Problem Based Learning: Teaching Engineers to Tackle the SDGs

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PLAY THE MISSING LINK IN EARLY DEVELOPMENT OF FUTURE ENGINEERS
Children are born problem solvers
The subject **MATHEMATICS** – gatekeeper/blockage to careers in Science

**PRESENT REALITY**
Maths Crisis in Education globally

- Poor infrastructure
- Language barriers
- Inadequate training of teachers
- 77% of learners take Maths Literacy
- Only 9% of Grade 6 learners have basic skills

The word: **MATHS**

fear  
frustration  
anxiety  
panic
Alarming Statistics:

- Present population in SA: < 14 years = 16 million
- 29% unemployment rate = 6.65 people unemployed at the moment
- 57% of unemployed – education level below matric
- 33% of unemployed had matric
- More than 50% of engineering students will not complete their course

- **Unemployment rose by 21 thousand to 16.31 million.**

- AFRICA – 1 million people in Africa turns 18 every day
- Africa needs innovators
- Africa needs new businesses

**Rest of the world????**
### Predictors of mathematics achievement

(Erasmus, 2013)

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<th>Total group</th>
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LEARNING IS AN EMOTIONAL EXPERIENCE

1. BELIEFS
   ABOUT MATHS
   I can't do maths

2. ANXIETY
   See, I can't do maths

3. PHYSICAL SYMPTOMS
   Stomach ache, etc.

4. Stop thinking and starts avoiding maths

5. Does not achieve

6. Renewed anxiety

7. Increasing negative self-talk
   See, I can't do maths

THINK

FEEL
Rational / Irrational

Experience

ACT
Engage or Disengage
Early years are critical for brain development

Frontal lobe development:
- Growth period between 1 – 3 years.
- Growth spurt at age 6 years.
- Growth period age 7 – 10 years.
- Growth spurt at 10 years.
- Growth spurt at 13 years.
- Growth period from 16 – 20 years

Age 3 months:
- Burst of synapses for visual and auditory cortex.
- Babies are born with the most number of neurons they’ll ever need –

4 months to 1 year:
- Relative synaptic maturity for visual and auditory cortex

NEUROPLASTICITY
- Neuro – brains
- Plastic - Changeable
- Brain – developing and changing
- What fires together wires together.
±400 repetitions to create a new synapse in the brain – with play, it only takes between 10 – 20 repetitions.

Purvis 2007
What is meant by play

Directed or non-directed play

Puppets

Stories

Apparatus

Technology

Board games

Creative arts
Kids learn through play and most play involves exploration. 

Exploration is, by definition, an act of investigation – children who play with magnets have their first experience as a scientist. Through play, children also learn how to control their impulses and social bonds. **PLAY IS LEARNING!** Dewar (2014)

Children learn about handling real world situations

*if we can give children coping strategies for handling certain situations during play activities, they will be able to use these strategies when they are adults.*

Pretend play correlated with 2 crucial skills: self-regulation and counterfactually reasoning

Improve reasoning about possible worlds

**Play is key to focusing attention and developing concentration**

Key aspect of executive functions, as related to mathematics, involve attentional control.

**Correlation between maths skill and play**

Children who used blocks in more sophisticated ways as pre-schoolers had better maths grades and took more maths courses as teenagers.

**Play is self-motivated and fun - FLOW**

During play, children are also in a state of flow (the psychological experience of being totally, and happily, immersed in what you are doing). **Play is a gateway to the state of flow.**
Bibliotherapy

Stories make maths concepts relevant and meaningful

**Goals for using stories:**

- Child can recognise their own anxiety or distress by relating for example with the Whartel or Whoblin character or situation in a story.
- Helping the child discover themes and related emotions which recur when they do maths, such as anxiety, fear and frustration.
- Helping the child to think about and explore alternative solutions to problems, such as: what else can I use when I do multiplication?
- Helping the child realise that other children experience the same challenges in maths and how they solved the problem. Helping them with exam preparation, for class tests and with clever ways to remember the 9x table.
- In Whartels, the child can also create their own story to express their journey with maths.
- Helping the child with emotional awareness.

"A Gebra Named Al" (Isdell, 1993) anxiety towards maths.
Puppets

• Puppetry is an alternative form of communication (Hadari, 2014).
• venue for expression and creates a safe space.
• child can use visual symbols and verbal metaphors to create understanding.
• help a child to visualise the thinking process.
• therapy as it is an excellent vessel for projection (the process of attaching one’s feelings and/or actions to another person or object).
• various settings, such as puppet therapy – where puppets explain what the child can expect when having to undergo surgery or in education, as seen in Sesame Street.

In learning maths, talk is very important for young children.

• Talk fosters mathematical understanding.
• Child needs to have someone to talk to.
• Parents or teacher don’t always have the necessary patience and skills to listen to what the child is expressing regarding maths.
• The puppets help to relate maths to real situations in the child’s world but in a non-threatening, fun way.

Puppets in Maths are used to:

❖ Help the child gain mastery over issues in maths (such as understanding a maths concept) or events in maths, such as homework or writing tests.
❖ Develop problem-solving and decision-making skills.
❖ Develop insight – e.g. why I avoid doing my maths homework if I don’t understand a concept.
❖ Improve communication skills – to express emotional needs with regard to maths.
Four messages are what the therapist / adult / teacher / parent wants the child to hear (Landreth, 2002):

 hmac{I am here} - while we are playing, nothing will distract me and I will fully present physically, mentally and emotionally. I want to enter your world, to sense what you are sensing, to feel what you are feeling, especially about maths.

 hmac{I hear you} - I will listen with my eyes and ears to everything: what is expressed and what is not expressed.

 hmac{I understand} - the therapist / parent needs to show the child that they understand what the child is communicating, feeling, experiencing and playing. In the world of maths - I understand how you feel about maths and what these feelings are doing to you and how you are experiencing maths at present.

 hmac{I care} - I really care firstly about you as a person and then to help you experience the world of maths through play and having fun and, in doing so, learning maths.
PROBLEM

POOR MATHS ACHIEVEMENT –
Global crisis

Subject Maths - gatekeeper / blockage to careers in Science

Word Maths: Frustration, Anxiety, panic, fear etc.

RESEARCH

PREDICTORS OF MATHS ACHIEVEMENT:
A Neuropsychological process:

INNOVATION

Board game and computer game/app for pre-primary and primary school learners aimed at improving pre- and primary school children’s maths achievement by focusing on cognitive aspects (maths concepts, metacognition and information processing) and psychological facets (executive functioning, study orientation in maths, maths anxiety, maths resilience, motivation, etc). Using e-learning and including principles used in play therapy (art, bibliotherapy, board games, puppets)

Maths Whartels™ Board Game with Maths apparatus –
Developed and distributed by

Researchers and Innovators:
Dr Petro Erasmus

COMMERCIALISATION:
4 Products

Whartels™ App for Android and Apple –
Developed by

Whartels™ Workshops
Continuous Professional Development (CPD) across disciplines, Teachers and Parents

Whartels™ Reporting System