

Science and Technology awareness for preschool children: a Working Model

A van Deventer

Meraka Institute, PO Box 395, Pretoria, 0001

Email: adevente@csir.co.za

Abstract

Skills shortages exist in the areas of Science and Technology, not only in South Africa but globally. This creates a need for more people to follow careers in Science and Technology. We need to do something to make sure 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. 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 way to this age group. The primary objective of TekkiTots is to introduce Science and Technology to children between the ages of six and seven in a fun and hands-on way. Initially the intervention was aimed at the children in the preschool environment with the primary intent to encourage a positive attitude towards Science and Technology and create an eagerness amongst 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 collaboration 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.

Keywords: preschool, science, technology, practical experiences

Introduction

A problem that needs urgent attention in South Africa is the skills shortages. The Youth into Science Strategy document from 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 will be to identify the problem, which in this case is the declining number of scientists and engineers in South Africa. The next step is to understand the problem as well as the extent and complexity of the problem. Skills shortages are a result of a wide range of contributing factors, which make it a very complex problem to solve. Skills shortages are also not unique to South Africa but a global phenomenon (Dobson, Koser, McLaughlin & Salt, 2001).

There is a need for interventions at different developmental levels to solve the problem 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 always has a 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 about 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, risk taking, thinking and do the impossible, creative, can see the end product, try over and over again and can learn through mistakes (Peel & Prinsloo, 2001: 5). Conezio & French (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, which mean something to themselves or the people in their lives (Papert 1993).

Methods 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.

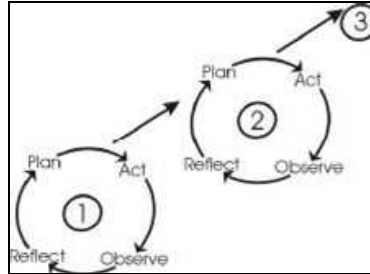


Figure 1

Action research is 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.

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 organization or program
- research to increase understanding on the part of the researcher or the client, or both (and often some wider community)”

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). Action research is a dynamic process and intended goals can change because of experiences and observations during a specific cycle. Projects need people to collect a suitable amount of data before we can make useful conclusions or derive trends. More resources demands proper planning, training, coordination and feedback from the project manager but also introduce more variables. What works in one environment might not be suitable for another environment because needs are specific and different.

The Objective of the TekkiTots project

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 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. The TekkiTots project started as part of The Young Engineers of 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.

I 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, children and the interaction between them. Although we aim the project 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 summarizes the TekkiTots action cycles, which started in 2006, continued during 2007, and is currently underway in 2008.

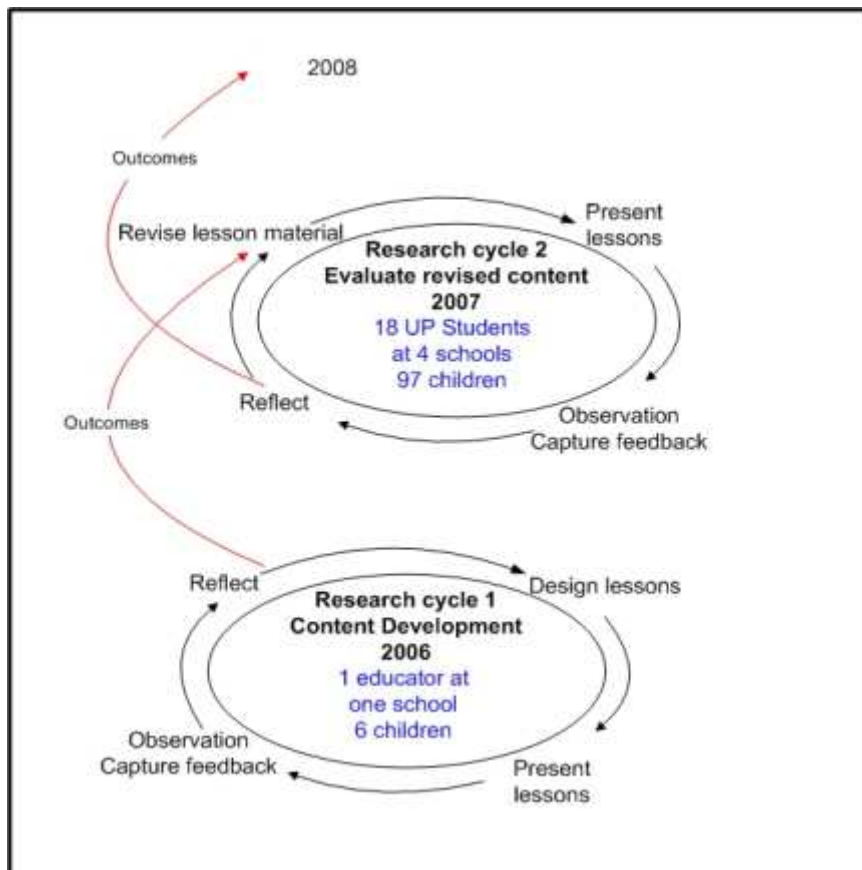


Figure 2

Cycle 1 (2006)

The purpose of the first TekkiTots action research cycle in 2006 was to determine if it is possible to introduce Science and Technology to preschool children. I put together twenty-five lessons and presented it to a group of six children at a Montessori preschool once a week. It took on average an hour to complete a lesson. I observed the interest the children showed and eagerness to take part and complete set tasks to measure the success or failure of the specific lesson. I reflected on the outcomes and changed or scrapped the material after each lesson. The outcomes of each lesson served as inputs for the next lesson as well as the next cycle.

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, Engineering, Built Environment and IT faculty allowed students to volunteer to work on the Tekkitots project as part of their community-based project. This community based project module is an eighty-hour module and takes the form of applied learning which is directed at specific community needs and is integrated with all undergraduate academic programs offered by the Faculty of Engineering, Built Environment and Information Technology (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 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.

I identified a few issues to address before the next cycle:

- Students should visit a preschool before starting to present to get practical experience working with this age group
- Format of feedback should be standardized
- Stress the necessity to prepare and build experiments at least once before presentation
- I need to give students more guidance to optimize success of the intervention.

I had to revise the logistics of the current model before the next cycle in order to minimize 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 2008

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

Figure 3 represents the current 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 work with the children. They are also 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 Meraka Institute supplies.


Two students who completed their Community based project during 2007 at Morning Star Montessori continue to present TekkiTots lessons at the school during 2008. The teachers assisted them by preparing equipment and managing the classroom. The teachers at this preschool are now prepared to present Science and Technology on their own next year at the school.

TekkiTots Model 2008




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Anita van Deventer
TekkiTots



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**Community Based
Project**

Dr Martina Jordaan
Dr Jordaan assists students in identifying
preschools and
Coordinate finances for equipment with
students



Children at Brooklyn Preprimary



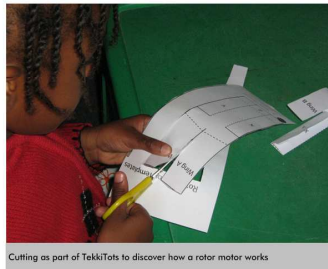
Explore how a crocodile clip works

Students

UP Engineering, Built Environment and IT faculty
volunteer to participate as part of their JCP
community module



I made my own electromagnet



Cutting as part of TekkiTots to discover how a rotor motor works

Students Duties:

Students identify a pre school - capture the
process and difficulties
Arrange with school for suitable times
(2009 Students to provide Meraka Institute with a
simple project plan of intended lessons and time
schedules)
Consent letters to school and parents
Buy practical material
Prepare presentations and practical equipment

Meraka Institute
Ethics Approval
Consent letters to school, parents and students
Lesson plans
(2009 Verify and accept student project plans)
Money for practical material to Martina
Training and assistance



TekkiTots Students at Brooklyn Preprimary

Present lessons at pre school once a week
Capture significant moments during lessons
Capture feedback with regards to lesson
material, equipment etc.
Questionnaires to parents, teachers etc.



Mixing Colours

Outcomes 2007:

97 Children
18 UP Students
4 X Schools: Brooklyn Pre Primary, Sunnyside Pre
Primary, Swaan en Flamink, Morning Star
Montessori

Feedback to Meraka
(Questionnaires, comments etc)



We graduate at Swaan en Flamink Preschool

2008

TekkiTots at 6 X schools: Floralise, Brooklyn Pre
Primary, Sunnyside Pre Primary, Tomorrow's
People Hatfield, Unisa Centre, Panda Preschool
in Hazzyview...

Morning Star Montessori continues for the third
year where 2 students do "skills" transfer to
teachers. The students are paid per lesson
presented while the school supply lesson material
Teachers feel confident to continue with lessons
when students leave at the end of the year



Students prepare for recording of SABC TV Takalani Sesame of Morning Star Montessori

Figure 3

Results

What makes this model successful?

To realise the intention of the project to introduce science and technology into the child's world we need quality people. These quality people are the students from the University of Pretoria Engineering, Built Environment and IT faculty. There first responsibility is to build a positive relationship with the children where they understand and accept what the children can and cannot do, explain to them that there is no such thing as "I cannot" or failure but encourage the children to try and to assure them that help is available. The children need to trust and accept the new people and "things" in their environment and it takes a little time.

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 recognize the important role 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. The children are eager to engage in activities when students present it 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 emphasize a preferred group size of six children to one presenter. Sometimes a child will take part because of unspoken group pressure. The child quickly learns that he or she will have to cope with the consequences of not taking part in an activity.

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 behavior during TekkiTots lessons. The teachers serve to guide and control the TekkiTots presenter's methods and amount of content. Teachers are given the opportunity to take part in the presentations at a level they feel comfortable. Some teachers are prepared to present the material to the children after being part of the TekkiTots experience at their school.

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 emphasizes the children's writing and counting skills. The students do the baseline evaluation in such a way that the children are unaware of the evaluation. 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 six and nine. 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 intension 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 different towards the same lesson content. Every child needs attention, guidance and encouragement. At this age acknowledgment of every small achievement is a positive influence on the child's self-esteem, confidence and positive attitude.

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 discovers how little content you need to keep a child busy for an hour.

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 achievement at the end of the lesson. Feeling of achievement will differ from child to child. Presenters need to prepare lesson equipment properly to ensure that the children can use the materials. By 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 acknowledgment 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 in order 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 to 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.

I 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, which is familiar to most children. TekkiTots intends to guide the children to discover and recognize 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 a 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

I base the evaluation 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:

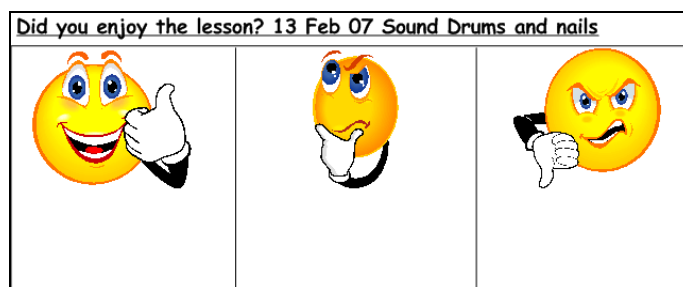


Figure 4

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, I 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. Watters & Diezmann (2007) also state the powerful effect of observing effective science teaching has on teachers.

The fact that parents need to sign ethical consent forms before their child can 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, organize, 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 timetables. 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 I hope that they will 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.

Conclusion

Similar to Papert's (1993) analogy when he introduced computers to children, the TekkiTots project's aim is to plant seeds in preschool, which can grow a Science and Technology culture. The preschool children enjoyed the Science and Technology lessons because it was at a level they could understand, and always encouraged to exceed what they thought they were capable of achieving. 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 to 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 University of Pretoria, Engineering, Built Environment and IT faculty
- Energetic, enthusiastic students from University of Pretoria
- Lesson content and material the children can relate to

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 suitable methods and procedures to measure the impact and long-term outcomes.

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Endnote

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