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CORE Research Programme: Baseline Investigation of Science Pedagogy

Dennis Kwek, Lee Yew Jin and Wong Hwei Ming

KEY IMPLICATIONS

- Better equip teachers with inquiry skills to enable students to explore, analyze evidence, formulate explanations, link explanations to a knowledge base, and communicate findings.
- More space for students to metacognitively review and reflect on their learning.
- Greater focus on teachers explicating and encouraging scientific virtues in the classroom.

BACKGROUND

Since the launch of *Thinking Schools, Learning Nation* (1997) and *Teach Less, Learn More* (2004), the CORE Research Programme has aimed to provide a systemic description and measurement of curriculum and reform initiatives. Both CORE 1 (2004-2007) and CORE 2 (2009-2014) have advanced our understanding of a range of pedagogical practices through rigorous designs and instrumentation. However, the studies had some limitations, which CORE 3 aimed to address. This study continued the CORE focus of providing policy-makers, stakeholders and researchers with well-informed, timely and evidence-based baseline descriptions of pedagogical practices in Singapore schools.

FOCUS OF STUDY

In view of major curriculum reforms in 2005 and 2008, which emphasized inquiry-based science pedagogy and the implementation of a new science curriculum in 2014-2015, a unique opportunity to collect baseline data on science pedagogy presented itself. Notably, CORE 1 (2004) classroom observations were prior to the implementation of science inquiry. This project provided an updated baseline dataset on Primary 5 (P5) and Secondary 3 (S3) science classroom practices using established CORE classroom observation methodologies to impart an empirical understanding of science teaching and learning, and to compare with future CORE datasets. It aimed to develop, refine, and test a coding scheme for science; and examine the relationships between pedagogical practices, the quality of knowledge work, and science teachers' pedagogical reasoning.

KEY FINDINGS

- We foreground key guiding principles in developing classroom-coding schemes. *A coding* instrument should: 1) capture "what counts" for classroom practices to enable reporting; 2) be grounded in curriculum expectations and/or understandings of subject-domain proficiency; 3) be parsimonious; 4) provide timely information appropriate to its purpose; 5) reflect both domain-general and domain-specific aspects of classroom teaching; and 6)contain binary and Likert codes to capture both quantity and quality aspects of teaching.
- Science lessons in 2015-2016 showed an approximately equal focus on factual,

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procedural and conceptual knowledge in terms of overall lesson time. However, factual knowledge was slightly more evident particularly, in P5. Comparing data from 2004 and 2015-2016, factual knowledge has sharply declined, procedural knowledge has remained fairly stable, and conceptual knowledge has increased considerably in science classrooms. These trends may be attributed to major reforms and curricula revisions that are strongly focused on inquiry.

- In terms of pedagogical practices, teacher exposition dominated followed by Initiate-Respond--Evaluate sequences. Teachers' closed questions were dominant. Whole class discussion was negligible. Students hardly engaged in pair/group work. P5 teachers tended to relate concepts to daily life and S3 teachers frequently checked for students' prior knowledge. During investigations, teachers provided more detailed than evaluative feedback.
- Based on Bybee's (1997) inquiry model, "Question" and "Evidence" are more strongly emphasized than "Explanations", "Connections" and "Communication". Inquiry is largely teacher-directed. In P5 and S3, there was modest evidence of students using observation skills, communicating in scientific terms, analyzing patterns, comparing, and drawing inferences. Teachers rarely mentioned or encouraged scientific virtues in the classroom.
- Teachers felt duty-bound to help students excel in high-stakes assessments and consider it important to teach examination skills and answer techniques. P5 teachers believed conceptual understanding is vital and can be built through hands-on activities and student talk.

SIGNIFICANCE OF FINDINGS

Implications for practice

- Greater student agency in conducting investigative activities.
- More space for students to metacognitively review and reflect on their learning.
- Greater emphasis on teachers explicating and encouraging scientific virtues.
- More focus on students justifying their knowledge claims.

Implications for teachers' professional development

- Need to better equip teachers with inquiry-based skills.
- More support for teachers to make science lessons fun and engaging.

Implications for curriculum refinement

- Fine-tune the nature of inquiry such that lower primary and lower secondary will focus on student-directed inquiry, shifting to teacher-guided inquiry at the upper primary and upper secondary levels, which have a strong examination focus.

PARTICIPANTS

Ten schools (5 Primary and 5 Secondary); 10 teachers; 10 units of curriculum work (90 lessons).

RESEARCH DESIGN

We observed (and video-recorded) each teacher's thematic/topical unit and conducted brief post-lesson teacher interviews. Student work samples and teacher tasks based on the unit were collected. We conducted an end-of-unit interview, semi-structured with each teacher and engaged with students in Focus Group Discussions (FGDs). Based on our coding scheme, lesson videos were coded (in Microsoft Excel) in five-minute lesson phases. The binary codes largely focused on knowledge work, classroom talk and inquiry, recording whether an instructional event happened during a phase. The lesson-level Liker! codes captured details of classroom instruction and communication. Coded data was compiled in SPSS for statistical analyses. Content and thematic analyses surfaced key themes in the teacher interviews and student FGDs.

REFERENCES

Bybee, R. (1997). *Achieving scientific literacy: From purposes to practices*. Portsmouth, NH: Heinemann Publications.

About the authors

Dennis KWEK, LEE Yew Jin and WONG Hwei Ming are with the National Institute of Education, Singapore.

Contact Dennis Kwek at dennis.kwek@nie.edu.sg for more information about the project.

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