A Large Scale Study of Singapore's Science and Mathematics Pedagogy

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Background

- Singapore's performance in science and mathematics international tests
- How do we explain the success?
  - students' attitudes towards science and mathematics learning
  - teachers' instructional leadership
  - considerable emphasis placed on maths and science (Toh, K. A. and Mendoza, P., 2002)
  - American Institute of Research :"Singapore's highly logical national mathematics framework, mathematically rich problem-based textbooks and highly qualified mathematics teachers" (AIR, 2005)
- What are classroom practices in science and mathematics like?
- What features might lead to Singapore students' consistent outstanding performances in international benchmarking exercises such as the TIMSS?

Centre for Research in Pedagogy and Practice Core research program

- Multiple databases
- Large corpora of data
- Input –Processes – Output Model
- Luke, A., Freebody, P., Lau, S., Gopinathan, S. (2005b). Towards Research-based Innovation and Reform: Singapore Schooling in Transition. Asia Pacific Journal of Education, 25(1), 5-28.

Singapore coding system (luke, cazden, lin, freebody, 2005a) i. classification

- sources of knowledge
- single or multidisciplinarity
- depth of knowledge
- knowledge criticism
- knowledge manipulation/generation
- metalanguage/technical vocabulary

Singapore coding system: ii. framing

- social arrangements, spatial arrangement
- teacher and student technologies: media and artefacts
- orders of talk: informal, procedural, behavioural, test-taking, curriculum-related
- social and emotional support
- engagement/time on task
- explicit rationale for learning
- weaving: known/new, commonsense/technical, everyday/scientific, concrete/abstract, local/global

Questions

- What activity structures/interactions are observed?
- What is the stated purpose for learning?
- What tools mediate learning?

Sample

- 30 secondary schools – Secondary 3 – Grade 9 (15 year olds)
- 66 units of lessons/teachers
- 222 lessons
- Data collection period – 2-year period
- Reliability
  - Training of coders (35 coders in subject specific areas)
  - Comprehensive manual
  - Monitoring of coder agreement
  - Ongoing coder meetings

Results

- ***Patterned Lesson Structure***
- ***Teacher-dominated activities***
- ***Strong Focus on Curriculum***
- ***Low Level of Student Voice***
- ***Lesson Rationale not usually Explicitly Stated***
- ***Tools: Presentation Focus of Teachers and Practice Focus of Students***

A science lesson

1	Teacher	Face the front all of you here. Right. What we're going to do today ...shh will be something that we discuss from the last lesson, which is on density. So, we said that, density is defined as .. what over ..what
2	Student	mass over volume
3	Teacher	mass over the volume if we put it in words, what will it be? mass per unit volume *(..)* Ah, this is in words. Mass per unit volume. In other words it depends on, it depends on how big the mass is, in respect or in relative to the amount of the volume. And then use the two values here, you compare. Or you divide using the mass divided by the volume. And then once you get the answer that is going to tell us how dense, that means how much substance this object will have. And we are going to look at a few things altogether. First one you are going to deal with will be the density of the glass block. This glass block here is what shape? Is it regular or irregular?

A science lesson

1	Teacher	Oh! Atoms, alright the wood, has a mass, has got a mass, same as this?
2	Students	(No response.)
3	Teacher	Same as this one? same as the stone? Will the mass of this and the mass of the stone be the same?
4	Students	Nooo!..
5	Teacher	They are not the same? The mass of the cork and the mass of the stone are not the same because they are made of different atoms..…….
6	Student	…..materials.

A science lesson

1	Teacher	Underwater? ... underwater it depends...underwater you are nearer and nearer, getting to the Earth, the centre of the Earth, of course the pull is more, so you find a lot of pressure on you because there is a lot of weight acting onto this, okay? **Right... lets highlight .....right on page four zero highlight the next paragraph,** the mass does not change, when the body is at another place, so it doesn't matter where the place is and this kind of question quite often, it will, it will be asked. Okay, what is the mass when the person is twenty kg on the Earth when you go to the moon, what is the mass. A lot of people will say two Newtons , whatever, two kg and all this, and the answer is that, no matter where the object is the mass remains ...
2	Student	The same.
3	Teacher	The same, unchanged. okay, a very important point. **And next ... beside Table 3.1, the other one that I want you to highlight, the SI unit for mass is the ...**
4	Student	Kg.
5	Teacher	Right, kay gee, kilograms, don't put it as grams. Grams is one of the units for mass but it is not the SI unit, okay. So smaller objects, we use, we don't use kay gee all the time. Sometimes we see the apple, (and say) oh this is hundred grams. They don't say that as zero point one kay gee and that kind of thing. And the pea, which is very small its only one gram. Then it's so difficult, they say what its zero point zero zero one, right **, so, the next, next, next line … highlight this as well. Smaller objects or measure are usually measured in grams".** Tell me the conversions between kg to grams.

Teacher-dominated activities

% of Classroom Activities	Subject Name	
	Science	Mathematics
Whole Class Lecture/Monologue	37.0	22.6
Whole Class Answer Checking/Initiate-Respond-Evaluate	22.3	44.9
Individual Seatwork	15.0	21.2
Small Group Work	2.5	3.6
Whole Class Elicitation and Discussion	9.0	3.3
Laboratory Work/Experiment	6.8	-
Others	7.4	4.4
Total	100.0	100.0

Lesson Rationale

% of Lessons	Subject Name	
	Science	Mathematics
Intrinsic Rewards	0.0	1.6
Institutional Performance	7.5	19.4
Disciplinary Knowledge	30.1	10.1
Functional Use	4.3	6.2
Moral and Ethical Value	0.0	0.0
National Interest	1.1	0.0
Nil	58.1	68.2

Tools

% of Lessons	Teacher's Tool		Students' Tool	
	Science	Math	Science	Math
Whiteboard	50.5	72.9	8.6	2.3
Overhead Transparency / Visualiser	30.1	30.2	1.1	0.0
Powerpoint	23.7	0.8	2.2	0.8
Textbook	1.1	4.7	22.6	29.5
Worksheet	14.0	6.2	64.5	51.2
Internet	2.2	0.8	1.1	0.0
Science or Mathematical Apparatus	10.8	0.0	18.3	1.6
Blank Paper	-	-	19.4	15.5

Discussion

- Macro picture with some descriptions of classroom practice
- Not the only picture – there are differences especially across ability tracks
- Can't make a direct link between practices and Singapore's performance in international tests but…
- A hypothesis: "The lecture and IRE format of classrooms creates an environment where students become extremely proficient at providing short answers, responding to worksheets and textbook stimuli, and reproducing knowledge provided by teachers and textbooks."

- Alexander, R. (2001): whole class teaching generally associated with a more sustained instructional focus
- Singapore: high incidence of whole class lecture/answer checking in the Singapore data showed a strong focus on the curriculum which enabled conceptual complexities to be transmitted to students efficiently.
- I.A.C. Mok & P. Morris (2000) cautions the teacher-centred, rote learning stereotype descriptions of Asian mathematics pedagogy- linked activities
- Further analysis to be conducted through content analysis, question analysis of what transpires in Singapore classrooms within the teacher-centred pedagogy

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