

New Ways to Teach Science in the Early Childhood Classroom



On a warm summer evening, I stood with a friend and his 4- year-old son to watch as a storm approached from the ocean. As we watched, the wind picked up and palm fronds waved wildly. My friend's son looked up and asked: What causes wind? The question was not surprising. While "mom" and "dad" are considered the most commonly used words among early learners, any parent can tell you

"why" is a close second. Children constantly ask: "Why?" No sooner is one "why" question answered than another is asked. In this sense, children are natural scientists. They begin talking about science and math even before entering preschool (Brenneman et al, 2009), and demonstrate an ability to observe, describe, compare, question, predict, experiment, reflect, and cooperate (Greenfield, 2009). A scientist always begins with a question and then uses observations to develop an answer to the question or a theory. My friend's son had started with the question.

I then turned the question around and asked him what he thought caused the wind. Looking thoughtful, he turned around studying our surroundings. He then slowly responded that the flapping palm fronds were generating the wind, which was only growing stronger.

This, of course, was a wrong answer, or an alternative conception, but that does not matter. My friend's son was doing science. He had asked a question, made an observation, which children do regularly (Eshach & Fried, 2005) and developed a theory. His theory was based on his past experiences and observations, which is normal (Duit & Treagust, 1995). He knew that a small moving object can make wind. He had used a fan and waved his hand and felt the wind generated by both. Extrapolating from those past experiences, he had reached what he thought was a reasonable conclusion. Since science is composed of two facets, knowledge and a process (Duschl, Schweingruber, & Shouse, 2007), he had more or less implemented the process of doing science, but not the knowledge. He had used the scientific method to learn about a natural phenomenon. (Charlesworth & Lind, 2010)

Dispelling alternative conceptions, such as the one my friend's son held, can be difficult. Further observations can sometimes be made. Another approach would be to turn to appropriate literature. This is difficult for two reasons. First, when it comes to nonfiction sources, early learners usually have access to textbooks alone. Textbooks contain collections of facts and are inaccessible to young readers. Still, reading relevant sources is vital to conducting science. Scientists both write about their ideas and read what other scientists have done. They write for one another and for the public. So, reading and writing are essential to science.

An alternative approach to the textbook is an authentic source such as a magazine or a trade book coupled with instruction (Norris et al, 2008). Instead of lists of facts, a magazine designed for the classroom contains nonfiction expository text with colourful photos and graphics that relate to the topic being researched (McCrudden et al, 2009). In addition to text that early learners can access, photos can form the basis for observations. Students can

then integrate text with images and observations of the natural world. These are necessary skills for success and often not taught.

Early learners come to authentic sources with a purpose in mind. Research has shown that when students develop a purpose for reading, they are more successful (Duke et al, 2011). A magazine also helps students learn to read nonfiction texts in a way that a textbook or fiction cannot. Early learners are usually taught to read fiction and are expected to apply those skills to nonfiction. However, the skills needed to discern meaning from nonfiction are vastly different from those needed for fiction. Teaching reading strategies helps early learners become successful readers (Harvey & Goudvis, 2017) who can integrate reading with hands-on activities.

Alternative conceptions abound and come from a variety of sources, ranging from media to experiences to peers to even science instruction. For early learners, associating size and weight is an alternative conception based on experiences and observations. Early learners are not always aware of the differences in meanings of specific terms (Inagaki, 1992). If you tell a child you are holding two 3-kilogram objects, one that is larger than the other and ask which weighs more, they will usually say that larger object weighs more. You may repeat the information over and over again and early learners will insist that the larger object is heavier. However, if you let children handle each object and add that to their experiences, they are more likely to reach the correct conclusion. Experiential learning is the best way to improve comprehension (Piaget, 1964). Because young learners' opinions of natural phenomena are stable (Schneps & Sadler, 2003), they may not readily transfer this or similar experiences to new circumstances. So, it is important to remind early learners of past experiences before presenting them with a similar activity with different objects.

This suggests that a strict constructivist approach to teaching science, which is commonly used for older learners (Gunstone, 2000) will not result in success for early learners. This inquiry-based approach allows students to work in small groups and make their own decisions concerning how best to conduct an activity. It helps to increase comprehension and allows students to apply the scientific method. However, younger learners may not be able to transfer prior knowledge to new situations until they learn to generalise what they have experienced when it runs counter to their preconceptions.

As a result, science is often taught as part of the arts-and-crafts curriculum. There is value in many arts-and-crafts activities. They often build fine motor skills and sometimes help students retain vocabulary and build valuable background knowledge. However, it misrepresents what science is and too often knocks out a natural interest in science. While these exercises can build background knowledge, they do not provide students with experiences that allow them to develop the observational and analytical skills to classify and organise information they will need to draw on as they are exposed to more advanced scientific concepts. In other words, arts-and-crafts projects may help build knowledge but not the process of science, when both are essential to the study of science (Shaffer, Hall, and Lynch, 2009).

Using an arts-and-crafts approach to teaching science also underestimates students' capacity to reason and ask their own questions. Contrary to what many educators believe, early learners are capable of engaging in exploratory play and other activities relating to science, math, and engineering. Playbased learning can increase student understanding (Fleer, 2017). Their ability to understand scientific concepts is quite sophisticated. (Duschl, Schweingruber, & Shouse, 2007)

Young learners need more scaffolding than their older counterparts. By dividing students into small groups and utilising a guided inquiry approach, a teacher can give students the

freedom to become active agents while focusing their attention, as well as reminding them of appropriate previous experiences and background knowledge. As students gain experience and confidence in their own work, the teacher can utilise a gradual release model to give them the appropriate freedom to conduct their own activities (Banchi & Bell, 2008). This will undoubtedly vary from group to group and the teacher will have to draw on her experiences using differentiated instruction models. She can allow some groups to develop their own questions and peruse them while giving more assistance to other groups.

Activity-based learning should also be repetitive. For instance, utilising the size and weight example given above, students can determine that the weight of various different-sized objects are the same. They can use rocks, jars, toys and other accessible objects. By making multiple observations students will begin to discern patterns and then employ those patterns in making future observations.

By integrating reading and inquiry, early learners become active learners who learn the process of doing science and learn that science is more than a collection of facts or a collection of already discovered knowledge. Instead knowing a lot of disconnected facts, early learners exposed to reading and inquiry know how to ask questions, observe, collect and organise data, and discover conclusions. Exposure to science in early education lays the foundation for greater success in science in the later grades (Eshach & Fried, 2005). This model will turn early learners into domain-specific experts. By developing an expertise in a single domain (Kuhn & Pearsall, 2000), such as science, early learners will find it easier to expand that expertise into other domains (Bowman, Donovan, & Burns, 2001), such as math and engineering, as well as reading and writing. Teachers can also pair students with varying domain expertise to create zones of proximal development in which children can help one another, or provide needed scaffolding (Vygotsky, 1978). This helps students become active learners who develop their own questions instead of waiting for a teacher to ask questions for them. These activities also promote the development of fine and gross motor skills just as arts-and-crafts activities do. It also develops spatial awareness and symbolic thinking, as well as awareness of cause and effect relationships and object permanence. All of this not only develops readiness for the upper grades but for a career and life. Students develop a curiosity and a purpose for what they are learning.

A student-centred inquiry approach has its risks, though. The teacher has to be willing to surrender some control to students and allow them to make mistakes and go in wrong directions. She must also be willing to let students ask question to which she does not know the answers. Instead of being the traditional sage on the stage, she must become a guide who assists students in answering their own questions without straying too far. They must also keep a variety of resources and supplies that students can use to answer their questions. So the classroom transforms into a laboratory in which the students and teacher share control and purpose. In essence, they become partners in education who prepare a scientifically literate generation that understands natural phenomena and can make informed decisions.