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Physical Phenomena to Promote The Learning of Physics in Mexican Preschool Education

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Abstract: The idea of global interdependence and solidarity, which must unite us as a society for the peaceful and equitable promotion of a sustainable future, is one of the main arguments that international organizations have raised and are intensely dedicated to researching and building systems around the world. However, few countries have managed to leave behind the "impressive curricula" of science, in which the idea is conveyed that it is made by and for superhumans, resulting in few choosing a career in science. Given this situation and the technological advances brought about by AI, it is important to rethink the teaching of physics in Mexico. Physics is still considered an unattractive, inaccessible subject with little exploration in basic education; despite it is one of the favourite sciences of people who, in the early stages of their development and without knowing that it is physics, show great interest in the phenomena that surround them. These are some of the questions that children explore and try to explain. But today there are no solid and contemporary strategies that address and investigate this theme to make possible to promote physics from an early age for children and the training of teachers.

Keywords: Physics Education, Physical Phenomena, Preschool Education

Introduction

Currently, teaching physics from basic levels has been little studied and relegated to primary education levels around the world, there are few countries that have accepted the challenge of researching and teaching physics; the purpose of this research is to investigate those experiences and successful educational policies that should be considered. Teaching physics from pre-school level is fundamental to foster children's natural curiosity, stimulate the development of critical thinking and problem solving skills, and it has been shown in studies from countries such as China, Switzerland and Japan that it is possible to lay the foundations for future learning in areas such as science, technology, engineering and mathematics by introducing students to a natural learning environment related to topics of interest to them and the world around them, promoting creativity and exploration.

However, people are often unaware of the benefits of studying physics, and it is often associated with the study of abstract or very difficult topics, with a boring subject that requires a high level of math skills, as well as having no practical application in daily life related to astronauts or black holes (Mbonyiryivuze, A. et al, 2020; Guido, 2018; APS, undated) and therefore has a negative impact on students' motivation to choose careers related to physics. In countries like Spain, "research in science teaching has repeatedly shown serious school failure, as well as the lack of interest and even rejection generated by scientific subjects" (Vilches and Gil, 2008), leading to a crisis of scientific vocations. As the authors declare, it concerns factors related to students, the subject, and teacher training.

In Mexico, physics has been relegated to the official curriculum until the secondary level curriculum, (SEP, 2022) having opportunities to address it from the preschool and primary level, with the study of natural phenomena (Solbes, Monserrat, Furió, 2007; Flores, 2012; Cuevas et. Al, 2016) but, due to a lack of understanding or training on the subject, teachers often omit it.

Methodology

The research methodology was based on Hernandez-Sampieri's (1997) technique of 'literature review', which consists of "detecting, obtaining and consulting the bibliography and other materials that may be useful for the purposes of the study, as well as extracting and compiling the relevant and necessary information that pertains to our research problem (available in different types of documents). This review is selective. The process consists of (Table 1)

a. Identifying sources of information
b. Guiding the selection of information
c. Extracting the necessary information, integrating it and developing the theoretical framework.

Table 1. Literature review. Own elaboration

	Literature review
Stage	**Guiding questions**
Sources of information	Primary, secondary and other source Types: articles, books, interviews, videos, etc.
Selección de informacion	Does the information relate to the research, how, what aspects does it address, from what perspective does it address the topic?
Marco teorico	Identification data, year, country, variables, categories, strategies, resources, etc. Outline of the main idea a. why, how and when a phenomenon occurs. b. make forward-looking inferences about how a phenomenon will manifest itself or occur given certain conditions. c. make forward-looking inferences about how a phenomenon will manifest or occur given certain conditions. d. define utility, advantages, disadvantages, areas of opportunity.

New technologies and Artificial Intelligence

The advancement of new information technologies and artificial intelligence has led to a rethinking of the role of teachers in an increasingly near future (OET, 2023; Chan C., and Tsi L., 2023). Various technological innovations and artificial intelligence are being used globally as effective teaching strategies that reinforce what is learned in school (UNESCO, 2023). In addition, efforts are being made to create technologies that gradually support the teacher's work in the classroom (Rodway, P. and Schepman, A., 2023), despite the general fear that the teacher's work could be replaced by AI (Kolchenko V., 2018).

Given this panorama, it is the task of classroom teachers, government educational organizations, teacher training schools and society in general, to consider what the teachers' position is, what paths should be taken and what adjustments or strategies should be considered to adapt to the changes that the digital age is leading us to.

The importance of physics for science education should not be overlooked (Ukoh, E. and Nicholas, J., 2022; Bitzenbauer, P., 2023). New technologies and artificial intelligence have great potential to positively impact the science and physics curriculum (Ellermeijer and Tran, 2019) as they can 1) change the relevance of physics in the lives of students and society in general (Nehra, 2022), 2) make physics more engaging and interactive (Banda and Nzabahimana, 2022), and 3) present a greater opportunity for accessibility for students who have different learning styles (Physical Sciences Consultorium, 2023) or have barriers to learning.

There are numerous opinions, doubts and skepticism about the extent of reforms that can be implemented to integrate technology into classrooms on a large scale (Donovan et. al. 2013), especially in countries that have problems with educational infrastructure. Challenges related to the training of teachers, who should receive timely support so that they can effectively use these technologies in classrooms (Dagdilelis, 2018); in addition to the costly expenses that this initiative may represent, making it difficult to implement. Nevertheless, there is a generally positive opinion in different sectors of society that affirm that the benefits that this initiative would bring outweigh the numerous challenges (MEXT, 2011).

Why start with preschool education?

Only a few countries have chosen to include the study of natural phenomena or physics in their official curricula from the first years of school. A notable example is the Swedish education system, which reformed its curriculum in 2011 to include the study of physical and chemical phenomena from pre-school age (Redfors et. al., 2022). China has also included a section entitled “Basic knowledge of natural phenomena” in its official curriculum, covering topics such as the sun, moon, stars, climate and seasons (CERNET, 2001).

The argument of both the Chinese and Swedish ministries for these initiatives is that teaching physics from preschool can help children to 1) develop a natural curiosity about the world around them (Swedish Ministry of Education, 2018) and create a suitable environment for children to construct their answers that explain natural phenomena while considering the opinions of others on topics such as energy, technology and the environment; 2) develop an early interest in science and technology; and 3) develop important skills such as critical thinking and problem solving (Redfords, et. al, 2022).

In Mexico, these topics have already been included in the preschool education curriculum, such as learning based on experience through the study of natural phenomena or processes that take place around the child (SEP, 2022). Within this framework, the SEP proposes transcendental points to consider for teaching, such as a) the importance of playing with physical objects that can be manipulated, b) the need for practical experiences that give agility to conceptual knowledge and make it usable in everyday life, and c) the importance of linking content to other areas of study such as mathematics.

The SEP has also created opportunities to professionalize science teaching in preschool through courses such as "Experimental Work in Teaching Science in Preschool Education I" (SEP, 2012) and "Learning through Projects in Science Education", "Doing Science, Experimenting and Transforming", etc. (SEP, 2023) offered by the system unit for teacher careers. However, teachers' doubts and skepticism about the new direction taken by the Mexican Ministry of Education's strategy are due to factors related to their professional ability to teach science, didactics, teaching materials, the resources and infrastructure available to them and the strategy to be trained (Ramírez et. al., 2015).

Physical phenomena

According to the Swedish Ministry of Education (2011), teaching physical and chemical phenomena at preschool age is crucial as it helps children to develop a better understanding of the world around them, to learn the basic principles that make up the world and matter, and to know how some objects work and why some astronomical or chemical events take place (Glauser-Abou, Pahl and Tschiesner, 2022). Improves children's skills in problem solving, critical thinking, prediction of phenomena and invention (Balanzario, 2017).

According to Piaget (1964) and his theory of cognitive development, between the ages of 3 and 5, cognitive processes such as symbolic thinking take place in the child's brain, allowing them to represent reality or objects through the symbols; cause and effect thinking, where children learn that events have a cause and an effect and can practice their observation skills at this age; classification and comparison, in which children group objects based on their characteristics and similarities; Trial and error, in which children create hypotheses or assumptions that explain a phenomenon or event and test them through experiments.

In addition, curiosity is a constant attitude at this age (Blake and Howitt, 2012) that allows them to ask questions about the world around them and, above all, natural phenomena (physical and chemical) are what draw their attention most attracts most attention (Solís, 2017). The authors mentioned agree that children satisfy their curiosity, even in play, by unconsciously developing scientific processes such as observation, experimentation and the creation of hypotheses (assumptions).

Asking children to explain physical phenomena such as rain or rainbows forces them to think more reflectively about the world but based on experiences they have had in their daily lives. This can help them develop the skills needed to succeed in other areas of their lives, such as math, engineering, art, literature, and science.

Methodology

Methodology for teaching physical phenomena.

Some important features of the teaching methodology that stand out from pioneering countries in preschool physics education such as China and Sweden are based on the idea of "learning by doing" (Swedish Ministry of Education, 2018), which allows children to start and explore their previous ideas and what they want to learn (CERNET, 2011). Studies from both countries show that information technologies (ICT), and educational games serve as a strategy, experiments, and STEM (Redfords et. al., 2022,; Hamdan, 2020; Fridberg et al., 2000 ; Spektor, O., Baruch, Y., and Mevarech, Z., 2013) as preferred methods.

A model of a Swedish class investigating a physical phenomenon or didactic situation is shown in the following map (Figure 1).

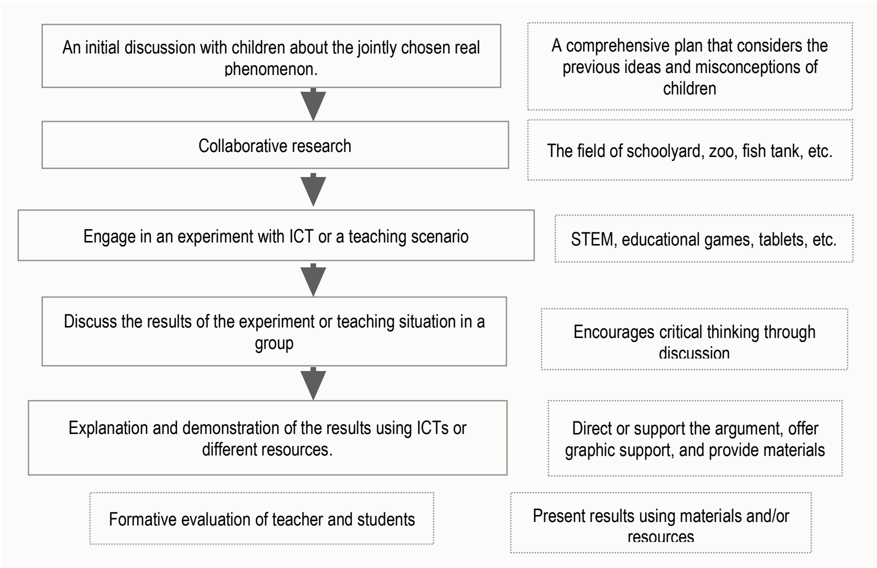

Figure 1. Map "The Swedish class"
Source: own elaboration

It must be considered that it is not a linear sequence, but that the processes are flexible, and the teachers are the ones who must explore the options they will offer to the students, based on the context, interests and style and rhythm of the students.

On the other hand, the Mexican educational system has proposed the methodological strategy of "scientific reasoning" (SEGOB, 2022), which is a way of reasoning based on strengthening skills such as exploring, interpreting, modelling, arguing and explaining the environment. Critical thinking is promoted through an axis that links the three levels of basic education (preschool, primary and secondary). As shown in Figure 1. Critical thinking.

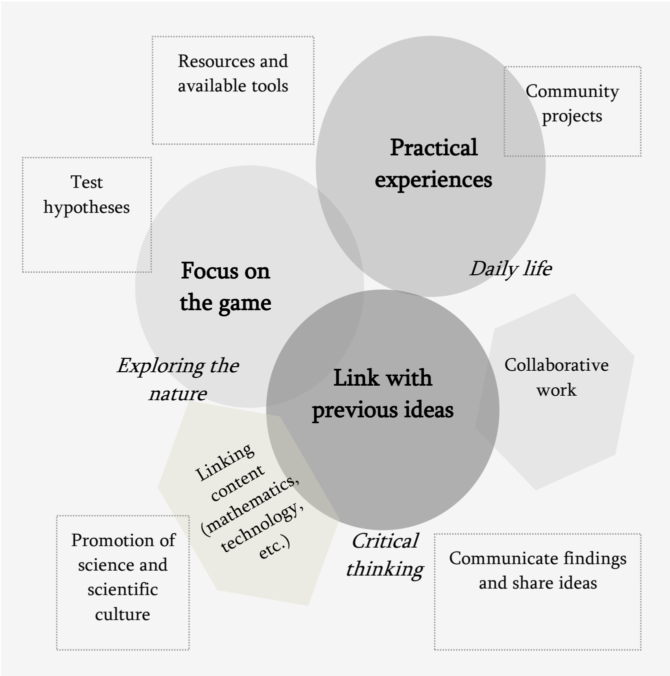

Figure 2. Critical thinking.

It should be noted that the Mexican Ministry of Public Education ascribes to the science curriculum in pre-school education the character of promoting scientific culture and not the theoretical aspect of the study of science. Therefore, in the recent reform of the curriculum, it decided to make the rules more flexible and to give teachers the freedom to choose the content according to the learning areas and the interests of the children (SEP, 2022).

The role of the teacher is of fundamental importance for the management and implementation of science lessons. They must respond to the children's doubts and questions about the phenomenon being studied or the didactic situation, establish a link between what they know and what they want to learn, and always consider the children's ideas about the object or phenomenon being studied (Fridberg, M. et. al., 2019).

Studies by different researchers show the fundamental role of teacher training during teacher training (Bawani E. and Mphahlele R., 2021; European Union, 2016), technical pedagogical support for the teacher (Rodríguez, A. et al. al. 2017; González J., et. Al. 2022) and educational research to know the data of the results (Hellberg, L.; Thulin, S.; Redfors, A., 2022).

Methodology is a tool that serves as a transcendental element in teaching natural phenomena because it provides a framework to explore physical concepts in a way that is appropriate to the cognitive development of young children (Gur, C. 2011; Moeed, A. and Saha S., 2022) and through which the mechanisms for lesson planning and assessment, as well as the necessary supports and requirements, are established to create a relevant environment that enriches their experiences and appeals to their interests.

There is no single way to teach physics or physical phenomena in preschool. Public and private schools rely on the same curriculum, but with a wide variety of methods (Swedish Ministry of Education and Research, 2016), from which important didactic considerations can be derived. One of the most important is feedback from both the teacher to the student and the supervisor (counselor, colleague) to the teacher. Analyzing and reflecting on what is being taught and the arguments used to reinforce, answer questions or clarify misconceptions is essential for building knowledge (Hellberg, L.; Thulin, S.; Redfors, A., 2022). The methods should not be standardized, but the teacher should choose them according to the situations in their context.

Result and Discussion

Below you will find some didactic considerations that have emerged from the literature researched:

- It is important to give children the opportunity to explore the world around them through play.
- Include everyday toys such as the spinning top, yo-yo, magnifying glass, Lego bricks and other objects to investigate how they work.
- Plan activities for experimentation with great regularity.
- Plan carefully by considering the most common conceptual errors related to a phenomenon or topic.
- Inquire about previous ideas about a phenomenon or topic.
- Encourage strategies that involve teamwork or collaboration.
- Extensive research on the topic, taking into account doubts about the conceptual content and its possible answers.
- Create a plan for sharing information or discussing possible problems or uncertainties in a language appropriate to the student's cognitive level.
- Introduce technical concepts gradually, taking into account progress and the achievement of expected learning outcomes.
- Use various digital technologies and tools, visit museums, watch videos, consult experts and so on.
- Give students the opportunity to use materials and resources to try to explain their findings.
- Help them to design scenarios in which they can use clothes, materials or toys.
- Facilitate creation of craft or artisan work that enables them to create or design.
- Investigate the same phenomenon by creating and carrying out different experiments.
- A reading place where young readers can read books that are suitable for their cognitive level.
- Participate regularly in simulations, prototypes or STEM activities.
- Go on schoolyard excursions and spend time observing. Then present your findings to the class and encourage discussion and reflection.

There are many advances that have been made in the recent educational reform of the pre-school science education curriculum (SEP, 2023) by allowing some flexibility to the curriculum and training teachers. However, it is necessary to structure a strategy that will endure over time, in the form of educational measures and policies that gives autonomy and freedom in conducting research in this area.

Some of these are based on the need to strengthen pedagogical work and research teams in the field of physics education from preschool; the creation of an organization specializing in physics education research; the compilation and dissemination of evidence on effective practices that can be replicated; the creation of training opportunities for preschool teachers through physics schools, etc.

Although the cases of Sweden and China are ambitious, they open the way for a discussion about the measures that should be taken and the effective practices that could be reproduced in the Mexican educational model. It is necessary that teacher training is also strengthened, and teachers are trained in continuing education (Olvera, M. et. al., 2018), as well as that education authorities help prepare the necessary infrastructure to offer 21st century schools where science is taught.

Conclusion

Children are curious by nature, like to explore through play and have an innate interest in the world they live in. Therefore, they try to give meaning and explanation to their everyday experiences and satisfy their curiosity. Studying physical phenomena using current digital resources and materials opens an opportunity to enhance science education and promote a culture of science. By using current resources such as technology and old analogic materials such as toys, you can make physics more relevant, interesting, and accessible to students.

Teachers' preparation in physical phenomena topics is a significant factor in educational results. The teacher's ability to communicate the love and interest in science will be impacted by training, accompaniment, and timely mentoring. The task is a shared responsibility among all actors in society, not just the teacher.

Even though we know that not all recommendations may be applicable to all contexts due to differences in culture, content, curriculum, teaching styles, learner needs, we believe it is important to use these findings and conduct further research to add to the available literature. The more findings and effective practices are disseminated, the better for the dissemination and creation of a scientific culture that benefits all.

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