Science and Technology awareness for preschool children: Practical lessons and experiences.

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Abstract:

TekkiTots is part of The Young Engineers of South Africa (YESA) research area within the ICT in Education, Youth and Gender research group at The Meraka Institute (CSIR). The aim of YESA is to increase the pipeline for the generation of more scientists, engineers and technologists by creating the necessary interest and involvement of learners. These interventions start at a preschool level with TekkiTots.

The primary objective of TekkiTots is to expose children between the ages of 5 – 7 to Science and Technology in a fun and hands-on way. The intended outcomes are to stimulate innovative thinking, a positive attitude towards Science and Technology and eagerness amongst theses small children to explore Science and Technology avenues once they enter and leave school.

This paper describes the formative or action research approach and process that were undertaken in the development of Science and Technology content for preschool children. It also provides an overview of the experiences and lessons learned when a group of five preschool children were exposed to the developed Science and Technology content.

Keywords: preschool, science, technology, practical experiences

1. Introduction

Today's children grow up with technology as part of their "natural" environment. They will learn to use all the available technology from a young age. The challenge is to influence these users of technology to become inventors of new technology. The question which then comes to mind is: "What is needed to become an inventor of new technology?"

If we take a look at the definitions of technology it is understood that technology products are the result of applied science knowledge. According to (The Franklin

institute's Recourses for Science Learning Glossary: Online), technology is: "the application of scientific advances to benefit humanity." The Encyclopedic Theosophical Glossary (Online) defines Science as "[from Latin scientia from scire to know] in its widest sense formulated knowledge, a knowledge of structure, laws, and operations"

In order to become an inventor in science or engineering we need to introduce subjects like Science and Technology as a part of the child's "natural" environment as soon as possible. Science and Technology require a child to be able to design, develop, build and test products. It is important to build a child's confidence and skills in these subjects from as early as possible. If TekkiTots can create an attitude of: "I know, I can do, I want to do or this is fun" towards Science and Technology at an early age we might be able to remove a barrier between the child and a possible career in Science and Technology. John Kehoe as sited by (Peel & Prinsloo, 2001: 5) reiterated that "thoughts that are emotionalised become magnetized and attract similar and like thoughts."

According to (Peel & Prinsloo, 2001: 5) "children are born as being inquisitive, energetic, passionate motivated, risk taking, thinking and do the impossible, creative, can see the end product, try over and over again and can learn through mistakes." The environment has a big influence, positive or negative on these attitudes. Great care should be taken when introducing Science and Technology to this age group in order to nurture and build on the positive attitudes already present.

Children between the ages of 5 and 7 years are gathering knowledge. Children need knowledge before they will be able to apply it in a meaningful way. By introducing Science to children it is possible to stimulate the creative thinking, inquisitive nature and to motivate children to take risks and belief that they can do the impossible.

1. The Approach

TekkiTots is a research project within the ICT in Education, Youth and Gender research group. The aim of this research group is to look at innovative ways of introducing or applying ICT in education. The goal of TekkiTots is to lay the foundation for Information and Communication Technology through the introduction of Science and Technology.

The TekkiTots project is based on the action research model as represented in Figure 1 (Zuber-Skerritt 1995) as sited by (Louw)

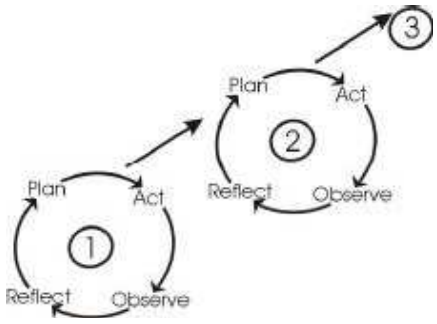


Figure 1

Action research is a cyclical process where the results of the first cycle influence the actions and research in the next cycle. The cycles will end when the desired outcome is reached. Each action research cycle includes planning, acting, observation and reflection.

Action research is according to (Dick B (1993) a methodology which has the dual aims of action and research.

- action to bring about change in some community or organisation or program
- research to increase understanding on the part of the researcher or the client, or both (and often some wider community)"

The motivation for the TekkiTots action research approach is to acquire first hand experience and information on some of the challenges a preschool teacher/educator will be facing when introducing Science and Technology to preschool children. Practical first hand experience will also enable the researcher or developer of the content to develop content which takes the developmental level of this age group into account.

The goal of the first action in the action research cycle was to find or develop suitable Science and Technology content and develop lesson plans to present to preschool children.

The following rules serve as basic guidelines to follow in the attempt to change children's attitudes towards Science and Technology:

- It is important to introduce Science and Technology as Science and Technology in order to familiarize the children with the subjects from a very early age.

- The children need to be exposed to the subjects on a regular basis in order to maximize the possible impact of the intervention.

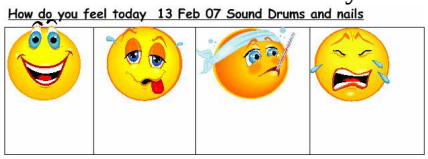
- The lessons should have a format where Science and Technology can be experienced as a fun (cool) activity. "Information is learnt best if it has an emotional

relevance to the learner and it is anchored as an enjoyable experience thus the AHA experience."(Peel & Prinsloo, 2001: 20)

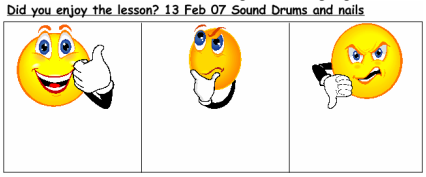
- The children get a hands-on experience. Every child works with his/her own lesson material to be able to explore, experiment, build, record etc. "Best learning takes place when children engage in designing and creating things, especially things that are meaningful to themselves or others around them." Mitchel J Resnick http://www.futureofchildren.org/usr_doc/vol10no2Commentary.pdf Quoted Papert, S. The children's machine: Rethinking school in the age of the computer)]

- Place the emphasis on the experience and not the materials. Use ordinary, freely available everyday material of low cost e.g. toilet roll tubes, elastic bands, balloons, kebab skewers, toothpicks, food colorant etc. The children can reproduce and experiment with relative ease at home.

- Lesson Components for each lesson
  - Evaluation: How do you feel today



  - Science and Technology as Science and Technology
  - A creative introduction (Practical demonstrations)
  - Simple and basic practical material
  - Determine existing knowledge (asking questions)
  - Short explanations – children do not want to listen
  - Hands-on do it yourself
  - Capture experience (drawings)
  - Evaluation: Did you enjoy the lesson?



2. The Process

The content development action (red rectangle) was the first action needed in the action research cycle Figure 2.

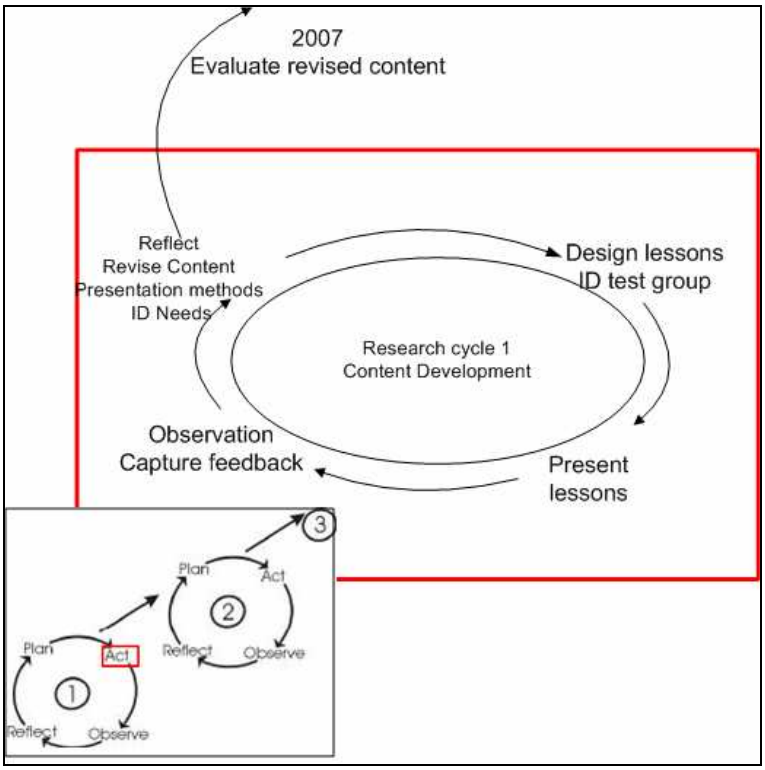


Figure 2

The participants:

A critical part in the development of suitable content was to select a suitable group to test the content. Morningstar Montessori preschool expressed a need for someone to present Science to the grade R group of children at the school. The headmistress, Jenny Miller agreed to the TekkiTots research in her school where there were 6 grade R children. The agreement was that Meraka Institute will present Science and Technology lessons to the grade R children once a week for one year.

Content Development

Questions that needed answers were:

- Why Science and Technology content?

The knowledge generated by basic sciences forms the core support for economic growth and improved quality of life. The attrition and ageing science researchers is identified in the South African Research and Development Strategy as a concern for South Africa (South Africa's National Research and Development Strategy: Online). The belief is that an intervention like TekkiTots at the preschool age will better the chances of children following careers in Science and Engineering.

- What do we want to achieve with the content?

The lessons are about building children's attitudes and confidence not about the content or the amount they learn. The intent is to ensure that each child accomplishes the task at hand

as far as possible on his/her own.

- What content is available?

The internet was the main source for lesson content and ideas for lesson plans.

- How do we present the content?

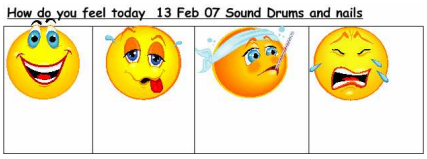
The content should be structured in such a way that it is flexible and creates a balance between challenge and guidance. Keep in mind that some children might like challenges and want to try without guidance while others might first want to build their confidence (follow step by step instructions) before taking part in the next step

- How do we measure if the children enjoyed the experience?

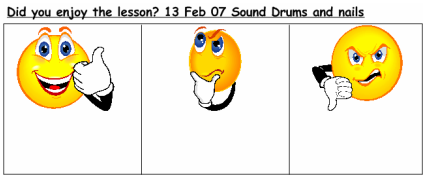
The intended outcome for different children and even different groups might be different due to content preferences.

A simple measurement system were introduced to measure the "success" = enjoyed the class.

Before each lesson started each child were asked to choose a face on the paper and write his/her name below their choice. The choices were:
Are you happy, tired sick or sad?



After each lesson the children had to choose one of the following:
Thumbs up if you enjoyed the lesson, thumbs down if you did not like the lesson and the middle one if you are still thinking about it.



- What content themes?

The Revised National Curriculum Grades R-3 Foundation phase of the Gauteng Department of Education describes **Technology** as "The use of knowledge, skills and resources to meet people's needs and wants by developing practical solutions to problems, taking social and environmental factors into consideration."

ICT is about communication and computer technology. Preschool children can use these technologies to make phone calls and play games, but the challenge for TekkiTots lies in stimulating their curiosity to find out how it works and what is needed to build equipment.

Basic scientific knowledge and understanding forms the foundation of technology inventions. **Electricity** as a first content theme was a personal choice based on the relation of electricity to cell phones and computers. Both need power to work. The first question to be answered is what is electricity and power? The next is where does it come from? How does it work (characteristics) what can we do with it? etc. The aim with electricity was to build some understanding from a simple electric circuit to the pc board in the back of a computer. Each lesson builds on the previous lesson experiences.

The next theme was inspired by the practical assignments my child in grade 5 received. They had to build a house using newspaper. They had to apply basic principles of strength of different shapes and structures. To be able to give some design specifications I decided to introduce **measurements** before introducing **shapes and structures** to ensure that the children would be able to measure the length and strength of a bridge.

The positive results of constructing in building the bridge and the amount of content on sound experiments resulted in **Sound** and **Mixtures** as the next themes. It was now a little clearer what was needed to create the fun experience (or so I thought).

The technology process of **design, make and test** was introduced based on the specifications in the curriculum for the foundation phase.

Sorting and presenting of data using sweets was intended as an experiment which turned out to be successful.

3. Lessons Learned

3.1 – Content Theme Sequence Lessons Learned

- All/most information are **new** to the children
- Start with more familiar content like sound. Do the electricity section later during the year. There is a big difference between the level of development of the children at the beginning and the end of the year and it is advisable to introduce Science and Technology with more familiar concepts like sound or mixtures.

- The intended sequence for 2007 will be:

- Sound (children know about instruments)
- Measurements (Children need to know that different tools are used to measure weight, length and temperature)
- Mixtures (Measurements are used to make clay etc.)
- Design, make and test (Follow picture instructions to build a product)
- Electricity (Basic circuit, conductive and non-conductive material, lightning, simple switch etc.)
- Shapes and Structures (shapes to bridges and measure strength of a bridge)
- Sorting and presenting data

3.2 – Theme Specific lessons learned

Sound (single string instrument)

- **Intended lesson outcomes** may not be reached due to undeveloped skills at this age. This age group will not necessarily be able to tie a knot but can be taught.
- Encourage them to **first try** a difficult task themselves and only offer assistance once they have tried
- **Motor skills** are still developing: The children will struggle to pull a cut balloon over a toilet roll tube but can be encouraged to achieve it with help if necessary.

Measurements

- This age group might be able to **recognise numbers 1 to 10.** Do not use numbers higher than 10 if you want them to measure length etc.

Measurements and Structures

- At this age **units of measurements** make very little sense to them e.g. measure the strength of a bridge by counting how many apples it can carry before it breaks.

Electricity (where does electricity come from?)

- Do not use the same picture sheet in more than one lesson

Electricity Sound Mixtures Measurements

- **Step by step instructions** work better to built self confidence and a sense of achievement for each child

Electricity (Conductive and non-conductive material)

- Do not try to **group things** in a table e.g. Two circles to group conductive and non conductive materials

Electricity **(paper switch vs. real switch)**

- Always let the children build their own simple example before testing the real equipment to prevent them from loosing interest

Mixtures (separation of colours vs. mixing of colours)

- The children **prefer to construct** (build things) rather than analyse (separate to find

components)

Mixtures (cupcakes)

- Always prepare the lesson in such a way that the children have **something to take home** even if it is only a picture of lightning

Mixtures (mix colours on worksheet then for cupcakes)

- **First do formal activities** then fun activities e.g. first let kids mix colours on paper worksheet and then freely to decorate their cup cakes. Close guidance will ensure completion of the worksheet

Design make and test (using paper)

- Children at this age tend to get bored when two consecutive lessons contain more or less the **same practical material** e.g. using paper to construct different products.

Design, make and test (where do wheels come from)

- The children **do not want to listen to explanations**, they want to do/make things. The method of info first (reading interesting facts) then apply the newly gained knowledge was a disaster. The method of transferring information should be done in such a creative way that the children's curiosity is not lost.

3.3 – General factors that influence the success of the intervention

- For an intervention like this to be successful in a school you need the **buy-in** from both the head master and the teacher in whose class the intervention will take place. The parents also need to support their child taking part in Science and Technology classes.

- **Social interaction** plays a critical role in the success or failure and even the flow of a lesson e.g.
    - who wants to sit next to whom,
    - it is sometimes necessary to create distance between children where there are too much competition as they will tend to copy each other in stead of doing their own thing.
    - colour preferences might cause unhappiness e.g. both want "red"
    - Give each child his/her own equipment to work with, they are very scared that they do not get the same as the others
    - Assure the children that everyone will receive the same equipment to prevent them from trying to get hold of everything.

- **Lesson time**: no longer than an hour to complete

- **Group size:** When the group is larger than 6 the children might get frustrated because they do not get helped immediately – and they need a lot of help due to skills that still need to be developed.

- Make sure that the **experiments work** beforehand, the children loose interest otherwise. "Immediate gratification is a distinctive feature of the first seven years in a child's life "(Peel, S. & Prinsloo, F: 16)"

- **Preparation** of experimental material is crucial, **always take extra** as outcomes may vary from the intended (plastic spoons break, more children than expected, perfectionists, want to try again, are not happy with the first attempt etc.)

- **Observations** can be captured by making use of drawings of the results of an experiment or of what they built. At first they might not want to because it is a skill that they still need to develop. Ask each one to explain their drawing. Remember there are no right or wrong drawings.

- There should be time planned during each lesson for **self exploration**.

- Children at this age start to read. Use **Comic Sans MS font** on their worksheets for them to recognise the letters.

- Give and **take equipment/material away**. If you want the children to listen, remove all material that might distract their attention.

- **Arrange the classroom** in such a way that all children are able to see and participate especially when you are demonstrating a principal.

- All the children in the class will not necessarily be interested in the **same Science content**. Some children enjoyed the lessons on electricity while others enjoyed the "craft" part more when sound and mixtures were presented.

4. Needs that were identified

There is a need to gather more research data to determine the impact of such an intervention through:

- Baseline assessment of each child before exposure to the intervention
    - Possible pre-assessment of each child (skills, age etc.)
    - Parental background and attitude toward Science and Technology (Scientific influenced/not)
    - Access to computers and cell phones at home or school
    - Teacher/school as environment's attitude toward Science and Technology
- Methods to improve participation from all the children especially the ones apparently not interested
- In order to understand and optimise intended and unintended outcomes of this intervention we need to explore and understand the following:
    - What is Science and Technology to this age group
    - Level of a child's development at age group 5 to 7

    - What is learning (Learning cycle)
        - Active engagement
        - Participation/Exploration
        - Frequent interaction and feedback
        - Connections to the real world contexts
    - What influences a child's learning
- Translation of lesson material into other SA languages
- Models for sustainability of such an intervention

5. Conclusion

There is a difference between reality and intended outcomes for each lesson. Outcomes are determined by the specific group of children, the content, the educator and the environment. The content as well as the method of presentation should be flexible in order to ensure that the primary goal of "Science and Technology is fun" is achieved with every lesson. Fun does not mean that there are no rules. Children tend to get unruly when they are having fun. It is important to communicate clear rules about what is expected from them and what behaviour is acceptable.

Most of the content is new to the children. It is always good to incorporate something familiar into each lesson to build the child's confidence. The content should be simple and relevant but challenging. Children feel a great deal of achievement when they manage to do something they perceived as difficult. It is important not to underestimate the children.

Each child should be treated as an individual. This might be their first encounter with Science and Technology and great care must be taken not to scare them away, but rather stimulate their curiosity and creative nature. The children will not find all the content appealing which will make some lessons more successful than others.

TekkiTots can change attitudes of "I cannot to I can, I don't want to, to I want to try and I do not know but I can learn or will you help/teach me".

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