Early childhood science education in an informal learning environment

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Abstract
In this paper we present a learning/teaching experience about objects and materials performed with 5 years old children in Giocheria-Laboratori. This is an educational facility of Sesto San Giovanni, a municipality near Milan (Italy), designed for kindergarten and primary schools' informal science education. Since many years, we are collaborating with its educators to improve their science education proposal. In particularly, in 2014 we collaborated to design and realize the "Unconventional matters" project, funded by the Italian Ministry of Education. The main aim of the project was to design and test some educational settings where many different types of scraps and unconventional materials are available to children of different ages (3-10 years old). The present learning/teaching experience was realized in the framework of that project, lasted one hour and a half and was focused on the young children's ways to approach objects and materials in a specifically designed setting. Here we illustrate and analyse the experience from a physics education perspective through a visual narrative of selected episodes.

Keywords
Early childhood, informal education, unconventional matters.

Introduction

In the last years, early childhood science education has been receiving increasing attention by the scientific community (Science, 2011). Researches in different fields, from neurosciences to learning and teaching sciences, have shown that children are far more competent in their scientific reasoning than suspected before and have substantial knowledge of the natural world since very early childhood (NRC, 2007).

In Italy we have a long tradition about high quality early childhood education, worldwide well known: Reggio Children experience and Montessori method and schools (Lillard & Else-Quest, 2006). Although activities and contents assume different meanings in these two approaches (Pramling Samuelsson, Asplund Carlsson, 2008), both are characterized by the care of emotional, artistic and social dimensions.

Recently, the Reggio Children group put in their proposals more emphasis on scientific aspects. The *Ray of light Atelier* in Malaguzzi International Centre is an example of its increasing interest in promoting educational contexts supporting "explorations that inspire wonder and curiosity and stimulate creativity and deeper inquiry" (Reggio Children, 2014).

They proposed the Remida cultural project "that represents a new, optimistic, and proactive way of approaching environmentalism and building change through giving value to reject materials, imperfect products, and otherwise worthless objects, to foster new opportunities for communication and creativity in a perspective of respect for objects, the environment, and human beings." (Remida, 2014).

In that perspective, they also created Remida centres to collect unconventional, alternative, waste, scrap materials with the aim to distribute them to schools and extra school educational contexts for specific educational projects.

In this paper, we present a learning/teaching experience about objects and materials performed in the informal environment of Giocheria-Laboratori. This is an educational facility of the municipality of Sesto San Giovanni (near Milan, Italy), offering informal science education to kindergarten and primary schools of the municipality since 1987.

Since many years, we are collaborating with the educators and the expert in childhood education of Giocheria-Laboratori. The collaboration aimed to improve their science education quality and to develop educational proposals linking the emotional, expressive, social and cognitive dimensions.

In 2014, we worked together to design and realize the "Unconventional matters" project, funded by the Italian Ministry of Education and aimed to design and test settings and laboratories about unconventional materials.

In particular, one of the main intents of the project was to transform the more spacious room of Giocheria-Laboratori, named the Pavilion, in a place where children could freely and safely explore many different types of materials and scraps recovered by Remida Centres and local industries.

Here, we illustrate and analyse a learning/teaching experience with 5 years old children from a physics education perspective, using a visual narrative of selected episodes from the entire experience.

Methodological details

The experience was performed in the "Unconventional matters" project's framework, during an one hour and a half visit of a kindergarten school to Giocheria-Laboratori. In that context, the research question of our investigation was how children of 5 years old are able to distinguish between objects' and materials' properties.

Setting and investigation of children's experience

The entire experience was made in the Pavilion, engaged 16 children of 5 years old, two educators of Giocheria-Laboratori and one of the author. The Pavilion's setting was designed by the architect involved in the project with the aim to allow wide and deep explorations through many different types of unconventional materials and scarps.

Children were divided into two groups and were invited to make an investigation about materials present in the Pavilion. The two tasks were slightly different: the first group was invited to select some objects in a restricted area; the second one was invited to search for different objects made of the same material (plastic) all around the room. The groups worked separately for almost one hour, then they met each other to compare and discuss their findings.

According to the international early childhood education's recommendations (NRC, 2001), the educators' behaviour was intended to be responsive to children's findings and questions. They had the role to be discrete guides trying to embrace what children caught during their explorations and support them in going further.

One of the author attended at the entire experience, following in particular one group. She had the role to be a participative observer. The approach she adopted was inspired by the observational "looking and listening-in" approach proposed by Sumsion and Goodfellow (2012). She used "openness, sensitivity, deep awareness, interpretation, and simultaneously, a suspension of judgement" in the way she tried "to gain insight into the meaning that infants make of their experiences" and to make her interventions (pag. 316-317)

Based on diverse theoretical perspectives (phenomenological, socio-cultural and social cognitive ones), the "looking and listening-in" approach was suggested "as a methodological approach for helping us to edge closer to understanding the infant's experience, and as a way of describing how the infant made meaning of his experience". In this context, we mainly used it in the first perspective.

Data collection and analysis

We generated data via observational and reflective notes and a video footage of the entire experience. The video gave us the opportunity to analyse children' actions, gestures and discourses with more detail than using only a written observational record.

We watched the video repeatedly and independently each other, searching for episodes that might be particularly meaningful from the physics education perspective about the difference between object and material.

We then transcribed the selected episodes using InqScribe video analysis software (InqScribe© 2005 – 2009) and, finally, we constructed the visual narrative to illustrate and analyse the experience (Table 1). The visual narrative was constructed following the example of Sumsion and Goodfellow (2012) and the relative references.

The visual narrative and its reading

The visual narrative involves the first group of children, some objects of the Pavilion, the educator and the researcher. It illustrates an episodes' sequence showing how the group investigates objects and materials with the support of experts in informal and physics education respectively.

Before the first episode represented in Table 1, children were sitting in a circle around the educator discussing with her about the objects they selected. After few minutes, a child introduced a jersey's ball and all began to discuss about it and the material was made of.

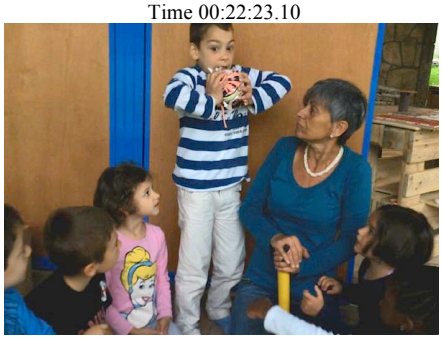
Table 1. Selected episodes' sequence of the learning/teaching experience

Photograph	Educator/Researcher	Children
 Time 00:04:30.20	"What have you chosen?(E) "How is it made?" (E) "Do you agree that is made of wool? Try to touch it" (E) "Someone says twine and not wool" (E)	"A ball" "Wool", "Yes" "Twine"
 Time 00:07:39.00	"What happens if you push the ball?" (E) "Is the ball made of the same thing as these threads?" (E)	"If I push, it seems that it is hard" "I think there is a stone inside here. It is impossible to destroy!" "Yes"
 Time 00:10:51.29	"Why the threads are soft and the ball is hard?" (R) "It would be nice unrolling the ball and looking what there is inside" (E) "Maybe, it is better rolling the ball from the other end than unrolling it" (R)	"Because inside there is something on which you can roll up the twine"

Table 1. *(Continued)*

Photograph	Educator/Researcher	Children
 Time 00:11:46.12	"Look at me. I don't put anything inside, I just start to roll the thread" (E)	
	"Can you try to touch the ball now?" (R)	"It is hard"
	"Can you try to touch the one I'm rolling up? (E)	"It is hard"
		"It is decreasing more and more"
 Time 00:15:05.21		"There is only a knot!"
	"So, what makes the ball hard? (E)	"Because it becomes very very big and it hardens"
	"I can make a very very big bunch of threads, is it hard? (E)	"No, it is soft"
	"Do you think there is more thread in the ball or in the bunch?" (R)	
 Time 00:17:04.14		"In the bunch"
	"How could we know that?"	"Because they are so many!"
		"Wow, I made it long"
	"Look, she attached two threads and she made a longer one" (R)	
	"So what could we do?" (R)	"We have to tie all of them"

Table 1. *(Continued)*

Photograph	Educator/Researcher	Children
 Time 00:22:23.10	"So, can we make a very long thread using these pieces and then roll it to make a ball?" (E)	"Yes, we make knots and then we tie the threads"
	"Do you think the thread made by small pieces will make a hard ball or a soft one?" (E)	"A ball very hard!"
	"If everyone ties two or three pieces, the thread will be long enough" (R)	
 Time 00:34:43.23	"We had to find if the ball made by small soft pieces is hard or soft. Try to touch it" (E)	"It is very hard!"
	"We still have to understand why many pieces tied together and rolled up make a hard ball. We have to think about it" (E)	
 Time 01:02:08.13	"They tried to tie the threads making knots, here she was able to tie two things in a different way. Do you show in which way to us?" (R)	The child shows how to attack two magnets. One child wedges a wire into a box and another wedges two cylinders.
	"Three ways to attack things without glue! (E)	
 Time 01:05:28.29	"Are there other ways to tie/attack things?" (R)	Children go all around the Pavilion and try to tie things together using glue, magnets, press studs, Velcro and even water. They also explore the possibilities to build stable structures and move tying things.

The pathway begin with a question “How is it (*the ball*) made?”. Children immediately say that it is made of wool, but touching the ball they change their minds (“it is made of twine”, photograph #1).

Pushing the ball, children feel that it is hard. Touching some threads, they realize that are made of the ball’s material even though the threads are soft (photograph #2). The researcher asks the reason why this happen (“Why the threads are soft and the ball is hard?”, photograph #3) and some children suggest the idea of a stone inside the ball.

This idea is explored unrolling the ball and simultaneously making another ball with the same thread. In this way, children verify that there is no stone inside the old ball and, at the same time, that the new one is still hard (photograph #4).

A child tries to explain the ball’s hardens introducing the volume (“Because it becomes very very big and it hardens”, photograph #5). The educator gets a lot of threads making a big bunch: it looks bigger than the ball but still soft. It is not a matter of volume.

The researcher then asks if there is more thread in the ball or in the bunch and how we could know that. A child realizes that two threads can be tie to make a thread longer than before (“Wow, I made it long”, photograph #6).

Her finding suggests the idea to make a long thread joining together the small pieces (photograph #7). Rolling it, the educator makes another ball and children feel that it is still hard. No matter if the pieces are soft. Children realize that pieces and ball have different properties, even though they are not yet able to explain why this happen (photograph #8).

The learning/teaching pathway seems to be arrived at its end when the other group arrives to share findings. However, two children of that group show two other ways to take things together without glue (photograph #9).

Children go around in the Pavilion trying to tie things together with many different types of materials and exploring the possibilities to build stable structures and move binding things (photograph #10).

Conclusions

The research we presented in this paper explored the possibilities to introduce young children to first ideas about objects' properties as depending on material and/or on structure of the small pieces they are made of.

The opportunity offered by the Pavilion and by the large amount of objects available allowed children to explore objects’ properties through senses (appearance, elasticity, softness, shine, texture, colour, etc.) and to look for similarities and differences among them. Moreover, its particular setting gave them the opportunity to investigate objects and materials following not stereotyped questions and finding their own answers.

The Pavilion' setting was an opportunity also for the adults involved in the experience. Scraps and cuttings without a conventional name or a recognizable function aided them to abstract from the idea of *object* to the *material* from which it is made and to make their interventions as much as possible from the children's perspective.

In the analysed experience, the educator let the children free to explore the environment using body and senses and to express emotion and creativity. She paid a lot of attention to children's questions and actions, trying to recognize hooks to the theme that children wanted to treat and dealing with the issue in a comprehensive way. She also supported the collaboration and the communication among children and the researcher.

As the visual narrative shown, the researcher was able to guide children to recognise that a jersey ball can be made of small pieces and that their properties can be different from the ball's one.

Althought it was not possible to introduce more advanced interpretations in the available time, children were introduced to the basic physics idea the object' properties depend on the properties of the single constituents, the kind of links among them and the arrangement of the entire structure.

Perspectives

Beside the experiences with kindergarten school, we are now working to introduce in the Pavilion workspaces with instruments and tools where primary school children can investigate objects and materials in interaction with water, light and heat sources.

Even though we are designing more structured experiences, it is our opinion that also primary school children need to recover the joy and the taste of exploring by senses before to be guided toward a more formalized knowledge.

For the next years, we hope to continue the collaboration with Giocheria-Laboratori and the schools of the municipality to design and test learning contexts and pedagogical progressions for formal and informal science education at different ages.

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