas.

I have made a selection of the routines I found more interesting for my project. Some of these routines will be explained in this chapter.

Routines for **introducing and exploring ideas**.

There are many routines teachers can use to introduce and explore ideas. In the chart below I explain some of these routines and little description of the routine.

Routine	Aim	Description
Think Puzzle Explore	To generate ideas and curiosity. To set the stage for a deeper research.	It helps students to let them realise about what they know and to start puzzling questions or areas of interest.
See Think Wonder	To make careful observations and thoughtful interpretations and wonder	At the beginning of a new unit to motivate student interest or try it with an object that connects to a topic during the unit of study.

The Explanation Game	To understand why something is that way.	It focuses on identifying something interesting of an object or idea and then think why is that way.
Compass Points	To flesh out an idea or proposition and eventually evaluate it.	Useful to explore various sides of an idea to take a stand or express and opinion on it.
3 2 1 Bridge	To uncover their initial thoughts, ideas, questions and understandings about a topic.	Helpful to build bridges between new ideas and prior ones.
Zoom In	To reflect how and why their thinking is changing through receiving more information about a topic	It helps students through making predictions to see the importance to be open-minded and flexible when receiving new information.
Chalk talk	To generate questions about a topic and to reflect on learning,	It is useful to provide flexibility to move from one idea to another and wonder about aspects.

Routines for **synthesising and organising ideas**

These are some of the routines teachers can exploit to help students to synthesise and organise ideas to get children develop a better understanding of a topic, in the chart below I explain some of these routines and little description of the routine.

Routine	Aim	Description
Headlines	To capture the core of the matter studied or discuss.	At the end of the class students think in a headline to sum up all the information they have gathered.

CSI: Colour, symbol, image	To identify the essence of ideas by using a colour, a symbol or an image.	After a reading, watching or listening activity, students enhance their comprehension using a colour, symbol or image to represent the three more important ideas.
Generate – Sort – Connect – Elaborate	To generate ideas about a topic and connect them.	Students generate a mental map individually to build a mental map of the whole class.
CCCC: Connections, challenge, concepts, changes	To provide a structure for a text-based discussion in which they make connections, ask questions, identify key ideas and considering the application.	After reading a text, students in groups discuss in these questions.
I used to think… Now I think	To reflect on their thinking about a topic consolidating their new learnings.	It is used to contrast the changes produced as a result of the learnings.
+1	To add new ideas or connections to others ideas	After receiving information from texts, videos or oral speech, students elaborate a list with key ideas. Then, they have to add some new ideas to their partners.

Routines for **digging deeper into ideas**

There are also routines teachers can benefit students to learn more and deepen into topics, concepts or ideas. In the chart below I explain some of these routines and little description of the routine.

Routine	Aim	Description
What makes you say that?	To promote evidential reasoning and to share their interpretations.	Students describe something and support their interpretation with evidence.
Circle of viewpoints	To help students to explore multiple perspectives.	Brainstorming a list of different perspectives.
Tug for truth	To help students to appreciate the deeper complexity of matters of truth.	Students identify a question of truth, they are asked to have an opinion about that and a tug of war diagram is drawn on the board.
Claim support question	To help students realise that reasoning is an ongoing process.	Students make a claim about a topic, identify support for their claims and ask questions about the claim.
Step inside	To learn how to see a situation through different points of view	
Peel the fruit	To help learners to deep into a topic peeling the layers of it and obtaining a deeper understanding.	Children take the information and start to work in big group thinking what they received, then they start thinking on what questions they have about that information. They start to build explanations and contrast their different viewpoints to take perspective of the topic. Finally, they look for the key idea.

Routines for **perspective taking**

There are routines students are helped to identify with several perspectives in a given situation. In the chart below I explain some of these routines and little description of the routine.

Routine	Aim	Description
Same and different	To go beyond the surface of similarities and differences.	Children study a topic in which opposite views are clear and analyse differences and similarities.
Compass Points	To flesh out an idea or proposition and eventually evaluate it.	Useful to explore various sides of an idea to take a stand or express and opinion on it.
Circle of viewpoints	To help students to explore multiple perspectives.	Brainstorming a list of different perspectives.

Routines for **with art or objects**

These are some of the routines teachers can use to generate ideas and foster their curiosity through the interpretation of images or objects. In the chart below I explain some of these routines and little description of the routine.

Routine	Aim	Description
See Think Wonder	To make careful observations and thoughtful interpretations and wonder	At the beginning of a new unit to motivate student interest or try it with an object that connects to a topic during the unit of study.
Thinking with images	To reason about topics by examining the relations on each image.	Students identify the correspondences between the topic and the image and draw the inferences about the image and the topic.

Think Puzzle Explore	To generate ideas and curiosity. To set the stage for a deeper research.	It helps students to let them realise about what they know and to start puzzling questions or areas of interest.
Looking: Ten times two	To make careful and detailed observations	Students look at the image for more than 30 seconds and list 10 words or sentences about the aspects of the image. Then they repeat the same processes and add 10 more words or sentences.

Routines for **objects and systems**

These routines help students to introduce and explore the concept of design complexity. In the chart below I explain some of these routines and little description of the routine.

Routine	Aim	Description
Think, Feel, Care	To generate new questions or ideas about the system and how it works	Children choose a system that involves several people. One person is selected from that system and it is asked to think what s/he does? How does s/he feel? What is important?
Imagine if..	To think new possibilities for an object or system	Students think on how it can work better, make easier use or faster, make it more beautiful.
Parts, People, Interactions	To explore that any change in a system can affect the rest of it.	Students analyse the parts and their functions, the people who acts and what they do, the importance of the interaction of the people.

Parts, Purposes, Complexities	To foster curiosity based on a topic through watching details, asking questions, making connections.	Students choose an object or system and analyse its parts, the purposes of it and the importance of working all parts together.

Routines for **perspectives, controversies and dilemmas**

There are routines the teacher guide students to have a broad view about a topic exploring the perspectives, controversies and dilemmas that topic envolves. In the chart below I explain some of these routines and little description of the routine.

Routine	Aim	Description
CCCC: Connections, challenge, concepts, changes	To provide a structure for a text-based discussion in which they make connections, ask questions, identify key ideas and considering the application.	After reading a text, students in groups discuss in these questions.
Same and different	To go beyond the surface of similarities and differences.	Children study a topic in which opposite views are clear and analyse differences and similarities.
Circle of viewpoints	To help students to explore multiple perspectives.	Brainstorming a list of different perspectives.
Tug for truth	To help students to appreciate the deeper complexity of matters of truth.	Students identify a question of truth, they are asked to have an opinion about that and a tug of war diagram is drawn on the board.

Routines for **possibilities and analogies**

There are routines students can use to link ideas through their possibilities and analogies. In the chart below I explain some of these routines and little description of the routine.

Routine	Aim	Description
Creative questions	To explore creative possibilities through the creation of creative questions.	Children make a list of questions that challenge the imagination. Then, they choose a question to explore in an imaginative way. Finally, they reflect on the new ideas.
True for Who?	To see how different viewpoints and situations affects people	A routine to explore truth from different perspectives Students make a list of different points of view and reflect on them
3 2 1 Bridge	To uncover their initial thoughts, ideas, questions and understandings about a topic.	Helpful to build bridges between new ideas and prior ones.
Questions Starts	To develop good questions to produce thinking and research	It is useful in the middle of an investigation to encourage students' curiosity and foster their inquire motivation.

Routines for **core thinking routines**

There are routines teachers help students to make thinking visible. They are a set of short sequence of steps useful in several activities. I explain some of these routines and little description of the routine.

Routine	Aim	Description
See Think Wonder	To make careful observations and thoughtful interpretations and wonder	At the beginning of a new unit to motivate student interest or try it with an object that connects to a topic during the unit of study.
Compass Points	To flesh out an idea or proposition and eventually evaluate it.	Useful to explore various sides of an idea to take a stand or express and opinion on it.
Think Puzzle Explore	To generate ideas and curiosity. To set the stage for a deeper research.	It helps students to let them realise about what they know and to start puzzling questions or areas of interest.
I used to think… Now I think	To reflect on their thinking about a topic consolidating their new learnings.	It is used to contrast the changes produced as a result of the learnings.
Claim support question	To help students realise that reasoning is an ongoing process.	Students make a claim about a topic, identify support for their claims and ask questions about the claim.

4.3. STEAM IN EDUCATION

STEAM stands for Science, Technology, Engineering, Arts & Maths.

When we talk about technology we usually think on computers, robots, tablets, smartphones and other devices but the definition of technology refers to anything that has been created by humans. When talking about technology for infant students we also refer to paints, scissors, cardboard, block, crayons...

The STEM movement was led by businessmen searching new solutions to create competitivity. As the STEM education started to be applied in education became stronger as an educative model.

The addition of the "A" to the term STEM recognizes the importance of creativity to contribute to the integral development of children. Through are they express themselves, analyse and solve problems.

STEAM education makes its focus on application of science, technology, engineering and math through art and design. STEAM educators can help students connect what they learn in these critical areas (STEM) with art practices and design elements. Ultimately, students should feel like they can wonder, critique, inquire and innovate.

It gives students tools and methods to explore new and creative ways of problem-solving, displaying data, innovating, and linking multiple fields.

STEAM projects provide a wide range of playful exploration opportunities for children. Children receive multiple sensory experiences in the disciplines. It is therefore an innovation generator; it helps students to associate logic thinking with creativity.

Project Work allow teachers to incorporate this methodology providing a variety of materials and experiences into what children may be interested in investigating.

The main aim of STEAM education is to help students to understand that sciences, technologies, engineering, maths and arts are not isolated subjects, and they have to learn that they help us to solve real problems when they work in a global way.

This is the reason that STEAM techniques should take place interconnecting subjects, knowledges and applying them in real situations. Some other methodologies can help to create these connections as Gamification, Collaborative and cooperative learning, Project Based Method, Flipped Classroom... They have to Learn by Doing.

To get a real STEAM situation, the teacher acts as a facilitator providing content, learning situation and spaces, creating knowledge and motivation strategies, while students' role is active leading their own learningship.

The teacher needs to foster cooperative learning to build knowledge, looking for a project that connect different subjects and intelligences in relation with their environment.

4.4. MULTIPLE INTELLIGENCES

Human beings were thought to have only one intelligence until the end of the last century. Various studies (Gardner, 1998 and 2011) suggested that all people have different kinds of "intelligences". He proposed that there are eight intelligences related among them. These intelligences establish meaningfully the way people learn, receive and understand the world. Each person has got a unique combination of them, having one or two intelligences more developed than the rest.

As mentioned previously, Gardner proposed that there are eight intelligences, and has suggested the possible addition of a ninth known as "existentialist intelligence". These intelligences that Gardner suggested in his theory in 2006 are: visual-spatial, linguistic-verbal, logical-mathematical, bodily-kinesthetic, musical, interpersonal, intrapersonal, naturalistic.

- Verbal-Linguistic Intelligence: The ability to use words and language
- Mathematical-Logical Intelligence: The ability to use number and reasoning skills. The capacity to discern logical or numerical patterns.
- Musical Intelligence: The ability to produce and appreciate rhythm and sound
- Visual-Spatial Intelligence: The capacity to think in images in three dimensions and to visualize accurately and abstractly.
- Bodily-Kinesthetics Intelligence: The ability to control their body movements and to handle objects skilfully.
- Interpersonal Intelligence: The capacity to understand and interact appropriately to the moods, motivations and desires of others.
- Intrapersonal Intelligence: The capacity to understand oneself and in tune with inner feelings, values, beliefs and thinking processes.

- Naturalist Intelligence: The ability to recognize and categorize plants, animals and other objects in nature.

- Existential Intelligence: The sensitivity and capacity to tackle deep questions about human existence.

The main contribution of this theory in education is that the school must foster all intelligences in our students not only verbal and logic ones.

Diversification of the teaching-learning activities to stimulate different intelligences will encourage children's integrated development, as well as ensure to treat diversity.

To stimulate lateral thinking means to boost the creation of different ideas, in association with others reaching different conclusions.

Actually, in Organic Law 8/2013, 9th December, for the improvement of the educational quality, there is no direct reference to Multiple Intelligences but the idea of the key competences has several common points with them.

4.5. GAME

Play is essential to self-expression, self-discovery, explore, feel sensations, movements and relations... through children get to know themselves and to form concepts about the world around them.

Play allows children to use their creativity while developing their imagination, dexterity, and physical, cognitive, and emotional strength. Play is important to healthy brain development.

There are four underlying dimensions emerge as important factor in child development:

Psychomotor: that boosts the body and senses development.

Intellectual: that generates a chance to make successes and errors, causes and facilitate children's creativity. Children apply their knowledges and solve problems. They build thinking patterns.

Social: children get in touch with peers helping them to meet people around, to learn behaviour rules...

Affective-emotional: children receive pleasure, entertainment, and let them to express freely and releasing stress. Through the game, children develop their personality, emotional stability and mental health.

Attending to these dimensions, there can be established several benefits that game produces in children:

One important reason to apply in this research is that in games, children practice their vocabulary when they understand others and when they speak. Even more, in social play, they exchange information and actions to reach agreements.

Game stimulates children's brain development. Through an environment enriched with play materials and game situations children are provided perfect life experiences to foster the brain to produce braincell connections.

Creativity and divergent thinking are increased by playing. Children explore many possible solutions to get their objective.

In order that games usually are played with others, they provide children a good environment to self-regulation, control negative emotions and to persist in challenging activities. It is essential in enhancing social development while they play with peers and relatives. They learn social interaction, learn to cooperate, understand and follow the rules…

4.6. PROJECT BASED LEARNING

One of the main purposes of the project-based learning is to foster the participation of children in a democratic way. They ask questions, interact among themselves looking for the answers and getting those answers interrelation different fields of knowledge. Children experiment and share their ideas, emotions and experiences with their peers and families.

Projects are meaningful when facilitate the building of knowledge, fostering the comprehension of the world and the capacity to act in it in a responsible and solidary way.

The scientific competence is the skill to apply the knowledge to understand and help children to take decisions about the natural world and the changes produced by the human activity.

These projects help children to identify different ways of thinking and doing, to be critical of many culturally accepted ideas.

The Project based Learning is a different way to organise teaching-learning activities around one question or problem that children must solve managing different resources. They are responsible of their own learning and they need to learn to learn. Students not only listen and memorise, but they must investigate, explore and think how go on with their learnings.

Children develop cooperation, collective intelligence, initiative, conscious participation simultaneously in their learning process. They are proud and increase their self-confidence when they are able to solve the problem.

5. DESIGN

5.1. BACKGROUND AND SCHOOL CONTEXT

This project was carried out in a Public School located in a village in Palencia. It is a rural school of 7 students in the same classroom of different ages: 2 three years old students, 3 four years old students, 1 five years old student and 1 seven years old student. These students belong to KStage-0 and KStage-1.

It is a very well cohesioned group. They work together in almost all subjects and the explanations are made in Big group

Due to the great diversity of this classroom, this project offers a big chance to both students and teacher to handle with different abilities and learning paces.

I think that Sciences (Social and Natural) are learnt through language. That is the reason why following The Common European Framework Reference for Languages they should learn to read and write with confidence and understanding; to be interested in books, enjoy reading and know what they really like to read; to understand a range of field in fiction and non- fiction text: poetry and narratives; to monitor and self-correct their reading; to be interested in new words and word meanings, while they are improving their vocabulary and to have good and understandable handwriting

The only way to implement all the assumptions is through the use of the CLIL approach (Content and Language Integrated Learning) where students learn subjects as Science and Literacy through a foreign language, in our case, in English.

5.2. DESIGN STAGES

5.2.1. First Stage: Initial assessment

This stage was carried out thinking on two main aspects. On one hand, the study of the methodological strategies and the didactic resources used by the teacher, on the other hand, the students' responses at the events proposed by the teacher.

5.2.2. Second Stage: The topic

The teacher thinks and suggests a topic to develop in the Assembly. The most important thing is to get out students in our project, so the students' interests and needs must be used in planning it. The best way to engage students in learning is to design thinking and problem-solving activities about their interests.

My proposal was to work on the perception and conception of time in enfant education. The Time awareness in these ages is linked to the idea of change in visible nature changes or through actions or events.

The project started one Monday. One of the students had visited a castle in the weekend. He told us about what he had seen, and he focus all his partners' interest on the topic. Finally, we decided to design a project about Castles and through them, we will learn the social dimension of time (historic time) and heritage creating cause and effect relations which explains change and continuity.

5.2.3. Third Stage: Routines Selection

The purpose of this stage is to establish a wide selection of routines to get a wide range of thinking situations avoiding single answers and increasing our students' knowledge.

The routines selected and used for this project to make the students' thinking visible taken from Ritchhart, Morrison and Church's (2014) works are: circle of viewpoints; headlines; I used to think… now I think; looking: Ten times two; parts, purposes, complexities; see, think, wonder; think, puzzle, explore and thinking with images.

Some of the routines used in this research are featured below:

Think, Puzzle, Explore.

Through this routine I get students connect their previous learnings and plan different research lines. It is useful to start a topic, to build new learnings or to find new concerns to explore. It generates ideas and curiosity on children.

When I introduce a new topic, in this case "Castles", students start saying to the teacher their ideas and I write down a list with them. Once the list is written the teacher read it aloud and children start to identify puzzling questions. These questions show the interests of the students about the topic and set the start point of their exploration and investigation.

Headlines

At the end of every class all the students think on a headline of the session. Children must capture the main aspect they have worked on. They have to sum up all their learnings of the day and to arrive to a conclusion.

The teacher will ask students to think individually in a headline of the session. Then they share with the rest of the partners.

See, think, wonder

Showing a picture of a castle children think and wonder the uses of some parts of the castle. Through wondering, children deepen their thoughts and new lines of investigation arise.

Children, after watching the picture, express what they see. It is important they do not make any interpretation at first. Later on, they have to interpret what they see in the think section. At the end, children are asked to think about what makes them wonder about the object or topic.

Thinking with images

Children identify correlations between the topic with the images. They use analogical thinking to reason about the topic they are leaning and the images.
To understand a picture the brain works completely different that when reading a text. We understand pictures in a synthetic and global way, every part of the image are processed at the same time.

Compare and contrast

This routine is used to work with two topics, concepts, characters… focusing to compare those interesting features based on children's knowledge.

I have used several times in this project to get students realized about the differences among castles depending on their function (protection, residential palace), among Middle Ages people (kings, knights, fool) … I proposed several questions to reach a final conclusion.

I used to Think…, Now I Think…

This routine has been used to get students reflect on what their thinking has changed and why. Children realize about what they have learned about the topic identifying their understandings, opinions and beliefs.

In a first moment, the teacher shows the chart made at the beginning of the project and write down their previous knowledges about the topic worked. In big group, the teacher asks them if they still think in the same way and pushes to explain what they know and what have changed.

Circle of viewpoints

Children are able to see and explore different perspectives understanding that there are multiple sides to an issue. They learn about how others feel and think and gain a broader view and understanding of the topic.

The teacher selected the topic “Life in a castle” to explore. When children think about life in castles only focus their attention on the way that queens and kings live, but they usually forget about knights, peasants, craftsmen…

Looking: Ten times two

This routine generates great results that provide a wide range of stimulus to work with. Early ages children usually get observations that adults do not realize, but they make that observations in a chaotic way. With “Looking: ten times two” we help them to slow down and make careful observations.

The teacher shows them a picture of a castle and ask the students to look at the picture quietly for 30 seconds. Then, he asks them to say what they have seen. While the students go on to say the things they have seen, they teacher writes down on the blackboard their ideas (no more than 10).

When finished, the teacher asks them to watch the picture again for 30 more seconds and try to find more things they can see. It is important to remark that they cannot repeat any word or phrase said before.

Parts, purposes, complexities

This routine helps students to make a careful observation of the object and think how it works.

The teacher chooses a castle as the object to study and he asks what the function of the castle is. Then, children focus their attention on its parts. When they say some of the parts of the building, children have to think what those parts are used to.

When we work about complexities, the teacher focuses their work in improving or deteriorating the castle if they could make some changes.

5.2.4. Fourth Stage: Intervention

In the following lines, I will explain all the sessions worked and the routines used in each session. At the end of the research, in the Appendix I will show the evidences of the activities and routines.

The design of this project will be focused on developing Visible Thinking through thinking routines, STEAM and Project-based Learning. All the planning can be seen in Appendix 1

First session "Creating a Mind Map of our knowledges about Castles"

Objectives:

- To know the students' previous knowledges about castles.
- To foster teamwork

Description of the session:

In the assembly, the teacher asks the students what they know about castles. I use the dialogue and some questions to get students reflect on it and to get their previous ideas.

Some of the questions I make are:

"Is this a castle or a house?"

"Who live inside?"

I use picture to show their ideas on the blackboard.

Routines:

To develop this activity, I worked with two thinking routines:

Create a mind map: to create a mind map is a good way to visualize his thoughts and interests. It gives an overall vision that combines the visual and verbal to generate, structure and classify ideas to help children organize information.

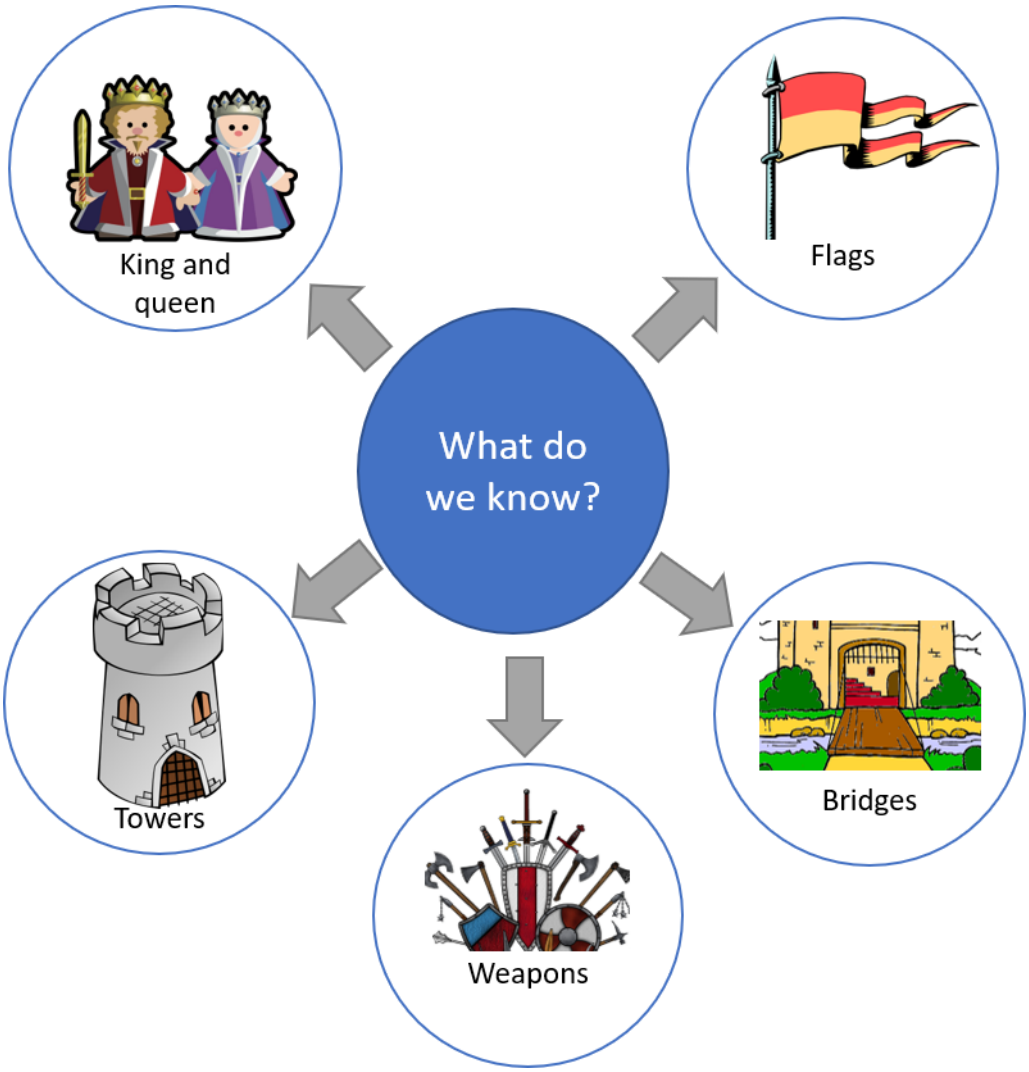

Figure 1. Mind map of their previous learnings.

What do we know? – What do we want to know? routine.

Then, students have visualized their previous ideas through the mind map, we create a "What do we know?" chart where all they knowledge about castles appeared and we put in on the wall of the classroom. Now, children provide more information. (Appendix 2)

In the lines below you can read some of their contributions:

"The king lives inside with his crown, his throne, his sword".
"The queen, the princess and prince lives inside the castle".
"There are knights with armours, swords, shields, helmets".

"It has got many towers"
"There are flags and banners"
"There are moats and bridges"
"They are built in big stones"
"They are built high in mountains or hills"

Later, I ask children what they want to know about castles. I write down all their ideas and we create another chart.

"The parts of the castle"
"Who lived inside?
"How do people enjoy?"
"How were castles built?
"What was their function?"
"How do they defend the castle?"

Second session "Drawing a castle"

Objectives:

- To discover, to develop and to share ideas through pictures
- To solve own problems and to help others to solve them

Description of the session:

Today, the teacher asks his students to make a drawing of a castle. Children have to draw of a castle. Students have been thinking on their previous ideas about castles. Now, they have to turn those ideas into a picture of a castle. (Appendix 3)

Routines:

I have used the routine "Thinking with images". This routine is based on the people's innateness ability to discover, develop and share ideas through pictures. "If they are able to draw, they have understood." [1]

[1] Dan Roam (2011) "Bla, Bla: What to do when words don't work"

They represent on it all their knowledges about castles and when they finish, they explain to their partners their drawings.

This explanation produces a debate in class where new ideas comes to light.

Third session "Starting the investigation: Groups of experts"

Objectives:

- To explore and select information.
- To interpret the information and share with others
- To understand the meaning of a coat of arms

Description of the session:

The activity consists of creating different groups to work on a topic. At the beginning of the class the teacher proposes a new routine where children connect their previous learnings and plan different research lines to build new learnings and to find new concerns to explore.

The teacher organizes the students establishing three cooperative and heterogeneous groups. Each group will be a group of experts (life in castles experts, weapons experts and castles building experts). He writes down children thoughts in the "Think" column and every group start to identify puzzling questions. The interests of children will appear in these questions that set the start point of their exploration and investigation.

I explain the concept of coat of arms. Every lord had his coat of arms. It is an emblem for the castle and the population who lives in there. It appears on shields, crowns, flags… to show the belonging to a group. The teacher shows some example of emblems.

Children have to design their own coat of arms and elaborate it in class.

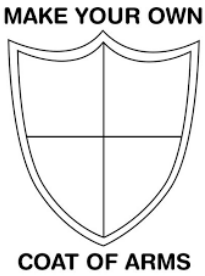

Figure 2: Make your own coat of arms sheet.

When students are organized and know what the questions are, they have to solve the teacher gives them a circular note for families talking about the project and asking them for documentation about castles to help their children. (Appendix 4)

Routines:

As I said previously, students work with a new routine "Think, puzzle, explore". This routine promotes a meaningful learning in which students seek and select information about a topic.

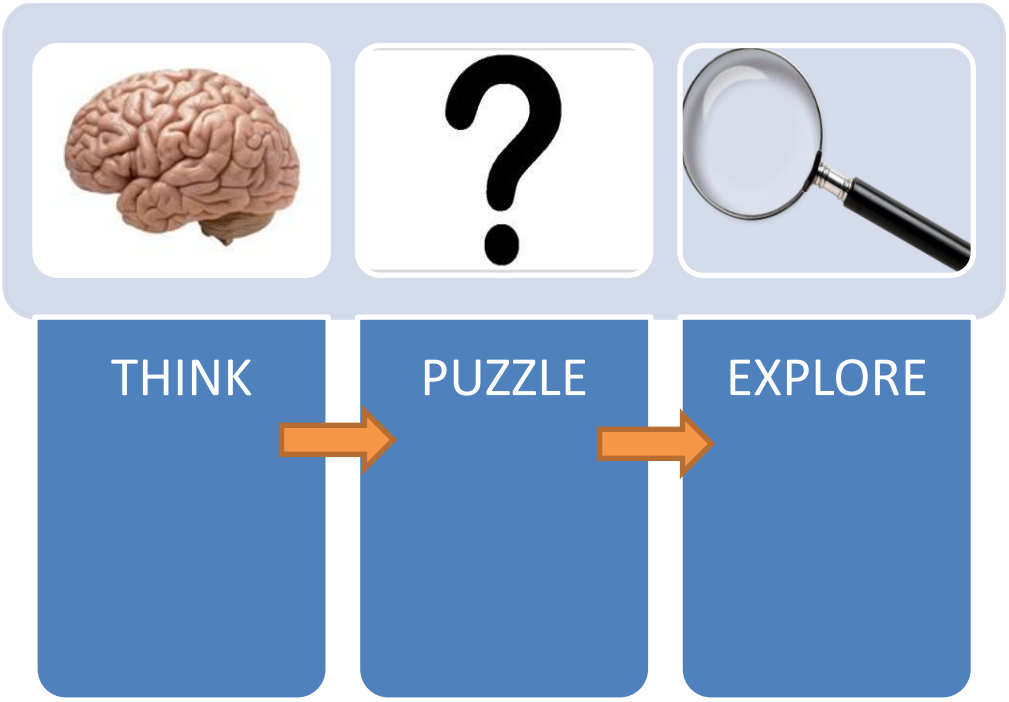

Figure 3: Think, Puzzle, Explore routine template

Fourth session "Main features of a Medieval castle"

Objectives:

- To understand the parts of a castle and their functions.
- To program a sequence of command to get the robot reach the goal.

Description of the session:

Our learning is centred on the investigation of the parts of a castle, their function and the relation among them.

The teacher shows a picture of a castle in the Interactive smartboard. The expert group of students who investigate about the parts of a castle explain some of the most relevant parts they have found. The teacher writes them on the picture to show them to rest of the students.

When all the parts are marked out in the picture, children start to explain their functions. To make a sum up of the parts and functions of the castle, children will have a blank poster of a castle with arrows marking some parts. They have to label those parts to check their understanding. (Appendix 5)

Once they know what the parts of a castle are used for, the teacher asks to the other two groups to think on some changes of the castle. One group will focus in improving the castle and the other group will do it to crumble it.

Now we work with floor robots. Students start from the Start box and they need to plan and combine a sequence of commands to achieve the part of the castle the teacher or another partner asks for.

At the end of the class the teacher asks children to think on a headline of the session worked today. Every student will think a headline to sum up their learning of the day. Then, I ask them to share their ideas to the rest of the class.

Routines:

In this session children are going to work with the "Parts, purposes, complexities" routine. Children carry out a close observation of the castle thinking how it works.
This routine helps students to make a careful observation of the object and think how it works. They focus their attention on its parts, and they wonder about their functionality. When they say some of the parts of the building, children have to think what they are used for.
The teacher focuses on the complexities some parts. Children are asked to think how they could improve or deteriorate the castle making some changes.
Finally, I work with another routine "Headline" where children must capture the core of their learnings of the session. Students think a word or sentence to describe what they have learnt and then they explain to their partners the reason why they used that idea.

Fifth session "Building our Castle"

Objectives:

- To distinguish between fortress and palace.
- To discriminate and to know the parts of a castle and their function.

Description of the session:

Children will learn today the parts and structure of castles depending on their function. The teacher shows a picture of a castle. Children explains only what they see and the teacher writes down, in the see column, the objects and parts that students say.

Now, children have to think what the purpose of those things is they have seen before. To every object seen they must give a function. They will have to analyse sizes, number of items, the position… I will write down in the Think column next to the concerning part.

Finally, the teacher asks them to wonder about the results seen in the previous column.

Some questions that the teacher can ask to help them wonder are:

"Is there much sunlight inside the castle?"

"Why are so few windows?"

"How many towers are there?"

"The towers are big or small?"

Coca Castle. Image from: https://destinocastillayleon.es/index/los-10-castillos-mas-impresionantes-de-castilla-y-leon-2/

When finished the routine, the teacher shows another picture of a castle Children have trained their observation in the previous activity and focus their attention on similar aspects. The teacher writes down again, in the interactive smartboard, in the see column, the objects and parts that students say.

Now, children think the purposes of those new objects seen before. The teacher needs to be careful that students do not make comparisons between this picture and the previous one. They have to analyse again the parts of the castle being objective. I will write down in the Think column next to the concerning part.

At last, students wonder the differences between the first castle parts and the new one.

Alcázar de Segovia. Image from: https://destinocastillayleon.es/index/los-10-castillos-mas-impresionantes-de-castilla-y-leon-2/

To sum up the routine, the teacher will help students to identify that both buildings are castles, but they will start to find differences between them. Number and size of the windows, moat, roofs, number of towers, thickness of walls…

The teacher asks children to think what castle looks stronger at first sight. Then, students will name some of the parts worked the day before and they make some observations about them.

In the next activity, the students will asks to compare one castle with the other. They focus their attention one those features that are similar and those that differentiates.

At the end of the class the teacher explains that there are different types of castles, depending on their function. Some of them were used as fortress to defend a territory while others were used as a palace providing housing for royal families.

The teacher proposes to the students to build a castle with recycled materials. I place smaller cardboard tubes and boxes out. Children create their castles individually or in group with those recycled materials. When the materials are organized with a castle shape I give them glue tubes.

Once the castle has been pasted and the glue dried, children can paint them with brushes or crayons. (Appendix 6)

Routines:

To carry out this session I have worked with two thinking routines:

"See, think, wonder" routine where children find connections between the parts of the castles they have learnt, and the images showed by the teacher.

Showing a picture of a castle children think and wonder the uses of some parts of the castle. Through wondering, children deepen their thoughts and new lines of investigation arise.

Children, after watching the picture, express what they see. It is important they do not make any interpretation at first. Later on, they have to interpret what they see in the think section. At the end, children are asked to think about what makes them wonder about the object or topic.

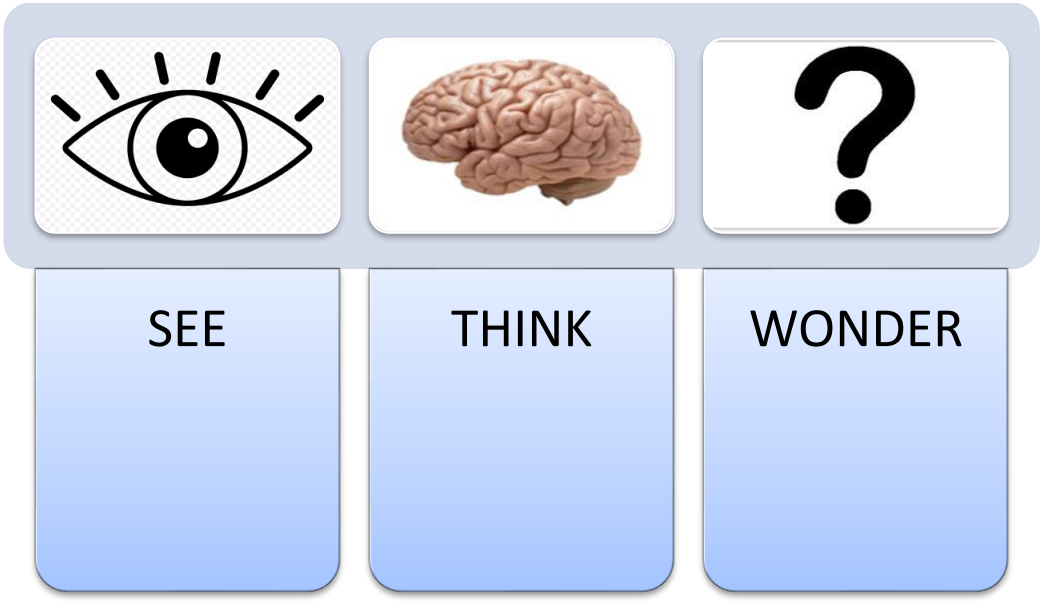

Figure 4: See, Think, Wonder routine template

With the "compare and contrast" routine they will compare that features seen in the routine before in both images. They discover through this routine that despite being two castles with the same parts, those parts are different in size, number, structure… (Appendix 7)

Sixth session "Castle Population"

Objectives:

- To know some of the characteristics of the people who lived in castles
- To understand different views of the life in castles.

Description of the session:

The teacher starts the activity asking students about the people who lived in castles. While children say their names, he put the pictures in the Interactive smartboard. This activity helps students to be conscious of the similarities and differences among them. We are going to focus on 4 groups: Kings and queens; knights, peasants and craftsmen. Students, watching the images, start to make predictions about their lives. Some of the questions asked by the teacher to get some information are:

"How many kings lived in a castle?"

"How many knights lived in a castle?"

"Are there more peasant or knights living in the castle?"

"What do they work?"

After knowing the previous knowledges of the children, the expert group of students who investigated about the life in a castle explains the most important aspects of each social class.

To make it clear, the teacher shows a diagram and writes down the learning outcomes.

Routines:

In this session I have used two techniques:

"Thinking with images" routine where children discover the different characteristics of the social classes that lived in castles through the images. (Appendix 8)

When using the "circle of viewpoints" routine, I want to get students to see and explore different perspectives understanding that there are multiple sides to an issue. They learn about how life was in castle, how they feel and work and gain a broader view and understanding of the topic.

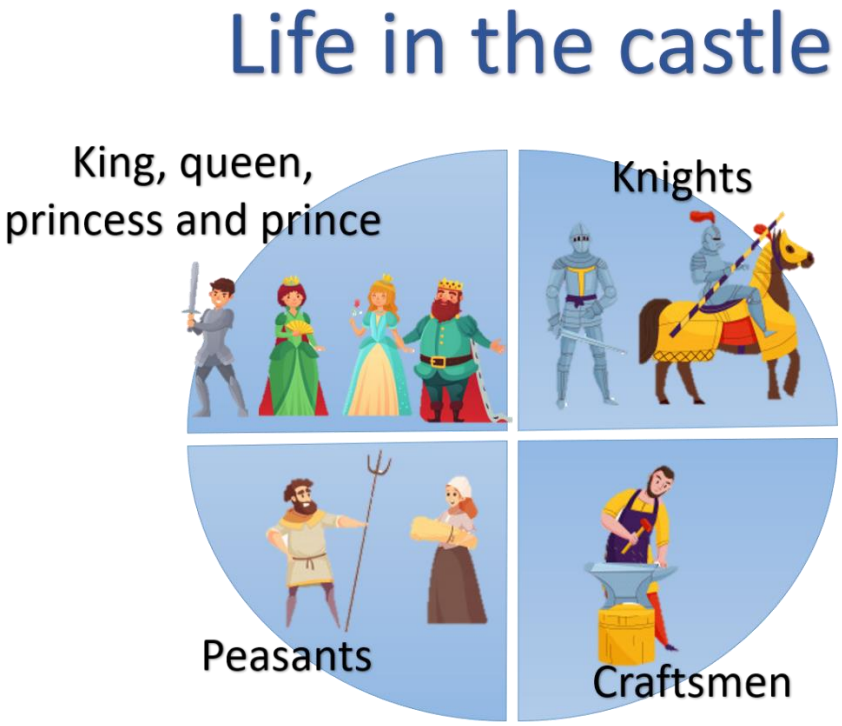

Figure 5: Circle of Viewpoints routine template

Seventh session "Life in castles"

Objectives:

- To identify some of the changes in lifestyle and traditions in relation with the course of time.
- To program a sequence of command to get the robot reach the goal.

Description of the session:

Some of the introductory questions at the beginning of today sessions are:

"What do you do to entertain yourselves?"

"What is a party for you?"

"How do you think people in castles entertain?"

Children explain their thoughts and start to contrast their way of entertainment with the possibilities in Middle Ages. They usually stuck thinking on the impossibility of having television, computers or tablets, few accesses to books… They need to think in different ways of entertainment depending on the social classes studied the session before.

The expert group of students, who were in charge to explore how the life was, shows to the class different cards with images. Each student of the group explains different ways of entertainment (jousts and tournaments, feasts, archery contests, plays, fairs, skittles, listening to Jesters and troubadours, watching to acrobats and conjurers…) through pictures.

Students connect those ways of entertainment with contemporary ones. Then, they make predictions about what activity was aimed to court audience and which ones to general audience.

Now we work with floor robots. Students start from a character (king, queen, knight, peasant, craftsmen) they choose. They have to plan and combine a sequence of commands to achieve a suitable entertainment for their social class. (Appendix 9)

At the end of the session, in big group, the students will reflect on the changes in their way of thinking about Middle Ages entertainment. The teacher will write down their ideas in the following schema.

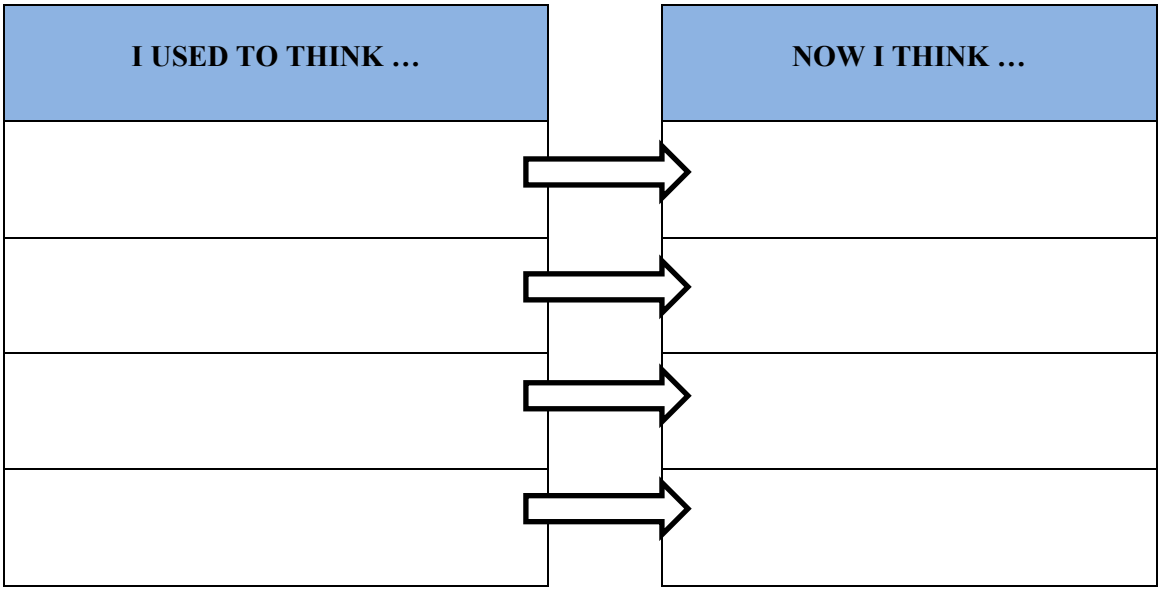

Figure 6: I used to think… Now I think… routine template

The teacher asks them if they still think in the same way and pushes to explain what they know and what have changed.

Routines:

This "I used to think… Now I think…" routine has been used to get students reflect on what their thinking has changed and why. The intention of this routine is that children realize about what they have learned about the topic identifying their understandings, opinions and beliefs.

Eighth session "The Knights"

Objectives:

To discover the world of knights: entertainment, functions, weapons and armour

To identify different types of weapons and their use: melee weapons, ranged weapons, assault weapons and defensive weapons (armours).

Description of the session:

The teacher carries to the class a wooden sword and a shield. Today, we are going to work on knights.

Children identify those weapons and they are asked to enumerate different weapons they know. The teacher adds in the interactive smartboard pictures of the weapons. When children finish creating a list of the weapons, the teacher asks them to sort them in four different groups: melee, ranged, assault and defensive weapons. They go to the interactive smartboard and move the pictures creating a mind map.

Routines:

We have worked with the "Generate – Sort – Connect – Elaborate" routine to help students to generate ideas about weaponry. Children create a list of weapons they know and sort them into four groups depending on their uses. Some weapons may fit more than one group.

While they are organizing the weapons, they elaborate a mental map.

5.2.5. Fifth Stage: Learning Process Assessment

The evaluation process requires to attend to all the things happened since the moment I started the project. That implies that everything the students and I do is important for the learning development of the children.

Assessment is an integral part of the teaching and learning process on a day-today basis. Research has shown that children learn best when they

- understand clearly what they are learning
- know what is expected of them
- receive feedback about the quality of their work
- are given advice about how to make improvements
- are fully involved in assessment and next steps in learning

I have divided the assessment in two parts: Teacher assessment and students' self-assessment

Teacher assessment

The teacher has the responsibility of designing the units and evaluate that them. But also, he must evaluate his way of applying that unit or project with the students, as well as creating an assessment about how much the students have learned during it.

The design

To carry out the evaluation of the design and the routines used I evaluate the following grid:

Routines assessment	
The activity or routine starts from the previous knowledges of the students	Yes/No
The routine is the most suitable to make visible the learners' thinking	Yes/No
Learner has reflected on their thinking process	Yes/No
The routine is clearly structured	Yes/No

Teachers assessment	
I act as a mediator of the knowledge	Yes/No
I give time to students to reflect on their thinking process	Yes/No
I give constructive feedback to support students	Yes/No
I use a suitable range of routines	Yes/No

Students assessment

To assess the performance and knowledge of the students I observe them directly and evaluate their improvement

Students assessment	
Asks questions about the work	Yes/No
Attends when presenting partners and teacher	Yes/No
Analyses individual and group observations	Yes/No
Reflects on individual and group observations	Yes/No
Evaluate individual and group observations	Yes/No
Is able to cooperate and collaborate	Yes/No

Students' Self-assessment

When we have created this project, I have thought about the objectives and competences I want the students to develop.

Thinking in I am working with 4/5 years old kids, I have designed a simple portfolio proposal to help students in their self-assessment. They have to put stickers to write down their own advances and to recognise how and when they learn. (Appendix 10)

The use of the portfolio as a daily tool aims to get that children realize about the different ways of thinking. This portfolio aims to get them conscious about their everyday knowledge.

6. CONCLUSIONS:

This set of methodologies, tools and guidelines promotes an environment of respect and rapport. They use a respectful talk and turn taking, respecting their partners backgrounds and lives outside of the classroom, they became more polite and with an active listening. But also, they realise the importance of establishing a culture for learning, they belief in the value of their work, and through this proposal their expectations are high. Therefore, the quality of their work, their effort and persistence are expected and recognized.

In this methodology the use of questioning and discussion techniques is quite important to make visible what our students know and what they are learning. Questions with multiple correct answers have been formulated even where there was only one possible correct response. The questions were formulated by both students and teachers allowing to the teacher to step out of the main role and acting as a mediator.

This project has engaged students in learning because of the activities and learning tasks required are in connection with the main goals of the lesson. It is important that students have been actively working during the lessons, rather than watching how the teacher works.

Students are encouraged to be curious, to show interest and respect towards all the opinions building a discuss atmosphere in which the ideas are explained. It is important to help students to argue their answers using patterns to assert, to compare, to evaluate or to defend an idea.

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APPENDIX

Appendix 1

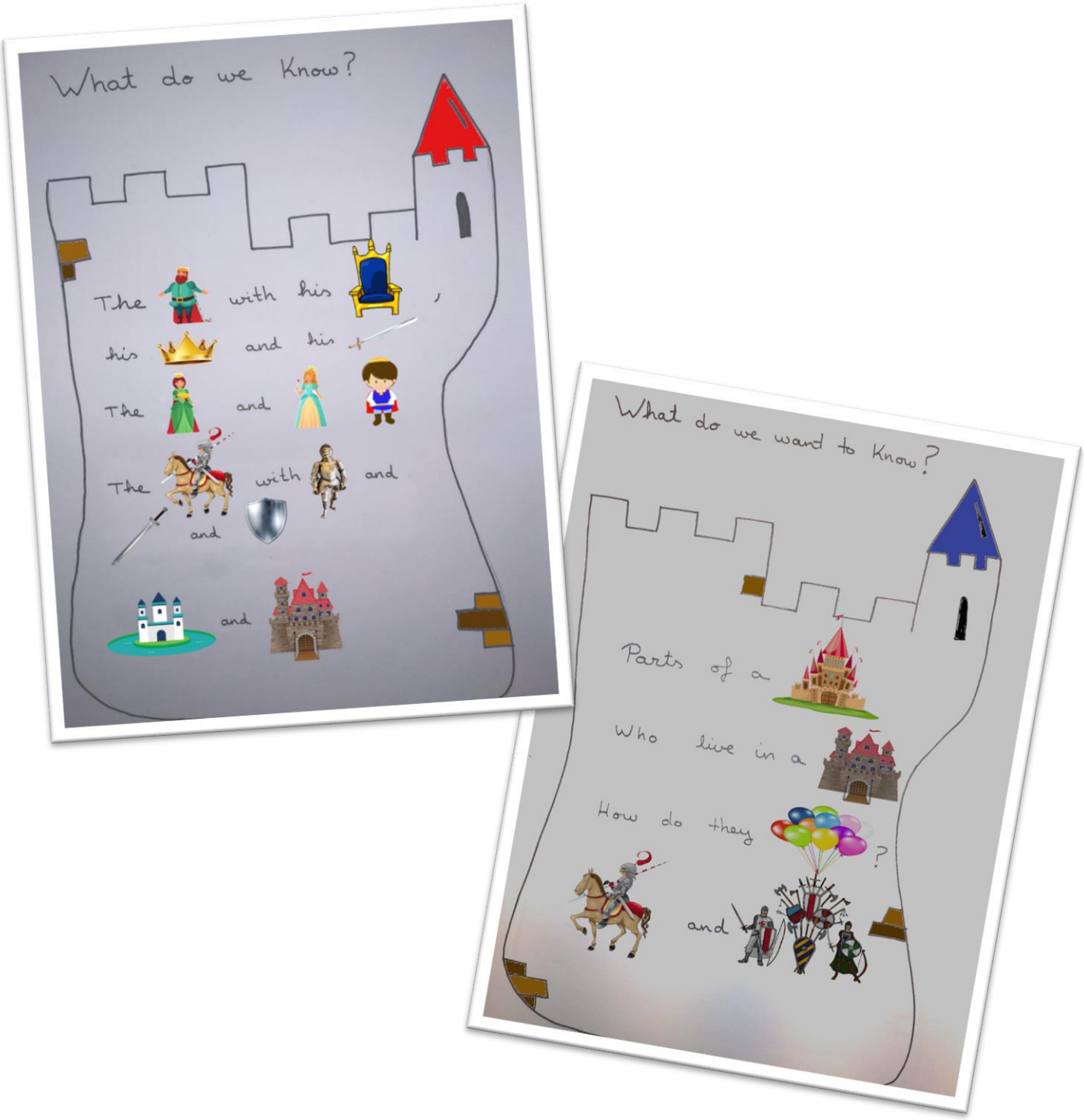
Session	Title	Objective	Routine	STEAM	Task
1	Creating Mind Map	To know the students' previous knowledges about castles. To foster teamwork	What do we know? – What do we want to know? Create a mind map		Mind map What do we know? Chart What do we want to know? Chart
2	Drawing a castle	To discover, to develop and to share ideas through pictures To solve own problems and to help others to solve them	Thinking with images	Make pictures with different techniques (opening doors or windows)	Make a drawing
3	Starting the investigation: Group of experts	To explore and select information. To interpret the information and share with others	Think, puzzle, explore	Build a coat of arms	Create the groups and a build a coat of arms

4	Main features of a Medieval Castle	To understand the parts of a castle and their functions. To program a sequence of command to get the robot reach the goal.	Parts, purposes, complexities Headline	Robotics: Castle learning mat	Picture dictation of the parts of the castle
5	Building our castle	To distinguish between fortress and palace. To discriminate and to know the parts of a castle and their function.	See, think, wonder Compare and contrast	Build a recycle castle	Build a recycle castle
6	Castle population	To know some of the characteristics of the people who lived in castles To understand different views of the life in castles.	Thinking with images Circle of viewpoints		Create a discussion about the way of life in castles
7	Life in castles	To identify some of the changes in lifestyle and traditions in relation with the course of time. To program a sequence of command to get the robot reach the goal.	"I used to think… Now I think…"	Robotics: Entertainment learning mat	Play some medieval games as bowling, jousts, make a medieval dance…

8	The Knights	To discover the world of knights: entertainment, functions, weapons and armour To identify different types of weapons and their use: melee weapons, ranged weapons, assault weapons and defensive weapons (armours).	Generate – Sort – Connect – Elaborate	Create weapons (Shields, swords, catapults…)	Create a Mind map

Appendix 2.

What do we know? – What do we want to know? charts.



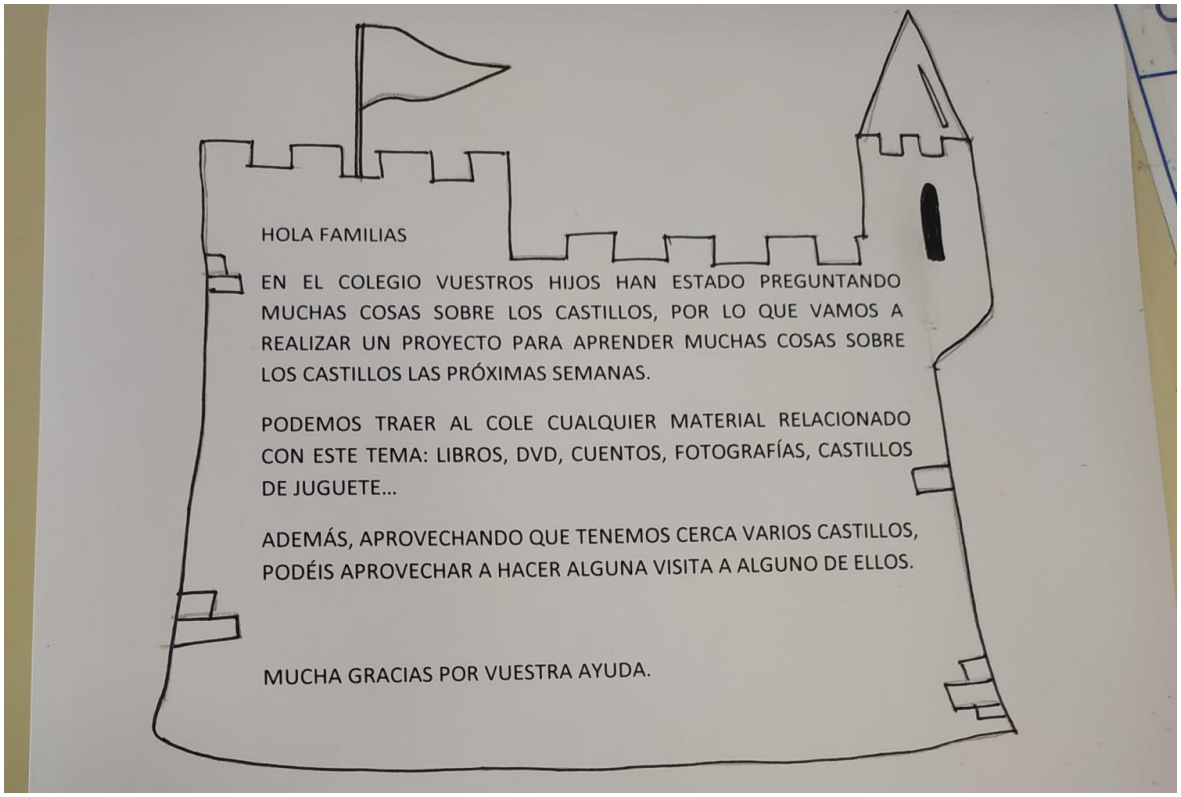
Appendix 3.

Children draw a castle to show their previous ideas.

3 years old picture

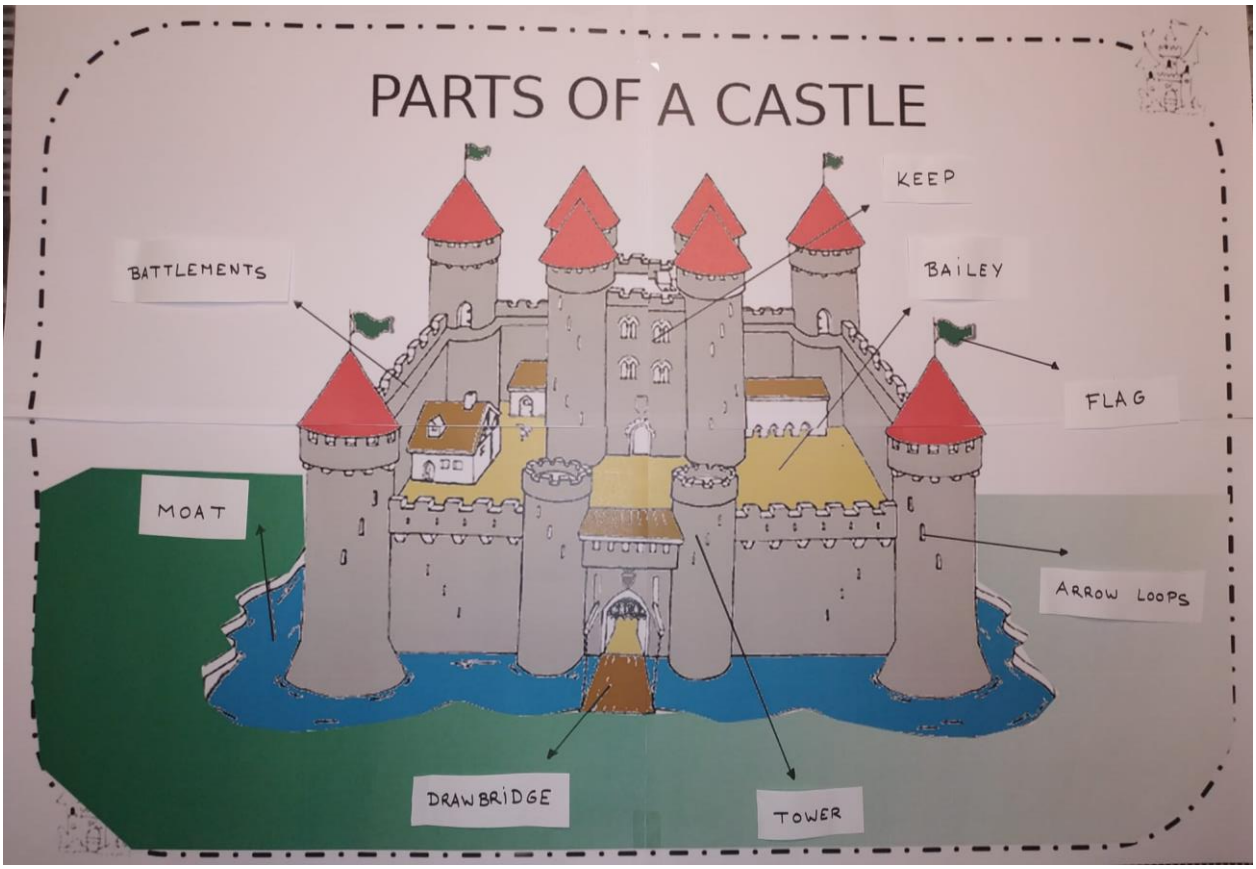
5 years old picture of a castle

Appendix 4.



Circular note for families talking about the project and asking them for documentation about castles to help their children

Appendix 5.

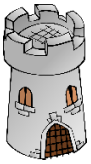


Parts of a castle

Appendix 6.

Cardboard and recycled materials castles

Appendix 7.

COMPARE AND CONTRAST		
 *Coca Castle*		 *Alcázar de Segovia*
SIMILARITIES		
		
		
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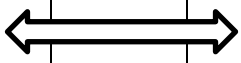
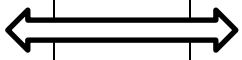
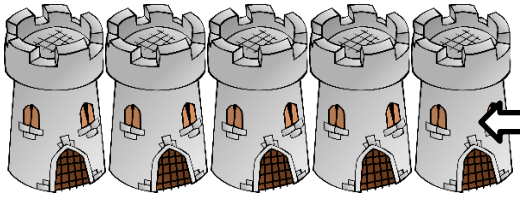
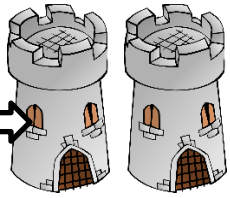
		
		
		

Compare and contrast template

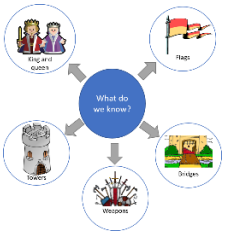
Appendix 8.

Some of the characters work in the project

Appendix 9.

Working with floor robots

Appendix 10.

I create		
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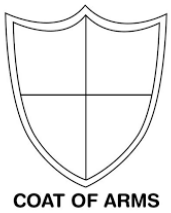
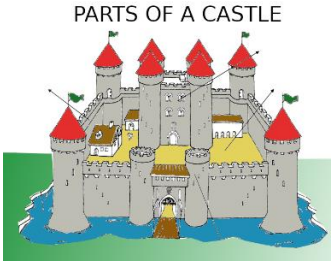
I create a		
I know the		
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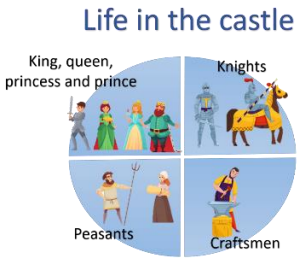
I know about		
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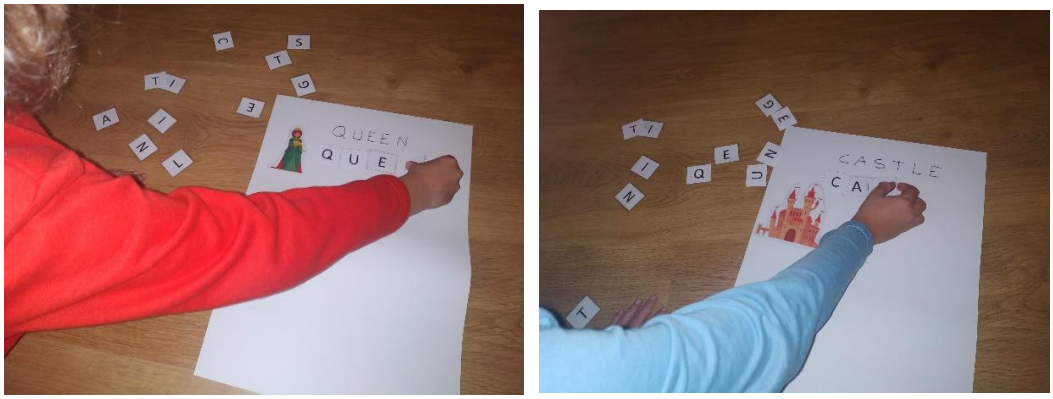
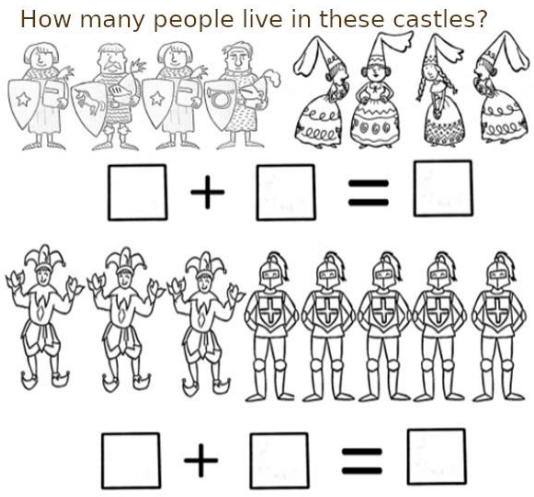
Appendix 11.

Other evidences of the project

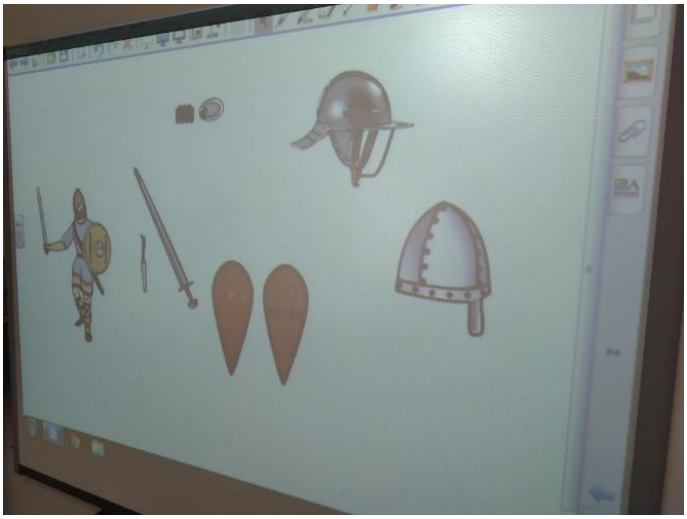
Working with numbers, before and after



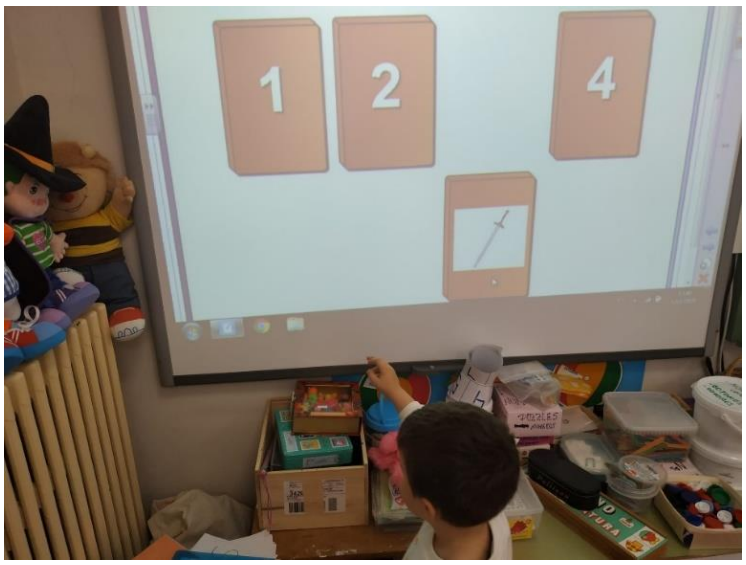
Practice writing



Iniciation to the sum worksheet



Learning about weaponry



Playing memory games about weaponry