TRANSFORMING EDUCATION IN A PRIMARY SCHOOL: A CASE STUDY

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ABSTRACT

In this project report, we describe the role that a 1:1 smartphone deployment played in transforming the education of P3 (primary 3/grade 3) students (350+) from a didactic/direction instruction pedagogy to an inquiry pedagogy. Based on the students' test scores - Not only did the students learn the prescribed content, but they also developed 21st century skills. This project builds on a small-scale pilot – and is leading towards a multi-grade/multi-school fully scaled up project.

KEYWORDS

Mobile learning, 1:1, smartphones, inquiry curriculum

1. INTRODUCTION

The Singapore Ministry of Education's Masterplan 3 (2010) has called for a change in Singaporean schools. The MoE has recognized that the direct instruction pedagogy, with its emphasis on memorization, while producing good test takers, is not producing the entrepreneurial, imaginative, innovative thinkers that the government feels is important to insure Singapore's continued growth.

At Nan Chiau Primary School (NCPS), the administration and the teachers are taking the MP3 very seriously. With external funding support, they have implemented a major transformation of their teaching and learning practices. As described in the following sections, six transformations were observed in 2012 in grade 3 at NCPS:

- Transformation #1 - Pedagogy & Curriculum:
- Transformation #2 – Technology
- Transformation #3 – Students Became Self-directed and Collaborative Learners
- Transformation #4 – Parent Attitude
- Transformation #5 – Teachers' Attitudes
- Transformation #6 – Scaling UP

And most excitingly, the impact on the grade 3 children is by and large what was desired:

- Test scores on more traditional measures were not appreciably impacted, negatively or positively.
- Test scores on 21st century skills *were* appreciably impacted - in the *positive* direction.

In what follows, we describe in more detail each of the 6 transformations. In addition, we describe the impact of these transformations on student achievement of the grade 3 (referred to P3 – Primary 3) children.

2. TRANSFORMATION #1 - PEDAGOGY & CURRICULUM

While the topics covered in 2012 in P3 English and science were in alignment with those specified by Singapore's MoE, the pedagogy and the learning activities associated with those topics were in alignment with the MoE's Masterplan 3 (MP3) directives – but in contrast to what typically goes on in a P3 classroom. That is, MP3 calls for classrooms to employ an inquiry pedagogy and focus, not only on content, but on two key 21st century skills: self-directed learning and collaborative learning. But instead of inquiry, P3 classes typically started with direct-instruction, worksheet driven pedagogy. As one youngster, in the HA (High Ability) category, commented to a teacher who was asking him questions: "Wait a minute, your job is not ask me questions it is to give me answers [to the questions on the worksheets],." But, by the end of the semester, as evidenced by the very high scores on the "Oral" part of the Year-End Test, students were quite adept at answering open-ended questions for which there could be no real preparation (because the questions were extemporaneous) – while also doing fine on the multiple choice questions for which drill and practice on the underlying content had been the standard way to prepare.
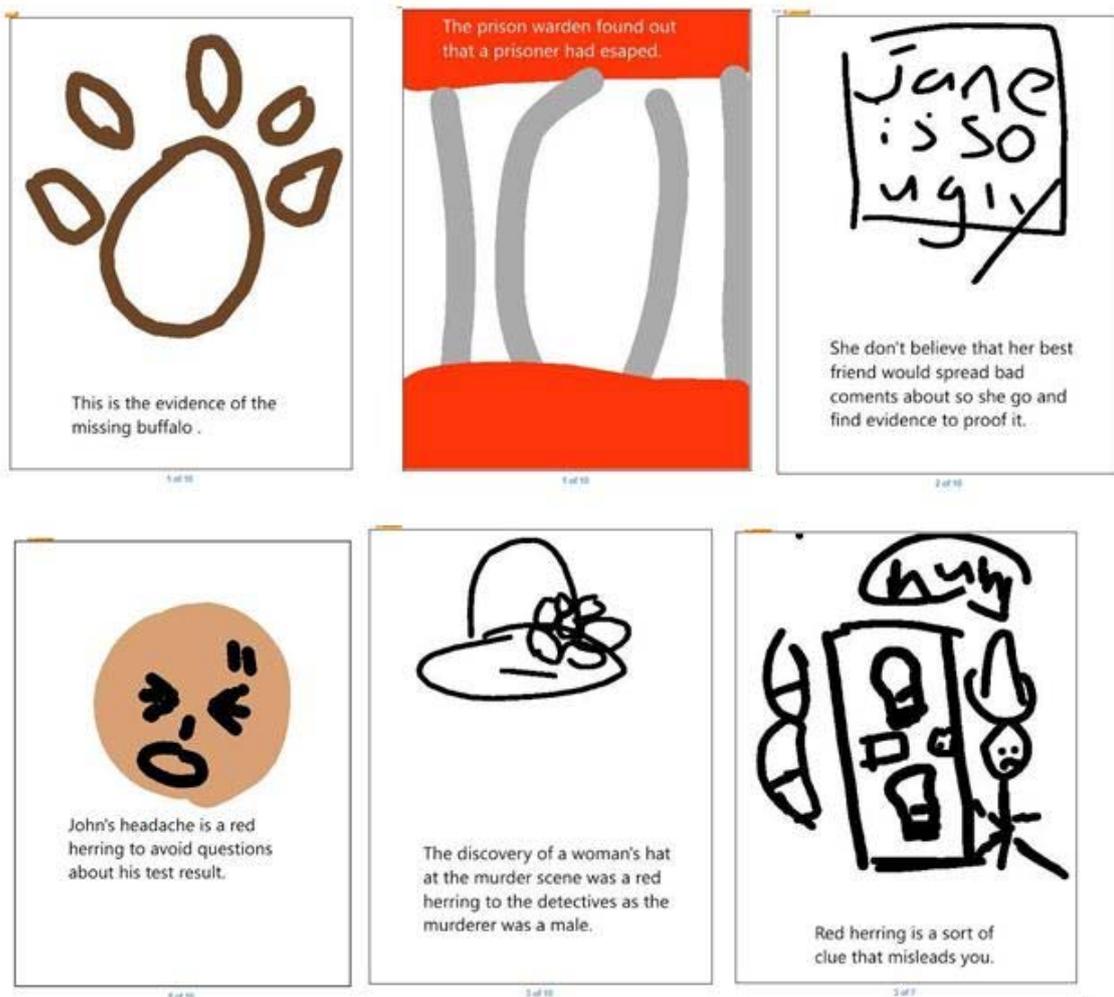

Figure 1. Using Sketchbook to Draw a Picture to
Develop & Demonstrate Word Understanding – and Then Write a Sentence

In English, the curriculum that was called "i.m.STELLAR" for ICT.mobilised.STELLAR. (ICT stands for the Information and Communications Technologies; mobilized stands for the use of mobile technologies – smartphones – being used as an essential tool in the STELLAR (2008, curriculum – the term used by the MoE for the P3 curriculum).

In "mobilizing" the STELLAR curriculum – and making it inquiry oriented, not direct-instruction oriented, the teachers and curriculum developers drew on two world-recognized pedagogical strategies:

- **P4C, Philosophy for Children**, developed by the philosopher Matthew Lipman (1980) with the goal of helping children learn how to ask "philosophical questions" – deep questions, questions that went to the heart, the assumptions, of the issues under instruction. P4C draws on the Socratic method of learning pioneered initially in Plato's dialogues. Learning how to ask a question and how to respond when asked a question – that's what P4C focused on.

- **6-steps to Better Vocabulary Instruction**, Marzano's (Marzano, R.J., Pickering, D.J., 2005) methods go beyond just memorizing the meanings of words; quite the opposite in fact! Marzano's methods help children understand words by building relationships and links amongst the words, by using words in their proper contexts.
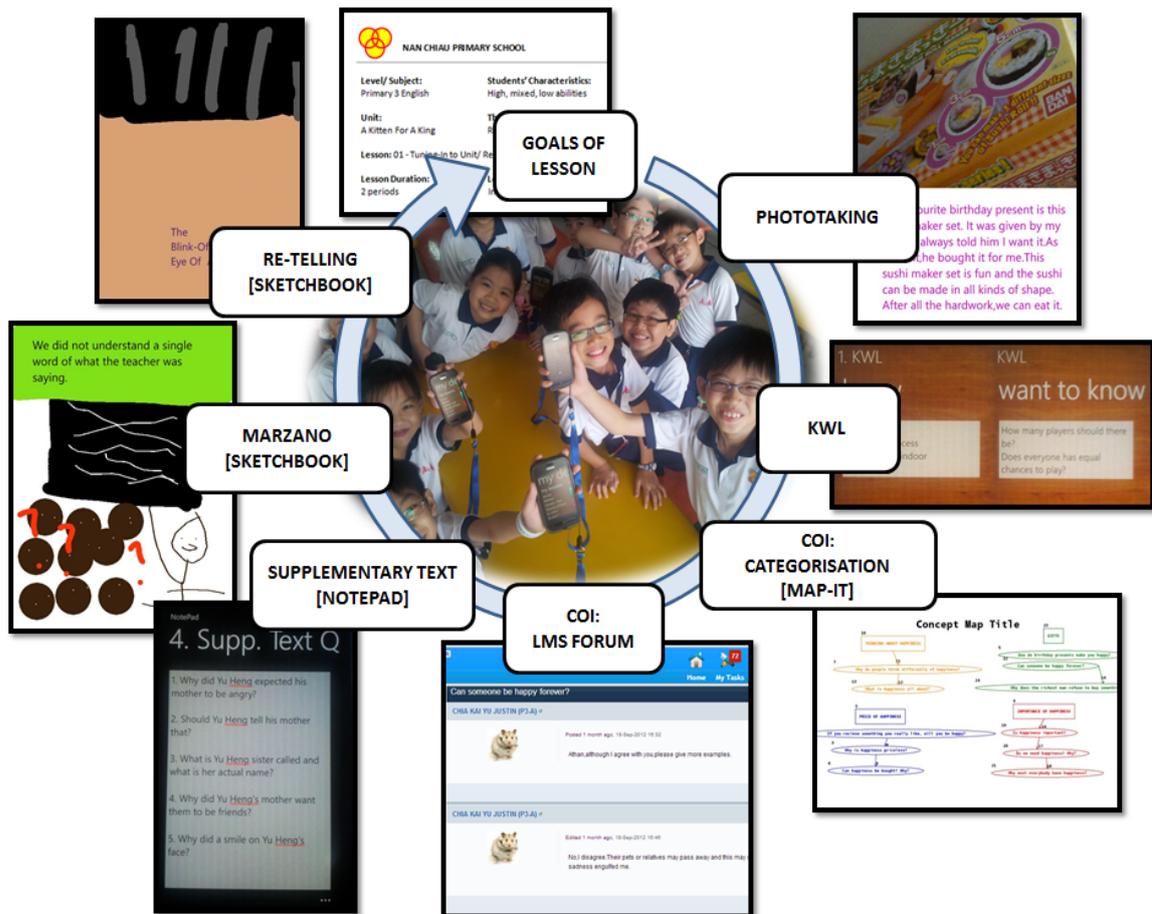

Figure 2. A coherent, cohesive lesson in English that uses 8 different apps – that 3rd graders seem to have no problem mastering.

These techniques were a perfect match for the mobile technology.

- The children used the Internet that was literally embedded in the palm of their hands to explore questions and have verbal discussions to resolve issues. (When a question came up, the children would say: "Ask the phone." Now, the children knew better than to trust everything "the phone" said, i.e., the answers returned from the Internet. To foreshadow a later section, we point out here that the students using the smartphones with the P4C pedagogy scored exceedingly high on the open-ended, oral, question –answering part of the test. Clearly, the P4C helped the children develop valuable, 21st century skills!

- And, the children had apps on their smartphones that enabled them to use words in drawings, in animations, in concepts as well as in textual contexts. This multi-modality opportunity was absolutely key – especially for the MA (Mixed Ability) and LA (Low Ability) students. In Figure 1, we see drawings that students made to describe words such as evidence and red herring. They used illustrations to see if they actually understood the word. After they drew the pictures, they were in a better position to give the word its textual meaning.
- In Figure 2, then, we present an entire lesson where P4C and Marzano are combined into a coherent, cohesive series of learning activities.

In science, curriculum that was used was called "Seamless Learning (SL)." The idea behind SL is that learning takes place all the time and everywhere – in school as well as after school; learning is, in effect, 24/7. Helping your parents learn about the digestive system at home is part of SL, and the mobile technology plays a critical role in supporting SL. For example, in teaching their parents about the digestive system, a child might create an animation, or the child might work with their parents to collaboratively create a concept map with the key terms.

At its core, Seamless Learning is a flavor of social constructivism, a flavor of Dewey's "Learn by doing" pedagogy:

- "They [teachers] give the pupils something to do, not something to learn; and the doing is of such a nature as to demand thinking, or the intentional noting of connections; learning naturally results." (J.Dewey , 1916)

Note too that Marzano's pedagogy is all about intentionally building connections amongst the words, about understanding how the words are related to each other. Thus, both in English and in science, while the particular flavors of pedagogy have their differences, the pedagogies are, at their roots, inquiry-oriented, learn-by-doing pedagogies that reinforce each other.

Just as in English, the mobile technology afforded the students the ability to use multiple modalities – multiple media. Here are two children's understandings of how the digestive system works – rendered in an animation that is annotated with text.

Science is ahead of English in that all 8 classes used Seamless Learning, while English was in its pilot, first year. As such, Science took a step further in its curriculum evolution – science tried to create a range of curricular activities that differentiated learning, that address explicitly the different needs of students in the HA, MA, LA classes. Next year, English will also address the issue of differentiated learning and develop materials specifically for the HA, MA, LA classes.

3. TRANSFORMATION #2: TECHNOLOGY

The use of mobile devices as an everyday tool for learning is a huge transformation for a school. The school is making a sincere commitment to making Internet access as easy as getting a drink of water. While the goal is clear – the path to achieving the goal is less so:

- SingTel continues to throw up administrative issues and its coverage at NCPS is less than wonderful, and
- Nan Chiau's physical construction projects present challenges to maintaining an always on, always available Wi-Fi signal.

But, since Nan Chiau's curriculum is so dependent on network connectivity, solutions are being found.

The MyDesk mobile learning environment has gone through several major changes over the year. Currently, the backend that was developed by students at UMich is being replaced by a version created by a commercial concern, WizLearn. WizLearn has a robust Learning Management System (LMS) that is already in place in a number of Singaporean schools. Thus, scaling up to other schools will be that much easier if the cloud-based student artifact repository and teacher portal are the same across a number of schools. On the other hand, we will need to transition away from Windows Phone 7 to another platform, e.g., Windows Phone 8, Android, iOS. Indeed, at the University of Michigan the transition of the productivity apps in MyDesk to WP8 is already underway.

More software is needed!! The students and the teachers have virtually insatiable appetites for new software. The lesson depicted in Figure 2 already has the 3rd graders using at least 8 pieces of software. However, as the teachers develop new learning activities, they will want new apps – as will the students. Currently, adding new apps is not a straightforward process unfortunately. Given the experience – and the demands – of the students and the teachers at Nan Chiau, we are rethinking the architecture of MyDesk.

4. TRANSFORMATION #3 – STUDENTS BECAME SELF-DIRECTED AND COLLABORATIVE LEARNERS

With an Internet-connected smartphone virtually glued to the palm of their hands, students grew more independent and more inquisitive. Teachers observed them asking questions that were not exactly in the curriculum – and then pursuing their questions using not only their technology, but conversations with their peers. The teachers, over the course of the year, learned how to encourage and nurture this growing independence. Teachers encouraged students to see school and learning as 24/7 – use the technology to link the abstract ideas explored in the classroom to the concrete, real world instantiations that appear on one's walk home, appear at the dinner table, appear in the mall.

The theme of the Qualcomm project – WeLearn – has truly become ingrained in the culture of the P3 students – and teachers. Learning is in the conversation; learning is in the pursuit of understanding. Even at P3, even with a small-screened device, learning is all the time, everywhere.

5. TRANSFORMATION #4 – PARENT ATTITUDE

At the beginning of the 2012 the parents were nervous about the "new" program in science and English. They were concerned that there children were "playing" with the phones and not doing their homework. Mr. Tan, the principal, fielded a number of concerned calls from parents. However, over the course of the year, the concerns seem to evaporate as the parents saw their children producing interesting artifacts and spending considerable time on their devices doing so. The final straw appears to be the test scores at the end of the year. Children using the smartphones and the inquiry curriculum performed on par with the students who were using the more traditional, direct-instruction curriculum in addition to acquiring all of the, as yet unquantifiable skills relating to self-directed learning, collaborative learning and self-expression.

6. TRANSFORMATION #5 – TEACHERS' ATTITUDES

At the beginning of 2012, there was concern that the inquiry pedagogy would be too difficult to implement and it would take up additional class time to use the technology. However, over the course of the semester, those fears turned out to be groundless. In fact, one teacher said "Teaching is fun now. I know what I am supposed to teach, but I don't know how it will go in class. I have to follow the students' responses so the path is different in each class." This teacher is talking about using her skills as a teacher in a way that she hadn't been using them when she was enacting a direct instruction pedagogy. The sentiment expressed by this one teacher was essentially universal among the English and science teachers.

7. TRANSFORMATION #6 – SCALING UP

Because four other principals expressed an interest in transforming their schools too, Nan Chiau will be hosting meetings with teachers from other schools during 2013. Teachers from the other primary schools will be visiting classes at Nan Chiau in order to see how "it looks." Teachers learn by watching other teachers. The realization that "I can do that" comes from classroom observations.

There are a myriad of challenges in scaling up – making the curriculum sensitive to the each school's context, developing professional development programs for the new teachers, creating a robust technological infrastructure in the various schools, etc. Those are all barriers to change. But, the biggest barrier – the willingness to change in the first place – has been breached.

8. END OF YEAR TEST SCORES: AN ANALYSIS

There is one more element to describe: end of year test scores in English and in science:

English: We did an analysis of the English scores, comparing the children who used smartphones for learning vs the children who didn't. There is a seemingly almost natural comparison group in that 3 classes used smartphones and 5 didn't. But the problem is this: each of the classes was different, thus lumping the 3 smartphone classes together and comparing them to the 5 non-smartphone classes isn't statistically "fair." That said, we will do it, just to give a sense of the comparative performance.

There were four measures on the English language test: Oral, Language, Listening Comprehension, and Composition. While there were slight differences – in favor of the traditional, non-smartphone using students, there was a whopping difference in the oral skills – in favor of the smartphone using children.

Simply put: **the children using the inquiry curriculum, with the mobile devices, learned how to ask and respond to questions.** The children using the inquiry curriculum learned how to think on their feet, in real time. There are no drill and practice techniques to help children improve their oral skills. The way to develop oral skills is to practice them by engaging in conversation, in question asking and in question responding. A focus of the curriculum designers in 2013 in English will be to polish and improve the other lesson components so that the children will achieve even more in the years following this initial pilot.

Science: There were 8 science classes. What we compared, then, to see about growth of understanding is how the children scored on the SA1 test, given in April and the SA2 test, given in November, at the end of the school year. We also compared the students' scores in 2012 with their scores in 2011 and 2010. Here are the key findings.

The students in P3 are definitely learning a vital 21st century skill: how to respond to an open-ended question. Here is the statistical evidence:

- The whole cohort (HA, MA, LA) improved more on the Open-Ended (OE) questions than on the Multiple-Choice Questions (MCQ).
- The whole cohort improved significantly on the Open-Ended questions when compared with how they did on the OE questions in 2010 and 2011.

And, it is key that the students are not doing better on OE at the expense of MCQ; while the students are not showing significant gains on the MCQ section – they are not showing any significant drop, either. Interestingly, as we see below, the gains are coming from the MA and LA groups!

It appears that the technology-supported, inquiry pedagogy-based learning experiences are significantly benefiting the MA and LA groups. The HA group already has very high scores on both the SA1 and SA2 tests and on both sections, MCQ and OE.

- The MA/LA cohort improved more than the HA cohort due to their high scores on the OE section since there was no improvement on their MCQ scores.

9. CONCLUDING REMARKS

The project herein described is an education project, not a technology project. The goal is educational change; a catalyst for that change is mobile technology. First and foremost the mobile technology empowered the students to be independent learners, to "own" their own learning. With a mobile device in the hands of each student, 24/7, a student was no longer dependent on the teacher or the textbook as the giver of information. For example, during a discussion, when a question arose, the children would say: "ask the phone" meaning let's look up the information on the Internet.

The ripple effect of this independence was great. As described above, the various transformations were now possible:

- Transformation #1 - Pedagogy & Curriculum:
- Transformation #2 – Technology
- Transformation #3 – Students Became Self-directed and Collaborative Learners
- Transformation #4 – Parent Attitude
- Transformation #5 – Teachers' Attitudes
- Transformation #6 – scale up – is now about to take place as grade 4 is about to undergo change and several other schools are looking to adopt (and adapt) Nan Chiau's educational program for their grade 3 classes.

ACKNOWLEDGEMENT

REFERENCES

Dewey, J. (1916) *Democracy and Education: an introduction to the philosophy of education*

Marzano, R.J., Pickering, D.J. (2005) *Building Academic Vocabulary: Teacher's Manual*, ASCD

Lipman, M (1980) *Philosophy in the Classroom*, Temple University Press, Philadelphia

(2008) STELLAR: Strategies for English Language Learning and Reading, http://www.stellarliteracy.sg/

(2010) The ICT Connection: Masterplan 3

http://ictconnection.moe.edu.sg/cos/o.x?c=/ictconnection/pagetree&func=view&rid=665