AN EARLY UNDERSTANDING OF MECHANISM OF RAINFALL: A STUDY EXAMINING THE DIFFERENCES BETWEEN YOUNG MINORITY IMMIGRANT AND NATIVE-BORN CHILDREN

José Domingo Villarroel
University of The Basque Country, Leioa, Spain
E-mail: txomin.villarroel@ehu.es

Abstract

Preschool and lower grades of primary education (that is, before the age of 8) are a crucial period to attempt to reduce the educational performance gap between minority immigrant and native-born children. Regarding the science education field, it is believed that early exposure to scientific explanations on natural phenomena may positively influence to not only a better comprehension of the surrounding world but, also, the pupils' success in grasping subsequent and more formal scientific concepts.
In this respect, little research has been conducted to examine whether the learning process on the subject of the comprehension of natural phenomena varies significantly in the case of young minority immigrant children in comparison with the mainstream process covered by native-born children.
In this vein, this study aims to study how 5 to 7 year old children understand the rainfall phenomenon (N=124) and to examine whether this comprehension differs according to the differences regarding the socio-cultural background of the children comprised in the sample.
To that end, children's answers to a semi-open questionnaire and their pictorial representations are analyzed and socio-cultural perspectives on the human cognitive development are utilized to assign meaning to the results obtained.
Key words: *cognitive development, early understanding, natural phenomena, science education.*

Introduction

A growing body of research indicates the significant role that quality science learning experiences give support to cognitive (Sackes, Trundle & Flevares, 2009; Eshach & Fried, 2005), social (Ginsburg & Golbeck, 2004; Inan, Trundle & Kantor, 2010) and language development, especially at early ages (Peterson & French, 2010).

Thus, it is believed that early exposure to scientific phenomena prompts the formation of deep reservoirs of both verbal and non-verbal information that, eventually, provides the cognitive foundations for grasping subsequent and more formal scientific learning (Eshach, 2006).

Predictably, making scientific interpretation of natural phenomena accessible to young children seems to be related not only to a better comprehension of the surrounding world and natural phenomena but, also, to their success in schooling (Inan et al., 2010). In this sense, an early and effective link between young children and science-related activities is a recurring recommendation promoted from the field of science education. (Osborne & Dillon, 2008).

In this regard, atmospheric phenomena, such as precipitations, are fundamental science related concepts which have been proposed to be introduced in the early stages of the beginning of their scientific understanding (Cross & Bowden, 2009; Gillespie & Gillespie, 2007; Loxley, Dawes, Nicholls & Dore).

Rainfall is a natural, observable and daily phenomenon that facilitates the connection between classroom activities and children's interests, questions and inquiries. Therefore, the precipitations phenomenon is broadly utilized as a didactic resource in order to introduce scientific perspectives into elementary science educational levels (Fernández & Rodríguez, 2006).

However, despite being familiar and apparently easily understandable, the fact is that the understanding of the precipitation phenomenon, far for being an obvious learning process, requires children to grasp the non-observable mechanisms that underlie the cyclical changes that water goes through in the environment. Science offers the so-called water-cycle account (Bennett, 2008) in order to explain what happens to water in the environment which involves deep notions about physic, biology, chemistry and earth sciences.

So, to understand how science accounts for the mechanisms of rainfall, children need to deal with abstract elements among which are such concepts as the invisible role of the sun movement of water in hydrosphere, the function of water reservoirs in nature (clouds, sea, rivers, atmospheric water…) and the phenomenon of the reversibility of the changes of water states.

The perspectives related to the domain-general theories on development barely recognize children's competence to deal with the above-mentioned abstract science notions. In this light, young children's cognitive capacities are too dependent on perception inputs and as a result, young children's ability to manage abstract concepts turns out to be more than questionable (Gelman & Brenneman, 2004).

Nevertheless, research in specific domains of knowledge provide consistent data to correspond with the idea that early in the development, human beings are able to generate abstract representations of objects, agents, numbers and causes (Carey, 2009). Accordingly, human cognitive structures are innately predisposed to move onto specific learning paths and to actively scrutinize the surrounding environment looking for relevant data (Gelman, 2009).

Bearing in mind these aforementioned thoughts, looking into the explanations used by young children to make sense of natural phenomena seems to be a relevant research goal. On the one hand, it is beyond any doubt of the relevant role that atmospheric phenomena, and specifically, rainfall, have as didactic resources to introduce science to kids in elementary and primary educational levels (e.g. Ashbrook, 2003; Newton, 2002; Williams, 2008). In this respect, the more relevant our knowledge is regarding how young children give meaning to natural phenomena, the better conceptual foundation can be presented for designing educational proposals.

On the other hand, investigating the explanations given by young children to account for natural events, such as the precipitation phenomenon, can provide significant data for the still pending debate between domain specific accounts and domain-general theories regarding the origin and evolution of the early competence for reasoning about non-obvious concepts (Christidou & Hatzinikita, 2006). In this vein, a better comprehension about the process of the understanding of the mechanisms of rainfall, and hence the water cycle itself, will contribute to more precise knowledge of the process of acquiring scientific thinking skills during early childhood.

It is also worth noting that the research efforts made during the last decade regarding the investigation of children's ideas and accounts related to natural phenomena has been focused on students in the upper levels of the compulsory educational system (Henriques, 2002; Lewis, van der Hoeven Kraft, Bueno, Watts, Baker, Wilson & Lang, 2010; Shepardson, Wee, Priddy, Schellenberger & Harbor, 2009) but little research has been done with regard to young children in preschool and the lower grades of primary education. In this sense, Christidou and Hatzinikita

(2006) and Sackes, Trundle & Flevares (2009) have conducted the most noteworthy research regarding how preschoolers assign meaning to the precipitation phenomenon.

In this respect, it has been profusely pointed out the importance that visualizations (that is, a novel visual presentation of data) may have in the conceptual organizations of information by the construction of mental models (Rapp, 2005) and specially, in the field of the understanding of physical world (Buffler, Lubben, Fred & Pillay, 2008).

Additionally, as far as our knowledge extends, there is no research into the learning process of young children coming from immigrant families on the subject of the comprehension of natural phenomena and, particularly, regarding the mechanism of precipitation and whether this learning process differs fundamentally from that shown by native children.

However, this lack of research contrasts with the widely accepted appeal to produce more extensive investigation in regard to the special needs that children of immigrants may require in relation to their learning science process (Ginsburg & Golbeck, 2004). Undoubtedly, this is a significant research line, given that preschool and lower grades of primary education are a crucial period to assured academic success during later schooling, and, consequently, it ought to be a critical point in time to reduce the educational performance gap between native-born and minority immigrant children (Kim, Chang & Kim, 2011; Saçkes, Trundle, Bell, O'Connell, 2011).

Therefore, this research addresses and analyses the comprehension that 5-7 year old children exteriorize on the topic of the mechanism of rainfall to examine the following two points:

• Firstly, there is the supposition that, to some extent, young children are able to resort to some of the non-obvious scientific concepts in order to give meaning to their own explanations related to the precipitation phenomenon.

• Secondly, whether the usage of scientific notions regarding the mechanisms of rainwater varies significantly in the case of young minority immigrant children's explanations in comparison with those given by native-born children.

The eventual purpose of this research is to contribute to a better understanding of how young children achieve to understand the basic notions that underlie the science explanations related to atmospheric phenomena. This goal seems to be desirable in order to have more data regarding both young children's skills to manage abstract concepts on natural phenomena and the differences in the learning process of elementary scientific notions that may be related to children's cultural backgrounds. Eventually this complementary data can be utilized for the design of more accurate educational proposals for science education at elementary levels.

Methodology of Research

According to the framework presented in this introductory chapter, the following describes firstly, the characteristic of the sample; then, the procedure used to undertake the study and, finally, the aspects related to the analysis of data.

Characteristics of the Sample

The sample studied is comprised of 124 young children (61 boys and 63 girls) aged between 5 and 7. Just over a half of the subjects of the sample (56.8%) were in the final year of infant education when the investigation was carried out and the remaining individuals were in the first course of primary education.

The data were collected from 4 pre-school and primary state schools came from two different towns with more than 4,000 inhabitants belonging to The Basque Autonomous Community, Spain (Wikipedia, 2011a).

ISSN 1822-7864

The authorization to interview the children was obtained from the academic board of each school and the meetings with children were held in the first quarter of 2011 taking place at the schools during normal classroom hours. The language used was Basque or Spanish according to the linguistic profile of each school.

Interestingly, 28.2% (N=35) individuals of the sample were minority immigrant children belonging to families coming from Morocco, Colombia, Ecuador, The Ukraine, Pakistan and a few Gypsy children. Moreover, native-born children totaled 71.8% of the sample (N=89). All the children in the sample studied were in the appropriate academic level according to their age.

Procedure

The procedure used to carry out the investigation was based on individual sessions with subjects of the sample. During these meetings, which lasted no longer than fifteen minutes, two major tasks were presented to the children: (a) a semi-structured dialogue led by a set of interview questions shown in table 1 and (b) a pictorial task

Regarding the semi-structured questionnaire, it is worth noting that a similar series of questions have been used in other studies on the topic of young children's understanding of the precipitation phenomenon (Saçkes, Flevaresa & Trundle, 2010) and they involve the most relevant concepts regarding the basic understanding of the rainfall mechanism and the water-cycle process.

Table 1. Questions used to undertake the semi-open questionnaire (Saçkes et al., 2010).

Questions	Objective of the question
Have you ever seen rain?	Introductive question
1. What does rainwater consist of?	Informative question
2. Where does rain come from?	Informative question
3. Where does rain go after it falls?	Informative question
4. Sometimes after it rains there are puddles but eventually they disappear. What happens to these puddles?	Informative question
Have you ever seen clouds?	Introductive question
5. What do clouds consist of?	Informative question

With respect to the pictorial task, children were encouraged to draw items related to rainfall. To this end, the researcher put sheets of paper and issued pens and pencils but no color pen was available.

During the drawing task, the interviewer encouraged children to express themselves by drawing everything connected to rainfall. After the child indicated that his or her drawing was finished, the researcher and child reviewed the elements of the picture, taking note of their meaning.

The dialogues with the children were audio-recorded and the transcriptions were linked with the drawings. Moreover, the children's educational level, gender and school were collected with the aforementioned data.

Data Analysis

The answers collected in the semi-open questions were initially examined according to the procedure suggested in the Saçkes' work (Saçkes et al., 2010). However, this preliminary framework came to be exceeded by the range of responses that emerged from the studied sample and, accordingly, it was necessary to add new categories and occasionally, to re-define others. Regarding the children's pictorial productions and water-cycle related elements these were considered in the analysis of the drawings.

The ultimate version of the code utilized to quantitatively analyze the data collected from the two tasks proposed in the interviews will be presented in the results section of this paper as the outcomes of each task are unveiled.

Finally, the quantitative analysis was undertaken by the nonparametric Mann-Whitney U test (Siegel & Castellan, 1988) for comparison of means and Chi-square tests to analyze the possible differences between nominal variables. The level of significance used in the study was $p<0.05$, and statistical work was done using the SPSS version 18 software.

Results of Research

The results of this research are presented by addressing, firstly, the analysis of the data associated with the semi-open questionnaire and subsequently, the examination of the information related to the children's drawings.

Considering the first question of the verbal survey, the vast majority of the children interviewed (83%) asserted that rain consists of water. However, very few children (6%) mentioned other substances, such as sugar, juice or, even, plastic as a constituent of water.

With regard to the question of the origin of rainfall, the children interviewed mostly ascertained that clouds were the source of precipitation (54.4% of children), but a significant number of children (41.2%) pointed out that the sky, or simply up above was the place from where rainwater came.

Moreover, table 2 shows the frequency of the answers found regarding the query to what happens to rain after falling. In this respect, only 14% of the children gave an explanation as to what the conclusion to the water-cycle might be (for example: "The sun dries it and waterfall becomes vapour"; "After falling rainwater goes underground"; "Rain is taken by plants"; "Rain goes to the sea thanks to rivers"). On the contrary, the majority of the responses (83.3% of the sample) given were related to situational and urban linked statements (for instance,: "Rain falls to the ground"; "It goes down"; "It makes puddles", "Rainfall disappears through the sewer and then goes to the houses by pipes"; "It falls over the towns";" It wets the playground").

Table 2. Relatives frequencies of the answers regarding the question: "Where does rain go after it falls?" (N=114).

Category	Mentioned concepts	%
Unknown or unintelligible		1.8
Natural	River or plants or sea or dry or underground.	14
Situational	Ground or down or puddle	59.6
Urban	Pipe, sewer, house, playground, cities	23.7
Disappearing	Destroying, disappearance	0.9

Furthermore, table 3 breaks down the frequency of the responses regarding the children's explanation about why puddles disappear. Preponderantly, the children of the sample (52.6%) not only indicated the sun as an agent of the disappearance of puddles but also attempted to point out the evaporation process by labelling this phenomenon with different names such as drying or melting (for instance: *"the sun makes puddles disappear because it dries water"* or *"Water melts due to the sun"*). Additionally, in a significant number of responses the sun was not mentioned as an agent of the phenomenon of rain but natural processes related to changes in the rainwater are pointed out. (for example: *"Because puddles are dried"; "Because water changes"; "Because puddles become waterless*") or do not try to identify the process that the sun causes (for instance: *"Because the sun rises"; "Because the sun appears"*).

Table 3. Relative frequencies of the answers regarding the question: "Why do puddles disappear?" (N=114).

Category	Mentioned concepts	%
Unknown or unintelligible		12.3
The sun & process	The sun dries or melts rain.	52.6
The sun w/o process	The appearance of the sun.	15.8
A process w/o the sun	The rain changes. Puddles become waterless or are dried.	7.9
Non natural	Destroying or disappearance (for example through sew-ers).	11.4

As for the fifth and final issue of semi-open questionnaire which refers to the composition of clouds, the majority of the answers given referred to different kind of substances such as cotton, sugar or air (45.5%) and a significant amount of children (31%) admitted that they did not know what clouds consisted of. However, 23.6% of the answers recorded were linked to *water* as a constituent of clouds.

Regarding the study of the answers to the semi-open questionnaire considering the family origins of the children, it is worth noting that no significant differences were found between minority immigrant and native-born children.

Moving on to the analysis of the children's drawings, some examples of the drawings analyzed are presented in the appendix at the end of the paper). Moreover, table 4 accounts for the pictorial elements found in the pictures which were linked to water-cycle. This table also indicates the category assigned to each drawn items.

Table 4. The water-cycle related categories of elements drawn in the pictures of the sample studied.

	Elements drawn	Categories
Water cycle related	Sun	Solar
	Clouds, river, sea, lake, vapor and steam.	Water reservoirs
	Soil, mountains, sky, caves,	Geographic
	Rainfall, snow, hail, thunder, storms, rainbow, wind.	Atmospheric
	Flowers, grass, trees, leaves.	Living beings

In order to facilitate the study of the distribution of this variable, three groups were defined in relation to the total of water cycle related elements found on each drawing

The range of these sets is presented in table 5 and the corresponding relative frequencies are separately indicated for minority immigrant and native-born children due to the statistic differences identified (=8.4, df=2, p< 0.05).

Table 5. Relative frequencies (%) of the drawn elements linked to the water cycle in each group of children considered according to their family origins.

	Minority immigrant children (N= 35)	Native-born children (N=89)	Total
Between 0 and 2 items	34.3	15.7	21
Between 3 and 5 items	57.1	56.2	56.5
Between 6 and 8 items	8.6	28.1	22.6

More specifically, table 6 provides information regarding the frequency of the utilization of water reservoirs in the pictures with each group of children surveyed. The indicated differences are statistically significant (U=1162; p< 0.05).

Table 6. Statistic descriptors for water reservoirs related elements drawn on each group of children considered according to their family origins.

		N	Mean	SD
Water reservoir	Minority immigrant children	35	1.31	0.72
	Native-born children	89	1.73	0.85
	Total	124	1.61	0.83

Finally table 7 illustrates the statistically significant differences found (=6.5, df=2, p< 0.05) in regard to the appearance of, at least, one living organism in each picture.

ISSN 1822-7864

Table 7. Relative frequencies (%) of the appearance of living organisms each group of children considered according to their family origins.

	Minority immigrant children (N= 35)	Native-born children (N=89)	Total
No living beings	65.7	40.4	47.6
One or more living beings	34.3	59.6	52.4

Concerning the remaining water-cycle related categories, the sun was represented in 43.5% of the pictures studied. Furthermore, 33.1% of these pictures presented, at least, one element belonging to the already mentioned geographic category (soil, mountains and sky) and, finally, 25% of the drawings presented, at least, one element of this atmospheric category (rainfall, snow, hail, thunder, storms, rainbow, wind).

As for the study of potential differences between minority immigrant and native-born children with respect to the frequency of illustrated elements belonging to the sun, and geographic and atmospheric categories, no significant differences were found in the sample analyzed.

Discussion

In terms of scientific discourse, rain is considered as one of the types of hydrometeors that occurs in the atmosphere and is responsible for much of biological, geological, climatological and also, cultural phenomena (Wikipedia, 2011b). It may be also pointed out as a significant element of the so-called water-cycle; that is, the most highly structured scientific understanding regarding the movement of water substance on the Earth (Bennett, 2008).

In terms of educational praxis, the precipitation phenomenon is a widely used didactic resource so as to introduce elementary scientific notions and to stimulate pupils' interest towards characteristically scientific activities such as observation, measurement and the drawing of conclusions (Fernández & Rodríguez, 2006; Ashbrook, 2003; Newton, 2002; Williams, 2008).

Despite the fact that rainfall is an observable phenomenon, the understanding of its scientific explanation is far for being evidence of its being learnt. The understanding of even the most basic form, of some of the non-observable mechanisms that underlie atmospheric water phenomena, (such as the sun's role in the movement of water between different reservoirs or the permanence of water as a substance despite its changes in appearance) requires some developmental steps that do not seem easily covered, especially by young children (Shepardson, et al., 2009; Uyen, Payne, Whitley, 2010).

Given the intrinsic cognitive difficulties that characterize scientific concepts, the so-called domain-general perspectives on development, call into question young children's competence to grasp abstract notions (Gelman & Brenneman, 2004; Sloutsky, 2010). However, a growing body of data collected by research into specific domains of our knowledge suggests that the early human skills to produce abstract representations of objects, agents, numbers and causes (Carey, 2009) have to be seriously considered.

In this regard, the data presented above is consistent with the idea that young children are capable of making representations of non-evident happenings and also are able to incorporate them into their explanations, in this case, concerning the mechanisms of rainfall.

Regarding the semi-structured dialogue with the subjects of the sample, the third and fourth questions seem to be milestone points in order to examine children's competence to deal with non-evident scientific concepts. In this regard, 14% of the children interviewed used arguments that, to some extent, were consistent with a scientific point of view regarding the water-cycle, pointing out that rainwater is taken by plants or it goes to the sea or to rivers or it becomes vapour. Contrary to answers based on perceptual evidence used by other children (for instance, rainfall makes puddles or it disappears through or it makes the playground wet), no simple observable evidence can be found to support the idea that rainwater is taken by plants or it goes to the sea.

Similarly, half of the sample studied not only mentioned the sun as the agent that causes the disappearance of puddles but also referred to a specific process involved in this change (evaporation, drying…). Once again, the link between the sun and the evaporation of rainwater is not obvious or perceptible (in comparison, for instance, with the evident relationship expressed in the answers that pointed to a simple disappearance or to the idea that it disappears through the sewer system).

Concerning the pictures drawn during the second part of the interview, 56,5% of the depictions examined, illustrated between 3 and 5 elements that matched the components of the water-cycle; for example, the sun, different water reservoirs (rivers, vapour, the sea, lakes, clouds…), living beings (plants and animals) or geographic location (mountains, caves, soil,…) and atmospheric elements (winter, storms, rainfall, snow,…). Moreover, 22.6% of the subjects of the sample drew more than 6 the aforementioned elements related to the water-cycle.

Currently a well established body of research gives an account of the capacities that young children display in order to manage such abstract and non-obvious notions such as spatial intelligence (Newcombe & Frick 2010), numerical understanding (Villarroel et al., 2011), probabilistic thinking (Gonzalez & Girotto, 2011), causal reasoning (Cook, Goodman, Schulz, 2011) and timing capacities (Busby & Suddendorf, 2009).

Nevertheless, little research has been carried out regarding the understanding of the non-evident scientific concepts which are required to grasp the scientific explanations on natural phenomena (Saçkes, et al., 2010). In this sense, the results presented in this study show that a significant number of children included in the sample studied use non-obvious notions when verbally trying to get across their understanding of events related to the crucial aspects of the mechanisms of rainfall. Similarly, their pictorial representations of the elements that they consider to be related to rainfall, more often than not, include representative elements of the water cycle.

Conclusions

Generally speaking, the presented results may support the thought-provoking consideration that there is no reason to keep young children away from the essential core of the abstract explanations that science uses to assign meaning to natural phenomena, in the case of using appropriate instructional interventions.

Moving on to the analysis of the potential differences between the young minority immigrant children and the native-born children comprised in the sample, both groups of children seem to perform similarly regarding the oral explanations about the rainfall phenomenon. However, regarding the study of the pictures presented, the minority immigrant children were less likely to draw water-cycle related elements in their pictorial representations, given that only 65.7% of the children whose parents do not belong to mainstream culture drew 3 or more water-cycle related elements, in comparison with the figure of 84.3% achieved by native-born children.

These differences also turn out to be significant regarding two of the most characteristic elements belonging to the scientific understanding of water cycle: the presence of different water reservoirs through which water substance moves (rivers, sea, lakes, steam, clouds, vapor…) and the role of living beings (plants, grass, trees, animals,…). In this regard, it may be significant to highlight that daily life may barely provide children with enough observable experiences through which they can make a connection between water and water reservoirs. Likewise, the relationship that living beings have with rainfall is not easy to conclude based on experiences in the environment (in fact, some aspects of this relationship involves even more complex concepts such as what happens in the case of the evapotranspiration or on the issue of the mutual influence between forest and rainfall).

Children's pictorial productions are considered a very useful technique for exploring very young children's ideas. On the one hand, drawings are believed to be a mirror image of a child's representational development (Cherney, Seiwert, Dickey, & Flichtbeil, 2006; Kress, Jewitt, Ogborn & Tsatsarelis, 2001). On the other hand, drawing activities prevent children from reproducing conventional answers (Rennie & Jarvis, 1995) and encourage them to exteriorize their thoughts even in the case of kids who have communicational difficulties (Holliday, Harrison & McLeod, 2009).

As a result, the significant differences found between young minority immigrant and native-born children with respect to their pictorial representations may be interpreted in terms of different levels of an in-depth understanding of the rainfall phenomenon. Consequently, it seems to be reasonable to consider that native-born children of the sample analyzed, exteriorize a more accurate comprehension of the rainfall event, in comparison with their other classmates.

Nevertheless, according to the aforementioned differences the lack of dissimilarities found regarding the oral explanations given by children in the semi-open questions remains as a challenging fact to be explained. In this respect, it has been pointed out that during the early emergence of abstract concepts learners find in the communication exchanges the essential support to conduct the verbal usage of new non-obvious concepts by virtue of linguistic routines (Sfard, 2000a, 2000b). These early stages, known as linguistic template-driven phase, does not guarantee a deep understanding of the abstract concepts but only serves as a linguistic scaffolding to use the concepts that, eventually, can sustain the emergence of an in-depth sense of the concepts.

In light of this socio-cultural perspective that underlines social interaction and language as catalysts of learning, the mentioned similarity between the two groups of children studied as regard their oral explanations and the corresponding differences concerning the pictorial representations may be understood as a consequence of differences in the learning process. In this respect, it may be pointed out that while the subjects belonging to both groups analysed seem to have achieved a similar level of linguistic practice of non-evident concepts to explain the rainfall phenomenon (and consequently, all the children seem to have achieved a similar linguistic template-driven phase on the subject of the mechanism of rainwater), only the native-born children, as a whole, seem to have interiorized a deeper understanding of these notions, which may cause differences in the pictorial expressions.

Nonetheless, it is necessary to carry out further research to confirm the validity of socio-cultural standpoints in order to better understand how young children give meaning to the notions that science gives us about the rainfall phenomenon by means of the water-cycle account. In this vein, it is required to set up additional investigations with larger samples of young children but, more importantly, it seems to be necessary to study more exhaustively how young children carry out the appropriation process of scientific perspectives on a broader range of natural phenomena, an undoubtedly interesting research line which has been little developed so far.

Acknowledgements

The author would like to thank Malcolm A. Cook for language supervision of the article and the following educational centres for their collaboration: Gorlizko Ikastexea, from Gorliz, Aranbizkarra Ikastola, from Vitoria-Gasteiz; Landazuri Ikastola, from Vitoria-Gasteiz and Sta. María de Vitoria Ikastola, from Vitoria-Gasteiz.

References

Ashbrook, P. (2003). *Science is Simple: Over 250 Activities for Preschoolers*. Maryland: Gryphon House.

Bennett, A. (2008). The water cycle: Managing long term sustainable water use. *Filtration & Separation, 45* (1), 12-15.

Buffler, A., Lubben, F., Fred, B. I., Pillay, S. (2008). *A model-based framework for understanding the role of visualization in physics education*. Paper presented at SAARMSTE conference, University of Lesotho, Maseru.

Busby, J., Suddendorf, T. (2009). Preschoolers begin to differentiate the times of events from throughout the lifespan. *European Journal of Developmental Psychology, 6* (6), 746-762.

Carey, S. (2009). *The Origin of Concepts*. New York: Oxford University Press.

Cherney, I. D., Claire, S. S., Tara, M. D., Flichtbeil, J. D. (2006). Children's Drawings: A mirror to their minds. *Educational Psychology, 26*, 1, 127-142.

Christidou, V., Hatzinikita, V. (2006). Preschool Children's Explanations of Plant Growth and Rain Formation: A Comparative Analysis. *Research in Science Education, 36,* 187-210.

Cook, C., Goodman, N. D., Schulz, L. E. (2011). Where science starts: Spontaneous experiments in preschoolers'exploratory play. *Cognition, 120*, 341-349.

Cross, A., Bowden, A. (2009). *Essential Primary Science*. England: Open University Press. McGraw-Hill Education.

Eshach, H., Fried, M. N. (2005). Should science be taught in early childhood?. *Journal of Science Education and Technology, 14* (3), 315-336.

Eshach, H., (2006). *Science Literacy in Primary Schools and Pre-Schools*. The Netherlands: Springer.

Fernández, R., Rodríguez L. M. (2006). Los pequeños de cuatro años en el rincón de ciencias: qué ven y qué dicen sobre el nacimiento de las plantas. *Alambique: Didáctica de las ciencias experimentales, 49*, 105-113.

Gelman, R., Brenneman, K. (2004). Science learning pathways for young children. *Early Childhood Research Quarterly, 19*, 150-158.

Gelman, R. (2009). Innate Learning and beyond. in Piattelli-Palmirini, M, Uriagereka, J.., & Salaburu, P. (Eds) *Of minds and language: A dialogue with Noam Chomsky in the Basque country*. New York: Oxford University Press, pp. 223-238

Gillespie, H., Gillespie, R. (2007). *Science for Primary School Teachers*. England: Open University Press. McGraw-Hill Education.

Ginsburg, H. P., Golbeck, S. L. (2004). Thoughts on the future of research on mathematics and science learning and education. *Early Childhood Research Quarterly, 19* (1), 190-200.

Gonzalez, V., Girotto, V. (2011). Combinatorics and probability: Six- to ten-year-olds reliably predict whether a relation will occur. *Cognition, 120*, 372-379.

Hernandez, D. J. (1997). Child development and the social demography of childhood. *Child Development, 68*, 149-169.

Henriques, L. (2002). Children's ideas about weather: A review of the literature. *School Science and Mathematics, 102* (5), 202-215.

Holliday, E. L., Harrison, L. J., McLeod, S. (2009). Listening to children with communication impairment talking through their drawings. *Journal of Early Childhood Research, 7* (3), 244-263.

Inan, H. Z., Trundle, K. C., Kantor, R. (2010). Understanding Natural Sciences Education in a Reggio. *Journal of Research in Science Teaching, 47* (10), 1186-1208.

Kim, S., Chang, M., Kim, H. (2011). Does teacher educational training help the early math skills of English language learners in Head Start? *Children and Youth Services Review, 33*, 732–740.

Kress, G., Jewitt, C., Ogborn, J., Tsatsarelis, C. (2001). *Multimodal Teaching and Learning: The Rhetorics of the Science Classroom*. London: Continuum.

Lewis, E. B., van der Hoeven Kraft, K. J., Bueno Watts, N., Baker, D. R., Wilson, M. J., Lang, M. (2010). Elementary Teachers' Comprehension of Flooding through Inquiry-based Professional Development and Use of Self-regulation Strategies. *International Journal of Science Education*, *33* (11), 1473-1512.

Loxley, P., Dawes, L., Nicholls, L., Dore, B. (2010). *Teaching Primary Science*. England: Pearson Education Limited.

Newcombe, N. S., Frick, A. (2010). Early Education for Spatial Intelligence: Why, What, and How. *Mind, Brain, and Education, 4* (3), 102-111.

Newton, L. D. (2002). Questions that help children understand elementary science. *Investigating, 1* (2), 6-9.

Osborne, J., Dillon, J. (2008). *Science Education in Europe: Critical Reflections*. London: The Nuffield Foundation.

Peterson, S. M., French, L. (2010). Lucia French, Supporting young children's explanations through inquiry science in preschool. *Early Childhood Research Quarterly, 23* (3), 395-408.

Rapp, D. N. (2005). Mental models: Theoretical issues for visualizations in science education. In J. K. Gilbert (Ed.), *Visualization in Science Education* (pp. 43–60). The Netherlands: Springer.

Saçkes, M., Flevaresa, L. M., Trundle, K. C. (2010). Four- to six-year-old children's conceptions of the mechanism of rainfall. *Early Childhood Research Quarterly, 25* (4), 536-546.

Saçkes, M., Trundle, K. C., Bell, R. L., O'Connell, A. A. (2011). The influence of early science experience in kindergarten on children's immediate and later science achievement: Evidence from the Early Childhood Longitudinal Study. *Journal of Research in Science Teaching, 48* (2), 217-235.

Sackes, M., Trundle, K. C., Flevares, L. M. (2009). Using Children's Literature to Teach Standard-Based Science Concepts in Early Years. *Early Childhood Education Journal, 36*, 415-422.

Sfard, A. (2000a). Steering (dis)course between metaphors and rigor: using focal analysis to investigate an emergence of mathematical objects. *Journal for Research in Mathematics Education, 31* (3), 296-327.

Sfard, A. (2000b). Symbolizing mathematical reality into being. In K. Cobb, E. Yackel, K. McClain (Eds.), *Symbolizing and communicating in mathematics classrooms: Perspectives on discourse, tools, and instructional design*, 3 (pp.37-98). Mahwah, NJ: Erlbaum.

Shepardson, D. P., Wee, B., Priddy, M., Schellenberger, L., Harbor, J. (2009). Water Transformation and Storage in the Mountains and at the Coast: Midwest students' disconnected conceptions of the hydrologic cycle. *International Journal of Science Education, 31* (11), 1447-1471.

Siegel, S., Castellan, N. J. (1988). *Nonparametric statistics for the behavioral sciences* (2nd Ed.). New York: McGraw-Hill.

Sloutsky, V. M. (2010). Mechanisms of Cognitive Development: Domain-General Learning or Domain-Specific Constraints? *Cognitive Science 34*, 1125-1130.

Uyen, L., Payne, D. L., Whitley, L. (2010). Research on Learning and Teaching Ocean and Aquatic Sciences. *NMEA, Special Report, 3*, 22-26.

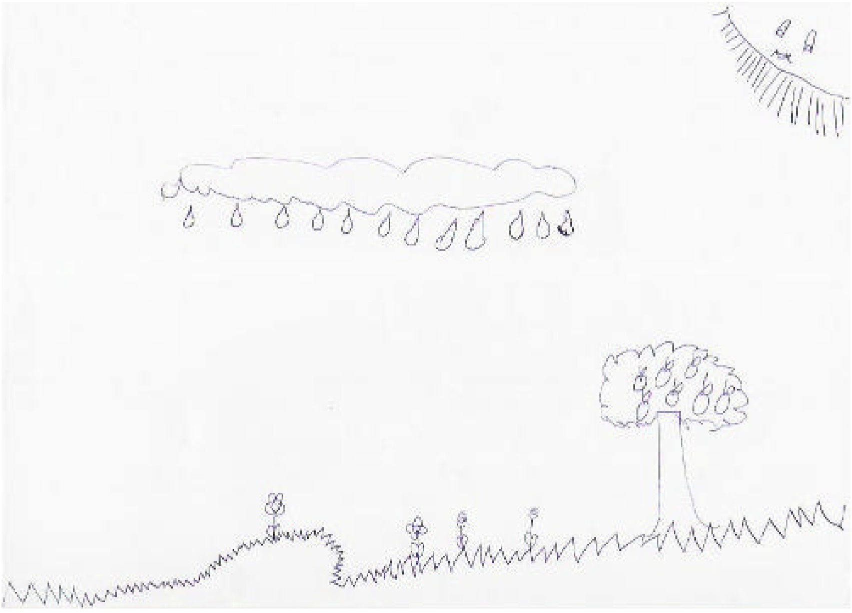
Villarroel, J. D., Miñón, M., Nuño, T. (2011). The origin of counting: A study of the early meaning of 'one','two' and 'three' among Basque- and Spanish-speaking. *Educational Studies in Mathematics, 76*, 345-361.

Wikipedia (2011a). *Basque Country*. Retrieved on August the 10th, 2011, retrieved from Wikipedia online: http://en.wikipedia.org/wiki/Basque_Country.

Wikipedia (2011b). *Rain*. Retrieved on August the 10th, 2011, retrieved from Wikipedia online: http://en.wikipedia.org/wiki/Rain.

Williams, A. E. (2008). Exploring the natural world with infants and toddlers in urban settings. *Young Children, 63* (1), 22-25.

Appendix



Advised by Laima Railienė, University of Siauliai, Lithuania

Received: *October 03, 2012* Accepted: *November 02, 2012*

José Domingo Villarroel PhD., Lecturer at the University of The Basque Country, University College of Teacher Training in Bilbao, Barrio Sarriena s/n. Campus of Biscay, Spain.
E-mail: txomin.villarroel@ehu.es
Website: http://www.ehu.es