Steam Learning for the Development of Scientific Skills in Infants

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Abstract

In infants, teaching strategies focus on play and experiential activities; The development of scientific competencies based on STEAM involves a series of pedagogical approaches, so the purpose of this work was to implement a mini-ecosystem as a teaching strategy. 20 children between 4 and 5 years old from the educational institution "Dulces Brotecitos" participated. The study is developed within the qualitative paradigm, as a case study over a period of 2 months for the operation of the mini-ecosystem and 3 months for its implementation. Non-participant observation, recording of photos and videos were used; and field notebook to analyze the results.

In the findings, 4 and 5 year old children spontaneously and flexibly use their senses to observe different phenomena and objects of everyday life, they also raise hypotheses and make inferences to solve problems. The various experiences presented to infants activate their interest in science, such as robotics.

The STEAM approach, acronym for Science, Technology, Engineering, Art and Mathematics, aims to integrate these disciplines into the educational process and encourage the development of each of them (Pahnke, Janna ; O'donnell, Carol; Bascopé). The approach of STEAM learning sessions at an early age favors the development of skills in these subjects, which will then facilitate subsequent learning (Zollman, 2012).

The objective of this project was to analyze the development of scientific thinking skills in children aged 4 and 5 at the Initial level, under the STEAM approach, working in a Mini Ecosystem, in which the sectors are implemented: the pedagogical garbage dump, games to build and sensory tables. The work with parents, community entities and private companies contributed to the implementation of a mini-laboratory, as part of the mini-ecosystem.

Keywords

Teaching Strategies, STEAM, Mini learning Ecosystem, Scientific Competence.

1. Introduction

The STEAM experience is proposed as a learning strategy called Miniecosystem, it seeks to develop scientific competence, through challenging situations, that interdisciplinaryly relate these areas, in search of creative, sustainable and verifiable solutions for children. It was determined to address the planning and execution of the sessions through the implementation of

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6 sectors: Construction Sector, Sensory Tables Sector, Inquiry Sector, Pedagogical Garbage Sector, and Robotics and Programming Sector.

In the mini-ecosystem, children are encouraged to identify problems, then choose the best space for their resolution. The sectors are implemented with diverse materials, for daily use and safe for handling. In this sense, as indicated in the Guide to free time in Minedu sectors (2009), it is recommended to observe in which setting or sector children feel most comfortable and safe, and where they can best express their creativity and imagination. These experiences strengthen this strategy proposed by the guide as one of the main actions to be carried out by teachers. It also indicates that materials and supplies must be varied and organized in well-defined sectors. In our mini-ecosystem, children find the six defined sectors and with the necessary material to provoke learning and encourage reasoning, creativity, imagination and critical thinking.

In the Inquiry sector, it was sought that, based on the challenges posed, students could develop scientific skills such as observation based on their senses, posing hypotheses and making inferences to solve problems. The 4 and 5 year old children expressed interest in elements of the experiences that were in their environment, they questioned everything, asked themselves questions and made hypotheses and conclusions such as:

Thiago: "why is your body like that (squid)?" (Example raised from the collection of comments from 5-year-old children of the EI. Dulces Brotecitos.)

Eyal: "surely with the ink he hides from his enemies" (Example raised from the collection of comments from 4-year-old children of the IE. Dulces Brotecitos)

Figure 1: Indagation sector

Note: Students in the Inquiry Sector, observing marine animals. Own elaboration

Figure 2: Research Sector
Note: Students observing the squid using their senses. Own Preparation

Figure 3: Research Sector
Note: Students manipulating and discovering what the body of the squid is like. Own preparation

Figure 4: Research Sector
Note: Students describing what the body of the squid is like. Own preparation

"The STEAM education offer must support the acquisition of Century Skills 21, as it has been highlighted, for example, in the 2030 Learning Framework proposed by the OECD. Many good practices and initiatives have developed their offer based on a constructive understanding of learning across 3 domains: Cognitive, social and behavioral. Exploration and learning based on exploration and inquiry are the paths to learning for children and pedagogues, from which they can build new knowledge and skills." Pahnke, Janna; O'donnell, Carol; Bascopé. (2023).

Applying inquiry-based STEAM sessions has allowed children to develop not only the aforementioned scientific skills, but also skills for the 21st century such as collaborative work, development of critical and creative thinking, effective communication, and decision making. It has also allowed teachers to question themselves and find important findings about their performance and the role they play in the classroom as learners.

Massiel: "Then the butter comes out of the milk, and it is because the milk has fat" (Example raised from the collection of comments from 4-year-old children from the IE Dulces Brotecitos)

Figure 5. Research Sector
Note: Students testing their hypotheses about whether milk has fat, through experimentation. Own Preparation

Figure 6. Indagation Sector
Note: Student testing his hypothesis about whether milk has fat, through experimentation. Own preparation

Figure 7. Research Sector
Note: Student experimenting with straining milk after separating the fat through churning. Own preparation.

Figure 8. Research Sector
Note: Student creating new flavors for homemade butter. Own preparation.

In the Construction Sector, the challenges involved the participation of strategic allies of the STEAM MINIECOSYSTEM, such as the Municipality of the Commune and the Private company, ORICA Mining Services. Field visits were established, as well as

interviews with STEAM professionals. Starting from contextual situations that involve solving real problems allows learning and context to be articulated, empowering the significance of what is learned. "In this regard, it is established that meaningful learning is opposed to rote learning, which means promoting understanding instead of memorization; This means that the child's discovery and experiences must be prioritized, rather than memory, repetition and training, since the latter become an obstacle to the development of scientific skills in early childhood" Carbajal, Paola; Gallego, Adriana; Vargas, Enid; Arroyave, Leysy. (2020). In these experiences, students, based on field visits, reconstruct their lived experience in the sector, challenged to create a mini-scale prototype that can be the solution observed and/or another solution created by them. (The construction of a retaining wall for a sector of the community was visited). They asked questions on the work based on observation, raised hypotheses, executed the prototype, tested it and finally concluded.

Gustavo: "The retaining walls serve to protect the population from landslides. My dad is a builder and he says they are important because otherwise people could be crushed to death" (Example posed from the collection of comments from 05-year-old children from the IE. Sweet Sprouts.)

Angely: "I saw a news story on TV, that with the rain a wall was falling" (Example posed from the collection of comments from 5-year-old children from the EI. Sweet Sprouts.)

Figure 9. Construction Sector
Note: Students on field visit. Retaining wall work. Own preparation.Figura 10

Figure 10. Construction Sector
Note: Students, engineers, teachers finishing the field visit to the retaining wall work
Own preparation.

The Pedagogical Dumpster is the sector in which children, based on the desire to satisfy the innate curiosity they have to know how things, objects, work; They can do it through the disassembly and assembly of electronic equipment. It is necessary to mention that this equipment were donated by the Municipality, and were examined so that their handling is not risky or dangerous for children. The Guidance Guide for the use of the science module for children from 3 to 5 years old, Minedu (2012) indicates: "We know then that they have capacities that are innate to them, such as curiosity, admiration, surprise and the tireless desire to investigate. : observe, explore, experiment, question, investigate, seek answers to your questions, reason, discuss, share ideas and build your knowledge." In this sector, children have the possibility of discovering not only how these objects work; but to feel free to do so.

Liam: "I always wanted to know how computers worked, but my mom doesn't let me touch it at home" (Example posed from the collection of comments from 4-year-old children of the EI. Sweet Sprouts.)

Cielo: "I would love to be a professional in assembling computers, I like the way the cables look and also the keyboard; I think I can help many people when things go wrong" (Example from the collection of comments from 4-year-old children of the EI. Dulces Brotecitos.)

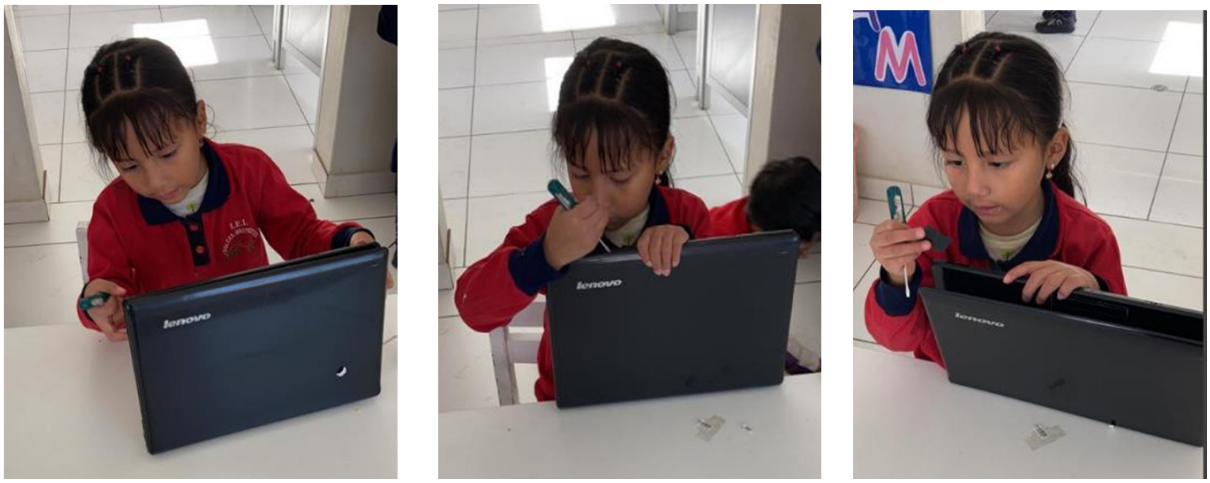

Figure 11. Pedagogical Dumpster Sector
Note: Student, in the process of disassembling a laptop. Own elaboration.

Sensory tables are materials that promote learning through discovery. Infants are amazed by natural phenomena and the discoveries they find in their play, such as: Why do some objects float and others don't? Why can I see colors when there is light?, etc. "As we see, the many questions that children ask themselves after interacting with their reality in each "experiment" are what invite them to continue investigating and building their explanatory theories of what happens around them: they ask questions looking for answers, seeking to satisfy their curiosity and "take

ownership" of the things that surround them. It is a way of getting to know your world" Carbajal, P; Gallego, A; Vargas, E; Arroyave, L. Scientific competencies in Early Childhood boys and girls. (2023).

Juan Adriano: "Wow, red and yellow together in the light give orange" (Example raised from the collection of comments from 04-year-old children of the IE. Dulces Brotecitos.)

Eduardo: "Look miss, I discovered how the green comes out, look friends; Just put the blue and yellow together on the table. I put double yellow so that it came out light green" (Example raised from the collection of comments from 04-year-old children of the EI. Sweet Sprouts.)

Figure 12. Sensory Tables Sector
Note: Students at the light table, experimenting with colors. Own elaboration.

Figure 13. Sensory Tables Sector
Note: Students at the light table, observing different objects. Own elaboration.

Robotics and programming contribute to the STEAM Miniecosystem strategy, the use of materials (Blue bots) as tools to develop skills in areas such as mathematics, communication, etc. Also making possible the development of socio-emotional skills such as empathy, self-control, resilience, collaborative work, decision making. "RE is conceived not only as an end in itself but as a way that allows problem-based learning, where students must collaborate to solve challenges in this way, their cognitive and communicative skills are enhanced around the meaningful learning of curricular contents" Moreno, V; Rodríguez, F(2023).

Figure 14. Robotics and programming sector
Note: Students making trajectories on the large grid. Own elaboration.

Figure 15. Robotics and programming sector
Note: Students carrying out trajectories programming the Blue Bots. Own elaboration

Figure 16. Robotics and programming sector
Note: Students carrying out different trajectories on cards with different challenges to reach a goal. Own elaboration

2. Development

The earth is going through not only environmental problems, but thanks to globalization it has been proven that the problems that affect one country have a direct impact on the entire world;

That is why it is crucial to educate all children to be sensitive and respond appropriately to everyday problems.

“A powerful and sustained implementation of future-oriented science, technology, engineering and mathematics (STEM) education that focuses on critical issues such as those highlighted by the SDGs, as well as potential solutions to These will provide tools to young people, their teachers and their parents, to face social and health problems that can negatively affect their lives” Pahnke, Janna; O'donnell, Carol; Bascopé. (2023).

The education of preschool children according to the Initial Education Curricular Program

(2017) points out that children “Are subjects of law, who need specific conditions to develop; subjects of action, capable of thinking, acting, relating and taking from the environment what they really need to grow and modify it." The context we are going through as well as the guidelines for the training of infants fit perfectly, requesting an education focused on the development of skills that allow children to be active agents and take part in searching for solutions.

The Initial Educational Institution “Dulces Brotecitos” was founded as such in the year

2019. Previously, it fulfilled the role of an out-of-school program with a population of 10 children per classroom. Currently, 25 children are served in the classroom. The area where it is located is characterized by families with limited economic resources, most of them are informal and temporary workers in mining and commerce. Likewise, the school is located in a district considered an area of direct impact of the Mine, since very close to the population there is one of the largest and most significant mining companies in the country, as well as other important companies dedicated to the mining sector.

In this sense, alliances with private companies, as well as the communal Municipality, are strategies that were used to carry out this study. These being part of the Mini-ecosystem where the families of the school children live and coexist and are mobilized by direct responsibility with the formation of future citizens capable of living in harmony and peace; capable of facing problematic situations using reasoning, criticality and creativity to seek sustainable solutions for their commune.

3. Performed Activities

3.1. Formation of the STEAM Miniecosystem and implementation of the laboratory

Calling on parents from the educational institution to publicize the project and make them active participants in their children's education was one of the biggest challenges faced. They were involved by explaining with experiential examples in Workshops, the importance of forming a STEAM Mini-ecosystem.

From the formation of the Miniecosystem with parents, they are the ones who propose to involve the private company and the Municipality of the Commune. Discussions and presentations of student learning were held to achieve their incorporation. It is important to mention that the private company Orica Mining Service supports the district's schools serving students at the primary and secondary level with the purchase and coaching of a platform of Australian origin called Stempuk for STEAM education; However, upon learning about the project they were surprised because they did not know that it could be applied to infants and they committed to being active members of the project.

With the Miniecosystem formed, the implementation of the Laboratory in the school began. Closed spaces were adapted with furniture and materials to have the six learning sectors, where the STEAM learning experiences were carried out.

Figure 17. STEAM Mini Ecosystem Laboratory
Note: Entrance to the STEAM Miniecosystem Laboratory. Own elaboration

Figure 18. STEAM mini-ecosystem
Note: Mothers of school families, teachers, officials and mayor of the district Commune, official of Orica private company, children of the Educational Institution; members of Miniecosistema STEAM at the Inauguration of the Laboratory. Own elaboration.

3.2. Learning experiences in STEAM sectors

The experiences of the inquiry sector address contextual challenges such as the consumption of milk derivatives, with infant nutrition being an immediate problem to address. In this experience, children are challenged to find different ways to consume milk through its derivatives, specifically butter. They produce prototypes of homemade butter. Observation through all their senses made it possible for infants to ask questions about milk and its characteristics. "As we see, the many questions that children ask themselves after interacting with their reality in each "experiment" are what invite them to continue investigating and building their explanatory theories of what happens around them" The Guide to guidance for the use of the science module for children from 3 to 5 years old, Minedu (2012)

Massiel: "Look Yamileth, when you put the detergent in the milk, the fat escapes; like when my mom washes the dishes" (Example raised from the collection of comments from 4-year-old children of the EI. Dulces Brotecitos)

They formulate hypotheses against the challenge established through a question, they carry out experiments and verify their hypotheses, finally they conclude.

Bayolet: "Today I teach my dad to make butter by churning milk. He is not going to believe that we can make it with milk, always buy it from the store" (Example raised from the collection of comments from 5-year-old children of the IE. Dulces Brotecitos)

The marine world and the diversity of fauna that lives in it led the children to wonder if all those animals that live in the sea were fish. An experiential experience of dissection of a squid was carried out and from this the guided inquiry was carried out. The conclusions that the children reached from the experience were that not all marine animals are fish. As well as other important findings about the anatomy of the squid, the way they move in the sea, and something that caused an impact was the way they fed and defended themselves with the ink they produced.

Alejandro: "Squid are marine animals that are different from fish, I like that they have two large tentacles to hunt. Its mouth is shaped like a beak" (Example raised from the collection of comments from 5-year-old children of the IE. Dulces Brotecitos)

Field visits are part of the Miniecosystem strategy. The children visited the construction of the retaining wall in an area of the district, and conducted interviews with its workers with STEAM professions. Some of the most interesting questions they asked during the visit were:

Thiago: "What would happen if there was no wall?" (Example raised from the collection of comments from 5-year-old children of the EI. Dulces Brotecitos)

Bruce: "But if there is rain, where would the water fall? (Example raised from the collection of comments from 5-year-old children of the EI. Dulces Brotecitos)

In this experience, two main areas of STEAM were articulated, engineering and mathematics. The children replicated a prototype of a retaining wall with building blocks to stop the sand from crushing the dolls that represented the communal district sector.

The sensory tables allowed different experiential experiences to be carried out through spontaneous play. The children discovered that some objects floated and others did not. The hypotheses they raised are based on this experience and the relationship with their previous knowledge. The infants indicated that light objects that have no weight are those that float; while the heavy ones sink. They answered some questions asked by the teachers, such as

If you indicate that light objects are the only ones that can float, and heavy objects sink; So what happens to the big ships that sail on the sea? They began a guided inquiry process, where the experience was planned using aluminum foil, first experimenting whether the boat made with it floated and then crumpling it like a metal ball that sank. They answered the question: What happened? Rethinking your hypotheses:

Enrique: "What happens is that, not only should they be light but empty, like an empty bottle. That's how boats are and they float" (Example raised from the collection of comments from 4-year-old children of the IE. Dulces Brotecitos)

Lionel: "Boats have that thing that rotates, it gives them speed so they don't sink. Since swimmers move their arms like this (stroke gesture) they also move and do not sink. (Example raised from the collection of comments from 4-year-old children. "Dulces Brotecitos")

Figure 19. Research sector experience
Note: Children experimenting with different objects on the water sensory table. Own elaboration

Figure 20. Research sector experience
Note: Children writing and drawing their hypotheses about objects that do not float. Own elaboration.

Figure 21. Research sector experience
Note: Children testing their hypotheses with aluminum objects on the water sensory table. Own elaboration.

Robotics and programming as a teaching resource to develop skills were of high cognitive demand for the infants. "Constructionism, which emphasizes the value of ICT as powerful mental construction tools, useful for developing complex thinking in students; as long as their incorporation is encouraged through strategies where they build interesting and even fun learning products within the framework of innovation environments." Vicar, C.

(2009). The challenges revolved around programming the bot to reach a target via a trajectory (the shortest and fastest). Children show a positive attitude and excitement when programming with Blue bots.

Infants make trajectories using their body on the floor grid, using pieces of concrete material marked with arrows or directionals; Finally, they program the bot to make the same trajectory, on the grid of the tables. They verbalize their actions by creating sequences, counting with numbers, verbalizing spatial location with terms such as forward, back to the right side, left to the other side.

The areas of Technology, as well as Engineering, Mathematics and Communication, are developed interdisciplinary; ensuring that children develop different skills.

4. Results and Progress

The Initial Education Curricular Program, Minedu (2017) indicates; that one way to organize the competencies in an articulating way is through the six areas: Personal Social, Psychomotor Skills, Communication, Spanish as a Second Language, Mathematics and Science and Technology.

- In the area of Social Personnel we had the result that the children are capable of living together democratically, they promote and comply with agreements to use the sectors. They are able to express their emotions by working collaboratively on inquiry experiences, as well as their tastes and preferences in the pedagogical garbage sector by interacting with different materials.
- Robotics and programming played a fundamental role in developing different skills in the areas of Communication, Mathematics and Psychomotor skills in a transdisciplinary way. The infants were able to verbalize and write the different actions when programming and carrying out the different trajectories with the Bots. They mathematized the challenges that were given to them, that is, they translated the problems from common language to mathematical language (paths with spatial notions and directions, number of squares to cover, comparison of quantities more than less than, etc.), generating their own strategies to resolve them. Using your body as the first strategy to move through walks,jumps with two feet, square by square, on the floor grid, as indicated above.
- The experiences at the sensory tables, field visits, pedagogical garbage dump and inquiry sector; They made it possible for children to develop skills in the area of Science and Technology. When making observations using all your senses as in the experience of squid, derived from milk, or when trying to answer the challenge: Why do objects float? It allowed us to describe its characteristics, ask questions about the experience; as well as pose hypotheses, modify their hypotheses, then test them and finally conclude and communicate their results. They satisfied their curiosity by freely disassembling and assembling objects
electronic devices and found findings about how they work and how dangerous it is to use them without supervision.
- In that sense, we can affirm that scientific competencies were developed, and also in a transdisciplinary way the competencies of all curricular areas of the Initial level Curricular Program, improving the educational quality of children at the initial level.
- The methodological strategy of Mini STEAM ecosystem is an educational model for teachers of the level that allows them to achieve the standards of curricular competencies, promoting challenges that children solve through play in different sectors; as well as developing skills for the 21st century: teamwork, development of critical and creative thinking, effective communication, autonomy, in contexts of real significant situations, bringing them closer to sensitivity and decision-making to improve and preserve our world.

5. Analysis and Reflections

One of the strengths of the Steam Miniecosystem as a learning strategy is that it was possible for the infants to develop skills in the area of social personnel, such as living democratically in the laboratory, establishing and fulfilling agreements proposed by them, developing their identity through manifestation of their tastes and preferences in the gaming sectors, and respecting that of others, as well as the achievement of collaborative work by solving the different challenges proposed in the activities. “The orientation of individual actions towards certain explicit and reflective values allows us to act from the local environment in such a way that we also take responsibility for the world around us, combining our "personal identity, local identity and global identity" as we use our STEAM knowledge to do social good” Pahnke, Janna; O'donnell, Carol; Bascopé. (2023). The systemic approach developed in the Miniecosystem learning experiences allows children to develop scientific skills and also skills that in the future will be reflected in society as good citizens with civic commitment.

The experiences of infants through Robotics and programming as teaching material for the interdisciplinary achievement of mathematical, communicative and psychomotor skills, demonstrate that children at the initial level are capable of solving challenges, using play as a strategy to achieve this. It is important to highlight that the proposed experiences are aligned with the achievement of standards of the Initial level Curricular Program; Therefore, the gap of thinking that STEAM does not agree or is not compatible with the achievement of curricular areas was overcome. On the contrary, it reaffirms its importance as an educational strategy for improving the educational quality of infants and a model for teachers. at the initial level, in contrast to those in Korea, "Lack of alignment between STEM curricula and limited opportunities for early STEM education have caused some children to fall behind during the crucial period of learning and development. While following the mandatory play-based Nuri curriculum, practitioners in this study should consider improving children's computational thinking skills, using materials such as KIBO, that are appropriate for children's developmental stages, and preparing an environment for children to experience technology and engineering" Sung, J; Lee, J; Chun, H. (2023).

6. Conclusions

The learning strategy of the STEAM Miniecosystem is based on a systemic approach that focuses on the development of scientific skills in early childhood and to achieve this it not only focuses on the role of teachers, but also on that of parents as active agents in education, community leaders and leaders of private business; involves them as trainers and decision makers in the education of future citizens.

The implementation of the six sectors in the Laboratory as part of the STEAM Mini-ecosystem strategy, for the development of scientific thinking: demonstrated that through significant contextual situations in its environment, inquiry-based learning is promoted, skills such as observation, the formulation of hypotheses, checking the hypotheses through exploration, drawing conclusions, achieving

a reflective, transformative learning oriented to action and centered on the child as the main actor in the construction of learning.

After this analysis, based on the implementation of the STEAM Miniecosystem strategy, it is important to highlight future research topics, in order to identify possible challenges in its application in early childhood, such as the impact on children with different abilities. , and the application of the strategy with 3-year-old children.

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