Physics for skills development in preschool in Mexico.

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Abstract. Physics has historically been a goal and as a media to reach out for other educational skills. Unfortunately, in Mexico preschool teachers lack tools to develop science in their little students. To help in this situation, we propose the use of “Einstein Box,” a set of toys where the kids can select and play with, then teachers explain the general physics concepts involved in the working of the toys. The results for the kids are amazing because they not only learn about basic physics, furthermore, mathematical thinking, social skills and verbal abilities, all around physics concepts.

1. Introduction
In the present document we work a proposal, which aims to help thinking skills, the elaboration of explanations, from the implementation of named Einstein Box using toys. In recent years, evaluations of the knowledge gained in science by Mexican students (such as the PISA report) show low performance rates, being well below the averages shown by other countries. This situation leads us to reflect on the need to study why the performance of young Mexicans is so low. One of the most recurrent explanations given by teachers is that the students "come with very bad bases" of the previous levels, besides that it has been documented that not only the students but the general population, have an idea that the Sciences are "difficult and do not like" [1]. This couple of situations leads to the need to evaluate from the most basic levels the attitudes and skills that Mexican children acquire in science and that will be reflected in the later levels, so that they can detect -and possibly avoid or eliminate- the creation of conceptual errors and negative attitudes towards science. This project is looking for to study as the introduction of active methodologies, like Kathy Short's investigation cycles [2], support the development of the different training courses at the preschool level and help to improve the standards in science that students reach and that are demanded by the Ministry of Public Education of Mexico in their program for preschool [3]. The proposed learning cycles include different learning strategies like the so called "Einstein's Box" (https://scatoladieinstein.com/), where children learn from toys and evaluation strategies such as headings and interviews both children and parents. The research looking for demonstrate that based on science issues (particularly physics) preschool students do not only develop the formative field of exploration and knowledge of the world (which would appear to be the one for developing skills and attitudes towards science), but in addition, the formative fields of language and communication, mathematical thinking, expression and artistic appreciation, physical development and health and personal and social development. The above, by considering the sciences as a means and not as an end, so it can allow to evaluate the different training fields of the preschool students creating also skills and attitudes towards science that are enduring and allow in the future Achieve better performance in international testing. To record the relevant student development moments and their academic performance, the preschool teachers carried out permanent evaluations, preparing children's records (narrative), matching lists, rank scales and headings for final performances. The investigation cycle was used with the students to investigate on various topics of interest where they asked a
question, created their hypothesis, investigated in various sources, shared and exchanged information obtained, created graphic organizers to sort information and finally communicate what they learned using visual supports such as cartoons, presentations of Power Point, posters, etc. The results were very good, 80% of the students were able to perform most of the steps and their exposures were of great quality for their young age.

Finally, this proposal arises from the need that was observed that existed in kindergartens, where the formative field of exploration and knowledge of the world is retaken by educators in a very superficial and sometimes is limited to the simple fact of conducting experiments in the classroom and where the participation of children is limited to only observe and where they are explained in a very limited way what happens during an experiment.

2. Construction of a preschool science assessment proposal.

Based on the demand for "Evaluation of the learning of basic education students" that the National Institute of Educational Evaluation (INEE) has done in the wake of the new educational model to the institutions of higher education in Mexico, it was proposed to formulate the present research as a study of evaluation processes that implement Alternatives and innovations for the evaluation of both cognitive and non-cognitive skills of students at different levels of basic education, in particular preschool.

So, as a scientific problem the following main research question was formulated:

*How to contribute to the development and evaluation of skills in the formative fields in preschool education from the teaching of science, in line with the daily events that children live?*

From this main question the following secondary questions are detached:

*What is the effect on the learning evaluation of the preschool level formative fields by introducing science-based research cycles?*

*What are the evaluation criteria to consider in the different formative fields of the preschool level from the introduction of research cycles based on science issues?*

From the above, it follows that this work has as its main objective: "To contribute to the improvement of the development and evaluation of intellectual skills in the training fields of preschool, through the teaching-learning process of Sciences ".

In the course of this research, a set of instruments were designed and developed for the study of natural phenomena and the carrying out of experiments in classes [4], which are essential components of the process of teaching-learning for the integral study of natural phenomena through the combination with other means and resources.

In the case of this proposal, the organization was followed as a fundamental route in small groups when it comes to carrying out and evaluating experiments, the attention to individual differences is possible when determining the members of the small groups, providing differentiated attention to those who have difficulties in understanding the experiment. On the other hand, fulfilling this premise means considering the interests of the children for the accomplishment of the teaching tasks.

In this research, it was considered the mediation of other subjects in personal learning, in a dialogic and collaborative context, through which pre-schoolers actively participate in the culture. Dissent, valuing, validating, consensus are aspects not only of the intersubjective construction of knowledge but also of ways of thinking and driving. In this way it contributes to the cultural formation of the students because of the utilization of the potentialities of the experimental sciences and the potentialities of the didactic science. Key requirements for the implementation of the proposal include:

• Participate in decisions about the science experiments that are most interesting to them.
• Not merely to solve problems, but also to formulate and question them.
• The carrying out of activities in small groups, in execution of tasks where they work with the experiments designed and proposed later.
• Observing activities where collective work is conducive in and out of the classroom.
• The control of the personal balance in the relationships between the students. When you work both individually, in small groups, and in a total group form, you will achieve the self-regulation of emotions so difficult to control in these ages.
• Use forms, methods, means and procedures to enable pre-schoolers to develop skills about observation, interpretation, argumentation, etc. proposals in the PEP 2011 [3] for the comprehension of natural phenomena through a well-structured teaching activity.

The development of interpretative thinking in preschools where it is necessary to explain why natural phenomena occur, what their consequences are, what they are studied for. If these tasks are systematized, the skills can be developed, and only in this way they can be transferred to other fields of knowledge, as well as in the analysis of personal and social situations. The adoption of flexible and collaborative attitudes. In this case they can promote a series of experiments proposed and that with them can develop a task or an activity always guided by the educator.

Despite being clear because it is important to evaluate, and to know some instruments, in the case of early childhood, the evaluation is fundamentally qualitative, focuses on the identification of advances and/or difficulties of the students during their process of learning. Therefore, it is necessary that the preschool teachers observe, reflect, identify, and systematize the information recorded as well as their pedagogical intervention.

To record the relevant student development moments and their academic performance, the educators were asked to carry out permanent evaluations, starting from the elaboration of children’s records (narrative), matching lists, scales of rank and rubrics for final notes. These instruments were designed within the research based on the arguments noted above, the instruments are available (just in Spanish language) in [link](http://physics-education.tlamatiliztli.net/documentos.php).

3. Design and analysis of the experiment.

As mentioned, in this project we studied the implementation of research cycles oriented to physical issues, which were sought to evaluate with the mentioned instruments. Based on the proposed of Kathy Short [3] a design was made of learning situations. Table 1 shows an example of these didactic situations, aimed at using the electrical circuits for the development of skills and competencies in the small preschool.

| Learning situation | Electrical circuits |
|--------------------|---------------------|

**Objective:** Progressively develop reflective thinking and intellectual skills to manifest science standards by posing electrical charge issues to preschool children.

**Formative field:** Exploration and knowledge of the world.

**Appearance:** Natural World

1. **Competition:** find solutions and answers to problems about the natural world.
   1.1 A. E. Elaborates your own explanations for questions that arise from your reflections, from your peers or other adults, about the world around you, how they work and what things are made of.

2. **Competition:** Formulates alleged assumptions about phenomena and processes.
   2.1 A. E. raises questions that can be answered through investigative activities.
   2.2 A. E. contrasts his initial ideas with what observed during A situation of experimentation and modifies them as a consequence of their experience.

3. **Competition:** Understand what an experiment is and anticipate what can happen when you apply one of them to test an idea.
3.1. A.E. proposes what to do and how to proceed to carry out an experiment and uses the appropriate instruments or resources (balloons, cables, batteries, bulbs, mass, straws, etc.) according to the specific experimental situation.

3.2. A.E. follows safety rules when using Materials, tools and instruments when experimenting.

3.3. A.E. communicates the results of experiences.

4. Competence: Identifies and uses means at your fingertips to obtain, record and communicate information.

4.1. A.E. collects sample electrical apparatus, to observe and identify some characteristics of the process it analyzes.

4.2. A.E. observes carefully the object or process it studies.

4.3. A.E. asks to know more and listen attentively to who informs you.

4.4. A.E. records through its own brands or drawings, which it observes during the experience and relies on those records to explain what happened.

Starting from the inquiry cycle, the first step involves "Building on the known (prior knowledge)". For this purpose, as initial activity the teacher was showing small objects to the kids, before showing the object she would tell a small description of the subject and then asked the children "to guess" what object it was. These objects were things like a blender, a lamp, a laptop, cell phone, etc., when they were shown the teacher tried to turn them on but she was "unsuccesful", then she asked them what they thought the reason was, which spontaneously the kids responded that it was because "they were not connected" or that "they had no battery". This activity enabled a first connection with the ideas of the young students in the way that the objects of their common life had a need for "electricity" to proper operation. The next step at the end of the sample of objects was that the teacher will ask to the kids: “What do the objects that we just saw have in common?” Given the context of the activity, it was more significant that the kids will bind at objects displayed with the need of electricity to function. The following statement was aimed at strengthening this first intention to build on the knowledge of the kids and to use different representations, in this case in its diary of inquiry the kid is asked to draw one or more objects they know that use electricity to operate, they had to comment on the drawings with both peers and the teacher. This activity was given a period of approximately 10 minutes. In the next activity the children are asked, “where does the electricity come from?” Then, “what would you like to know about electricity?” With this couple of questions, furthermore answers about previous ideas of the children were obtained [4]. In this part we will work with abstract conceptualization of the kids from its concrete experience. In the following activity, gives way to experimentation, in a first stage demonstration and in a next active step. Small balloon and carbon graphite (pencil shavings) are shown to the kids, and the teacher asks, “What will happen if the pencil gets closer?”. Children make their predictions in their diary of inquiry; these can be written or drawn, and they have five minutes for a group discussion. The teacher shows them the experiment and again asked them to register what was observed in the diary of inquiry. The teacher now proposes to "rub" the balloon on their hair and bring the balloon back to graphite and asked the question again: “What would happen if it gets closer?” The process of the registration of the prediction (hypothesis) is repeated, the observation and the results. Closed this demonstrative part, the kids seem excited and this attitude leads to an active experimentation, where the little students undertake a personal exploration with the material provided by the teacher, a "kit" with a balloon, confetti, plastic ruler, and graphite, so that the little ones can experience what is going through the attraction of materials when charging the globe. Children are free to experiment with the material, and the teacher acts as a facilitator and only answers questions that the kids made. Upon the completion of this step, the teacher returns to the abstract conceptualization. The teacher explains to the children that there is a property called electric charge and attract the balloons after
rubbing materials due to the exchange of these electrical charges. It’s important to remark that part again of what children already know, in previous stages of training camp and Knowledge World Exploration the little ones had learned about properties of matter as "smooth and soft" and acquired language is used to introduce the new concept in terms of the same language. At this point, the children ask questions about the topics covered, using the new introduced terms such as: electricity, charge, attraction, rubbing; fact that allows to anticipate the science standards required by the Ministry of Education are being developed.

Finally, this had a closure of the inquiry cycle where the kids are questioned on what they learned in the session, the children answered that they added new words to their vocabulary (load, attraction, electricity, rubbing), compared with what was said at the beginning of the activity, they manifested a pleasure for the experimental activity and they actually asked the teacher if she can do more of this exercise and to continue using at home the "kit" provided. At the closure, the teacher congratulates the kids for being inquisitive, thoughtful, and balanced.

The session lasted a total of 50 minutes, as planned in the inquiry cycle.

4. Conclusions

This investigation cycle was used with the students to inquire about various topics of their interest where they asked a question, they created their hypothesis, investigated in different sources, shared and exchanged the information obtained, they created graphic organizers to order their information and finally communicate what they learned using visual supports such as mock-ups, presentations of Power Point, posters, etc. The results were very good, 80% of the students were able to perform most of the steps and their exposures were of great quality for their young age.

The preschool exploration cycle was developed based on the following:

a) Assign a timetable to the work of science in the classroom.

b) To implement the use of visual codes related to the different steps of the inquiry cycle, which resulted in great support for students due to their age requiring specific, experimental and visual activities.

c) We worked with toys and games to cover the experimental part of the Cycle, where students observed the codes during the game process, at the same time recorded their observations, hypothesis and results, acquiring scientific vocabulary and developing a positive attitude to science.

By systematizing this process, students developed communication skills by increasing their vocabulary and having greater security when expressed to their peers, developed research skills by observing, and experimenting during Various experiments presented, formulate hypothesis and interesting questions that generate new learning and new research, finally learned to work and share in team toys.

The teacher evaluation rubric to know the level of learning reached in terms of the standards of Ministry of Education. The rubric considerate three Achievement levels: Prentice, Rookie, Expert and Master; and evaluate three criteria: Knowledge, made questions and Applied of knowledge in different contexts. With the results of the rubric is possible to determinate if the standards were reached and their level.

Since the results exposed from the implementation and evaluation of the an inquiry cycle based on a physics theme develop in the preschool students, the acquisition of a basic vocabulary to advance on the construction of a scientific language, the developing of a greater capacity to interpret and represent natural phenomena and processes and the increasing linkage of scientific knowledge with other disciplines to explain natural phenomena and processes and their application in different contexts and situations of social and environmental relevance. As result of this is possible affirm that in this study case did achieved successfully, Scientific knowledge, Application to the Scientific Knowledge and Technology, Science Associated Abilities and Science Associated attitudes, all this in the expert level at least in majority of kids.

On the mastery of the subject, they indicate that it is excellent that physics is located in the preschool level so that teachers can understand physics and carry out these types of activities in the classroom. On the pedagogical approach of the activities, they found the activity stimulating and intend to do it in
class by themselves. Finally, the organization of this type of activities was ideal for them, because time was allowed for addressing their own questions and "open play” with the management of the electrical circuit, a situation that surely will occur in their own classrooms.

In general opinion, preschool teachers left motivated to replay the experience in their classes, and even suggested more themes of physics in the future such as magnets, light, sound, and heat, since these activities would be of high interest for the children.

After this experience, it was created a great interest for the community of preschool teachers in Mexico, an example of this is that courses of this type were requested by several schools in places like

References

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