Feedback on Mathematics Education
R & D Activities
of the FRF Chair @ NMMU
2013 & 2014

Prof WA Olivier
August 2014
Structure of Presentation

• Rationale & Framework for Mathematics T&L model and scaffolding platforms
• Offline Techno-Blended Model for Mathematics - latest developments and designs
• Programme in FRF schools
  o Classroom implementation & Teacher support
  o Learner incubation & Extra-school Tablet support
  o Desktop PC support in schools
• CAPS Mathematics on Mobile phones – Mxit projects
• Research projects – PG students and studies
• Mathematics development projects and partnerships outside FRF schools
Why a techno-blended approach?

We all live in knowledge-based societies where digital industries are driving a high-tech integrated economy.

Towards Digital Citizenship

Young people’s interest and fluency in Mathematics, Science and Technology is essential for sustainable economic growth in our country.
21st Century Digital Citizenship

Global Digital Citizenship Foundation
Due to the unique challenges in the South African education system, an innovative approach is called for in order to harness the potential of modern digital technologies towards effective 21st century scaffolding support for mathematics teachers and learners.

**Scaffolding** refers to a variety of instructional techniques used to move learners progressively toward stronger understanding and, ultimately, greater independence in the learning process.

The overall goal is to utilize various off-line technologies in an integrated way to create constructivist learning environments for Mathematics that are sensitive to and compatible with the school curriculum needs and socio-economic environments in most South African schools.

Inter-disciplinary approach was followed using participatory action research (PAR) within a design framework.
Integrated use of Appropriate Technologies

Innovative & Modern

CAPS Syllabus Aligned

Flexible User Access

User-friendly & Exciting

Affordable Sustainable & Scalable

Sensitive to academic & technology skills profile of target population

TEACHER FOCUS:
Professional Development Content, Pedagogy and Technology Skills

Short Term Urgent

LEARNER FOCUS:
Content skills Development and Scaffolding Support

Not dependent on Internet and sophisticated Windows & PC Skills

Design framework for a modern off-line FET Mathematics T&L Model in SA
Theory of Action for Change: FET Mathematics Teaching and Learning

Use of Instructional Technologies:
1. Video
2. PPT
3. GeoGebra

Teacher Skills Development and Support

Maths Classroom

Off-line
Techno-blended T&L Model & Resource Material Development

Scaffolding Learner Support
1. TouchTutor
2. Mxit - mobile

Learner Development:
1. Academic
2. Involvement

Incubation Selected Learners (ISP)

Professional Learning Community

Accredited Content Training MATHSUP

MID-HUB

Professional Learning Community

Learner Achievement
Off-line Techno-blended T&L Model components for CAPS Mathematics

Learner Workbooks Aligned with Content

Syllabus Aligned Video Content Gr 10-12 Lessons & Tutorials

Mxit Tests Support & Feedback

Past National Exam Videos

TouchTutor Package

Desktop PC Support in schools for Learners

Syllabus Aligned Video Content Gr 10-12 Lessons & Tutorials

Mxit Tests Support & Feedback

CALCULATOR Video Support

Laptop Support for Teachers

TABLET Support for Learners

Learner Workbooks Aligned with Content
Teacher Centred Model

Too much talk – To little action!

What's on the blackboard:
12\sqrt{5}\times 7:(6+2\sqrt{4})2+ab-c*145\sqrt{v}
1+(-5x+6y*22\sqrt{4}d+2\sqrt{r}(3+[8\sqrt{v}2x+2])34\sqrt{4}u*3ea*

What the teacher is seeing:
2 + 2 = 4

What the students are seeing:

What the students remember:

而不是鍵入一個美好的譯員
胡說我有一個夢想, 夢想鏡的
話'的事情在衣帳裡, 他認的結
橋到有經驗的獵人阿哈小姐
Learning Pyramid

- **Lecture**: 10% average student retention rates
- **Reading**: 20%
- **Audiovisual**: 30%
- **Demonstration**: 50%
- **Discussion**: 75%
- **Practice doing**: Teach others

Source: National Training Laboratories, Bethel, Maine

TBM Model vs the Learning Pyramid
Teacher Development - FRF Schools

Technological Content Training

Grade 9&10 Content Training

GeoGebra Workshops

Professional Learning Community Sessions

GeoGebra Certification
CAPS Maths Support - Teachers/Lecturers

Additional free material: Applets, Simulations, Videos etc.
TBM Classroom Implementation and Teacher Support in FRF Schools

Eight professional learning community meetings per annum

- Updates Grades 10-12 Resources & Equipment - Laptop & TouchTutor Package, Learner Workbooks;
- Facilitation of **Grade 11 Tablet & TouchTutor assisted learner support** after school hours – selected learners from 6 FRF schools – 2014;
- **CAPS specific content training** – Grade 10 Teachers in 2013, Geometry and Probability Theory – 2014;
- **Reflection on classroom practice** with TBM since 2012;
- **Assessment skills development** – Common Mathematics Exams in FRF Schools;
- **GeoGebra skills development** – pilot GeoGebra certification from the GI@NMMU.
Integration of ICT in Classrooms

Specializing in the use of ICT
Understanding how and when to use ICT
Learning how to use ICT
Becoming aware of ICT

(a) Stages of ICT usages

Transforming
Infusing
Applying
Emerging

(b) Pedagogical Usages of ICT

Creating innovative learning environments
Facilitate learning
Enhancing traditional teaching
Supporting work performance

C. Moersch – LOTI Scale

Instrumental Genisis – Heid (2005); Semiotic Mediation – Drijvers (2009)
GeoGebra Certification Programme
Basic User

- Pilot certification programme
- Skills development and affective goals
- Four key areas of the CAPS curriculum
- Part of establishing PLC’s

GCP Components

- Orientation session
- Four structured workshops – Functions & Calculus, Trigonometry, Data Handling & Statistics, Geometry
- Assignments – portfolios
- Resource & ongoing support
Integrated Techno-blended T&L Model in Action
Tablet assisted Extra Classroom Scaffolding Support at FRF Schools
Tablet assisted Extra Classroom Scaffolding Support in FRF Schools
### Grade 10 Maths Profile – Common Exam 2013

<table>
<thead>
<tr>
<th>School</th>
<th>Total Learners</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>Pass Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>151</td>
<td>1</td>
<td>0.7</td>
<td>1.3</td>
<td>9</td>
<td>22</td>
<td>110</td>
<td>72.8</td>
<td>27.2</td>
</tr>
<tr>
<td>2</td>
<td>89</td>
<td>0</td>
<td>0</td>
<td>1.1</td>
<td>5.6</td>
<td>5.9</td>
<td>75</td>
<td>84.3</td>
<td>15.7</td>
</tr>
<tr>
<td>3</td>
<td>128</td>
<td>1</td>
<td>0.8</td>
<td>1.6</td>
<td>89</td>
<td>50</td>
<td>124</td>
<td>96.9</td>
<td>3.1</td>
</tr>
<tr>
<td>4</td>
<td>92</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3.3</td>
<td>89</td>
<td>96.7</td>
<td>3.3</td>
</tr>
<tr>
<td>5</td>
<td>112</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3.3</td>
<td>89</td>
<td>96.7</td>
<td>3.3</td>
</tr>
<tr>
<td>6</td>
<td>74</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3.3</td>
<td>89</td>
<td>96.7</td>
<td>3.3</td>
</tr>
<tr>
<td><strong>Overall:</strong></td>
<td>646</td>
<td>1</td>
<td>0.2</td>
<td>2.3</td>
<td>12</td>
<td>22</td>
<td>553</td>
<td>85.6</td>
<td>14.4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level 1 Analysis</th>
<th>1(20-29)</th>
<th>1(10-19)</th>
<th>1(0-9)</th>
<th>Pass Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>29</td>
<td>38</td>
<td>43</td>
<td>28.5</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>17</td>
<td>51</td>
<td>57.3</td>
</tr>
<tr>
<td>3</td>
<td>18</td>
<td>39</td>
<td>67</td>
<td>52.3</td>
</tr>
<tr>
<td>4</td>
<td>7</td>
<td>29</td>
<td>53</td>
<td>57.6</td>
</tr>
<tr>
<td>5</td>
<td>17</td>
<td>44</td>
<td>40</td>
<td>35.7</td>
</tr>
<tr>
<td>6</td>
<td>8</td>
<td>25</td>
<td>21</td>
<td>28.4</td>
</tr>
</tbody>
</table>

**Overall for 10 FRF Schools**

- Total Learners: 1000
- 23 (2.3%)
- 85 (8.5%)
- 892 (89.2%)
- 102 (10.2%)
- 221 (22.1%)
- 569 (56.9%)
- 10.8

### Percentage of Learners

- **0%–29%**: 42%
- **30%–39%**: 30%
- **40%–49%**: 13%
- **50%–59%**: 8%
- **60%–69%**: 3.5%
- **70%–79%**: 2%
- **80%–100%**: 0.5%
- **90%–110%**: 0.3%
- **100%–120%**: 0.2%
Learner Incubation Support Model: 2013 -

- Learner support NCS Maths and Science - 2013
- Formative Assessment & Interactive Support via Mxit - 2013

Saturday Lessons

Learner Workbooks
### PE Schools Grade 11& 12 ISP Groups 2014

#### Period February - June 2014

<table>
<thead>
<tr>
<th>Feedback on Incubator School Training Programme</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1. Objectives of incubator programme were clearly stated.</td>
<td>2.1</td>
<td>5.0</td>
<td>15.0</td>
<td>10.0</td>
<td>12.0</td>
</tr>
<tr>
<td>1.2. Programme was well-structured and easy to follow.</td>
<td>2.3</td>
<td>6.0</td>
<td>10.0</td>
<td>10.0</td>
<td>12.0</td>
</tr>
<tr>
<td>1.3. Appropriate materials and classroom activities were used.</td>
<td>2.5</td>
<td>2.0</td>
<td>12.0</td>
<td>12.0</td>
<td>10.0</td>
</tr>
<tr>
<td>1.4. Feedback on the degree of difficulty of the programme.</td>
<td>2.7</td>
<td>1.0</td>
<td>14.0</td>
<td>12.0</td>
<td>4.0</td>
</tr>
<tr>
<td>1.5. Feedback on the pace of programme presentations.</td>
<td>2.9</td>
<td>1.0</td>
<td>16.0</td>
<td>12.0</td>
<td>1.0</td>
</tr>
<tr>
<td>1.6. The programme assisted me to understand Mathematics and Science at school.</td>
<td>2.11</td>
<td>1.0</td>
<td>17.0</td>
<td>12.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

#### Period February - June 2014

<table>
<thead>
<tr>
<th>Feedback on Incubator School Facilitators</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1. Teaching methods during presentations were interesting.</td>
<td>3.1</td>
<td>5.0</td>
<td>12.0</td>
<td>15.0</td>
<td>10.0</td>
</tr>
<tr>
<td>2.2. Teaching strategies promoted learning in the classroom.</td>
<td>3.3</td>
<td>5.0</td>
<td>12.0</td>
<td>15.0</td>
<td>10.0</td>
</tr>
<tr>
<td>2.3. A range of different presentation technologies were used during presentations.</td>
<td>3.5</td>
<td>5.0</td>
<td>12.0</td>
<td>15.0</td>
<td>10.0</td>
</tr>
<tr>
<td>2.4. Time was allocated for reflection, questions and discussion.</td>
<td>3.7</td>
<td>5.0</td>
<td>12.0</td>
<td>15.0</td>
<td>10.0</td>
</tr>
</tbody>
</table>

#### Feedback on Teaching and Learning Resource Material

<table>
<thead>
<tr>
<th>Feedback on Teaching and Learning Resource Material</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1. The Mathematics video on the tablet helped me to understand the subject content.</td>
<td>4.1</td>
<td>5.0</td>
<td>12.0</td>
<td>15.0</td>
<td>10.0</td>
</tr>
<tr>
<td>3.2. The calculator and CASIO video on the tablet assisted me to solve problems.</td>
<td>4.3</td>
<td>5.0</td>
<td>12.0</td>
<td>15.0</td>
<td>10.0</td>
</tr>
<tr>
<td>3.3. The Mathematics video on the tablet helped me to prepare for tests.</td>
<td>4.5</td>
<td>5.0</td>
<td>12.0</td>
<td>15.0</td>
<td>10.0</td>
</tr>
<tr>
<td>3.4. The Science video on the tablet helped me to prepare for tests.</td>
<td>4.7</td>
<td>5.0</td>
<td>12.0</td>
<td>15.0</td>
<td>10.0</td>
</tr>
<tr>
<td>3.5. The Science experiments video on the tablet helped me to understand Science concepts.</td>
<td>4.9</td>
<td>5.0</td>
<td>12.0</td>
<td>15.0</td>
<td>10.0</td>
</tr>
<tr>
<td>3.6. The Mathematics workbook helped me to practice my Mathematics.</td>
<td>5.1</td>
<td>5.0</td>
<td>12.0</td>
<td>15.0</td>
<td>10.0</td>
</tr>
</tbody>
</table>

#### Feedback on Technology Based Teaching Model

<table>
<thead>
<tr>
<th>Feedback on Technology Based Teaching Model</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1. I feel the tablet is an extension to my textbook.</td>
<td>5.1</td>
<td>5.0</td>
<td>12.0</td>
<td>15.0</td>
<td>10.0</td>
</tr>
<tr>
<td>4.2. I have a wider learning from a video than from a text book.</td>
<td>5.3</td>
<td>5.0</td>
<td>12.0</td>
<td>15.0</td>
<td>10.0</td>
</tr>
</tbody>
</table>

#### Feedback on Own Use of Technology Learning Resources

<table>
<thead>
<tr>
<th>Feedback on Own Use of Technology Learning Resources</th>
<th>Seldom</th>
<th>Sometimes</th>
<th>Regularly</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1. I watched videos to prepare for incubator school tests.</td>
<td>2.0</td>
<td>17.0</td>
<td>13.0</td>
<td>11.0</td>
</tr>
<tr>
<td>5.2. I used videos to understand work that was done at school.</td>
<td>3.0</td>
<td>10.0</td>
<td>12.0</td>
<td>15.0</td>
</tr>
<tr>
<td>5.3. I shared videos on my tablet with some of my friends at school.</td>
<td>4.0</td>
<td>11.0</td>
<td>10.0</td>
<td>5.0</td>
</tr>
<tr>
<td>5.4. I used the calculator during home learning on my tablet.</td>
<td>5.0</td>
<td>10.0</td>
<td>12.0</td>
<td>8.0</td>
</tr>
<tr>
<td>5.5. I used the calculator during school learning on my tablet.</td>
<td>1.0</td>
<td>12.0</td>
<td>10.0</td>
<td>5.0</td>
</tr>
</tbody>
</table>

### PE ISP: % Annual Progress to University

<table>
<thead>
<tr>
<th>Year</th>
<th>NMMU Access</th>
<th>University Access</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>1.0</td>
<td>10.0</td>
</tr>
<tr>
<td>2011</td>
<td>1.0</td>
<td>10.0</td>
</tr>
<tr>
<td>2012</td>
<td>1.0</td>
<td>10.0</td>
</tr>
<tr>
<td>2013</td>
<td>1.0</td>
<td>10.0</td>
</tr>
</tbody>
</table>

### PE ISP: Annual % Bachelor Passes

<table>
<thead>
<tr>
<th>Year</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maths Passes &gt;50%</td>
<td>5.0</td>
<td>7.0</td>
<td>5.0</td>
<td>6.0</td>
</tr>
<tr>
<td>Science Passes &gt;50%</td>
<td>4.0</td>
<td>5.0</td>
<td>4.0</td>
<td>6.0</td>
</tr>
</tbody>
</table>
# ISP Grade 12 Results from the 2013

<table>
<thead>
<tr>
<th>Subject</th>
<th>Passed &gt; 50%</th>
<th>Passed &gt; 30%</th>
<th>District Pass &gt;30%</th>
<th>Provincial Pass &gt; 30%</th>
<th>National Pass &gt;30%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics</td>
<td>77.6%</td>
<td>100%</td>
<td>62.2%</td>
<td>43.4%</td>
<td>59.1%</td>
</tr>
<tr>
<td>Physical Science</td>
<td>71%</td>
<td>95%</td>
<td>66.9%</td>
<td>55.8%</td>
<td>67.4%</td>
</tr>
</tbody>
</table>

**13 Maths Distinctions**

**Highest 96%**

About 80 learners
# Tablet – Assisted Learner Success

## Pupil excels all thanks to brothers and technology

Tablet helped Siviwe reach her goals

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## Tablet – Assisted Learner Success

<table>
<thead>
<tr>
<th>Name</th>
<th>School</th>
<th>Maths 2012</th>
<th>Maths 2013</th>
<th>Science 2012</th>
<th>Science 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Majikazana Zintle</td>
<td>Johnson Ngongoza SSS</td>
<td>35</td>
<td>51</td>
<td>42</td>
<td>88</td>
</tr>
<tr>
<td>Zondi Anele</td>
<td>Johnson Ngongoza SSS</td>
<td>26</td>
<td>39</td>
<td>45</td>
<td>62</td>
</tr>
</tbody>
</table>
Golden Award for the Maths and Science Incubator School Programme from the Impumelelo Social Innovations Centre

Baxter Theatre, Rondebosch CPT
December 2013

Min. Derek Hanekom, Prof Jonathan Jansen
Research Students – TBM implementations in FRF Schools and elsewhere

Melisa Koorsse:  Post Doc; **Adaptation of m-system for Mathematics learner support via Mxit**

Dany Kamuhanda:  MSc  **Visualisation of Usage Data of an M-Learning System**

Noname Munemo:  M Ed  **Comparing Learning when off-line TBM is used with learning when no technology is used**

Thelma v Vught:  M Ed  **Offline TBM as Scaffolding support for teaching FET Maths**

Pamela Zinn:  D Ed  **Offline TBM as scaffolding support towards the self-regulation of learners**
Mathematics Development projects outside the FRF Schools

- MATHSUP in-service teacher training; (Six districts, 2010 in-service teachers)
  Provincial Lead Teachers

- Tablet assisted Incubator School Programs for learners; (five districts, 550 learners)
Dedicated Maths and Science Scaffolding Support via Desktop PC’s in Schools

Workbooks
Desktop Preparation and for Distribution
An innovative mobile system to facilitate a problem solving competition for grades 9 and 11 mathematics and science learners across the Eastern Cape.
Curriculum aligned Mathematics Competition via Mxit

The graphs defined by
\[ f(x) = a \cos \left( \frac{x}{b} \right) \]
\[ g(x) = b \sin \left( x - \frac{90^\circ}{a} \right) \]
are drawn for
\[ x \in [-180^\circ; 180^\circ] \]
Die grafieke gedefineer
\[ f(x) = a \cos \left( \frac{x}{b} \right) \]
\[ g(x) = b \sin \left( x - \frac{90^\circ}{a} \right) \]
word getekent vir
\[ x \in [-180^\circ; 180^\circ] \]

The values of \( a \) and \( b \) are:
Die waardes van \( a \) en \( b \) is:
\[ f(0^\circ) = a \cos \left( \frac{0^\circ}{b} \right) = 3 \]
\[ g(0^\circ) = b \sin(0^\circ + 90^\circ) \]
\[ \Rightarrow a \times 1 = 3 \]
\[ \Rightarrow a = 3 \]
\[ \Rightarrow b \sin 30^\circ = 1 \]
\[ \Rightarrow b = 2 \]
Mathematics competitions and learner scaffolding support via mobile phones

- Identification of Talent;
- Popularizing of Mathematics;
- CAPS examination revision support;
- Independent curriculum aligned learner self-assessment and feedback;
- Continuous Assessment Tasks in schools?
- Scrambling of distractors and Questions
- Data visualization - feedback to stakeholders
- Additional layer of TBM
Mathematics Development projects outside the FRF Schools

- Maths on Mxit support – vShool - Mxit Reach;
  - Touchtutormathscicomp
  - Touchtutormathsupport
Mathematics Development projects outside the FRF Schools

- Annual GeoGebra 2-day conference;
  - Regional – 80 teachers
  - Workshops, Demos, Plenaries

September 2013
Mathematics Development projects outside the FRF Schools

- TECHRED project in Cofimvaba – MERAKA CSIR;
  - 40 Grade 11 learners
  - Extra-school support programme
Teachers in FRF Schools as source of inputs and testing group in 2015-
Consolidation of free online Maths support

MidHub
Mathematics information delivery Hub for teachers
Funded by the National Research Foundation (NRF)

Research
- FRF
- Grade 8-12 Maths teachers

Partnerships
- Universities
  - University of Pretoria
  - NMMU
  - UFS
  - Walter Sisulu

Product: Information Hub
Best quality CAPS aligned resources at your finger tips

Why MidHub? We support you 24-7 with quality CAPS aligned resources. This easy access to quality resources will save you time.

Who? Grade 8-12 FRF Maths teachers

When?
- 2014: September – Determine teachers’ needs
- 2015: Develop Hub and App for teachers
- 2016: Test and improve Hub and Apps

Team
- Gerrit Stols (University of Pretoria)
- Werner Olivier (NMMU)
- Alta van der Merwe (University of Pretoria)
- André Pelser (UFS, Sociology)
- Jaca Prince (Walter Sisulu University)
- Ronél Ferreira (University of Pretoria)
- Carina de Villiers (University of Pretoria)
Challenges & Future Plans

- MC assessment on Tablets aligned with content lessons
- GeoGebra certification for Maths teachers
- Extensions of Mxit competition and curriculum support projects in collaboration with Mxit Reach
- Automatic extraction of TouchTutor usage profile from offline devices
- Extension of TouchTutor package to include the best that are out there to support the T&L of the Mathematics curriculum.
“Education is the most powerful weapon which you can use to change the world.”

Nelson Mandela
1918-2013

Dr Govan Mbeki (LLD)

“Our South African youth must study Mathematics and Science in order for us to be a winning nation.”

FRF Maths Education Chair

Nelson Mandela Metropolitan University