<table>
<thead>
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<th>An evaluation of design and enactment of smartphone-enabled primary science curriculum</th>
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<tbody>
<tr>
<td>Author(s)</td>
<td>Wu Longkai, Looi Chee-Kit, Peter Seow and Kim Mi-Song</td>
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An Evaluation of Design and Enactment of Smartphone-enabled Primary Science Curriculum

Longkai Wu, Chee-Kit Looi, Peter Seow, Mi-Song Kim

National Institute of Education
Our key ideas

• Seamless Learning
  – Linking formal & informal learning

• Transformative affordances of mobile technology
  – 24x7 access through 1:1 computing
  – Mobile device as a learning hub
Key messages

- A mobilized curriculum can make a difference to students’
  - Engagement
  - Self-directed learning
  - Collaborative learning
- Mobilizing the curriculum to harness mobile technologies in the classroom is a key challenge
- Mobile technologies mediate in-class and out-of-class learning
- Rich descriptions of informal learning in homes of students
What is Seamless Learning?

- **Environmental Plane**
  - School
  - Home
  - Others (e.g. designed spaces, informal spaces)

- **Social Plane**
  - Community
  - Family
  - Friends

- **Personal Plane**
  - SKA
  - Emotions
  - Preferences

- **Time**

- **Nexus represent Technology**
Formal and Informal Learning Spaces Mediated by Mobile Devices in 1:1 classroom

<table>
<thead>
<tr>
<th>Out Class</th>
<th>In Class</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type II</strong>&lt;br&gt;Planned learning out of class&lt;br&gt;e.g. field trip to an art museum which is part of a school curriculum</td>
<td><strong>Type I</strong>&lt;br&gt;Planned learning in class&lt;br&gt;e.g. searching for answers in the classroom</td>
</tr>
<tr>
<td><strong>Type III</strong>&lt;br&gt;Emergent learning out of class&lt;br&gt;e.g. using mobile phones to capture pictures and video clips of animal and directed by self-interest</td>
<td><strong>Type IV</strong>&lt;br&gt;Emergent learning in class&lt;br&gt;e.g. teachable moments not planned by the teachers</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Planned</th>
<th>Emergent</th>
</tr>
</thead>
</table>
TYPE I and TYPE II
Planned
Lesson Design Framework for MLE

Step 1 Unpacking:
Analyzing learning objectives
and student learning and student learning difficulties

Step 2 Brainstorming:
Gathering ideas and resources
based on student learning scenarios

Step 3 Composing:
Developing student learning tasks and resources

Step 4 Repacking:
Stitching different pieces to form a coherent mobile curriculum

Step 5 Implementing:
Students carrying out learning activities in and out of classroom

Step 6 Evaluating:
Reflecting and evaluating the effectiveness and informing new design cycles
Process Framework for Curriculum and PD

Teacher (SKA)
- Pedagogical Content Knowledge
- Subject Matter
- Understanding of students’ learning
- Understanding of the curriculum
- Design capacity
- Perceptions of students
- Students’ Prior Knowledge
- Understanding of Self-Directed* and Collaborative Learning*

Researchers

Technology Affordances

National Curriculum
- Syllabus
- Pedagogy
- Assessment

School based Curriculum
- Curriculum Materials e.g. Textbooks, Publisher’s Teaching Guide, Workbook, SOW, Current Lesson Plans

Co-Design with Teachers

Seamless Learning

Planned Curriculum

Assessment of Learning Outcomes, Teaching Strategies and Planned Curriculum

Enacted Curriculum
Rationale for studying emergent learning

1) To study integrated and synergistic effects of learning in both formal and informal settings for continuity of learning experiences across different scenarios.

2) To acquire sophisticated understanding of students’ social, intellectual and cultural capital.


Informal learning can be explored by looking at the four dimensions:

• Location
• Purpose
• Process
• Content
## Characteristics of Seamless Learning

<table>
<thead>
<tr>
<th>Learning</th>
<th>Technology Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participatory Learning (Rogoff)</td>
<td>Pictures, Video,</td>
</tr>
<tr>
<td>Collaborative Learning</td>
<td>Sharing artefacts, Blogs,</td>
</tr>
<tr>
<td>Authentic Learning</td>
<td>Pictures, Video,</td>
</tr>
<tr>
<td>Knowledge Construction</td>
<td>Searching, Comparison,</td>
</tr>
<tr>
<td>Learning across timescales (Lemke)</td>
<td>Connecting, Collect Artefacts, Hub</td>
</tr>
</tbody>
</table>
SA1/SA2 Results in Science

• Background
• Overall Performance Gains
• HA-MA-LA Effect
• Teacher Effect
• Summary of SA1/SA2 Results on Science
Background

• There are totally 299 students in eight classes (3A, 3B, 3C, 3D, 3E, 3F, 3G and 3H) at the P3 level in NCPS that have participated in the intervention of smartphone science curriculum in 2012. The eight classes are divided by teachers into three levels of ability, named as HA-MA-LA, according to their prior performances.
# HA-MA-LA Classes

<table>
<thead>
<tr>
<th>Level</th>
<th>Class</th>
<th>Teacher</th>
</tr>
</thead>
<tbody>
<tr>
<td>HA (High Ability)</td>
<td>3A (44 students)</td>
<td>T1</td>
</tr>
<tr>
<td></td>
<td>3B (43 students)</td>
<td>T2</td>
</tr>
<tr>
<td></td>
<td>3C (42 students)</td>
<td>T3</td>
</tr>
<tr>
<td>MA (Mixed Ability)</td>
<td>3E (41 students)</td>
<td>T4</td>
</tr>
<tr>
<td></td>
<td>3F (40 students)</td>
<td>T5</td>
</tr>
<tr>
<td></td>
<td>3H (39 students)</td>
<td>T3</td>
</tr>
<tr>
<td>LA (Low Ability):</td>
<td>3D (25 students)</td>
<td>T2</td>
</tr>
<tr>
<td></td>
<td>3G (27 students)</td>
<td>T6</td>
</tr>
</tbody>
</table>
• The scores for the SA1/SA2 tests in Science are divided into three parts: Total Scores, MCQ (Multi-Choice Questions) Scores and OE (Open-Ended Questions) Scores.

**Components of SA1/SA2 Scores**

<table>
<thead>
<tr>
<th>Scores</th>
<th>SA1</th>
<th>SA2</th>
<th>Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Scores</td>
<td>SA1_Total</td>
<td>SA2_Total</td>
<td>SA_Gain</td>
</tr>
<tr>
<td>MCQ (Multi-Choice Questions) Scores</td>
<td>SA1_MCQ</td>
<td>SA2_MCQ</td>
<td>MCQ_Gain</td>
</tr>
<tr>
<td>OE (Open-Ended Questions) Scores</td>
<td>SA1_OE</td>
<td>SA2_OE</td>
<td>OE_Gain</td>
</tr>
</tbody>
</table>
In Science classes, children using smartphone-enabled curriculum showed significant 7.69% improvement in their total scores, more specially, 27.04% ability improvement to answer open-ended questions.
In recent three years, Year 2012 is the first one to experience the most prominent progress in SA1/SA2 OE (Open-Ended Questions) scores leading to a remarkable growth in total scores for the recent three years at the P3 level.
Implications

• When Science OE improves, other than a possible improvement in content knowledge, we may be able to interpret it as a sign of process skills like communication, synthesis of ideas etc. Once the children possess the right skills, they will be able use them across contexts.
The analysis shows that MA and LA students have achieved more learning gains as comparing to the HA students.

- As to SA_Gain, there is significant difference between HA and MA (Mean Difference = 5.12, $p < .05$) and between HA and LA (Mean Difference = 7.47, $p < .05$).

- As to MCQ_Gain, there is significant difference between HA and MA (Mean Difference = 2.81, $p < .05$) and between HA and LA (Mean Difference = 4.86, $p < .05$).

- As to OE_Gain, there is significant difference between HA and MA (Mean Difference = 2.33, $p < .05$) and between HA and LA (Mean Difference = 2.61, $p < .05$).
Year 2012 is the first year for MA and LA cohort to achieve more learning gains than HA cohort in recent three years.

HA group in 2012 shows 11.7% increase in answering open ended questions.

MA group in 2012 shows 8.6% increase in total scores, 29.6% increase in answering open ended questions.

LA group in 2012 shows 20% increase in total scores, 60.3% increase in answering open ended questions, 10.4% increase in answering MCQ questions.
Teacher Effect

The t-test Result of Total, OE and MCQ Gains for Class 3B and 3D under T2 in Year 2012

<table>
<thead>
<tr>
<th></th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA_Gain</td>
<td>8.399*</td>
<td>.005</td>
</tr>
<tr>
<td>MCQ_Gain</td>
<td>7.329*</td>
<td>.009</td>
</tr>
<tr>
<td>OE_Gain</td>
<td>.002</td>
<td>.967</td>
</tr>
</tbody>
</table>

A t-test shows that class 3D (LA) makes more progress in SA_Gain ($F = 8.399, p < .05$) and MCQ_Gain ($F = 7.329, p < .05$) than 3B (HA). It is consistent with the HA-MA-LA effect as discussed before.

The t-test Result of Total, OE and MCQ Gains for Class 3C and 3H under T3 in Year 2012

<table>
<thead>
<tr>
<th></th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA_Gain</td>
<td>4.313*</td>
<td>.041</td>
</tr>
<tr>
<td>MCQ_Gain</td>
<td>3.397</td>
<td>.058</td>
</tr>
<tr>
<td>OE_Gain</td>
<td>.033</td>
<td>.856</td>
</tr>
</tbody>
</table>

A t-test shows that class 3H (MA) makes more progress in SA_Gain ($F = 4.313, p < .05$) than 3C (HA). It is also consistent with the HA-MA-LA effect as discussed before.

Teacher effect is not obvious in 2012 SA1/SA2 learning gains.
Summary of SA1/SA2 Results on Science

Overall the results are very encouraging so far.

1. The SA1/SA2 gain in total scores is significant in 2012 for the whole P3 cohort.
2. MA/LA cohort has more SA1/SA2 gain comparing to HA cohort, which is the first time in recent three years at the P3 level.
3. The SA1/SA2 gain is mostly due to the improvement in Open Ended questions as there is no significant improvement in MCQ scores, which is the first time in recent three years at the P3 level.
4. For teachers teaching two classes:
   1. The gain in the SA and MCQ for 3D was higher than 3B, which is consistent to the HA-MA-LA effect.
   2. The gain in the SA for 3H was higher than 3C, which is also consistent to the HA-MA-LA effect.
Summary

• Overall, Nan Chiau Primary School has provided more than 350 students, teachers and school staff with 3G mobile internet access to complement the school’s pedagogy and curriculum

• During the project’s pilot phase, students using smartphones for learning became more independent, inquisitive and self-directed

• Overall, test scores have improved significantly:
  – In Science classes, children using smartphones showed significant improvement in their ability to answer open-ended questions
Summary

- Teachers are adapting their teaching methods to incorporate technology and reflect the positive results and response from students.
- Parents have become more open to using technology for learning and support new learning tools such as text, drawings, and audio and visual recordings.
- Partners will expand the project to include 300 new students in the P4 level at Nan Chiau Primary School in 2013.