# *Using drama techniques for the teaching of early years science : a case study*

Article

# Using Drama Techniques when Teaching Science in the Early Years: A Case Study

**Abstract:** This paper investigates the effect of drama techniques when employed to facilitate teaching and learning early years science. The focus is a lesson intervention designed for a group of children aged between four and five years old. A number of different drama techniques, such as teacher in role, hot-seating and miming, were employed for the teaching of the water cycle. The techniques were implemented based on their nature and on what they can offer to young children considering their previous experiences. Before the beginning of the intervention six children were randomly selected from the whole class who were interviewed aiming to identify their initial ideas in regards to the water cycle. The same children were interviewed after the end of the intervention in an attempt to identify the ways in which their initial ideas were changed. The results appear to be promising in terms of facilitating children's scientific understanding and showed an improvement in the children's use of vocabulary in relation to the specific topic.

## Introduction

In an early years classroom we can observe a variety of children who have different learning needs and knowledge. By taking this diversity into consideration, teachers should offer students a range of different and equally important learning prospects (Rubin & Merrion, 1996). There is good evidence that the arts are a way of reaching and engaging children with diverse learning styles, of fostering and supporting social growth, of unifying content, and of powerfully communicating meaning (Rubin & Merrion, 1996). Through the arts, children can better understand themselves and others (Rubin & Merrion, 1996). Thus, via the arts in education, children can improve and consolidate their learning.

It has been generally acknowledged that by using arts-based teaching and learning, in general, learners are able to express themselves as well as their knowledge through different, creative and novel approaches (Goldberg, 1997).

Goldberg (1997) stresses that the arts play a fundamental role in teaching and learning since they provide challenges and opportunities to children in exploring their own questions and queries. Such approaches also serve as a mode of expression when working with ideas and feelings. Research also supports the notion of arts providing and amplifying pupils with opportunities to take upon more risks in their learning (Burton, Horowitz & Abeles, 1999). Hence, the positive and constructive role the arts play in engaging children's learning can be acknowledged. One of those art forms considered to be of great use in this context is drama.

However, there are very few studies on the use of drama for science education (Yoon, 2006). This paper attempts to examine the potential of employing drama techniques to aid the children's understanding of specific scientific ideas. The intention was to develop and employ an intervention lesson, based on the children's age and previous experiences, which utilises a number of different drama techniques. The paper describes a science lesson which was designed specifically for the topic of the water cycle by two teachers/researchers: the first one has experience in using drama techniques with early year's children; the second one has a special research interest of teaching science in the early years. This enabled the development of a lesson intervention which blended the expertise coming from the two complementary fields.

## The Learning of Science

When investigating ways that can help children's learning of science, it is important to refer to the way in which children learn science and construct their knowledge. Children's concepts are thought be formed as a result of previous experiences. Much of young children's scientific learning comes from the varied environment in and around their homes, the information that is shared around them and the skills' demonstration by close adults, like their parents (Bradley, 1996; Hollins, Whitby, Lander, Parson & Williams, 2001). Children's scientific views are a result of personal experiences, which can include watching television, reading books and oral language interactions in addition to the interaction with family members and other adults (de Kock, 2005; Guest, 2003). As a result, children develop their ability to think and construct concepts based on their experiences and interactions.

As Guest (2003) contends, concept development is not just a case of becoming faster or fuller of knowledge; there are also qualitative changes in the way that children process new information as they develop cognitively. Science education needs to consider these qualitative changes and it needs to engage participants in active participation (Yoon, 2006). However, science educators usually prefer to demonstrate experiments and organise investigations to collect evidence, plan observations and develop logical thinking (Yoon, 2006). Teachers might fear that actively engaging children might lead to 'losing classroom control' since control is usually perceived as the structure that a teacher applies to classroom management (McSharry & Jones, 2000). Consequently, the way that science is typically taught in schools with older children tends to be very information-driven (Lobman & Lundquist, 2007). The children who benefit more from this type of teaching are the ones who are already familiar with the concepts through previous out-of-school experiences. In the last few years, researchers have confirmed that middle-class children come to school with life experiences that provide a foundation on which school learning can occur. These children can access the science curricula because they have prior knowledge and/or experience (Lobman & Lundquist, 2007).

***Drama and Science Education***

Combining the literature and research for drama on one hand and science on the other reveals that some similarities exist. The fact that both offer children the engagement in active participation of meanings and understanding was the core of this study. Grainger (2003) portrays drama as the art which involves social encounters and which offers particularly rich and affective experience for both teachers and children. Drama enables both children and teachers to enter a world of experiences and knowledge. Through drama children are given opportunities to construct and analyse new ideas and additionally reconstruct and produce new understandings and meanings (Grainger, 2003). Neelands (2002) points out that children have the tendency to learn by experiencing and acting out, all of which can be illustrated through drama (or can be thought of as dramatic ways of demonstrating learning). Through drama children are given the opportunity to construct their own knowledge by allowing them to have control over this knowledge (Avdi & Hatzigeorgiou, 2007). In addition, the notion of drama contributing to children's learning of science can also be considered as a creative and innovate aid and a means for teaching knowledge which is otherwise

difficult to achieve through conventional educational approaches (Metcalfe et al., 1984; Sergi, 1991).

Drama has frequently been acknowledged as a means to teach different curriculum subjects as well as a curriculum subject on its own that facilitates and enhances children's learning (Winston & Tandy, 2001; McGregor, 2014). The benefits of applying drama in teaching vary from externalising emotions and feelings (Sergi, 1991) and reflecting upon their experiences and relationships regarding the world and people around them (Smith, 1983), to enriching children's vocabulary and comprehension of language (Rubin & Merrion, 1996). Drama techniques are also seen to have a positive effect in developing children's vocabulary and language comprehension, usually due to the use of dialogue (Rubin & Merrion, 1996).

There have been several examples of drama's usage in curriculum subjects (including science) as a means to construct knowledge (Scher & Verrall, 1975; Sergi, 1991; Winston & Tandy, 2001; McGregor, 2014). Research regarding the use of drama activities in science has indicated the positive role that drama has on children's learning as an aid to expressing meanings and understanding (Metcalfe et al., 1984; Varelas et al., 2010). Metcalfhe et al. (1984) report that although no statistically significant differences were found in the effectiveness of using drama in science in primary ages, drama gave children an insight to science meanings. Moreover, Varelas et al. (2010) suggests that primary children enact science meanings through drama improvisations; hence drama can offer children a different perspective of science and can enrich science learning through offering experiences as well as knowledge. Drama activities can offer opportunities to children to express and construct scientific ideas in conversation with their teacher and their peers about the phenomena and topics they study while they can also enable children to reconstruct scientific meanings (Varelas et al., 2010).

In addition, Dorion (2009) noted that positive outcomes were found when drama was used in teaching chemistry, biology and physics in secondary school. The same author (Dorion, 2009) reports that employing drama techniques for the teaching of secondary science can assist students understanding of more abstract scientific topics. Braund et al. (2013) also reports that using drama in science lessons enables students to experience a phenomenon. McGregor (2012) similarly reports that when

teachers employ drama for the teaching of science to children from five to seven years old, both children and teachers benefit. This is because drama enables teachers to get an insight view of children perceptions, thoughts and understandings and stresses the view of implementing innovative approaches to teaching science (McGregor, 2012). A more recent study by McGregor (2014) indicates that the use of drama techniques for the teaching of primary science engages and motivates children and also aids them in grasping more challenging conceptual and procedural ideas.

According to Precious and McGregor (2014) children agree that the use of drama techniques can support them in many areas of scientific enquiry and help them understand scientific ideas which are traditionally thought to be difficult. The majority of the children report that these activities are both fun and help them learn science through acting out and talking about their ideas (Precious and McGregor, 2014). The beauty of using drama for the teaching of science is that it allows children to develop their understanding of emotional and behavioral real-life events in a safe way (McSharry & Jones, 2000). The use of appropriate drama techniques can offer children the opportunity to learn without warring about what they do or do not know (Lobman & Lundquist, 2007).

There are a number of different drama techniques which can be applied in a science classroom. Techniques such as hot seating, teacher in role, still image, mantle of the expert, action narration, mimed, thought tracking and many others (Neelands & Goode, 2000; Avdi & Hatzigeorgiou, 2007). The structure of these techniques allows children to say or act out things that are beyond what they would in other circumstances say or do under more traditional school conditions (McSharry & Jones, 2000). Drama techniques can introduce children to the terminology of the science topic in a supportive environment. For example, in creating an improvised scene that takes place on the moon, one child might begin walking in a funny way and the group could then use this offer to discover how they might move in a gravity-free environment. Each child does not need to worry if he or she knows anything about gravity; they just need to follow the game (McSharry & Jones, 2000). However, several factors need to be taken into consideration when it comes to applying drama in science education such as the age of the participants as well as their experiences in relation to drama and the topic under investigation (Avdi & Hatzigeorgiou, 2007).

In conclusion, there is evidence in the literature that drama can successfully be a useful approach when teaching science. A variety of drama techniques with some alterations to suit the age and experiences can also be applied for the teaching of early years science (Avdi & Hatzigeorgiou, 2007). However, there is a lack of research in relation to the use of drama for the teaching of early years science. This paper describes the deployment of drama in delivering science. In particular, this paper will examine its use with early years children.

## Methods

This paper is based on a small case study which employed the implementation of an intervention lesson designed by the teachers/researchers and the use of pre and post semi structured-interviews. The sample comprised of six children between four and five years of age attending a private pre-primary school in Cyprus. The researchers chose a typical urban school and the children attending could be considered as a small but representative sample in terms of the range of early years children in Cyprus[1]. After the identification of the specific school the headteacher was approached to grant permission for the school's participation. Next, a letter was sent to parents/guardians informing them about the purpose of the study and asking permission for their children's participation. Due to lack of time only six children were selected for the interviews. Even though the number of boys and girls that would participate was not an issue as gender was not one of the focuses of this study, we chose to focus on three boys and three girls.

The children were interviewed to identify their understanding and ideas relating to the water cycle phenomenon prior and after the lesson intervention. Using direct questions to ask children about what they know is an obvious shortcut (Schmidt, 1997; Treagust, 1988) and thus it was very helpful to use such questions for the pre- and post-interviews. This type of question also helped in making a comparison of children's answers before and after the lessons. After obtaining permission from the participants and their parents, the three girls and the three boys, were interviewed and the conversations were audio-recorded. The pre- and post-

[1] A normal Cypriot early years classroom would be consisted from no more than 25 children and approximately the same number of boys and girls coming from a middle socioeconomic background.

interviews with the children were designed to be semi-structured to allow flexibility during the discussions. The children were interviewed individually by both researchers in a familiar, quiet and relaxed area of the school. The children had to answer the same questions, either in a different order or with additional sub-questions, to further investigate their understanding. The recordings of the interviews helped to protect the authenticity of the data and cross check the evidence which helped to avoid being inaccurate or incomplete (Robson, 2002).

The children were interviewed an hour before the lesson intervention and a day later. Each interview lasted approximately fifteen to twenty minutes. The aim was to compare the children's answers from the pre- and post-interviews and investigate whether the lesson intervention helped the children to further construct their initial ideas and improve their use of vocabulary when talking about the water cycle. In addition, the teacher who was delivering the lesson wrote a reflective note right after the completion of the lesson. This enabled the researchers to recall the process and further examine the children's engagement and reaction to the specific techniques (Basit, 2012).

***The Lesson Intervention***

The lesson intervention was developed by the two researchers based on the existing literature review for drama techniques and on children's age and previous drama and science experience. The lesson was video recorded to enable the researchers to go back and reflect on the whole process. Permission from all parents to video record the lesson and to take photographs was granted in advance. The aims of the intervention was for the children to be able to a) represent the water cycle (journey of a water drop) by drawing, acting or describing, b) improve their initial understanding of the water cycle and c) improve their use of vocabulary related to the water cycle phenomenon (e.g. steam, evaporation, water).

The lesson intervention begun with the drama technique known as 'the teacher in role'; this technique enables the teacher to participate in drama by taking upon a role, and through that role to narrate a story from that role's point of view (Dodwell, 2009). The teacher entered the classroom wearing a blue cloth around her. She took upon the role of a water drop and begun to tell the story of the journey that a water drop goes through; the teacher presented the story from the water drop's point of

view. While the teacher was narrating her (the water drop's) story she displayed a representation of the water cycle as an aid to the story she was telling.

During the next activity the teacher continued to be in role and asked the children, to answer specific questions in relation to the story. The teacher asked questions like: "What do you think that happens to water when it's very hot? What happened to the water drop in the story during her journey (e.g. when she was in the river, when she was in the sea, when she was in the cloud)? Where will the water drop go afterwards (after the river, after the sea, after the cloud)? What will happen to the clouds when they will get cold?" The teacher gave time to children to use their imagination and reply to each one of the above questions.

The following activity used the 'hot seating' technique. During hot seating a character of a story is seated and questioned by the rest of the drama participants (Neelands & Goode, 2000). The specific activity involved different children who were seated in the middle and took upon different roles. The rest of the children asked each one of the children seated on the 'hot chair' different questions. In this particular activity the children took several different roles according to the story that they heard such as the sun, clouds, mountain, and water drop.

The next step was based on the 'mimed' technique; during this activity the children acted out the story they heard through movements. This particular technique concentrated on movements and generally on the use of the body instead of dialogue and spoken words (Neelands & Goode, 2000). Since the specific children had no previous experiences in learning through drama it was important to break down the mimed activity into steps. Firstly, the children were asked how they imagine that the characters of the story would move, for instance how water runs through the trees, or how a tree moves. After deciding on the move of each character and scene of the story children were split into two groups. One represented the story with moves during which the other group narrated the story to them, then the two groups switched places.

When the two groups completed their presentation, a discussion followed regarding the context of the presentation and not how well they performed or acted out the drama technique of mimed. The aim was to discuss the water cycle phenomenon and revise the different stages of this phenomenon. The children were finally given time to express their understanding of the water cycle on paper. During

this final activity both teachers were moving around the classroom discussing with children and helping them to find a way to express their thoughts and understanding. Some of the children decided to use arrows to demonstrate the series of events taking place during the water cycle.

**Results and Discussion**

The main data was collected during the pre- and post-interviews that were conducted with the six children. The interview recordings were then transcribed by both researchers and notes on the differences in relation to each child's responses before and after the intervention were made. An initial descriptive analysis was completed by reading through the transcripts and making sense of the data. Then a more interpretative analysis was completed during which similarities or norms were identified between different children's answers with an attempt to see if there was any correlation with children's age, gender and engagement during the lesson.

The analysis of the pre-interviews suggests that the children held a number of initial ideas regarding the concept of the water cycle before the lesson intervention. During the pre-interviews the researchers presented two pictures from which the first one was showing a rainy day and the second one a cloudy sky. The children were asked to describe the pictures as well as answer to specific questions in reference to the water cycle like 'Where does the rain come/fall from?, What is the rain?, Why do you think that it rains?, Where do clouds come from?, Is there anything inside a cloud? If yes, what is there inside a cloud?'. Children particularly seemed to have difficulties in defining how clouds are created, for instance they would state that "God makes clouds with cotton" (John, 5, years old), "From the wind" (Andrew, 4.5 years old) or even "From the cloud machine" (Amy, 4 years old). Moreover, when the children were asked "where do you think that rain comes from?" they either remained silent or said that they didn't know. Only one of the boys, Andrew (4.5 years old), said that "Rain comes from the clouds" but he seemed unable to further explain this.

On the other hand, during the post-interviews the children appeared to be more able to illustrate additional explanations and details concerning the water cycle in comparison to the pre-interviews. This was evidence based on the responses they gave to the same questions and also based on their explanations deriving from their

drawings. Specifically during the post-interviews the children were asked to describe the drawings they made the previous day, during the last activity of the lesson intervention. During this process, two specific children provided a very accurate description of the water cycle based on their drawings, a summary of which is provided here:

> "Rains drops fall from clouds in the sky. They drop in the sea and in the rivers and everywhere. Then the sun heats the water drops and makes them vaporise and they go up in the sky and make clouds. And then they get cold and become grey and start raining again (Anna, 4 years old).

> "This is the cloud that rains (showing a cloud in his drawing). The water drops fall into the rivers and the sea and the trees. Then the sun heats the water in the sea and they get very very hot and they vaporise and they go back to the clouds. Then in winter the clouds get cold and it rains (John, 5 years old).

A comparison of the children's descriptions of before and after the intervention indicates a positive effect on the use of vocabulary relating to the water cycle. It also indicates an improvement in their understanding of the specific topic. All six children were able to provide an improved description of the phenomenon after the lesson intervention, something which suggests that their understanding was developed. Furthermore, comparing the answers given by the children in the pre-interviews and post-interviews, in relation to the pictures that were shown to them, significant improvement was shown concerning their explanations of what rain is and where it comes from and also what clouds are made of and how they are created. Following, Mary's (4.5 years old) responses during the pre- and post-interview are presented as an example:

Pre-interview:
Researcher: (First picture) What do you see?
Mary: Clouds
Researcher: Can you explain what a cloud is?
Mary: No. They are up in the sky. The sky made them.
Researcher: What do you think that clouds are made from?
Mary: I don't know
Researcher: Do you think that there is something in the clouds?
Mary: Yes.
Researcher: What?
Mary: I don't know.
Researcher: (Second picture) What do you see here?
Mary: Rain, there is water.

Researcher: Can you explain what rain is?
Mary: No
Researcher: Where does it come from?
Mary: I don't know
Researcher: Do you know why it rains?
Mary: Because God brings it.

Post-interview:
Researcher: (First picture) What do you see?
Mary: I see rain.
Researcher: How can you tell that its rain?
Mary: I can see the water drops.
Researcher: (Second picture) What can you see in this picture?
Mary: I can see clouds.
Researcher: Do they have something inside?
Mary: Rain… va… vapor.

The above quote demonstrates that the specific child could not completely describe or indicate the origin of clouds and rain during the pre-interview, whereas we can observe that there is a positive change in her responses during the post-interview. The comparison of this case, as well as each child's case, suggests that children's post-interview answers are more accurate than the ones given during the pre-interviews and there is a notable improvement in the use of proper vocabulary relevant to the water cycle.

Overall, based on the interviews five out of the six children benefited from the lesson which might indicate that most of the children who participated in the lesson benefited in relation to their learning of science and specifically in relation to the use of vocabulary. It is important to acknowledge the significant improvement of vocabulary since drama has been indicated to benefit children's vocabulary development. The fact that the 'teacher in role' technique was applied along with a narration is something which amplifies the idea that telling stories can have a positive effect on the children's language development (Ellis & Brewster, 1991; Grainger, 2005). This indication points out that combining drama techniques in science lessons can enable children gain access to science terms and vocabulary in a more creative and active approach. This can also help children improve their understanding of scientific phenomena.

Even though the specific results cannot be generalized due to the limited number of participants and the small scale of the research it is important to

acknowledge that they indicate that drama techniques can have a positive impact on children's learning of science and can help children to comprehend and recall specific words. However, the fact that children's vocabulary concerning the topic of water cycle was improved cannot guarantee that their understanding of the water cycle phenomenon was improved as well or that these results will last. This does not suggest that other techniques cannot be successful as well. It does though stress out the positive impact of drama as well as its capacity as a creative and innovating approach when teaching science (Metcalfe et al., 1984; Varelas et al., 2010).

***Implications for the Early Years***

This study employed drama techniques in teaching a specific science topic. The particular intervention is a lesson that can be considered as a creative one, since it combines innovative activities that are not usually applied when teaching science. One of the main experiences that this lesson offered to the children is the one of seeing the curriculum subject of science through a different lens. As Yoon (2006) highlighted science drama may enable children to talk, express, adapt and evaluate their knowledge and thoughts. By entering roles, like the drama technique of hot seating, children can experience the meaning of a context from a different perspective and at a different level. Different drama techniques can be used for the teaching of other topics as well. As Odegaard (2003) argued, drama enables children to process and stretch their meta-cognition through empathy.

Although the techniques described above were applied for the teaching of the water cycle this does not mean that the children have taken all the experiences that the chapter of the water cycle has to offer them. The above lesson should be considered as an initial lesson regarding the water cycle and part of a unit of lessons on the specific topic. For instance, children could be given different scenarios and asked to act out with the use of the drama technique known as 'small-group-playing' that implement experiments. Experimentation in science is an essential aspect, thus it would be useful for teachers to continue with a follow up lesson that would implement experiments and include inquiry based and hands on activities as well. A third lesson could include more science-drama techniques such us still images, live images, thought tracking or dramatisation (Neelands, 2002; Grainger, 2003).

This study demonstrates the importance of the teachers' role regarding children's learning and teaching. Teachers should seek opportunities to be creative and innovative when it comes to their teaching and in sequence children's learning (Grainger, 2003) and to look at a range of approaches to supporting learning. Drama can offer this creative approach and benefit children's cognitive, emotional, kinesthetic and social development (Smith, 1983, Sergi, 1991; Rubin & Merrion, 1996). The positive outcomes that drama has to offer can be applied across the curriculum as well as in science.

**Conclusion**

The results of this small scale study indicate that the application of drama techniques for the teaching of science can have a positive effect on children's construction of scientific knowledge, at least as far as vocabulary is concerned. It is essential to point out that the purpose of using drama techniques for the teaching of science should not be for the children to act out correctly and efficiently the drama techniques but to enable them to develop their understanding of the topic under investigation.

Drama should be seen as a creative approach and as an aid for teaching young children (Rubin & Merrion, 1996; Goldberg, 1997). The opportunities and experiences that drama has to offer to children and to teachers can give access to new aspects of knowledge and understanding (Grainger, 2003). The variety of opportunities which drama offers is what makes it a valuable and creative means in teaching a range of curriculum subjects (Baldwin, 2008). Teachers can implement drama to complement their teaching as it can help to provide opportunities to see what children know and think in different and more accessible ways (Yoon, 2006).

This is an initial exploration of the advantages of using drama to support young children's learning when teaching early years science. Further attempts should continue to be developed until we have a better understanding of how drama can be employed when teaching science in the early years and how it builds on, supports or enhances learning. Future work should gather evidence on a larger scale to improve our knowledge of how drama can help to support and develop children's scientific

understanding, as well as ways in which it can be used to increase children's engagement, enthusiasm and motivation for learning science.

**References**


Avdi, A., & Hatzigeorgiou, M. (2007). *The Art of Drama in Education: 48 suggestions for theatrical workshops*. Athens: Metaixmio. (In Greek)

Basit, T. N. (2012). Ethics, reflexivity and access in educational research issues in intergenerational investigation. *Research Papers in Education*, 28:4, 506-517.

Baldwin, P. (2008). *The Primary Drama Handbook.* New Delhi: SAGE

Bradley, L. S. (1996). *Children Learning Science.* Oxford: Nash Pollack.

Braund, M., Ekron, C., & Moodley, T. (2013). Critical Episodes in Student Teachers; Science Lesoons using Drama in Grades 6 and 7, *African Journal of Research in Mathematics, Science and Technology Education, 17*(1-2), 4-13. doi: 10.1080/10288457.2013.826966

Burton, J., Horowitz, R., & Abeles, H. (1999). Learning in and through the Arts: Curriculum implications. In B. E. Fiske (Ed.), *Champions of change: The impact of the arts on learning*. Washington: Arts Education Partnership.

de Kock, J. (2005). Science in Early Childhood. *ASE Papers*., (16), 117-126.

Dodwell, C. (2009). Drama and storytelling: Creative approaches for teaching historical, geographical and social understanding. *Primary History, 53*(6), 22 – 23.

Dorion, K. (2009). Science through Drama: A multiple case exploration of the characteristics of drama activities used in secondary science lessons. *International Journal of Science Education*,*31*(16), 2247-2270. doi: 10.1080/09500690802712699

Ellis, G. & Brewster, J. (1991). *The Storytelling Handbook: for Primary Teachers*, London, Penguin English.

Goldberg, M. (1997). *Arts and Learning: An integrated approach to teaching and learning in multicultural and multilingual settings*. New York: Longman.

Grainger, T. (2003). Creative teachers and the language arts: Possibilities and potential. *Education 3-13: International Journal of Primary, Elementary and Early Years Education, 31*(1), 43 – 47. doi:10.1080/03004270385200071

Grainger, T. (2005). Oral Artistry: Storytelling and Drama. IN Wilson, A. (Ed) *Creativity in Primary Education*, Exeter, Learning Matters.

Guest, G. (2003). *Alternative frameworks and misconceptions in primary science*. available: http://www.ase.org.uk/sci-tutors/Page1 [accessed January 25th, 2010].

Hollins, M., Whitby, V., Lander, L., Parson, B., & Williams, M. (2001). *Progression in Primary Science: A Guide to the Nature and Practice of Science in Key Stage 1 and 2*. London :David Fulton Publishers.

Lobman, C., & Lundquist, M. (2007). *Unscripted learning. Using improve activities across the K-8 curriculum*. New York: Teachers College Press.

Neelands, J. (2002). *Making sense of drama: A guide to classroom practice*. Oxford: Heinemann Educational.

Neelands, J., & Goode, T. (2000). *Structuring drama work: A handbook of available forms in theatre and drama* (2nd ed.). UK: Cambridge University.

McGregor, D. (2012). Dramatising Science Learning: Findings from a pilot study to re-invigorate elementary science pedagogy for five- to seven-year olds,

*International Journal of Science Education, 34*(8), 1145-1165. doi: 10.1080/09500693.2012.660751

McGregor, D. (2014). Chronicling innovative learning in primary classrooms: conceptualizing a theatrical pedagogy to successfully engage young children learning science, *Pedagogies: An International Journal,* 1-17. doi: 10.1080/1554480X.2014.899544

McSharry, G., & Jones, S. (2000). Role-play in science teaching and learning, *School Science Review, 82* (298), 73-82.

Metcalfe, J. A. R., Abbott, S., Bray, P., Exley, J., &Wisnia, D. (1984). Teaching Science Through Drama: an empirical investigation. *Research in Science & Technological Education, 2*(1), 77-81.

Ødegaard, M. (2003). Dramatic science. A critical review of drama in science education. *Studies in Science Education*, *39*, 75-102.

Precious, W., & McGregor, D. (2014). Just Imagine: Using Drama to Support Science Learning h Older Primary Children. *Primary Science.* 132, 35-37

Robson, C. (2002). *Real World Research*. Oxford: Blackwell.

Rubin, E. J., & Merrion, M. (1996). *Creative drama and music methods: Introductory activities for children*. USA: Linnet Professional.

Sergi, L. (1991). *Dramatic expression and child education* (2nd ed.). Athens: Gutenberg. (In Greek)

Scher, A., & Verrall, C. (1975). *100 + Ideas for Drama*. London: Heinemann.

Schmidt, H - J. (1997). Students' Misconceptions- Looking for a Pattern. *Science Education*, 81(2), 123-135.

Smith, S. (1983). *The primary drama handbook.* London: Ward Lock Educational.

Treagust, D. F. (1988). Development and Use of Diagnostic Tests to Evaluate Students' Misconceptions in Science. *Int. J. Science Education*, 10(2), 159-169.

Varelas, M., Pappas, C. C., Tucker-Raymond, E., Kane, J., Hankes, J., Ortiz, I., & Keblawe-Shamah, N. (2010). Drama Activities as Ideational Resources for Primary-Grade Children in Urban Science Classrooms. *Journal of Research in Science Teaching, 47*(3), 302-325.

Winston, J., & Tandy, M. (2001). *Beginning Drama 4-11* (2nd ed.). London: David Fulton Publishers.

Yoon, H-G. (2006). *The Nature of Science Drama in Science Education*. Paper presented at The 9th International Conference of Public Communication of Science and Technology.