LEARNING GEOLOGY FROM PLAY AND EXPERIENCE - A RESEARCH ACTION PROCESS FOR A GEOLOGY PROPOSAL IN THE LAB 0_6 SPACE

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Abstract

Children are natural explorers and enquirers of their respective environments. Exploring and experimenting through direct experience with materials and tools is a powerful pedagogical resource to promote active learning in children. The “Lab 0_6: Center for Discovery, Research and Documentation for Early Scientific Education” is a pedagogical space with free-choice proposals about science and created to allow the free exploration and experimentation so to approach science experimentation and processes to children from 0 to 6 years old. In this space different phenomena and proposals are presented to allow children discover, explore, compare, and enter into problem-solving situation related to scientific procedures. This paper presents a Research – Action process carried out by members of the GRENEA research group in the Lab0_6 minerals proposal. The aim is to show the changes made during this Research – Action process based on several aspects. A number of observations, analysis and subsequent improvements carried out for the proposal are presented up to one of its latest versions in which other Geological phenomena were progressively included. Although the materials presented (rocks, minerals, sand, ...) are a common resource in schools, they are often discarded by teachers as pedagogically useful. Observations of children interacting with this Lab0_6 Geology proposal, however, show that if these types of geological materials are presented and organised with pedagogical criteria and opportunities for hands-on interactions, they become useful resources for teachers in their schools, to promote the discovery of new things about geological or mineralogical phenomena.

Keywords: Science Education, Early Childhood, enquiry process, Free-choice space.

1 INTRODUCTION: LEARNING SCIENCE BY INTERACTING WITH MATERIALS AND PEERS IN THE LAB 0_6

Discovering the world and exploring new phenomena is something children naturally do. As John Dewey [1] already pointed out, children interact with their immediate environment, since very early ages, as any other biological being would do. Due to this, finding appropriate stimuli to promote the children’s exploration and investigation of their multiple environments is something teachers and educators should take into account to promote new learning possibilities. Yet, while stimuli are important for children’s development, also the adult’s role is critical to lead such opportunities towards a specific direction and also to avoid stressful situations in children to allow them focusing in a process of joyful learning.

In addition to this, we know that children are natural enquirers and problem-solvers and that they constantly try to understand and provide explanations of new occurring phenomena. Yet, learning doesn’t occur just by a mere looking at things and, from such distanced observation of the object of enquiry, a mental inference is produced deducing all causal effects involved with such object. Instead, learning occurs by getting mentally, physically and emotionally involved with the occurring phenomena. In other words, hands-on approaches are very important (both for children and adults) to provide important information about specific objects or phenomena. But often, to promote children’s learning it is also vital to create situations that involve or promote further thought-processes in children, dialogue and exchange of ideas and hypotheses with their peers and a stimulating atmosphere that involves positive emotions that catalyse the enquiry-processes and curiosity in children. In other words, not only a hands-on approach is necessary but also a minds-on (thinking) approach too [2]. Also, words-on (speaking, sharing ideas) and hearts-on (getting emotionally attached or interested in the occurring phenomena) approaches [3] play a powerful role in learning processes.
Now, one of the ways in which such learning occurs is through experimentation and enquiry-based processes, where children are given the opportunity not only to engage with new occurring phenomena but also to investigate the multiple intervening factors, variables and solutions or outcomes of a particular problem or situation and following the above-mentioned ideas on children’s learning processes. Inspired by this interest in promoting experimentation and enquiry-situations in very young children the staff members of the BA studies in Early Childhood Education from Umanresa (Faculty of Social Sciences of Manresa, UVic-UCC) created a science space addressed for children from 0 to 6 years old, within the university premises. This space, called Lab 0_6: Discovery, Research and Documentation Centre for Science Education in Early Childhood was created with the aim not only of promoting an interest towards naturalism and scientific experimentation processes in children. It was also created to provide new pedagogical tools and strategies for teachers interested in science education by providing better empirical basis for the science teaching practice in based upon evidences of children’s behaviours and interests. To boost children’s enquiries and investigations, the Lab 0_6 space is designed as a free-choice space with real materials and multicausal science proposals designed in a hands-on/minds-on/words-on/hearts-on way. In this space children can decide on their own where to go, how long they want to stay, what they want to do and with whom they want to enter into enquiry processes. The only limits that are explained to the children are that they cannot use the material to hurt others and that they have to respect their peers when engaging in an activity.

Science, however, against the notionist idea [4] is not just some specific set of pre-defined theoretical contents or concepts there-to-be-discovered and transmitted. Neither is a set of unitary and predetermined specific rules that ought to be followed step-by-step in an orderly manner to obtain the expected result, as if experiments, real experiments, were ready-made recipes that would be known beforehand [5]. Furthermore in so far as there is a plurality of methodologies used in sciences (observation, experimentation, classification, comparison, modelling, etc.) such pluralism of methodological strategies and procedures in science activities is also presented in the Lab 0_6. There children can freely choose to realise experiments with multicausal outcomes and multiple variables (for example with wind and ramp proposals), to carefully observe and touch real specimens (animal bones, minerals,…), to test the properties of some specimens by physical intervening upon them (for example by using a grater to see if some rocks are soft or hard) or by classifying specimens to observe their similarities and differences (for example with different types of seeds). The aim is to design proposals that promote adaptive answers in children (i.e. open questions with multiple answers) rather than determinist answers (i.e. questions that only lead to one possible answer) [6] and to promote science proposals based upon a constructivist approach [7] stimulating the intrinsic-endogenous (rather than exogenous) attention of children [8] upon the phenomena presented.

Yet, the Lab 0_6 proposals are conceived, in general through an understanding of how children behave at specific ages, of what their interests tend to be and of how they tend to explore and discover during these 0-6 period. From this standpoint we are aware that children are natural enquirers but also that low-tech approaches to phenomena are better than high-tech ones to promote their focused attention and to invite using materials and tools closer to their everyday realities (so that they can understand how to use their tools and can even continue using them at home or at school) [3]. Sometimes creating a sci-fi environment with lots of high-tech modules, with “bings”, and “bangs” and lots of handle rotators an buttons, might be attractive for adults and children, as well, but not very useful to engage children in a careful and focused investigation about what could occur and what could be modified though direct physical contact with the science proposals . Thus, if we want to have children with their attention focused upon their science enquirers, we also need to give them time to investigate, to know what is happening and why [7] and a quiet and we must also design a stimulating environment where they can act autonomously, at their own pace and without continuous excess of stimuli and atmospheric interferences.

But science is not only about experimenting to obtain expected results. Often, as Osborne [5] and Eshach & Fried [10] remind us, it is about completely unexpected and even counterintuitive results. Due to this, in the Lab 0_6, children can also encounter some proposals that contain situations with surprising outcomes or counterintuitive results (for example with the magnetic board with wood pieces that also stick to the board) thus leading children to further thinking and hypothesising. And this hypothesizing, as in real science, often doesn’t occur in isolation, but rather together with other peers and colleagues working in teams or by engaging in public discussion with them by creating communities of enquiry [10] to clarify the occurring events or to define better and refine the terminology used, in so far as scientific language requires conceptual clarity and specificity beyond the everyday language [9]. Thus, the different proposals are designed in a way that invite children to share
the space and interact with one another (for example in the radiographies section), help one another (for example with the water pipes, where water moves from one place to another when opening and closing pipes), or even complement one another (for example with the proposal of the ball falling down upon an inclined slope, where children often have to coordinate and complement actions with other peers to solve the suggested enquiry). Thus, in so far as science is not just about finding pure raw data but also involves analysis and interpretations [5] [11] as well as a process of collective discussion and clarification, designing spaces that make possible the creation of communities of enquiry [10] (or rather, communities of enquiry –in plural) is one of the aspects that is also taken into consideration when designing the Lab 0_6 space and proposals. The Lab 0_6 activities also attempt to promote children to engage with other peers not only during the visit, but also before they come (searching for materials or phenomena they think they will encounter in the Lab 0_6) and after the visit (when they continue their enquiries at school with their classmates).

2 METHODOLOGY

In order to have a better understanding of the enquiry and learning processes of children in the Lab 0_6 and to make sure the existing science proposals and modules provide the adequate stimuli to children’s curiosity, a Research-Action process is conducted with the minerals’ table. Such proposal consists of a table with different types of minerals, tools and sections to promote classification of minerals. After some informal observations during some visits to the Lab 0_6 it was detected that children seldom interacted with such proposal and that whenever they came to the proposal they tended to remain only for very brief periods and doing very simple actions. With the intention to detect what happened during the children’s interaction with this proposal and to detect potential improvements, a series of observations of this proposal began to progressively implement improvements to provide more adequate stimuli in children in relation to this proposal.

To do so, a qualitative type of research has been conducted through a Research-Action methodology. A Research-Action methodology, is a phenomenological, interpretative approach that doesn’t aim at obtaining pure theoretical data and to just increase the existing literature on the topic, but rather aims at a substantive act aiming at having a specific social impact [12] by engaging the researcher/s into solving practical issues of specific cases that matter to them and that is useful as a diagnosis for the practice and the quality of the actions of these education professionals [13]. In addition to this, a research-action process aims to progressively improve a specific reality through different cycles of research and action [14]. Thus, the observations made of these general actions of children led to a series of hypothesis that had to be tested by introducing modifications and possible improvements of the proposal. Once these were introduced, new observations-evaluations were made to test whether the modifications were successful for children’s learning processes and interactions or not. This process has been realised in consecutive stages of Observation-intervention (stage 1) – Observation-intervention (stage 2) – etc

This Research-Action process has been systematic and continuous. All the observations and modifications have been realised along 13 days during morning visits from schools during the second half of November of 2017. The children’s age groups were 3, 4 and 5 years old. Due to the fact that the groups each day were from different schools, the improvements have been implemented upon the evidences obtained on the general actions and tendencies of children rather than on the evolution of the same group of children in relation to this proposal. The observations were taken in a natural context without restrictions imposed upon the children (other than telling them not to hurt other or create conflicting situations) rather than in an experimental-controlled situation.

The data has been gathered on site, by writing down, on a fieldwork booklet, the types of actions and interactions of children in this proposal, with the aim of detecting specific evidences of an improvement in the actions and interactions of children. Due to the fact that the Lab 0_6 is a space where children can spontaneously decide where to go, how long they want to stay in each proposal, what to do and with whom they want to be, the observer had to collect the data in a natural context focusing only upon those actions that were more relevant for this type of research to detect and analyse the quality of the learning processes in children. After the Research-Action process was finished, the data was transcribed upon an Excel Chart and the actions and interactions of children organised using a set of categories to allow a better in-depth analysis of the whole process. The categories used have been previously validated by experts from the GRENEA (Research Group on Education, Neurosciences, Experimentation and Learning) research group allowing a better codification and analysis of the data gathered allowing a closer look at the whole process and the improvements introduced.
3 RESULTS

This Research-Action process, as mentioned above, has gone through several phases. Each phase refers to the first moment of Research (observation / detection / analysis) followed by another moment of Action (intervention / modifications). Each phase follows this procedure. Next, the various Phases are presented in a summary manner.

3.1 Stages of development of the Research-Action Process: From the minerals table to the geology area in the Lab 0_6

PHASE 1.1 - Observation: Some preliminary observations of the table with minerals are taken to check if this proposal attracts children and to verify the types of actions and interactions children carry out. The proposal is located in front of the windows (with a stool where to sit down) and contains a variety of minerals, utensils to classify (some separators and boxes), a magnifying glass and tweezers. The first observations of this table show that children seldom interact with the proposal and when they do so, they only do brief actions before leaving. Also the actions carried out are very basic (grab a mineral and look at it very briefly). Nor is there much social interaction between children, partly because they tend to come one by one.  

PHASE 1.2 - Intervention: From these first observations, some initial modifications are implemented, with the hypothesis that the proposal is located in a table too small and low and uncomfortable for children, causing them lack of concentration and little interest in the proposal. As a result, a first attempt to move the material to a higher table is realised with the expectation that a more comfortable position of children (in relation with the table) will allow them to interact for longer periods and with more intensity.

PHASE 2.1 - Observation: After more observations, although there is a slight improvement in relation to the time of stay of children (they stay a bit longer), the lack of social interactions between children and the persistence of superficial actions (basically grabbing minerals and looking them very briefly) and the short span of time of children in the proposal, indicates that more changes are needed to improve the minerals’ proposal.  

PHASE 2.2 - Intervention: It is decided to place the table away from the windows so that several children can be placed around its 4 sides and thus interact more leading to more complex actions with the minerals and research interactions between peers.

PHASE 3.1 - Observation: new observations show that children come more, settle now in peer groups and interact socially between them. Both the interactions and the length of time in the proposal is longer. In spite of everything, the actions remain the same (look at the minerals, pick them up and leave them) and it is also observed that the size of the minerals in the proposal makes it difficult to use tweezers on the part of the children who often ended up leaving the tweezers aside and using their own hands to grab the minerals.  

PHASE 3.2 - Intervention: In order to enrich the mineral exploration activities, more changes are introduced in the proposal: minerals with different properties (some metallic, other transparent or translucent metallic minerals or with different colourings and others of different masses and textures) are now added so to allow more interesting comparisons and observation of their properties. Smaller rocks are also added (inside a box) making it now easier to children to use the tweezers (the previous rocks were too big for the tweezers). Also different types of boxes with a diversity of colours, shapes, sizes and materials are also incorporated to invite children to have different classification criteria. Additionally various types of magnifying glasses or visual utensils (magnifying glass, fly eye ...) are now available in the proposal. Industrially transformed minerals are also added (a ball of aluminium foil, a chalk pencil and a marble) to motivate curiosity in children about their connections with minerals. Also, in an adjacent area, the proposal is expanded with other types of specimens such as different rocks (metamorphic, sedimentary and magmatic) and other larger minerals placed on round carpets with a set of lanterns to detect if minerals are translucent or not. Also several photographs of minerals, rocks and various phenomena or geological activities (volcanoes, mining, stratification, etc.) are added in this area. On another table there are some envelopes with different sedimentary material (forest sand, beach sand, desert sand, weathered granite, thick and thin salt grains, etc.) and some boxes where it is possible to classify those sediments together. Magnifying glasses can also be used to look closer at these sediments. In a third table, a scale with some minerals and rock specimens is placed so that children can weigh and compare them.

PHASE 4.1 - Observation: As a result of all these substantial changes, it is now observed that children spend longer periods in the new area (now this area is called the “Geology area” instead of the “mineral area” because more geological specimens and materials are included: sand, sedimentary deposits, rocks,...). Additional observations show that social interactions are now constant and that
children's actions are now much more varied (now they not only grasp and look at minerals, now they perform various actions with new tools such as: weigh, classify, show, fill in-empty boxes, illuminate, compare, etc. **PHASE 4.2 - Intervention:** Some changes are made after observing that certain elements still generate distortion or little interest. In the previous intervention the photos occupied too much space in the carpet so different options are considered now, to make them available to children without disturbing too much the children's space: Several places are tested to locate the photos and finally the small round carpets where the images were are now substituted by a larger rectangular carpet that allows children to sit in it while looking at the images. Also, the elements manufactured industrially (ball of aluminium foil, chalk and marble) are removed because they do not generate the expected interactions, The plastic measuring-scale is substituted by a more traditional one (as it seems more intuitive to use for children) and a tray with stones covered in sand for children to clean them with some special brushes and an air pump is also set up.

**PHASE 5.1 Observation:** Many varied actions now take place: to clean, to balance both sides of the scale, to look and organize (and comment) the images, to use the air pump to clean the sand, etc. and children stay for longer than initially with the first and second minerals’ tables **PHASE 5.2 - Intervention:** Finally, the lanterns are removed from the carpet area as we realize that the children do not understand how to use them to detect the translucency of minerals (they often take them to light and shadows room). Also the tray with the buried minerals is removed because, although the children use it, it is considered to bear no relation with geological activities.

### 3.2 From the Geology area to the Geology Module and some more improvements

After the above-adjustments are made through this Research-Action process, a better overview on how to promote children's interest and investigation with geological specimens is obtained. This knowledge is used to develop a more compact geological proposal that could also be more consistent with geological enquiries.

To design this new compact version, some ideas are proposed to a carpenter who designs and creates a portable and adaptable table with different opportunities for investigation. The new Geology table consists of 5 geological proposals on its various sides, and this time including different sets of tools after observing that richer actions and interactions occur with minerals and rocks when different tools and instruments are included and also by organizing the space around the table in a way that several children can interact together and engage in common enquiries.

Also, a variety of minerals (some new ones) and rocks with physical and visual stimulating properties (colors, shapes of crystals, transparencies, weight, forms, with inclusions, ...) seeing that stimulating and varied specimens provoke more interest in children. Also an adaptable classification table (with separators that can be put and removed depending on the interests of children) is set up to invite children’s activities of selection and comparison;

Another side of the table contains rocks with different graters and files are included to allow children to explore the hardness of each of the specimens. A large magnifying glass is added to the table so that the children can see the minerals. Envelopes with the different types of sediments are also included in the hangers. A showcase for heavy or delicate minerals and rocks is also included in the bottom of the table for children to look at. Another side of the table has a piece of polished slate where children can leave their drawing or marks by using the different minerals and rocks (to see the color of the trace and the hardness of the specimens).

Progressively, after further observations some aspects of the proposal are improved, such as the introduction of a turntable in the center of the table where minerals and rocks are placed, the hangers with the envelopes are placed now on the top of the table to make them more visible to children. Also a barrier is incorporated in the grater and files proposal to make it difficult for children to reach other valuable minerals from the turntable when using the grater and tiles. Some books about minerals or geology are also included in the geology area so that children can consult them. Finally, after observing that at time the children don’t use the files for polishing the specimens properly (they have a shape similar to knives and thus they often use them as such) some hard brushes with metallic points are now included to allow grating the materials with other types of tools. Also a scale is included to allow children weigh the minerals and thus allow a different type of comparison between them and the envelopes with sedimentary materials are substituted by small transparent pots where the sand can be observed but making it more difficult for children to open them. A chromatic circle was also included in the center to allow children observe better the differences in color of the different
specimens but due to the brightness of these colors in the chart it was removed and a new one will be included in due course, using colors closer to those of real rocks and minerals (to make the comparison more intuitive).

Currently further observations are being conducted in this area. In order to obtain more data, sessions are now recorded in video and the data (actions conducted by the children) is analysed through the video-analysis software program “Lince” [15] through an inter-judges method to validate the data gathered by all the involved researchers. Currently some pilot observations of these new observations are being undertaken and some preliminary findings have been obtained (although further discussions and analysis are required): the plurality of instruments is seen as enriching the proposal, in so far as more actions are realized by the children and longer periods of time are spent in this area. Some proposals from the table seem to be working better than others: the area with the graters and files and the use of glass magnifiers seem to be working better than the area with the polished slate where children seldom use it to make drawings. Also, the classification table is seldom used for classifying and instead is more often used to just place those minerals that children discard. Additionally to these we observe in some of the recordings that adults (school teachers or Lab educators) also come to the table either to interact with the children or, in the case of school teachers, also to observe the different specimens and take pictures of the table, showing that such proposal is opening a window of interest for their pedagogical tasks in school. In some other cases is has also been observed that children who reach adults or other peers to interact with them in the table, so it is seen as a positive aspect that children themselves search for other friends or educators to show them what they have discovered or to find new types of enquiry in this table. As a result rich interactions have been observed at times (although, in general, the children seem to find themselves well when investigating the specimens on their own). So far, no struggles or fights between children have been observed around this proposal. Also these preliminary observations of this new geology table seem to point towards the fact that children require time to familiarize with the different tools and materials of the proposals: in some cases it was observed that children tended to begin doing simple actions with the materials and tools, and, after leaving for a while, returned with renewed curiosity trying different actions in relation to the materials and tools. However, further observations and more intensive analysis are required to provide more solid data on the learning processes of children in the Geology table.

4 CONCLUSIONS

Children spontaneously tend to engage with their surrounding environment. The role of adults in providing materials and tools and in pedagogically designing a space becomes crucial for children’s learning. The observations made during the different observations in the Minerals table and afterwards in the Geology area and finally the Geology module show that children’s enquiry processes become enriched when displaying the proposal allowing several children to meet together and collaborate or interact with one another. This involves conceiving carefully the activities within the space where they interact and also the materials placed to provoke interest, dialogues with their peers to engage together in common observations and actions. Additionally, displaying a variety tools allow children to do more actions and promote their curiosity for discovering new properties of the materials. As a consequence this makes possible that children stay longer in the proposal and try different actions with the materials.

REFERENCES


