

Science and technology awareness for preschool children: A case study

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Abstract

Skills shortages exist in the areas of science and technology, not only in South Africa but globally. Endeavours to address the subsequent need for more people to pursue careers in these disciplines are widespread. We need to ensure that we do not lose the opportunity to have a positive influence on the attitudes of people towards science and technology.

The question that comes to mind is where and when to start?

There is no clear answer to these questions, but what is obvious is that we cannot sit back and wait to see what happens in the future. We need to start today, learn from mistakes, but make sure to create opportunities where learning can take place.

TekkiTots is an intervention to introduce science and technology to preschool children. Age-appropriate content was developed and serves as a vehicle to introduce science and technology in a meaningful, fun and hands-on way to this age group (six-seven years). The initial intended outcome was to encourage a positive attitude towards science and technology and create an eagerness among these small children to explore science and technology avenues once they enter and subsequently leave school.

This paper reports on how this work was initiated, who the collaborative parties were and how this collaboration panned out.

In addition to the expected outcomes, we observed some unexpected outcomes as well. In the paper we report on these unexpected outcomes.

1. Introduction

The problem that needs urgent attention in South Africa is the skills shortage. The Youth into Science Strategy of the Department of Science and Technology (2006) states that career sectors most affected by skills shortages are professional engineers, scientists, surveyors, chartered accountants, actuaries, project managers, artisans and information technology specialists.

Problems need to be solved in a systematic way to ensure that as many variables as possible are identified and accounted for in a solution. The obvious first step towards any possible solution is to identify the problem. In this case: the declining number of scientists and engineers in South Africa. The next step is to understand the problem as well as its extent and complexity. Skills shortages are a result of a wide range of contributing factors which make it a very complex problem to solve. It is also not unique to South Africa but a global phenomenon.

Interventions at different levels are needed to contribute to solve the need in the short and longer term. Vygotsky (1978) states that children's learning begins long before they attend school and that any learning a child encounters in school is in some way connected to previous history. According to the Harvard University Scientific Council on the Developing Child (2007) the quality of a child's early environment and the availability of appropriate experiences at the right stages of development are crucial in determining the strength or weakness of the brain's architecture, which, in turn, determines how well he or she will be able to think and to regulate emotions.

It is important to get an understanding of the preschool environment with regards to the way the children learn and that the social and intellectual characteristics of teachers and parents have an influence on the children (Vygotsky, 1978). Vygotsky (1978) further argues that there is a difference in the way preschool and school children learn. Children are born as being inquisitive, energetic, passionate, motivated, willing to take risks, thinking they can do the impossible, creative, able to see the end product, willing to try over and over again and able to learn through mistakes (Peel & Prinsloo, 2001: 5). Conezio, K. & French, L. (2002) states that many early childhood teachers are hesitant about introducing science in their classrooms, often because of their own unpleasant science education experiences.

Once you understand the environment and the role players, you need to make sure that the content you want to introduce are at a level the child can understand. Children will learn more when they have to design and create things that mean something to themselves or the people in their lives.(Papert, S 1993).

2. The objective

The goal of TekkiTots is to introduce the words science and technology to preschool children as an age appropriate meaningful positive experience. The intention is that children will then have these positive experiences as references to support their developing interests and attitudes towards science and technology.

The intended outcomes of TekkiTots are:

- Children with positive attitudes towards science and technology
- The words science and technology mean something to the children.

3. The method of study

The TekkiTots project is based on the action research model as represented in Figure 1(Zuber-Skerritt 1995) as cited by (Louw). The action research approach gives the researcher or implementer the opportunity to acquire first hand experience and information on some of the challenges a preschool teacher/presenter will be facing when introducing science and technology to preschool children

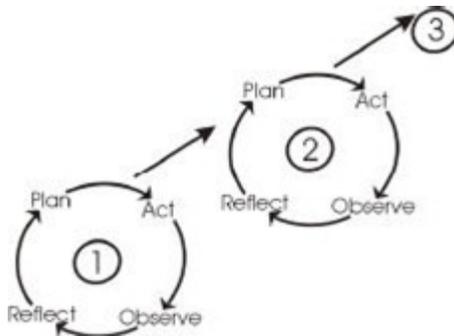


Figure 1

Action research is according to (Dick B 1993) “a methodology which has the dual aims of :

- 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 choosing the action research approach is based on the need to understand the environment and the people in the environment - not through literature studies but by acquiring 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.

Action research is a cyclical process where the outcomes and experiences of the first cycle serves as input for the actions and research in the next cycle. Each action research cycle includes planning, acting, observation and reflection. The result is then the refinement of the actions planned for the next cycle.

What makes action research difficult is the amount of uncontrollable variables the researcher has to cope with in the real world environment (Collins, A. et al.,2004). Intended goals can change due to experiences in a specific cycle. Much data are needed before useful conclusions can be made or trends derived. This implies that many people are needed to be trained and coordinated to work in different environments to collect as much data as possible. This, in turn, results in a logistical challenge. By using more resources more variables are introduced that can also affect results and conclusions.

4. The process

TekkiTots started in 2006 when Morning Star Montessori preschool in the Pretoria area expressed the need for science lesson material, someone with some form of scientific background and a willingness to present these lessons to preschool children through practical experience. It was decided to prepare some lesson material, present it to the head of the school for acceptance and then present the content to the children. The preschool environment includes the school, teachers, parents, the children and the interaction between them. Although the project is aimed primarily at the children, the success depends on the buy in from the school, teachers, the parents and presenters of the TekkiTots material.

Figure 2 shows the TekkiTots action cycles that started in 2006 and continued during 2007 and is currently underway in 2008.

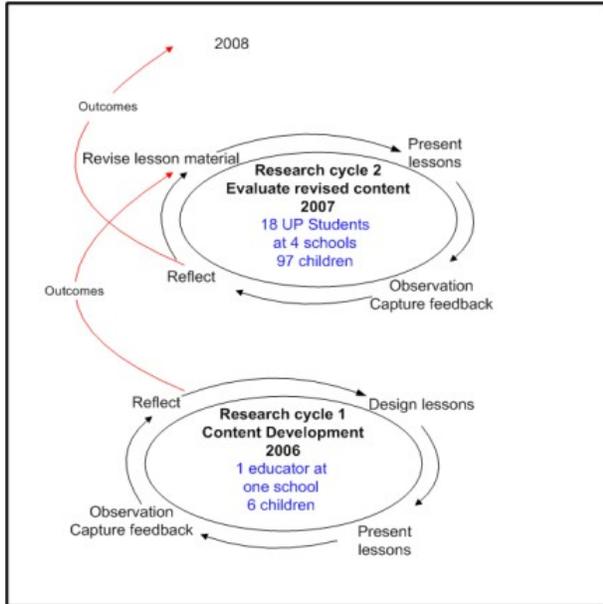


Figure 2

Cycle 1 (2006)

The purpose of the first TekkiTots action research cycle in 2006 was to determine if science and technology could be introduced to preschool children. A total of twenty-five lessons were put together and presented to a group of six children at a Montessori preschool once a week. It took on average an hour to complete a lesson. The content was evaluated on the basis of the interest the children showed and eagerness to take part and complete set tasks. Problems and successes were noted and reflected on after each lesson. The outcomes of each lesson served as inputs for the next lesson as well as the next cycle.

Overall positive feedback from the six children in the preschool class as well as the school resulted in a request from the school to continue the TekkiTots project in 2007.

Cycle 2 (2007)

The purpose of the second cycle in 2007 was to test the usability of the content with more children in other preschools using more presenters. The outcome of this cycle would be a good indicator of the applicability and usability of the content.

Dr Martina Jordaan, head of the community-based project module at the University of Pretoria's

Engineering, Built Environment and IT (EBIT) faculty allowed students to volunteer to work on TekkiTots as part of their community-based project. This community-based project module is an 80-hour module and takes the form of applied learning that is directed at specific community needs and is integrated with all undergraduate academic programmes offered by EBIT.

The students had to form groups to work together on the project. They had to identify and arrange with the preschools to present TekkiTots there. They received lesson material and basic training from the Meraka Institute as well as the needed lesson equipment for each child. The students had to report back on their experiences with the children as well as the usability of the content.

The use of engineering students turned out very successful. Feedback from teachers was very positive and the schools wanted the students to return.

The original school where TekkiTots started in 2006 expressed the need for the project to continue at their school in 2007. Two students joined the TekkiTots project and took over from the Meraka Institute staff member to present the lessons there with extreme success.

A few minor adjustments were identified during this cycle:

- Students should visit a preschool before starting to present to get practical experience working with this age group
- Format of feedback should be standardised
- Stress the necessity to prepare and build experiments at least once before presentation
- Student group dynamics should be managed to optimise success of the intervention.

Logistics of the applied model using students had to be revised for the next cycle in order to minimise the involvement from Meraka to supply lesson material. A possible approach would be to make money available to the student groups to buy their own lesson material. This would also empower students to improve on existing material and equipment when they have a choice on what to buy for a specific lesson.

Cycle 3 Model for 2008

TekkiTots is currently (2008) in its third cycle with support from Dr Martina Jordaan, the UP students and different preschools.

Appendix A represents the flow of the current (2008) TekkiTots model. Within this model the students need to volunteer as presenters of the TekkiTots project. They need to sign ethical consent letters and receive training from the Meraka Institute on the use of the TekkiTots content. The students are responsible for identifying a suitable preschool and get consent letters signed by the school and the parents of each child. They have to attend the preschool for a few hours before they are allowed to work with the children and they are responsible to buy and prepare the necessary equipment for every child for each lesson. The students have to present a minimum of eight lessons over a period of eight weeks to the children at the preschool. They have to capture their observations and experiences after every lesson. They need to get feedback from teachers and parents in the form of questionnaires, which the Meraka Institute supplies.

Two students who completed their project during 2007 at Morning Star Montessori continued to present TekkiTots lessons at the school during 2008. The teachers assisted them with regard to equipment and class management. The teachers at this preschool are now prepared to present science and technology on their own next year at the school. This is a direct result of the confidence they built during the 2008 TekkiTots experience.

5. The result

What makes this model successful?

It is my personal opinion that the main contributor to the success of this intervention is the positive, energetic and passionate attitude of the presenters and not in the content itself. It is, however, important to recognise the important contribution the children, teachers, parents and the environment plays in creating a 'symbiotic' learning experience for everybody. The children will take part in activities not necessarily because they are interested but because positive attitudes are contagious and the children will want to please the presenter. These children are eager to engage in activities when it is presented in a positive enthusiastic way to them even if they find some activities a little difficult. The children need to know that they will receive help when needed and that is

why I emphasise a preferred group size of six children to one presenter. In some instances a child will participate because of unspoken group pressure. An example is that the child knows that he/she will have to make the end product if they want it.

The preschool teacher

This is where the value of action research lies. Experience is invaluable. Skills needed in a preschool classroom environment go far beyond the teacher's subject knowledge. The teacher creates a safe environment where children feel free to explore, make mistakes and try again. A safe environment implies acceptable social behavior and discipline within the TekkiTots class. The teacher contributes to good discipline and behaviour during TekkiTots lessons. The teachers serve to guide and control the TekkiTots presenter's methods and amount of content. In some instances teachers are positively influenced by the TekkiTots experiences.

The child

The purpose of the baseline evaluation is to confirm or inform the presenter about the developmental level of the age group. The presenters who are second and third year university students do not have background or experience of working with preschool children. The baseline evaluation emphasises the children's writing and counting skills. The baseline evaluation is done in such a way that the children are unaware that what they are doing is being evaluated. The children have to write their names on a piece of paper in a set time and count the number of grouped hats. Some children are able to write their names while others can only write the first letter. Most of the children are able to count to five but have more difficulty in writing the numbers. Their spatial orientation skills are still developing and, therefore, they sometimes struggle to write the numbers 2, 3 and 5 properly. The children also struggle with numbers 6 and 9. This gives the presenter an indication of how much help, encouragement and acknowledgement each child might need. The baseline evaluation will also prevent the over-enthusiastic presenter from wanting to use written instructions and do measurements with numbers larger than five.

Every child is unique and in general they are able to communicate in an understandable way. There are observable differences in their gross and fine

motor skills and emotional and social skills are still developing. The intention of the project is to make use of the zone of proximal development theory as explained by Vygotsky (1978). In principle it means that the developmental stage of the child consists of those skills the child has mastered at a certain age as well as the skills the child are able to master under guidance.

Experience during the first cycle showed that the children want instant gratification and need encouragement to complete a task themselves if they struggle. Social interactions, such as who sits next to whom, also influence the success of the lesson. Personal colour preferences can result in children fighting or refusing to continue to take part in the lesson.

The children have different interests and react differently towards the same lesson content. Every child needs attention, guidance and encouragement. At this age acknowledgement of every small achievement has a positive influence on the child's self esteem and therefore willingness to take part even if the content is not related to science and technology.

The TekkiTots presenter

The presenter needs to understand the environment and the capabilities of the children. The presenter should only assist and not complete the task for the child. It is necessary for the presenter to spend time at the specific preschool before presenting any lesson to this age group. It is only through practical experience and observation that one gets a feel for how much or how little content should be used in an hour with small children.

This person needs a lot of enthusiasm, endurance and patience. Children should be encouraged to first try and then ask for help. The presenter needs to understand that there is no wrong or right way of presenting lesson material but it is crucial to make sure that every child feels a sense of achievement at the end of the lesson. Feelings of achievement will differ from child to child. Success of every lesson depends largely on the proper preparation of material to be presented to ensure that the materials can be used by the children. Preparing or building the object beforehand can give an indication of how much assistance the children will need to complete the same task. Instant gratification is a key success factor for this age

group. Children lose interest when they perceive an experiment to be very difficult or not working properly. It is very helpful to incorporate the school teacher to handle discipline in the class.

The class

It works well to have one presenter for every six children in the class. This gives each child the opportunity to receive much needed help, attention, guidance and encouragement to complete a task. When a child experiences achievement and acknowledgement he/she will be more willing to engage and explore the content.

The content

The preschool children do not know what the words science and technology mean. The presenter needs to make sure that whatever content they present is presented as a fun science and technology experience to make it part of the children's lives. Content themes should be relevant in the child's world and simple enough for the child to understand. This means that the child should find something familiar in the content that he/she can relate to. Most of the content is new to the children due to their limited exposure at this age. It is possible to teach this age group difficult words like 'vibration' through repetition and encouragement. The children have very short attention spans and they are not interested in long explanations. Each lesson lasts an hour due to the amount of assistance needed by each child. Lessons are more successful when children have the opportunity to build or do the experiment themselves. The children are eager to take their creations home.

Content presentation

TekkiTots aims to introduce science and technology by making use of a guided constructivist approach where the teacher guides the child to construct knowledge about the subjects in a fun and hands-on way. According to Shymansky (1992) constructivism is defined by Novak (1987) as the idea that humans construct or build meaning into ideas, experiences and events in an effort to understand or make sense of them.

It was found that children of this age group do not know what science and technology are and TekkiTots are introducing these subjects to them, thus giving the child the opportunity to give meaning to it. The lessons as it is now should only

serve as a guide for the presenter. The very first lesson introduces the words science and technology in a fun and hands-on way to the children. The equipment consists of simple balloons and toothpicks that every child can relate to. TekkiTots intends to guide the children to discover and recognise the presence of science and technology in every day life. In order to focus the children's attention, the presenter needs to move all equipment out of the children's reach and sight leaving only relevant equipment with the children. A good 'game' to focus their listening skills is to let them touch their knees, heads and ears every time they have to listen. The structure of the lessons resembles the scientific or the technology process. The aim is to guide the child to develop structured and logical thinking by making use of parts of the simple scientific experiment.

A simple scientific experiment has the following components:

- Purpose (what are we going to do today – maybe a little background information if needed)
- Hypothesis (what do you think will happen?)
- Materials (what are we going to use today?)
- Method (how are we going to do it?)
- Observation (what do we see, hear, feel, smell?)
- Conclusion (at this age the conclusion takes the format of a summary of the lesson by the presenter).

The TekkiTots technological process results in an end product each child builds on his/her own. The process includes:

- Design through drawing (depending on class skills)
- Evaluate your design based on supplied materials (e.g. is it possible to build a Ferrari using a square box with milk bottle lids as wheels?)
- Make the product by following instruction drawings or verbal instructions
- Test the product (does it work/is the child happy with the product?).

Content evaluation

Evaluation is based on observations during and feedback from the children after completing every lesson. The children have to evaluate the lesson experience by choosing one of three smiley faces

by writing his/her name in the block he/she chose. The choices are as presented in Figure 4:

Did you enjoy the lesson? 13 Feb 07 Sound Drums and nails

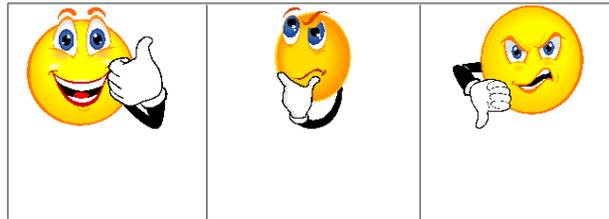


Figure 4

6. Unintended outcomes

It was not the original intention of the project to influence teachers at preschools to present science and technology lessons to the children. The teachers at the preschools do not feel that they have enough background and expertise to present science and technology and are therefore afraid to try. With TekkiTots the teachers have the opportunity to observe the presentation of science and technology lesson material. If they take an interest in the simplicity of the content and the methods used by the students, it was found that their attitudes toward the subjects and their own capabilities changed. Because of their practical experience educating preschool children these teachers can identify shortcomings in the material as well as the way the students present the lessons. These teachers indicated that they are prepared to continue presenting science and technology at the preschool after the students have left. The head mistresses of the schools perceive TekkiTots to have a positive influence on the preschool teachers because it introduces enthusiasm and fun ways of presenting material. The powerful effect of observing effective science teaching has on teachers is also stated by Watters & Diezmann (2007).

The fact that parents need to sign ethical consent forms before their child are allowed to take part in TekkiTots creates science and technology awareness with the parents. Feedback from questionnaires to parents showed that they are positive towards TekkiTots in the preschools and appreciate the science and technology initiative. Some parents commented that they would like to see the initiative continue the next year.

The main purpose of the students was to serve as enthusiastic presenters to present the lessons at more preschools. The TekkiTots project expects

the student to take responsibility on behalf of the university and the Meraka Institute. The students are required to enter a real-world environment with real-world challenges where they are responsible to assign roles to different group members, negotiate, plan, organise, prepare, communicate and take action to get things done. They have to make initial contact with the schools, sell the TekkiTots idea to the head mistress and the teacher before they can negotiate to spend time with the children in the school. They are responsible to coordinate their group members, plan, prepare and present each lesson at scheduled times suitable for the schools, which all have to fit into their existing time tables. To complete a project over a period of at least eight weeks takes perseverance within a busy study schedule.

These students will be tomorrow's parents and will hopefully influence their own children positively towards science and technology. All the students valued and enjoyed the opportunity to work with the children. Working with children is a life changing experience where you get the opportunity to learn more about yourself and personal skills needed to sell your idea and your own ability to commit, plan and stay committed in difficult circumstances.

7. Conclusion

Similar to Papert's (1993) introduction of computers to children, an intervention like TekkiTots in preschool is the seed from which a science and technology culture can grow. The preschool children enjoyed the lessons because they were presented at a level they could understand by people to whom they wanted to relate. The success of the intervention depends to a great extent on the successful creation of a symbiotic relationship between as many of the role players as possible. TekkiTots creates opportunities where all the role players can be empowered if they are willing to engage in the practical positive experiences.

The question lies in the sustainability and scalability of such interventions to try and reach as many children, teachers and parents as possible. Success of the TekkiTots project at this stage is due to the contribution of each of the following factors:

- The need for science and technology in preschools

- A champion who takes ownership of the project
- A school and teachers with a positive attitude and willingness to allow the project in their school
- Preschool children
- Parents allowing their children to explore science and technology
- Dr Martina Jordaan and the community-based project she runs for students in the EBIT faculty at the University of Pretoria
- Energetic, enthusiastic students
- Lesson content and material to which the children can relate.

Barnett (1995) states that "Poor quality early childhood care and education (ECCE) could be detrimental to the development of any child at any age". It is my personal belief that the lack of science and technology education at any age can be detrimental to the development of more scientists and engineers.

The TekkiTots intervention is still in need of proper methods and procedures to measure the impact and long term outcomes.

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9. Endnote

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