HANDS-ON SCIENCE IN ELEMENTARY SCHOOL: WHY AND HOW

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ABSTRACT:

This study describes action research to observe learning by lower elementary school students based on their hands-on science experiences. The data include student observations, evaluations and interviews. Level of involvement and interest was also taken into consideration. The study was conducted in three classrooms of twenty children each. Each group was comprised of first, second and third graders combined. The ages ranged from six to nine years. The research was conducted as a lesson cycle, starting with reading books, guided and independent practice. For the closing exercise, students watched a video and answered questions.

INTRODUCTION:

As the researcher walked down the corridors the building was very quiet. She noticed the top of children's heads on the other side of the window. She peeked in. There was a human skeleton on the table. Children all around the table were touching, prodding, and poking it. She could see that they were getting a lot of sensorial experience by that activity. These were elementary school children who were not afraid of a human skeleton.

The researcher has been to several school districts to inquire about their science programs in elementary schools. She was totally surprised that there was no structured program for that age group. Just like every educational field, science in schools need to start early in life so that it becomes part of their curriculum and they feel comfortable studying about it. Again since elementary school children are in concrete operational phase of development lecturing them on science would not work. For these students to grasp the science concepts at their age science must be taught hands-on. The researcher is writing this paper to support the idea of hands-on science in elementary schools.

DISCUSSION:

Elementary school children are in concrete operational stage of their development (Piaget, 1958). Teachers use all kinds of props, diagrams, pictures models etc. to make the science lesson understandable. What they are trying to do is make an abstract idea into physical reality. Invisible things must be represented in concrete form to enable these children to grasp the concepts.

According to Dewey and Piaget (1985), knowledge is not imparted by others but acquired by learners from their surroundings. Knowledge imparted in lecture form cannot be comprehended successfully by young children. Children in concrete operational stage need to touch and manipulate concrete material in order to get mental impressions of abstract ideas. In order to sustain their newly acquired knowledge there must be repetition which, provided by hands-on science, gives opportunities for reinforcement.

Maria Montessori was an Italian doctor who, during the course of her work with children, became aware of the hidden potential that children are born with. Her association with French physicians Jean Itard and Eduard Seguin led her to believe in the idea of scientific approach to education based on experimentation and observation. She is credited with the development of the open classrooms, individualized education, manipulative learning materials, and programmed instruction.

Montessori got her knowledge about “the child” by observing children busy working with things that could be manipulated with hands. According to her, “I studied my students and they taught me how to teach them”. She believed in Piaget’s theory that children develop knowledge as a result of a relationship between a child's current cognitive system and the task at hand (Piaget, 1985).

Early childhood is a wonderful time for learning science (Smith, 2001). Young children constantly want to make sense of their world, just like scientists. They perform activities such as dropping, mixing, touching objects in order to see what will happen. If we tap into their scientific curiosity in an appropriate way, young children will be empowered by scientific understandings. They will learn basic scientific processes and acquire positive attitudes towards learning science. If students are taught science using hands-on experiments, they have a better attitude about the subject than if they are lectured and assigned textbook reading (Lawton, M.1997).These attitudes will carry into later years of schooling.

Constructivism has dominated the educational debate in recent times. It ranges across different aspects of learning including science. According to Asoko (2002), learning science involves learning to use ideas of science, interpret, explain and explore events and phenomena in the natural world. It involves stimulating a process of change in the thinking of the learner. The teacher therefore needs to find ways to introduce and explain ideas in a way that make sense to children. This is a long term process which can be difficult and cause misconceptions. Constructivist perspectives share two basic beliefs (Green, Susan, Gredler & Margaret, 2002): learners construct their own knowledge and to achieve this goal teaching of science must change in major ways.

Over the last decades hands-on science activities have been considered the most appropriate way to help children learn science concepts. These activities produce excitement, perplexity and surprise, and appear to be more pedagogically appropriate

(Bredekamp & Copple, 1997). A good science activity would give children an opportunity for development while introducing them to fundamental science concepts.

The important role of manipulatives in the development of children and learning is well recognized, (Woodard & Davitt, 1987; Chaille & Britain, 1991; Kamii & DeVries, 1993; Marxen, 1995). Hands-on science activities that incite wonder can and should be incorporated in science presentations. Even stories can be made more exciting if they are complemented with hands-on activities during their narration. It is like acting out certain parts of the story.

The initial wonder specifically experienced by children in a science activity is very important. For example, topics like light, sound, water, force and motion can be presented in a way that engages children's attention. Children who are presented with stories in which certain ideas are embedded i.e. air has height, pressure and occupies space, will understand science better when using hands-on activities. Opportunities for action and experimentation will enhance learning (Yannis, 2001).

METHOD:

Science lessons were given to lower elementary students in three classrooms of twenty children each. Lessons were prepared to enable students to experience hands-on (three dimensional), paper and pencil (two dimensional), reading stories and watching short videos (abstract). The researcher chose grades 1-3 for her research because she knew that little emphasis is given to science lessons in these grades. The students would be learning about a human cell. For the focus activity books and magnified pictures of human cells were shown to the students. Then they proceeded to make three dimensional models of a human cell with colored plasticine. The researcher simplified the structure of the cell to just three parts i.e. cell membrane, cytoplasm and nucleus. She demonstrated the model and gave the vocabulary for the parts. Students used three colors of plasticine to make three dimensional models and colored construction to make two dimensional models. The words were written on the chalk board to avoid spelling mistakes. In the end short videos on cell division and human growth was shown to the children so they would understand that cell growth is directly related to human growth.

The next step was to make two dimensional models with colored construction paper. To show the students how a two dimensional model would look, a three dimensional plasticine model was cut into half to reveal the inside. Now they made circles out of construction paper and glued them one over the other to show parts of the cell. Each part was then labeled.

After an interval of four weeks, the researcher went back to the same classrooms to watch the students do independent work. As she walked in the class, carrying all the material, she was bombarded with questions from students: “Are we going to do what we did last time?” “Can we take our work home?” This was an indication of the excitement felt by them. The researcher explained that they would make three dimensional and two dimensional models independently. All the material was placed in a central location so the students could get their own material. The researcher observed the students and made notes. She saw hands diligently at work and eyes focused on the project. If eyes are windows to the brain, it was evident that learning was taking place. Since it was a mixed age class, younger children could ask older children for help if needed.

For an evaluation of the knowledge gained from their hands-on experience, the researcher went back to the same students after an interval of four weeks. This time a questionnaire consisting of ten questions was given to second and third graders while the first graders were interviewed individually. When the paper work was complete, students had a discussion about their feelings on the whole experience. The students expressed the desire to learn more, which made the researcher successful.

RESULTS:

During her first visit to the classrooms she found groups of bright eyed alert, curious and attentive students. They asked questions right away. They wanted to know more about the project. Hands-on experience making three dimensional and two dimensional models of cells captured their attention the whole time. It was very clear that when hands are involved focus is better. Total mental and physical involvement resulted in less socializing, a lot of learning and a longer attention span.

On her second visit the researcher saw the same interest level. Questions such as "Are we going to do the same project again?" and comments such as "I love cutting and gluing paper" were an indication that students were curious. They all worked independently without any difficulty, enjoyed the pictures and conversation about human DNA and were happy to take their projects home.

The third visit was solely for the purpose of evaluating how much information was gained and retained. Third grade students expressed test anxiety by asking questions "Will the tests be graded?", "When will you check the papers?", and "Did we all pass?" It was a surprise for the researcher to notice how that anxiety was effecting their enjoyment of the learning process.

Table 1 shows the results of evaluation of students' knowledge. Eighty percent of the third grade students answered questions one, two, and three correctly. Since they were familiar with the animal kingdom and the plant kingdom, they linked the new knowledge with the prior knowledge. It was interesting to see that only 60% of the students answered question four correctly. This may be due to the fact that they have not seen the microscopic cell. They have only seen magnified pictures. The information about the size was given verbally. It is too abstract for this age group to grasp the concept. The researcher had described in detail how the cells grow by multiplying from one to two, two to four and so on. The students were familiar the function of multiplication so they did not have any difficulty in answering question five. Questions six was directly related with the cell model which the students experienced hands-on, making it easy for them to answer.

Table 1: Results of testing by grade level.

QUESTIONS:		CORRECT ANSWERS		
		1st	2nd	3rd
1.	Is an animal cell the same as a human cell?	65%	70%	80%
2.	Where are these cells found?	60%	75%	80%
3.	What are the parts of a cell?	50%	75%	80%
4.	How small are these cells?	50%	60%	60%
5.	Life starts with how many cells?	76%	80%	84%
6.	What do see in the Cytoplasm?	60%	82%	90%
7.	What do you see in the Nucleus?	10%	20%	20%
8a.	Models of cell: three dimensional	80%	91%	98%
8b.	Models of cell: two dimensional	80%	89%	94%
9.	How does the cell grow?	65%	78%	88%
10.	Do plants have cells?	70%	72%	83%

Again for question seven, the information was given verbally with the help of books and pictures but no hands-on experience (they did not make the models of the DNA). This could explain why very few students answered question seven correctly. Students were most successful answering question eight because they had enjoyed making the cell models with plasticine as well as construction paper. Although students did not have any hands-on experience for question nine, they were familiar with the concept of multiplication and they knew how the cells grow. They put these together in their mind and came up with the correct answer. Question ten was added in the end to evaluate whether could make the connection that plants were living things, hence must have cells. To the researcher's surprise they came through like troopers. Most students answered that question correctly. It would be wise to mention here that all the classrooms had living plants as part of material for learning. Students were accustomed to seeing them grow and could relate growth to having cells.

CONCLUSION:

This study confirmed the researcher's belief that elementary age students learn best by getting sensorial experiences. Hands-on science provides those experiences. Watching the students ask numerous questions, expressing their interest in the subject and their desire to learn more was enough to convince her that children have a need to get totally involved in their lessons. This is possible only if they are allowed not only to get mentally but also physically involved in the process of learning. The researcher also realized that the areas where she could not or did not provide any hands-on experiences were not remembered as vividly as the lessons where students were involved in doing rather than watching. This would be a good topic for further research. A comparative study could be done to measure learning as an outcome of different methods of teaching.

In elementary schools children are in concrete operational stage of development (Piaget, 1958). They learn by getting sensorial impression from their environment. At this stage science education involves broadening children's knowledge of phenomenon and what affects them. They are building a foundation for science. Practical hands-on experience can contribute to this development.

As an elementary school teacher, the researcher has always been interested in devising teaching strategies that work. Being a believer in Montessori philosophy of teaching she has implemented curriculums in language arts, mathematics and social studies using concrete manipulative materials. This approach makes learning hands-on and fun. Since elementary school is such a wonderful time for attitude formation, (Lawton, 1997) it is good opportunity to help children connect with their environment. Life cycle of a frog can be best studied by observing a frog living in the backyard. Plants could be studied by growing a garden. Seven colors of light can be seen by using a glass prism in the sun light. Play is vital for children's learning. They will enjoy simple hands-on experiments in everyday life. Montessori teaching practices have not been given a fair chance to prove how much it can do. Teachers create a structured environment for learning, making extensive use of didactic materials that provide hands- on approach to learning. It is a great way to present science lessons.

Traditionally science has been taught as teacher directed reading assignments leading students to believe that science is BORING (Newport, 1990). Many educators believe that fifty percent of the students are being 'turned off' to science by age 9. They do not like to learn definitions of vocabulary words. All these difficulties could affect their self esteem. The problem actually lies in the methods used to teach science; methods that often do more harm than good.

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