

LOCAL EVIDENCE SYNTHESIS ON INSTRUCTIONAL CORE

*By Dennis Kwek, Wong Hwei Ming, Divya Bhardwaj,
Fatema Anis Hussain, Goh Sao Ee*



TABLE OF CONTENTS



3

FOREWORD

4

INTRODUCTION

8

KEY INSIGHTS

29

RECOMMENDATIONS

35

CONCLUSION

36

REFERENCES

39

ANNEXES

FOREWORD

The Office of Education Research (OER) as the National Institute of Education's (NIE) key education research arm, has been committed for the 12 years it has been in existence to leading NIE's efforts in providing research on education that is timely and relevant to Ministry of Education (MOE) officials, policymakers in government and even other ministries working on related issues.

The aim of the Local Evidence Syntheses (LES) Series is to make the results of our research available in a concise and digestible manner to inform policy formation, programme design and pedagogical practice in the education realm in Singapore. It does this by synthesising our research that is funded by the Education Research Funding Programme (ERFP) according to key themes of domestic interest and according to how they contribute to their specific fields of research. Key insights are distilled from the jargon and academic-speak that can sometimes make academic publishing opaque and inaccessible. As an aid to the reader, a glossary of terms is included in this LES. Future directions are also sought from authors to suggest what we can do or look out for in order to bring our education system to the next level.

Professor David Hung

*Dean, Office of Education Research
National Institute of Education*

INTRODUCTION

What is Instructional Core?

The Instructional Core (IC) is one of the five MOE priority research focus areas. Conceptually, it is framed by the Instructional Core Model (City et al., 2009) which comprises “the teacher and the student in the presence of content ... it is the *relationship* between the teacher, the student, and the content—not the qualities of any one of them by themselves—that determines the nature of instructional practice, [even though] each ... has its own particular role and resources to bring to the instructional process” (pp. 22–23). In other words, while the characteristics of the *teacher* (e.g., pedagogical content knowledge, attitudes beliefs), the *student* (e.g., motivation and prior learning experiences), and the *content* (e.g., knowledge/skills/ values/attitudes to be learned, cognitive demand, and learning task) are important factors separately, what is most important are the *interactions* between teachers and students with the content, as it is these interactions that fundamentally determine the *nature* and *quality* of the actual learning and teaching that take place in the classroom (Figure 1). Thus, IC research funded by the Education Research Funding Programme (ERFP) focuses on pedagogical research that investigates the teaching and learning practices framed by the model, and findings from the research studies can then inform decisions about how to improve these practices. Understanding interactions between any two of the three elements can contribute towards the understanding of teaching and learning in the classroom. Specifically, IC research seeks to examine the following research questions: (a) how teachers teach in Singapore, including

the common pedagogies they use and the implementation and extent of new practices; (b) why teachers teach the way they do, including variations in their practices; and (c) how effective are teachers in their teaching and curriculum enactment.

In the context of IC projects, the three elements of the Instructional Core Model (ICM) are interpreted as follows:

- **Student**, as characterised by aspects such as grade levels (e.g., lower primary, post-secondary), stream (e.g., Express, Normal [Academic], Normal [Technical])¹, student ability (e.g., low progress learners), and home background factors (e.g., socioeconomic status);
- **Content**, as primarily characterised by the knowledge, skills, attitudes, and values to be learned by the student, in both (i) subject domains² (e.g., English, Mathematics, Science, Humanities-based subjects such as History, Geography and Social Studies, Physical Education (PE), Character and Citizenship Education, etc. and (ii) non-subject domain specific outcomes of education (e.g., 21st Century Competencies (21CC) (MOE, 2010); and
- **Teacher**, as characterised by aspects such as classroom practices/pedagogy (e.g., inquiry-based learning, flipped classroom, and direct instruction), instructional

1 Future LES might be able to address Full Subject-Based Banding (FSBB), subject to data collected from various projects on FSBB.

2 The subject domains are aligned to school curricular subjects.

INTRODUCTION

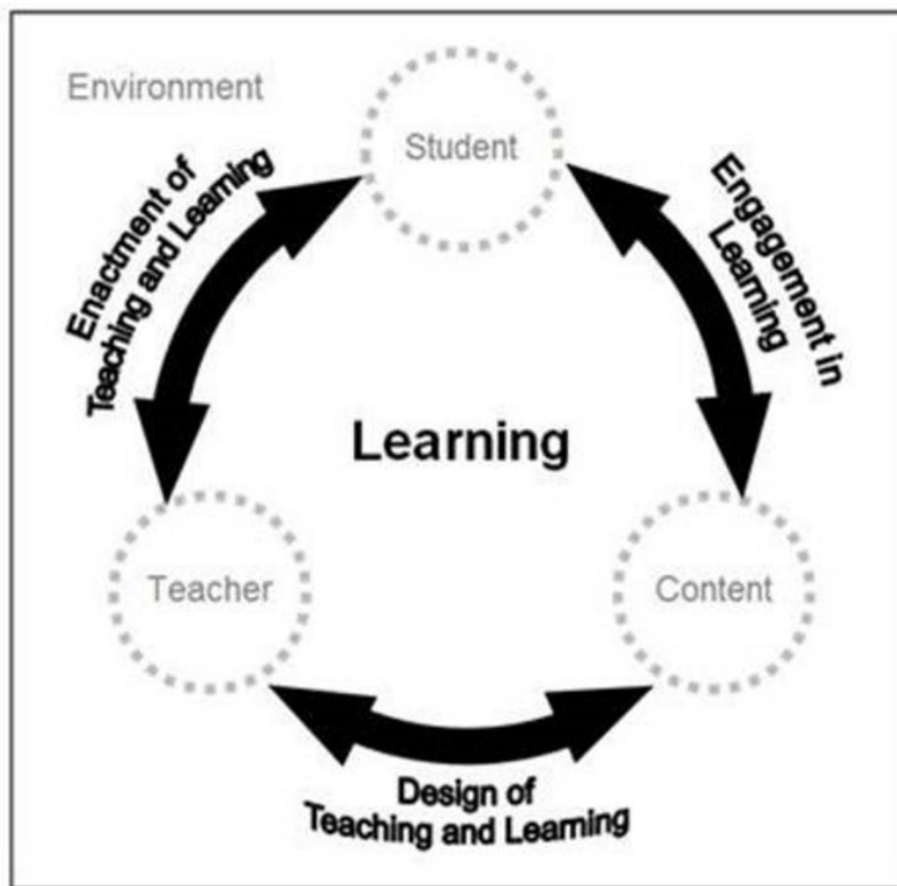


Figure 1. The Instructional Core Model (Adapted from City et al., 2009).

strategies (e.g., group work), and teacher profile (e.g., years of experience and beliefs).

More fundamentally, because the *interactions* among the three elements in the ICM are what determine the *nature* and *quality* of instruction and learning, they are the focus of all IC research projects. These interactions are depicted by arrows in Figure 1:

- **Teacher-Content Interaction:** The process in which the teacher uses content knowledge (i.e., the “what” of teaching³), pedagogical knowledge (i.e., the “how” of teaching), and

3 This includes knowledge of common misconceptions and difficulties of students in specific topics, and how to address students’ particular learning needs in a specific classroom context.

pedagogical content knowledge (i.e., the “how to teach specific what” of teaching) to “package” the content to be learned in a way that will facilitate student learning. This includes aspects such as the sequencing of content, the design of specific learning activities, the development of instructional materials to be used, as well as assessment and feedback, which together determine the *design of teaching and learning*.

- **Teacher-Student Interaction:** The *actual enactment* of the planned teaching and learning experiences in the classroom by the teacher and the *actual responses* of the students.

INTRODUCTION

- **Student-Content Interaction:** *Student's engagement in the learning experiences*, designed and presented by the teacher in the classroom.

Finally, these three elements interact in an *environment* comprising the immediate context (e.g., classroom processes, school characteristics, and institutional practices).⁴

The following are *broad research directions* for IC research⁵:

- To describe and measure patterns of pedagogical practices in Singapore schools;

4 The immediate context of the instructional core is in turn affected by the broader social, cultural, economic, and policy contexts.
 5 The Instructional Core broad research directions are not linked to the key insights for the purposes of the LES.

- To explain the factors affecting the pedagogical practices (including assessment practices);
- To measure the impact of pedagogical practices on student outcomes⁶, taking into consideration student/classroom/school characteristics; and
- To identify opportunities for the improvement of pedagogical practices by informing the design of an intervention strategy.

Figure 2 illustrates schematically how these broad research directions relate to the ICM. First, IC studies seek to describe and measure the patterns of pedagogical practices (Point a).

6 The reviewed studies do not explicitly indicate how the student outcomes are related to the pedagogical practices.

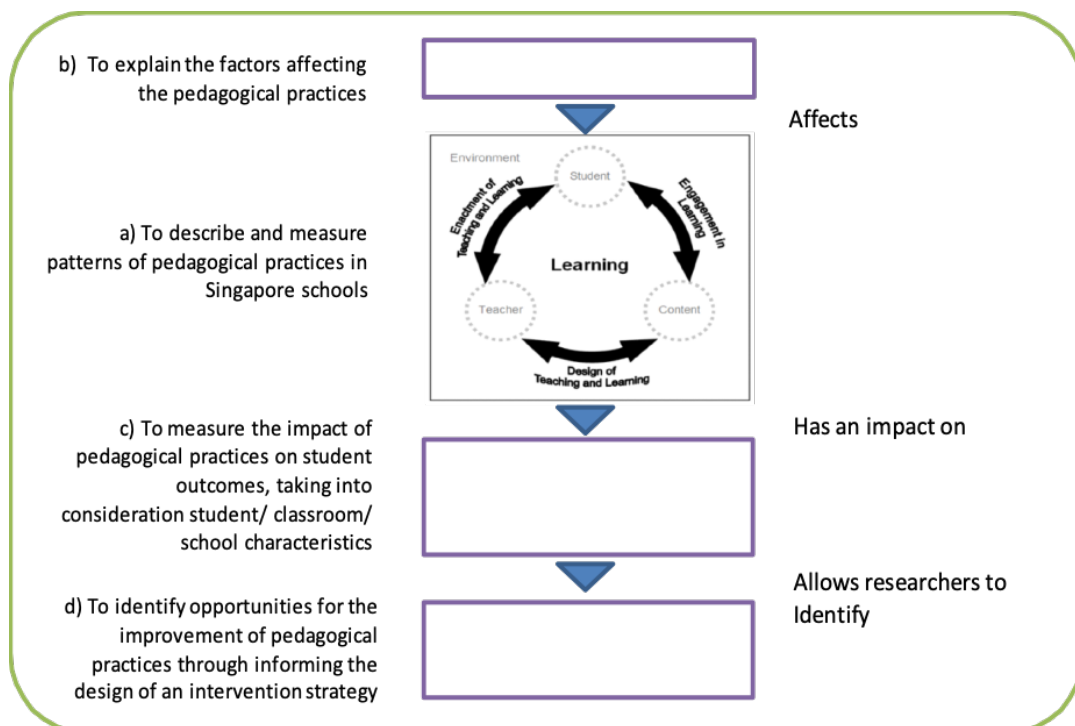


Figure 2. Relationship between Broad Research Directions and Instructional Core Model.

INTRODUCTION

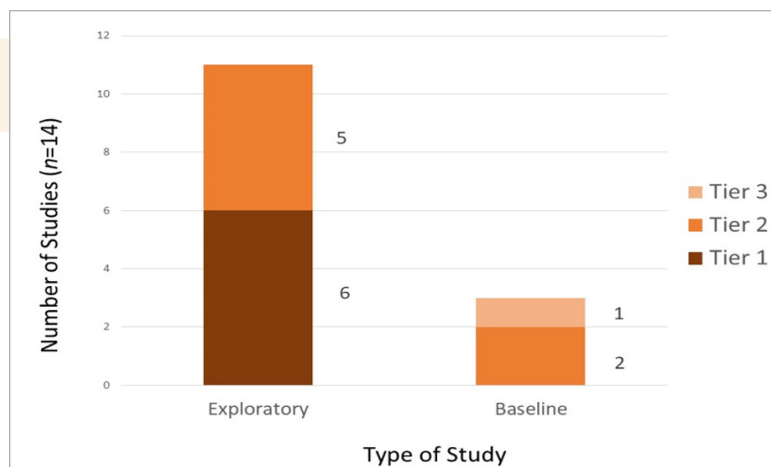


Figure 3. Types of Instructional Core studies.

(Point b) can be found within both the ICM and the environment. From our observation of practices, we can measure student outcomes (Point c), and then identify opportunities for improving pedagogical practice (Point d).

State of ERFP-funded research on Instructional Core

The nature of the learning and teaching in the classroom determines the quality of the pedagogical practice and its impact on learning outcomes. By focusing on the three elements (teacher, students, content) and the enacted interactions between them, IC studies can shed light on the state of teaching and learning (T&L) in Singapore schools, and how to improve T&L. It is of interest to the MOE and schools to gain a better understanding of what works and why it works in the ICM in our classrooms and schools as a critical step in the next developmental stage of our education system. Therefore, IC studies have a high degree of potential relevance and utility in terms of informing policymaking, programme development and instructional practice.

This LES report is a synthesis of 14 IC studies that fit the inclusion criteria. \$3,655,921 was awarded to the studies through the NIE

Education Research Funding Programme (ERFP) in the 3rd tranche (2013–2017) of funding from MOE. Six of the 14 selected studies were Tier 1, 7 were Tier 2, and 1 was Tier 3 (Figure 3) (See Annex A for a detailed explanation of the selection criteria). The three IC research questions frame our investigation for the LES and utilises a systematic review of qualitative evidence to distil insights from the IC studies and make recommendations to improve T&L in Singapore schools.

For the purposes of this LES, evidence is drawn from the findings and insights surfaced in the final reports of the 14 IC studies (See Annex A). Given the unique focus of each research project, different studies elucidate specific aspects of teaching and learning, which together offer a broader glimpse of pedagogical practices in the local context. To achieve the objective of this LES, an attempt is made to pull together salient findings of the 14 IC studies, as reported. The present LES provides a starting point for future syntheses that may focus on a more detailed analyses of IC research in specific areas such as Differentiated Instruction (DI), Special Education Needs (SEN), etc. including a focus on subject-specific variations.

KEY INSIGHTS

Insight #1: Teachers commonly use both student-centric and teacher-directed pedagogies depending on subjects and topics but teacher-directed pedagogies continue to be more dominant in our classrooms.

The reviewed studies surface that teachers commonly use both teacher-directed and student-centric pedagogies⁷ (Hogan et al., 2013) across subjects and topics, and these relate to both the affective and cognitive dimensions of student learning. Whole-class teaching is typically teacher-directed, as the review by Burns and Myhill (2004) shows. They find a dominance of teacher talk, lack of reciprocity in the exchanges and an imbalance of power relations during whole class interactions. The present synthesis reveals that teachers encourage student-to-student interaction, which potentially paves the way for whole class dialogic discussions. Student-centric pedagogies become evident when teachers focus on building rapport with their students, often acknowledging students by praising them and interacting with them, which fosters a more conducive classroom environment (10/17 KBK, 03/16 CBH, 04/16 LCK). Student-centric pedagogies are also evident when teachers employ humour and engage in heart-to-heart talks (16/15 LTW). In addition, drawing on teachers and low-progress students across academic disciplines, 28/15 ISC reports teachers' sensitivity, engagement and receptiveness to connect with students, facilitated by classroom configurations which permit students to sit in

a circle with their teacher. Similarly, Music teachers provide students with regular performance opportunities, which helps in improving students' confidence (17/15 TYC).

Other than affective aspects, the present review reveals that teachers frequently employ student-centric pedagogies to enable students' cognitive engagement in particular subject domains. For example, teachers in Social Studies, Mathematics, and Special Education Needs (SEN) classrooms are inclined to customise their lessons by employing the affordances of technology to cater to the needs of individual students and to make their lessons more engaging (25/15 KBK, 10/17 KBK, 12/16 VS). To scaffold students' learning, Science teachers in one study (16/16 SLH) use a range of resources including sentence starters, helping words, sentence/text construction tables. Additionally, they use more elaborate learning support in the form of peer-evaluation rubrics and a glossary of key terminology categorised in accordance with the key ideas in the topics. This indicates teachers' awareness of the potential challenges students may encounter in completing the tasks and eventually achieving the learning goals.

To enable students' cognitive engagement, teachers use student-centric pedagogies such as collaborative learning. Pair/group work is used consistently in English Language (EL), Mathematics, Music, PE, Computing and Visual Arts lessons, as reported in three

⁷ For the purposes of this review, teacher-directed pedagogy refers to classroom instruction in which the teacher plays a dominant role in shaping classroom interactions and guiding instructional activities. Student-centred pedagogy pertains to instruction enabling students' participation and engagement in classroom interactions and activities by leveraging on both the cognitive and affective dimensions of student learning.

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studies (10/17 KBK, 25/15 KBK, 04/16 LCK). Group work activities become evident, and with a specific cognitive focus in some instances (29/15 CCY, 28/15 ISC, 16/15 LTW, 17/15 TYC, 16/16 SLH). For example, in a study about the role of language in science teaching and learning, teachers design an open-ended group activity to generate students' awareness of the role of pronouns in writing. Collaborative work allows students to discuss with their peers about the (in)appropriate use of pronouns in sentences (16/16 SLH).

The above findings from the reviewed studies suggest an emerging trend that teachers are incorporating student-centric teaching strategies, which enable them to tailor their teaching approach to student needs depending on the subjects and topics. However, teacher-directed approaches continue to dominate classroom instruction, which may be attributed to the "tight coupling or alignment of national high stakes assessment system and classroom instruction" (Hogan et al., 2013, p. 60). For example, teacher-fronted lectures, Initiation-Response-Feedback/Follow-up (IRF) (Sinclair & Coulthard, 1975) or IRE exchanges (teachers ask questions, students respond, teachers evaluate responses) (Cazden, 1988) are predominant in primary and secondary lessons (10/17 KBK, 25/15 KBK, 28/15 ISC) (Figure 4). There is also a dominance of teachers posing closed questions to the students, with modest evidence of open-ended questions. Students tend to give short or medium responses (1-2 sentences),

whereas their extended responses (3 or more sentences) are far less evident (10/17 KBK) (Figure 5). Based on the CORE 2 large-scale study, Hogan et al. (2013) note that while teachers monitor student learning and provide feedback, they tend to do so in ways that focus on the accuracy of the student response rather than student understanding on the task. In terms of the cognitive dimension of student-centric pedagogies, lesson recapitulation is an important teaching strategy that offers avenues for students to articulate and share their thought processes, and consolidate their understanding. Lesson recapitulation is less evident than teachers' communication of learning goals and students' activation of prior knowledge (10/17 KBK) (Figure 6; Annex D). While teachers are showing more awareness of their students' needs and consciously fostering a student-centric learning environment, most teachers continue to rely on instructional strategies that are largely teacher-directed.

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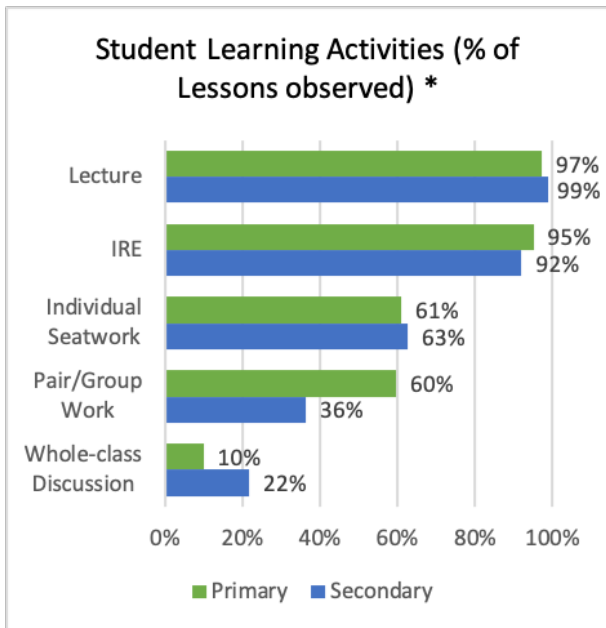


Figure 4. Types of student learning activities in Primary 5 (P5), Secondary 1 (S1)/Secondary 2 (S2) classrooms* (10/17 KBK).

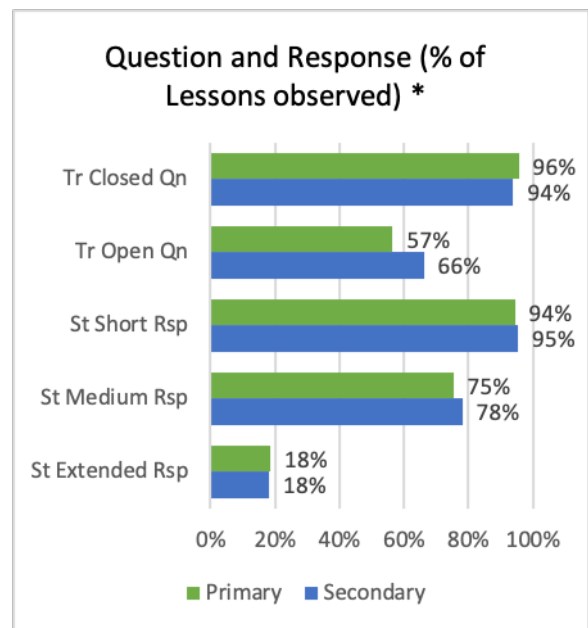


Figure 5. Questions and responses in P5, S1 and S3 classrooms* (10/17 KBK).

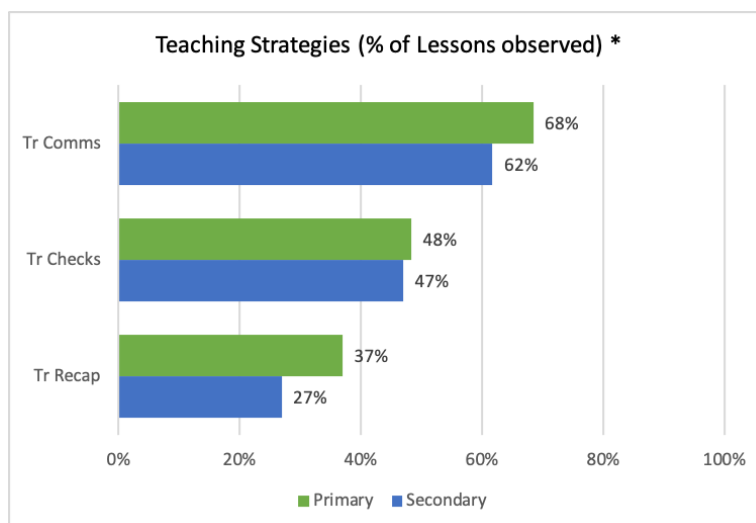


Figure 6. Teaching strategies in P5, S1 and S3 classrooms* (10/17 KBK).

*Average for all subjects by P5, S1/S3 levels.

KEY INSIGHTS

Insight #2: Teachers employ a range of instructional modifications to address diverse student needs but they experience significant barriers in employing Differentiated Instruction (DI) to enhance learning for all students.

Differentiation has gained international attention as an approach for the development of inclusive learning environments in which the use of teaching methods is based on flexibility and variety, and responds adequately to students' readiness, interests and learning profiles (Tomlinson, 2017). In the reviewed studies, teachers' lesson enactments indicate a range of instructional modifications to cater to diverse learners within mainstream classrooms, which potentially allow students of varying profiles to build their understanding of the lesson content. For example, based on students' initial drafts, an English Language teacher suggested three different groupings for students to revise their essays. Group 1 needed to incorporate the teacher's feedback and do the revisions. Groups 2 could choose to either rewrite the essay or incorporate the teacher's comments to revise their initial draft. Group 3 students were invited to the teacher's desk, and provided additional scaffolds for writing their essays (10/17 KBK).

According to Janney and Snell (2013), modifications may be curricular, instructional or alternative. Curricular modifications refer to what is being taught (i.e., content), instructional modifications pertain to alterations of the way instruction takes place (i.e., method, activities), and alternative adaptations involve altered goals, instruction and activities.

In the reviewed studies, teachers' choice of strategies and pacing of their lessons are heavily influenced by their perceptions of

their students' needs and characteristics. For example, teachers in one large-scale study across a range of subject domains (10/17 KBK) reported that they use DI by allowing certain low progress students more time to complete an activity and provide support through individual feedback during a task (Figure 7). Teachers in that study also reported that they design worksheets with easier to more challenging tasks, and that students are allowed to attempt less challenging questions that they are more comfortable with. During group activities, teachers group students by their readiness (current level of knowledge) to attempt certain tasks. The teachers in the study consider the above pedagogical practices as examples of DI.

In the study 12/16 VS, teachers use a variety of instructional strategies which they perceive would cater to the needs of individual students with SEN. Such modifications can be included under the umbrella of either process or instructional modifications (Janney & Snell, 2013). These strategies include providing "individual support during a task", "extra time" to complete tasks, "prompting", "peer tutoring" and "extra rewards". Teachers sometimes alter the process of instruction for students with Special Education Needs (SEN). For example, while the class is doing a different passage with the co-teacher, the class teacher would take a few students at the back of the classroom and read with them some text from the previous year to provide them more exposure to sight words. Teachers also

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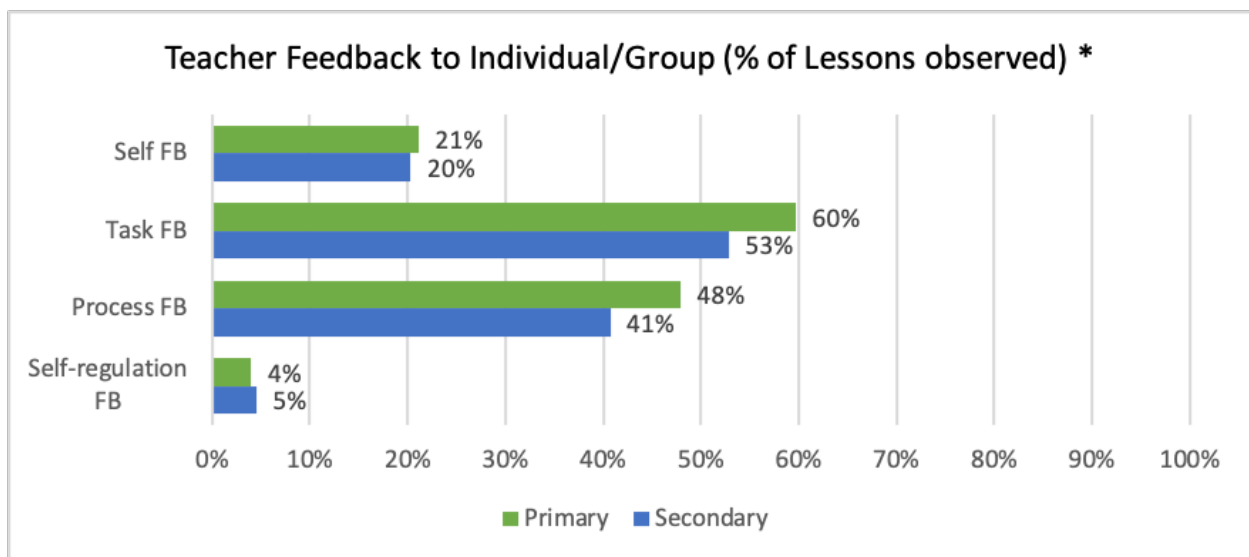


Figure 7. Teachers' individual/group feedback in P5, S1 and S3 classrooms* (10/17 KBK) [*Average for all subjects by P5, S1/S3 levels].

employ “disability-related” modifications such as A3-size worksheets for students with visual impairment, or pictures for students with autism.

The psychological needs of students also serve as the basis for teachers' classroom enactment. In 28/15 ISC, many teachers who acknowledge their students' low self-confidence provide ample opportunities for students to serve as peer mentors or assessors, to present their ideas on the board, and to structure their tasks and assessments into bite-sized forms. Teachers' instruction is done at a slow pace and is structured in such a way that each teaching phase has limited focus. Teachers' perception that students find it hard to remember or are forgetful prompted

them to engage in repetitions. A few teachers also recognised their students' need to have a sense of pride and ownership, so they make sure that the efforts of students are highlighted. They take students' emotions into consideration when dividing them into different groups to have different pacing and focus in learning, depending on their ability. In 12/16 VS, teachers encourage their shy students to use the school-based online platform *Padlet* to key in their questions for the teacher to answer, and use question cards, sentence strips or chunked texts to assist students with a writing activity.

Teachers who believe that Normal course students are visual or kinaesthetic learners tend to use manipulatives or concrete objects

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in teaching, conduct hands-on activities, write detailed ideas on the board, or allow students to present their answers to the class (28/15 ISC). Mathematics teachers report that they employ the affordances of technology and concrete manipulatives to cater to the needs of individual students and to make their lessons more engaging (e.g., *PowerPoint* slides, videos, newspaper articles, *Google Form* or *Mentimeter* interactive presentation software, *KooBits* for problem sums and animated games, and *Tangram* puzzles to teach geometrical shapes) (10/17 KBK). A study focusing on school music band (17/15 TYC) shows that teachers choose pieces of music that appropriately match the skill level of the band players.

The reviewed studies also reveal that teachers draw on students' lived experiences to understand the potential and developmental needs of their students thus encouraging conversations with their students inside and outside of the classroom on academic and non-academic topics (28/15 ISC). They link essay topics to students' experiences and common beliefs, and help students connect classroom learning to future careers. Findings from 16/15 LTW reveal that teachers of low progress students are deeply aware of the problems their students face beyond the classroom and the ways in which these are often related to the latter's home/family environment. The teachers reported that they seek to keep relations with their students fluid by being

inclusive and less hierarchical. For example, they maintain good communication, patient attitudes, and a safe learning environment by opening up to students and sharing about significant events in their own personal lives. They employ wit and humour to evoke positive emotions in their students and to build good teacher-student relationships.

The majority of the teachers teaching primary level students with SEN in 12/16 VS reported that they try to plan and deliver the same learning objectives for all students in the class. However, they use certain curricular or content modifications to balance the difficulties that the students with SEN have in responding to the same learning objectives as the rest of the class. The teachers consider DI as an approach to match the syllabus content to students' readiness by reducing the difficulty level of the content matter to be taught. In terms of instructional materials, they mainly use the same textbooks, worksheets and activities for all students, including SEN students. Only during pull-out lessons with the Allied Educators (AEDs) or Learning Support Teachers (LSTs), is the content differentiated and less challenging than that in mainstream classrooms. Some teachers use mainstream textbooks in pull-out sessions, while others refer to a separate "Dyslexia Remediation Programme" for pull-out support. Notably, a few teachers consider pull-out sessions as a type of DI.

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Most teachers do not use DI as much as they would like to (12/16 VS, 28/15 ISC, 10/17 KBK), which they attribute to the following factors: (1) lack of time to plan and implement DI; (2) the large number of students in the class; (3) the lack of training in teachers; (4) the notion that DI could stigmatise some students; and (5) difficulties in collaboration among the teachers. Teachers believe that time for collaboration is an important requirement in their attempt to deliver DI. School should provide time for meetings and DI should be included as a topic in these meetings in order to promote its delivery. The most important factor hindering the implementation of DI is the expectation that all students in the mainstream class, including SEN students, should learn the same content (common curriculum) in order to be ready for the high-stakes examinations. They use the same goals and assessments for all students because they feel “obliged” to prepare students for the examinations.

Both primary and secondary teachers face challenges in catering to individual student needs especially in relation to time constraints and syllabus coverage as well as considerations such as students’ prior knowledge, readiness for classroom discussions, and their perceptions of the subject (28/15 ISC, 01/16 SAJ, 25/15 KBK, 12/16 VS, 10/17 KBK). The teachers reported that usually time constraint is the reason for

not engaging students in class discussions and activities that can help develop students’ confidence (10/17 KBK, 28/15 ISC). The teachers also struggle with the dilemma of how to accommodate the cognitive, emotional, and social needs of individual children in terms of implementing DI effectively in large classes. They need to consider the diverse learning identities of their students in terms of home language, home support, tuition, family resources, subject preferences, talent in the subject (conceptualised as ability), willingness to talk, and learning gaps (01/16 SAJ, 10/17 KBK, 28/15 ISC).

KEY INSIGHTS

Insight #3: Teachers use metacognitive strategies and learning-enhancing feedback but there is hardly any evidence of students engaging in reflective thinking and self-regulated learning.

The present review surfaces evidence of teachers offering avenues for students to articulate and share their thought processes, which strengthen students' metacognitive awareness. According to Flavell's (1979) widely-accepted definition, metacognition comprises two inter-related dimensions: knowledge of cognition and regulation of cognition. Knowledge of cognition entails knowing oneself a learner, and knowing cognitive strategies and when and why to use the strategies while regulation of cognition involves planning, monitoring and evaluating one's learning (Bruning et al., 2004). The study 10/17 KBK indicates a shift (2004 to 2018/19) in knowledge foci from factual and procedural knowledge to metacognitive knowledge in most of the subject classrooms such as English Language, Mathematics, Geography, History, and Computer Applications (Figure 8).

Development of metacognitive knowledge is medium to strongly correlated with instances when teachers provide opportunities for reflexive talk (engaging students in thinking about their own learning), conceptual connections talk, explanatory talk (Figure 9, Annex E), epistemic knowledge (knowledge of the nature of the discipline, disciplinary standards to establish knowledge), and self-regulation feedback (feedback directed at students' self-monitoring, directing, monitoring of own learning processes; teacher focuses on conditional knowledge needed to help students know what they are doing). Evidentially, facilitating a metacognitive knowledge focus for classroom participants entails interactions centred on conceptual connections, explanation and reflection; a disciplinary focus; and feedback that helps students monitor and regulate their own

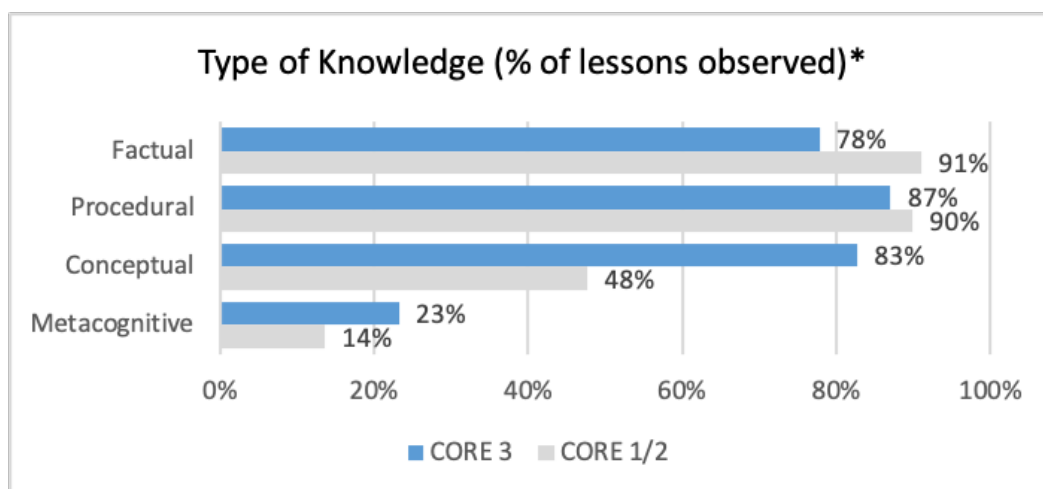


Figure 8. Trend from Core 1/2 to Core 3 (2004 to 2018/19): Increase in teaching of conceptual and metacognitive knowledge* [*Analysis includes P5/S3 English/Mathematics in Core 1/2 and P5/S1/3 subjects in Core 3].

KEY INSIGHTS

Insight #3: Teachers use metacognitive strategies and learning-enhancing feedback but there is hardly any evidence of students engaging in reflective thinking and self-regulated learning.

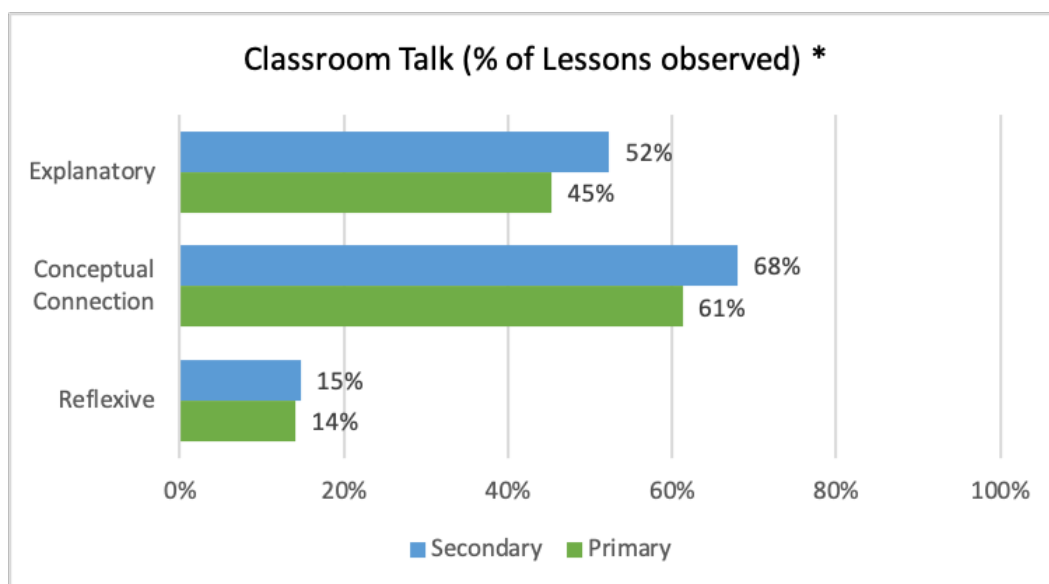


Figure 9. Classroom talk (Reflexive, Conceptual Connections and Explanatory) in P5, S1 and S3 classrooms* (10/17 KBK) [*Average for all subjects by P5, S1/S3 levels].

learning. In the same study, metacognitive knowledge in Music and Visual Arts lessons at the Primary 5 and Secondary 1 levels is strongly correlated to instances when students engage in assessment of their own or their peers' classroom work for which teachers may or may not provide rubrics. Clearly, involving students actively in their own and their peers' learning generates potential opportunities for equipping students with metacognitive knowledge.

Teachers, as facilitators of learning, employ a range of metacognitive strategies such as using directed thinking, domain-specific discussions, questioning strategies (10/17 KBK), and modelling. For example, teachers' modelling of thinking aloud in some classrooms (28/15 ISC) creates space for students to think about their own thinking, thus making learning transparent to the students. Teachers in 03/16

CBH orchestrate discussions around typical mathematical problems (standard textbook or examination-type questions) while making connections to students' prior knowledge from previous lessons, thereby generating opportunities for students' metacognitive learning. The reviewed studies also surface evidence of teachers using questioning strategies to enable students' metacognitive learning in the form of questions that encourage deep thinking (29/15 CCY), encouraging students' engagement by prompting (12/16 VS), and monitoring students' responses (03/16 CBH). In another study (04/16 LCK), teachers use "unplugged approaches" (i.e., teaching computing without using computers), which help students develop mental models of computing concepts and algorithms, become aware of their thinking processes, and make it easier for students to understand abstract Computer Science content. Through the

KEY INSIGHTS

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practical operation of unplugged learning materials and activities such as “sorting algorithm” and “swapping of variables”, students are able to intuitively understand computer programming, and develop the requisite logical thinking/reasoning skills for problem solving.

Other than metacognitive strategies, classroom participants’ feedback potentially enables students’ self-regulated learning. Self-regulation denotes “a multi-component, multi-level, iterative self-steering process that targets one’s own cognitions, affects and action, as well as features of the environment for modulation in the service of one’s goals” (Boekaerts et al., 2005, p. 150). In terms of students’ self-regulated learning, the present review reveals that teachers provide learning-enhancing feedback i.e., specific rather than non-specific feedback (Voerman et al.,

2012) related to information about the task requirements, the processing of the task, or information that allows self-regulated learning (Hattie & Timperley, 2007). In terms of learning-enhancing feedback, there is a predominance of task-level feedback which is directed at how well the task has been performed in Primary 5, Secondary 1 and Secondary 3 classrooms (25/15 KBK, 10/17 KBK). Figure 10 illustrates the feedback findings from 10/17 KBK. The study 28/15 ISC illustrates evidence of teachers providing immediate and personalised feedback. Interestingly, the “turnaround teachers”⁸ offer higher quality feedback which

⁸ In the study 28/5 ISC, ‘turnaround’ teachers were those who (1) received a net positive feedback of at least 40% from their students who were surveyed and/or interviewed; and (2) taught classes with at least 30% of academically at-risk students developing substantial academic resilience (i.e., students who were initially failing but received satisfactory marks after being taught by the teacher for at least a year). The ‘regular’ teachers were those who did not meet the stated criteria.

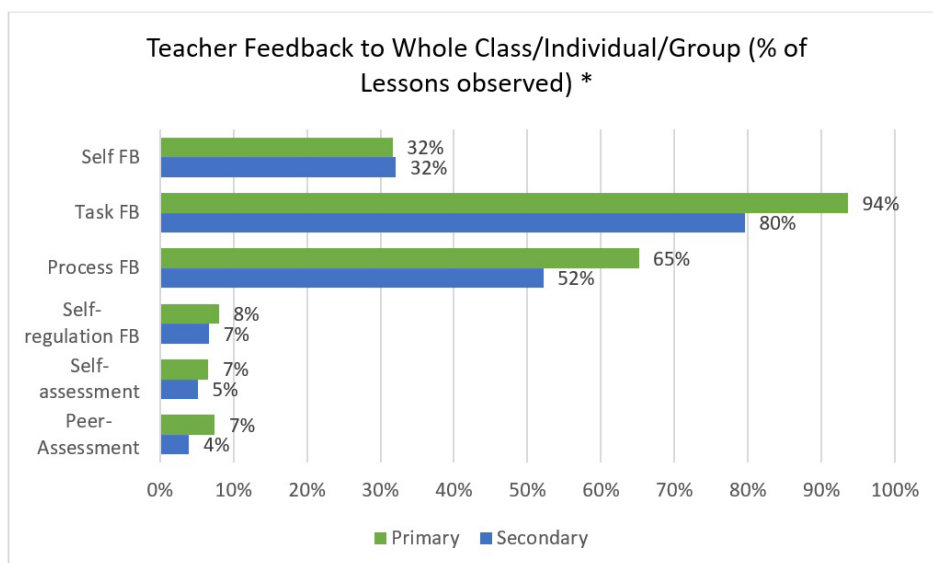


Figure 10. Assessment for Learning (AfL) instructional strategies in P5, S1 and S3 Classrooms (10/17 KBK) [*Average for all subjects by P5, S1/S3 levels].

KEY INSIGHTS

Insight #3: Teachers use metacognitive strategies and learning-enhancing feedback but there is hardly any evidence of students engaging in reflective thinking and self-regulated learning.

facilitate planning and carrying out of complex learning tasks by students, as compared to “regular teachers”. The provision of quality feedback by “turnaround teachers” may be better understood in view of their instructional repertoires. Compared to “regular teachers”, the “turnaround teachers” asked more higher-order and open-ended questions, and showed greater anticipation of students’ difficulties and offered pre-emptive support. Broader findings from the study 28/15 ISC show that the enacted instructional practices of “turnaround teachers” and “regular teachers” differed significantly in relation to classroom climate, sensitivity and responsiveness to students’ needs, quality of feedback, analysis of texts, and use of inquiry approaches. The domain-specific attributes of feedback become evident in a Science study (16/16 SLH) involving primary and secondary classrooms. Teachers give detailed and concrete feedback to students in both oral and written forms. Additionally, the teachers provide students with feedback, which helps to identify the inaccurate concepts adopted in the students’ explanations (conceptual perspective), and also how the language used was not able to represent meanings that are aligned with the scientific perspective (representational perspective). The specificity of feedback (Voerman et al., 2012) at the task, process and/or self-regulation level (Hattie & Timperley, 2007) enables students’ understanding/performance on tasks, and understandably, feedback at the self-regulation level explicitly opens up space for students to reflect on and regulate their own learning.

The reviewed studies reveal that teachers use metacognitive strategies and learning-enhancing feedback but there is little evidence of students engaging in reflection and self-regulated learning. In the 25/15 KBK study, students hardly work on tasks that incorporate reflection particularly, in Secondary 3 as compared to Primary 5 classrooms. In the study 01/16 SAJ, teachers focus on strengthening students’ capacity in metacognitive awareness and reflective thinking when they highlight the importance of reading and understanding in mathematical word problems. However, students are not able to articulate their ideas beyond surface learning, except in some cases, and their learning strategies in Mathematics are often related to practice and memory rather than learning for deeper understanding. As mentioned earlier, teachers provide learning-enhancing feedback but feedback enabling students’ self-regulated learning shows a very weak presence (25/15 KBK). Process-level feedback related to the use of strategies and heuristics is less evident than task-level feedback and feedback at the self-regulation level is infrequent (10/17 KBK, 25/15 KBK), which has obvious implications for students’ self-directed learning (see Figure 10 based on findings from 10/17 KBK). Tasks that allow students to articulate their thought processes and share their reflection with peers show a very modest presence therefore, students have few opportunities to engage in reflective thinking and self-regulated learning (10/17 KBK, 25/15 KBK).

KEY INSIGHTS

Insight #4: Teachers involve students in peer assessment, tutoring and mentoring more than self-assessment across the different subject-domains; but overall, concerns about syllabus coverage and examination preparation constrain teachers from using formative assessment of student learning.

One large-scale study across a range of subject domains (OER 10/17 KBK) examines the shifts in pedagogical practices between 2010 to 2018/19 and reports that teachers are employing more Assessment for Learning (AfL) in their lessons. However, AfL practices such as peer and self-assessment are not frequently implemented by teachers, much as they do value them. The findings indicate that while both primary and secondary teachers increasingly recognise the value of Peer Assessment, Self-Regulation Feedback and Self-Assessment, these remain infrequent and are areas for improvement (see Figure 10). The other reviewed studies also suggest that teachers provide more opportunities for students to serve as peer mentors or assessors and develop their skills in peer assessment as compared to opportunities for students' self-assessment to reflect on their learning (28/15 ISC, 12/16 VS, 17/15 TYC).

Students in English Language and Music classrooms at Secondary 1 and Secondary 3 levels have more opportunities to engage in peer assessment compared to their Primary 5 counterparts. Music teachers engage their students in peer assessment after a group performance by asking students to rate their own group members' singing, or eliciting opinions from the rest of the class on a group's performance (10/17 KBK). To arouse students' interest and make students' learning transparent, teachers create opportunities for peer tutoring via the 'Teach a friend' strategy (12/16 VS). They also provide opportunities

for students to serve as peer mentors or assessors, with the lower ability students carrying out the task prepared by teachers and the higher ability students acting as mentors (28/15 ISC). Students critically assess their peers on their playing of musical instruments (i.e., by listening carefully to how fellow band members play their instruments and assessing aspects of their playing, for example, articulation) and also engage in "peer-directed sectionals" (i.e., where students, usually section leaders, lead their peers in sectionals/group practice) in which band members practise fundamentals and musical drills (17/15 TYC). It allows students across levels to meet, learn from one another, forge friendships and be creative in how to teach their juniors. In English Language and Mathematics lessons, students are involved productively in applying what they have learnt to check their friends' work (12/15 CCD).

Clearly, students are activated as learning resources for one another but opportunities for students to take greater ownership of their own learning are less evident. Compared to Primary 5 classrooms, Music and PE lessons (10/17 KBK) in Secondary 1 and Secondary 3 classrooms show higher instances of teachers providing opportunities for students' self-assessments (10/17 KBK). For example, Music teachers ask students to evaluate their performances on what they have learnt from the lesson and whether they faced any difficulties. In another lesson, students evaluate their English writing based on a

KEY INSIGHTS

Insight #4: Teachers involve students in peer assessment, tutoring and mentoring more than self-assessment across the different subject-domains; and overall, concerns about syllabus coverage and examination preparation constrain teachers from using formative assessment of student learning.

checklist that the teacher provides, which outlines various criteria. A PE teacher, after playing a game of Tchoukball, asks students for their observations on their own performances, strengths and areas of improvement.

The findings reveal that teachers experience the pressure of getting their students to achieve good results and may be concerned with completing the syllabus to ensure that the necessary content has been taught prior to assessment. An Assessment for Learning (AfL) research study (12/15 CCD) in secondary schools in the English Language, Mathematics, Arts and Music classrooms surfaces teachers' beliefs that effective use of AfL strategies to help students learn contribute to positive learning outcomes as measured by the summative assessments (i.e., Assessment of Learning). Although teachers reported that they do not value "grading/reporting" practices associated with summative assessment, when they are too concerned about students getting good examination results, they lean towards more performance-oriented practices rather than learner-centred AfL strategies that nurture optimal learning dispositions. Such a conception of AfL as a means of getting better test results would in turn mean that the full potential of AfL as a tool for learning, including development of 21CC, in the longer term—as opposed to a tool for getting better results in the shorter term—is not tapped. For example, an important aspect of effective AfL is to help

students develop the ability to monitor their own learning, which is important for lifelong learning, not just for doing well in the national examinations. Notably, while most teachers reported valuing AfL, they reported less confidence in their proficiencies in practising AfL in their classrooms.

The modest evidence of students' self-assessment as a tool to formatively assess student learning may be attributed to teachers' concerns about covering the syllabus (25/15 KBK), preparing students for summative assessments (25/15 KBK, 16/15 LTW), time constraints (25/15 KBK, 20/15 JL, 28/15 ISC), large class size (28/15 ICS), and less confidence in their proficiencies in practising AfL (12/15 CCD). For example, Secondary 3 Social Studies teachers experience tensions in relation to time constraints and curriculum coverage (25/15 KBK), and secondary teachers report the effects of time and class size on their teaching (28/15 ISC). Teachers negotiate the tensions between competing assessment priorities and promoting learner autonomy by developing students' self-assessment skills through identification of performance criteria (16/15 LTW). Unsurprisingly, CCE teachers appreciate the flexibility in teaching minus the pressure of syllabus coverage or examination preparation (25/15 KBK). However, it is noteworthy that there is still very modest evidence of self-assessment in CCE.

KEY INSIGHTS

Insight #5: Inquiry-based pedagogy is practised but student agency and role in the inquiry process is seldom emphasised.

Varied understandings of inquiry-based learning have surfaced over the years (Barrow, 2006) though learner-centredness, knowledge construction and problem-solving are generally regarded as key aspects of inquiry (Khalaf, 2018; Kidman & Casinader, 2017). In terms of the curricular focus, the Social Studies and History syllabi (MOE, 2016, 2021) foreground a four-stage inquiry cycle: sparking curiosity, gathering data, exercising reasoning, and reflective thinking. Classroom observations in the reviewed studies reveal aspects of the recommended four-stage inquiry cycle for implementing 'Issue Investigation' (MOE, 2016), which strengthens thinking skills development through inquiry-based learning (Yang, 2021). The enactment of the inquiry cycle in Social Studies classrooms (Sparking

Curiosity, Gathering Data, Exercising Reasoning, and Reflective Thinking) is observed over the course of the teachers' classroom enactment in the lessons observed (25/15 KBK). The study 10/17 KBK illustrates evidence of teachers planning meaningful assignments, selecting relevant inquiry, and applying appropriate instructional strategies (Figure 11). Students gather data but they have few opportunities to plan the inquiry process, engage in deep and critical analysis of the data, and reflect on the inquiry process and findings.

Other than the four-stage inquiry cycle (MOE, 2016, 2021), the present review surfaces elements of inquiry-based learning, which become evident in instructional practices that

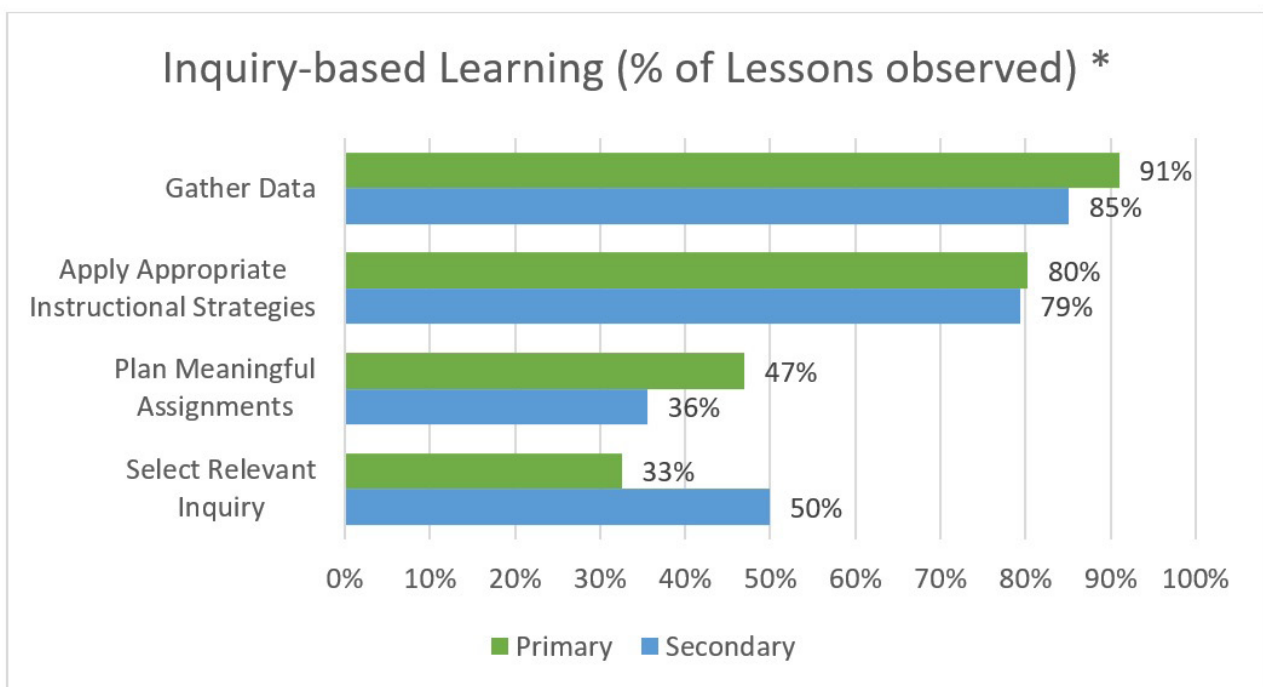


Figure 11. Inquiry-based learning strategies in P5, S1 and S3 Classrooms (10/17 KBK) [*Average for all subjects by P5, S1/S3 levels].

KEY INSIGHTS

Insight #5: Inquiry-based pedagogy is practised but student agency and role in the inquiry process is seldom emphasised.

potentially facilitate knowledge construction and examination of issues, with a focus on the learner in the classroom. Elements of inquiry-based practices become evident such as collaborative learning with peers and engagement in exploratory activities as well as the use of open questions and questioning strategies employed by teachers. The 10/17 KBK study shows pair/group work being used consistently by PE teachers and English Language teachers across both Primary 5 and Secondary 3 levels. In Music, Mathematics and Visual Arts lessons, Primary 5 students have far more opportunities to collaborate with their peers compared to Secondary 3 students. Another study (25/15 KBK) reveals that pair/group work in CCE is higher in Secondary 3 classrooms compared to Primary 5 while pair/group work in Social Studies is more frequent in Primary 5 than in Secondary 3. In one instance, students (in groups) were required to make a “decision” about the allocation of funds for one of the three co-curricular activity (CCA) groups in their school: sports, performing arts and uniformed groups. Each group had to study the proposal submitted by each CCA and decide on the CCA, which should be allocated the MOE funds to develop a niche area. Students’ collaborative learning in this case generated opportunities for students to grasp key concepts related to decision-making such as competing priorities, trade-offs and “Should the majority always win?” (25/15 KBK).

In a study about teaching Computing in schools, students engage in inquiry-based learning as teachers provide worksheets with printed instructions for self-paced group activities and discussions to guide students’ exploration (04/16 LCK). Teachers also draw on students’ everyday experiences: for example, students (in groups) discuss the problems they face when they visit the school bookshop, and write these down on an A3 paper (12/16 VS). In one study (16/15 LTW), students avail of opportunities to learn collaboratively with their peers, teach each other, and be responsible for each other’s learning. Group work activities also become evident in other studies (29/15 CCY, 28/15 ISC). Compared to “regular teachers” in the study 28/15 ISC, the ‘turnaround teachers’ (see Footnote 6) offer more opportunities for students to choose a range of experiences and share their ideas. The “turnaround teachers” also spend more time linking classroom learning to students’ lives and offer greater flexibility in establishing classroom structures.

Inquiry-based pedagogical practices in the form of exploratory and open-ended activities are observed, which arguably, provide space for students to take ownership of their learning and develop relevant 21CC. Across a range of subject domains at the Primary 5, Secondary 1 and Secondary 3 levels, teachers engage students in exploratory activities in about one-fifth of the lessons. In 25/15 KBK, Social

KEY INSIGHTS

Insight #5: Inquiry-based pedagogy is practised but student agency and role in the inquiry process is seldom emphasised.

Studies students need to make a “decision” (in groups) about fund allocation for the co-curricular activity (CCA) groups in their school, which allow them to grasp the complexity of decision-making and consider concepts such as trade-offs, competing priorities, and “Should majority always win?”. In another Social Studies classroom (16/15 LTW), the teacher helps students access the forms of cultural capital most often associated with public debate and engagement—ways of thinking, critical reasoning, expression, consuming information, comparing sources, etc.

In Music lessons, teachers encourage experimentation and exploration by asking students to think about how they can make the musical notes come alive. For example, students engage in creative musical activities outside the band context, and perform music that allows for improvisation (17/15 TYC). To emphasise the role of language in Science learning, a teacher designs an open-ended activity to generate students’ awareness of the role of pronouns in writing, and students discuss with their peers about the (in)appropriate use of pronouns in sentences (16/16 SLH). Participation in this open-ended task activates not only students’ language knowledge but also draws on their understanding of scientific concepts since students would not know what words to replace the “it” with if they did not understand the contexts in which the sentences were embedded.

Elements of an inquiry-based approach become evident in teachers’ questioning strategies and use of open questions, which stimulate students’ thinking and metacognitive learning. Question-driven learning constitutes a key element of the inquiry approach outlined in the humanities syllabus (MOE, 2016): questions stimulate students’ curiosity, activate their prior knowledge, and challenge their assumptions. Teachers ask questions that encourage deep thinking and open up space for discussion among classroom participants (29/15 CCY). In one study, teachers encourage student engagement via prompting (12/16 VS). Teachers monitor students’ answers; and select, sequence, and connect their responses in order to highlight their thinking in the application of the selected differentiation rules. To emphasise the connections between mathematical ideas and representations, teachers create opportunities for exploratory and/or constructive talk by orchestrating productive mathematical discussions around typical problems (03/16 CBH).

The recent 10/17 KBK study surfaces modest evidence of open-ended questions based on a range of primary and secondary school subjects though closed questions remains a strong feature (Figure 5). Secondary 3 English Language teachers employ open-ended questions more frequently than their counterparts at the Primary 5 level but the reverse is evident in Mathematics, Visual Arts

KEY INSIGHTS

Insight #5: Inquiry-based pedagogy is practised but student agency and role in the inquiry process is seldom emphasised.

and PE lessons (10/17 KBK). Music shows similarity at both levels in terms of teachers' consistent use of open-ended questions. Based on teacher interviews, 25/15 KBK reveals that engaging students with open-ended questioning and sustaining discussion comes into tension with syllabus coverage and high-stakes examination preparations, which has obvious implications for inquiry-based learning.

Overall, the reviewed studies surface considerable evidence of teachers incorporating elements of inquiry into their instructional repertoires by providing opportunities for collaborative work and exploratory activities as well as through questioning strategies to facilitate inquiry-based learning. However, in terms of the inquiry cycle, there is little evidence of student agency in determining and guiding the inquiry focus, design or outcomes (10/17 KBK, 25/15 KBK). The review also surfaces instances in which student learning may not be optimal when teachers employ the inquiry-based approach in the classroom. Students in the study 29/15 CCY reported that their anxiety significantly increased during some

practices such as pseudo-groupwork, which becomes evident in non-dialogical teaching where students are engaged in passive group tasks with little interaction amongst group members, working on individual worksheets or individual work, and where teacher continues to lecture. The study also reported that high-order teacher questions (e.g., questions that encourage deep thinking, or open up space for discussion), and disruptive learning environments increase students' anxiety. Students in lower ability English Language and Science classrooms are more likely to engage in such passive collaborative tasks.

KEY INSIGHTS

Insight #6: School-based adaptations of the intended curriculum are largely influenced by teachers' perceptions of student needs, teachers' focus on enhancing their cognitive engagement, and organisational support but such curricular modifications may not always align with curricular goals.

Brown (2009) characterised teachers' interactions with the formal curriculum by considering the varying degrees of responsibility shared between the curriculum and teacher resources to produce the enacted curriculum. On one end of the scale, teachers can *offload* their responsibility as designers of the lesson and instead choose to rely primarily on the curriculum resources (e.g., teaching in direct alignment with the textbook). On the other end of the scale, teachers can *improvise* by predominantly relying on their own resources. Lastly, an intermediate of the two processes is when teachers *adapt* the curriculum materials. By sharing the responsibility to design between the curriculum and teacher resources, teachers can use content in a textbook as inspiration for instruction. For example, instead of directly using an example given in the textbook, the teacher could generate a similar example by changing the context and figures, thereby applying their own subject matter and pedagogical content knowledge to ensure the lesson goals are still achieved.

The present synthesis reveals adaptations and improvisations of the intended curriculum fuelled by teachers' perceptions of their students' learning needs though these may not necessarily align with broader curricular goals of what organisations and academic programmes are required to do to equip

students with desired knowledge and skills. The findings from 20/15 JL show that schools on the higher socioeconomic status (SES) and mid-SES spectrum tend to adhere closer to the national Strategies for English Language and Reading (STELLAR) English Language (EL) curriculum and had higher fidelity than the low-SES schools. Teachers tend to adhere substantially more to the STELLAR curriculum materials to cognitively challenge their students in high- and mid-SES schools. It could be attributed to students from high- and mid-SES backgrounds having more family support for their learning. On the other hand, teachers in the low-SES schools improvise the STELLAR curriculum materials to create examination-driven materials to prepare their students for the school-based examination (Loh, 2021). It is a general perception of teachers in low-SES schools that the type of teaching advocated by STELLAR—student-centric, inquiry-driven and mastery of communication and thinking skills—is not aligned to the teaching needs and expectations of their students. Effectively, the adaptations of the intended curriculum in low-SES schools were almost antithetical to what STELLAR emphasises. It is noted that primary EL teachers expressed concerns about the following key issues that may affect the fidelity of the implementation of STELLAR in terms of its impact on students' learning: 1) time constraints (e.g., spending less time on teaching and more time on

KEY INSIGHTS

Insight #6: School-based adaptations of the intended curriculum are largely influenced by teachers' perceptions of student needs, teachers' focus on enhancing their cognitive engagement, and organisational support but such curricular modifications may not always align with curricular goals.

classroom management and administrative tasks that teachers need to attend to); 2) alignment with examination demands (e.g., heavy supplementation of worksheets with exam-oriented questions by the schools); 3) insufficient emphasis on certain components (e.g., due to the high non-teaching workload, teachers are pressed for time to complete each STELLAR unit of study within the stipulated timeframe); and 4) support for different progress learners (e.g., teachers have to grapple with non-educational issues and modify STELLAR to cater to students from low-SES community).

Findings from 25/15 KBK show that CCE teachers source for and create their own teaching materials while their Social Studies counterparts generally rely on teaching packages and materials from the school and MOE, which are occasionally modified or customised to students' learning needs. In secondary classrooms with low progress students (16/15 LTW), teachers feel responsible for meeting the intended syllabus/curriculum outcomes and that their students should perform well on tests and examinations. The teachers often seek to motivate their students not just by setting academic goals that relate to their interests and aspirations but also by taking account of their challenges. Teachers' choice of strategies and pacing of their lessons are also influenced by their perceptions of students' needs and

characteristics (28/15 ISC). The psychological needs of students serve as the basis for the classroom actions of a few teachers. Some teachers tend to note students' emotional states during teaching. Teachers mention conducting individual student profiling of students, building rapport with their students, and/or familiarising themselves with students' past experiences and home contexts. Arguably, the focus on students' non-academic aspects impact the extent to which teachers can realistically adhere to the intended curricular and instructional approach.

Other than catering to students' psychological needs, adaptations of the intended curriculum are also based on the rationale of strengthening students' cognitive engagement to cater to their learning needs. The enacted curriculum highlights how examination-type problems potentially provide an excellent avenue to direct students' attention to specific features of the target concept, beyond developing an instrumental understanding of Mathematics (03/16 CBH). The teachers modify or select typical problems (standard examination-type or textbook questions), and implement in ways that demonstrate the possibility of using such problems in lieu of rich tasks (with high cognitive demands that engage students in mathematical thinking), to open up opportunities for student thinking, or to direct students' attention to specific concepts and connections.

KEY INSIGHTS

Insight #6: School-based adaptations of the intended curriculum are largely influenced by teachers' perceptions of student needs, teachers' focus on enhancing their cognitive engagement, and organisational support but such curricular modifications may not always align with curricular goals.

Aligned with curricular goals, science teachers make deliberate attempts to explicate the representational demands of science writing in addition to the conceptual demands to scaffold students' construction of scientific explanations (16/16 SLH). While some teachers prefer a more discursive approach to highlighting and discussing the language issues by engaging students in oral interactions, others prefer a more activity/task-based approach, engaging students in pair/group discussion on language issues. To support science writing, teachers make extensive use of metalanguage in their oral interactions with the students. However, while the teachers demonstrate an enhanced focus on the representational demands of science writing as evident from the use of diverse discursive strategies⁹ and metalanguage¹⁰ in their oral interactions with students, there are variations in terms of the frequency and degree with which the teachers emphasise language issues.

⁹ While some teachers prefer a more discursive approach to highlighting and discussing the language issues by engaging students in oral interactions, others prefer a more activity/task-based approach. The latter often involve the teachers designing activities and tasks to engage students in pair/group discussion on the language issues. The former approach tend to be more teacher-driven while the latter tend to imbue students with greater agency.

¹⁰ Metalanguage refers to the second level of language used to analyse and describe the language of school science (Shanahan, 2012). Metalanguage identifies particular aspects of language being talked about and hence allows teachers to be explicit about the representational demands of science writing.

In terms of students' experiences of the enacted curriculum, students mostly have positive learning experiences across the different subjects, except when teachers' enactment focuses on preparing students for examinations. Students enjoy their History and Geography lessons and acknowledge the relevance of attaining knowledge about the past as well as the world and the environment, but they find it difficult to memorise the content for examination purposes (10/17 KBK). Students find Mathematics lessons more fun and engaging when teachers show different approaches to solve the problems. Solving problems on their own gives students a sense of pride and accomplishment, and problems like jigsaw puzzles (e.g., Tangram puzzles, number puzzles) improve their logic and thinking process. In English Language lessons (01/16 SAJ), students experience difficulty in learning the academic vocabulary necessary for school reading and writing. Students observe that their confidence increases through the processes of practicing, rehearsing, and regular band performances (17/15 TYC). As a Musical ensemble, when peers collaborate to make music together, they also understand the importance of collaboration, teamwork and interdependence.

Support from the school organisation is found to be as important in shaping teachers' practice in the classroom (20/15 JL) as leadership and

KEY INSIGHTS

Insight #6: School-based adaptations of the intended curriculum are largely influenced by teachers' perceptions of student needs, teachers' focus on enhancing their cognitive engagement, and organisational support but such curricular modifications may not always align with curricular goals.

school culture in affecting secondary teachers' perceptions of AfL (12/15 CCD). When the school organisation is supportive and focuses on building teacher competency, teachers' pedagogical decisions about offloading¹¹, adapting or improvising the curriculum are influenced by the school's goals and emphases, and takeaways from their teacher education programmes.

¹¹ Offloading refers to instances where teachers rely predominantly on the curriculum materials to support instruction, i.e., the curriculum materials were used in a literal manner. As such, the responsibility for guiding instructional activity was offloaded onto the curriculum materials.

RECOMMENDATIONS

Based on the key insights derived from this synthesis of IC studies, some recommendations are offered to potentially improve pedagogical practice and set research directions.

How can the system do better?

1. Focus on a more nuanced and contextual use of teacher-directed and student-centric pedagogies.

As highlighted in the first insight, teachers employ student-centric pedagogies but teacher-directed approaches continue to be dominant in Singapore classrooms, which do not necessarily facilitate or empower a learner's autonomous study-skills and subsequently, lifelong learning skills (Trilling & Fadel, 2009). While teacher-directed pedagogies have value in reinforcing foundational facts and procedures, teachers need to be less dependent on didactic forms of instruction, and shift more nimbly between teacher-directed and student-centred pedagogies to enable classroom participants to leverage on the co-construction of knowledge in a learning community.

In view of the varying classroom contexts, teachers need to exercise greater discretion in employing teacher-directed instructional approaches as well as student-centric repertoires such as collaborative learning, open-ended activities, and whole-class dialogic discussions including the use of open-ended questions. A broader range of learning experiences and opportunities can potentially develop students' skills, values and dispositions, which are relevant to their everyday contexts. Other than students' cognitive and metacognitive learning, their social and moral development as well as emotional wellbeing need to be better supported at the school and classroom level.

For instance, the review surfaces students' anxiety over inquiry-based approaches such as engagement in collaborative tasks, which suggests the need for a more flexible use of student-centric pedagogies. Teachers may use a different approach such as blended learning, or flipped learning, to reduce anxiety, or to provide more time for engaging in collaborative tasks. Importantly, students require more opportunities to have a say in ascertaining the lesson focus, assessment criteria, and learning outcomes (see also Key insight #6). A more nuanced approach in using teacher-directed and student-centric pedagogies can encourage students' agency in the classroom, paving the way for greater student participation, engagement and empowerment in the learning process.

2. Support teachers' responsiveness to students' needs.

Teachers need to be better supported in being more responsive to individual students' learning needs (Key insight #2). Allocation of personnel such as teacher mentors, teacher buddies providing support to teachers in mainstream classrooms is broadly recommended to facilitate teachers' curricular or content modifications. A stronger focus on fostering a positive classroom culture and teacher-student rapport can help teachers manage their students' expectations, and address their cognitive and affective needs. Thus, equipping teachers with a better understanding of DI strategies is recommended. Additionally, concerns about time constraints, syllabus

RECOMMENDATIONS

How can the system do better?

coverage and large class sizes need to be acknowledged to enable teachers to weave DI strategies into their instructional repertoires on an everyday basis. Importantly, the pressure of preparing students for high-stakes examinations needs to be alleviated through differentiated learning approaches for both SEN and non-SEN students. The study 12/16 VS reported teachers' preference for an exam-free pedagogy for SEN students as well as more teacher training to alter expectations and mindsets regarding the learning outcomes for SEN students.

The reviewed studies also surface the role of leadership, school culture and school organisation in shaping teachers' pedagogical practices (Key insight #6). Greater focus on fostering a school culture that supports collaborative teacher learning is warranted. Changing teachers' mindsets and beliefs while building up teachers' professional capacity in terms of training and guidance in employing DI is recommended. Since teachers' autonomy is "bounded" within institutional constraints (Coburn, 2004, p. 235), more broad-based opportunities to enhance teacher competencies can potentially enhance their responsiveness to diverse student needs in their unique classroom contexts.

3. Facilitation of students' metacognition.

The study 10/17 KBK indicates a gradual shift (from 2004–2018/19) from traditional pedagogies with an emphasis on factual (teaching facts) and procedural knowledge (teaching procedures and routines) towards conceptual (about four times higher instances

since 2004) and metacognitive knowledge (from 14% in 2004 to about 23% in most of the subject classrooms in 2018/19). As highlighted (Key insight #3), while teachers continue to focus on the foundational knowledge and procedural fluency that are important for more advanced knowledge work, they are aligning their teaching practices to build conceptual and metacognitive understanding, especially in some subjects more than others. As the study 10/17 KBK shows, metacognitive knowledge is medium to strongly correlated with instances when teachers provide opportunities for epistemic knowledge (knowledge of the nature of the discipline, disciplinary standards to establish knowledge), which possibly suggests that these shifts are aligned with the development of disciplinary literacies among students in particular subjects and classroom contexts.

The present review surfaces the need for facilitating students' metacognitive learning via a stronger focus on both knowledge about cognition and regulation of cognition (Flavell, 1979; Paris & Winograd, 1990; Schraw et al., 2006). Students need more opportunities to engage in metacognitive reflection of their learning, which is an essential element for developing 21CC in students across all subject areas and levels. Strengthening aspects of metacognition in the classroom includes opportunities for students to reflect via self-assessment and peer feedback, which potentially facilitate students' awareness, monitoring and regulation of learning. Also, students need more space to share and verbalise their learning to other classroom participants, which surfaces evidence of their

RECOMMENDATIONS

How can the system do better?

reflective thinking. Teachers need to provide more metacognitive scaffolds (e.g., feedback) to students. Specifically, greater focus on feedback at the self-regulation level (Hattie & Timperley, 2007) through the use of open-ended questions and space for students to communicate their learning needs can foster students' metacognitive learning. When integrated in everyday teaching across the curriculum, the use of these metacognitive strategies can play an important role in enabling students' learning and understanding in greater depth (Flavell, 1979). Planning teacher professional development programmes on metacognition for sustained and purposeful implementation across all subject domains and levels is recommended.

4. Focus on Assessment for Learning (AfL).

A greater focus on developing teachers' assessment competencies is needed. Assessment practices and assessment feedback need to be more facilitative of students' self-directed learning. While there

is evidence of teachers' learning-enhancing feedback (e.g., task-specific feedback), use of AfL practices, and student involvement in assessment (see Key insight #4), teachers should continue to use AfL with their students and look into giving more process and self-regulation feedback, when appropriate to address students' learning gaps. Students need more opportunities to be actively involved in their own and their peers' learning via critical reflection, self and peer assessment. Findings have shown that by activating students' prior knowledge and creating opportunities for student reflection, teachers are able to make student learning visible. However, more attention can be focused on consolidating and eliciting evidence of students' understanding through formative assessment strategies. Teachers can be given support to better understand the relationship between and the purposes of AfL and Assessment of Learning (AoL) which can work together to support student learning and inform teacher instruction. Enabling teachers to understand how AfL and

RECOMMENDATIONS

What research gaps exist in our current system?

AoL can complement each other to support student learning is especially important in view of time constraints and large class sizes.

1. Stronger focus on baseline classroom observational studies.

Further large-scale studies involving classroom observations are recommended to obtain a broader picture of pedagogical practices employed by different subjects and levels in varying school and classroom contexts. In order to extract more generalisable findings, other large-scale studies are recommended, which can build on the empirical evidence from these 14 studies to produce a more substantive evidence base.

Baseline, cross-sectional research can also meaningfully inform what makes pedagogical practices more (or less) effective, for what (i.e., content of learning, including subject disciplines, 21CC and non-academic skills e.g., communication, social and emotional skills) and for whom (i.e., student characteristics such as grade level, stream, and home background) across different timepoints in the Singapore context. Empirical evidence from a representative sample can help to answer how effective pedagogical practices, and the factors that make them effective (e.g., teacher characteristics) vary by the content of learning (e.g., subject disciplines, 21CC, non-academic skills), student characteristics (e.g., grade level, stream, home background)

and teacher characteristics (e.g., pre-service and in-service teacher learning, experience, belief and perception). The LES can be seen as a starting point for future IC studies and LES reports that can expand and clarify some of the findings documented here. There should also be greater encouragement for researchers to embark on IC research to generate the necessary evidence base for future IC syntheses.

2. Greater focus on translation approaches.

Moving forward, leveraging on the findings from existing research studies can potentially inform future interventions and improvements. Greater emphasis on translation approaches may be targeted to address nimble adaptation to new contexts that directly impact teaching and learning gaps. For example, the study OER 12/15 CCD led to an intervention project on assessment feedback. Translation approaches can potentially facilitate timely dissemination and application of relevant research findings to inform policy and programmes as well as improve pedagogical practices and learner engagement. Translation approaches will require deeper involvement of researchers including MOE officers and researchers from NIE's Academic Groups. Additionally, there is a need to ensure sufficient resources and flexibility is provided to researchers for pursuing cutting-edge research.

3. More emphasis on student engagement

RECOMMENDATIONS

What research gaps exist in our current system?

and learning.

IC research has surfaced certain limitations in describing and measuring patterns of student engagement and learning in Singapore schools, which future research needs to address. To have a more comprehensive understanding of student learning outcomes, future research studies need a stronger focus on the learner perspective in the Instructional Core Model. This requires the development and deployment of robust measures of learner engagement at the behavioural, affective and cognitive levels. Thus, a stronger focus on cognitive and academic aspects of students' learning is recommended.

Other than academic aspects, future research needs a stronger focus on non-academic aspects of student learning to surface a better understanding of how learners interact with the teacher and content in the classroom. Robust indicators of student perspectives need to be developed, deployed and analysed to ascertain student engagement on the behavioural, affective and cognitive levels. As such, studies can be conducted to investigate factors that affect student engagement. Specifically, a more optimal and strategic balance between breadth and depth in data collection and sampling is required via a range of indicators that capture multiple aspects of teaching and learning. In terms of student learning, future studies may focus on examining and seeking

to improve students' metacognitive strategies, feedback practices, peer/self-assessment practices, and opportunities for dialogic teaching. Specifically, patterns of domain-specific learning need to be further explicated to better understand the impact of pedagogical practices in different school and classroom contexts.

4. More focus on effective teaching and learning with technology.

Future research directions need to incorporate greater focus on identifying the factors associated with effective (or ineffective) teaching and learning with the aid of technology in order to better inform teacher training and professional development initiatives. The reviewed studies did not explicitly focus on the use of technology in the classroom thus, future research into the interactions between technology and IC is needed especially with the accelerated use of home-based and online learning during the pandemic. Given the increased use of technology for teaching and learning such as Singapore Student Learning Space (SLS), Personalised Digital Learning Programme (PDLP), research studies can focus on elucidating the opportunities for leveraging on the affordances of technology in the classroom as well as the challenges in terms of teacher readiness (e.g., time constraints and other challenges in facilitating technology enabled learning) and

RECOMMENDATIONS

What research gaps exist in our current system?

administration (e.g., students' inability to log in to portals). Studies into the use of Artificial Intelligence and learning analytics as well as emerging technological tools can also provide insights into teaching and learning practices. Future studies can examine how teachers use the whole ecology of technology-enabled resources to improve student learning and engagement.

5. Deeper insights into instructional practices.

Future research studies can serve to provide a more detailed understanding of teachers' classroom enactment in terms of the different Areas of Practice in the SkillsFuture for Educators (SFEd) framework such as differentiated instruction (DI), e-pedagogy, strategies for SEN students etc. More empirical research to elucidate DI i.e. teachers' instructional and curricular modifications in addressing the needs of both SEN and non-SEN students is warranted. Similarly, more

CONCLUSION

studies examining the teaching of 21CC (MOE, 2010) can serve to construct a fuller picture of pedagogical approaches, which enable students' holistic development.

The LES identified 14 ERF 3rd tranche studies related to the Instructional Core, which cover a wide range of subject domains and examine the state of teaching and learning in Singapore primary and secondary schools. The reviewed studies show that most teachers feel the need to prepare students for achieving academic goals and examination success but find it equally important to cater to the needs and interests of individual students, and equip them with greater ownership of their own learning. To promote holistic learning, teachers adopt instructional strategies such as positive classroom environment, encouraging student engagement through collaborative learning, use of questioning strategies to enable students' metacognitive learning, checking for students' prior knowledge, and feedback. Occasionally, teachers employ newer pedagogical approaches such as inquiry via exploratory and open-ended activities, and involving students in assessment. However, a stronger focus on the use of AfL strategies and students' metacognition is warranted to foster students' self-directedness in the Singapore classroom.

The studies surface school-based adaptations and improvisations to cater to students' needs, flexibility in implementing the curriculum as well as teachers' fidelity to the

planned curriculum, which has implications for policy decisions about what is intended for the classroom. Potential avenues for future IC research include elucidating further evidence of students' engagement and the impact of pedagogical practices on students' academic and non-academic outcomes in varying contexts. The findings suggest that teacher-student interactions in relation to the content cannot be devoid of a realistic consideration of the role of school leadership, culture and organisation. Moving forward, a stronger focus is needed on building teacher capacity in tandem with a culture of continual improvement and refinement of teachers' instructional repertoires, which can serve as a valuable international benchmark.

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ANNEX A

Selection Criteria for Instructional Core Projects

There is a total of 22 IC projects (13 RFP to 19 RFP) in the ERFP 3rd tranche. The following selection criteria were used to identify these projects:

1. The study involved a clear focus on all 3 aspects of the instructional core—teachers, students and content, as well as at least one relationship between them; and
2. The project sample focused on Singapore schools that range from primary to junior college levels

From these 22 projects shortlisted, 18 have been completed between 2015 and 2020. Of these 18, 14 studies with approved final reports are reviewed at greater depth and served as the main basis for this LES. The remaining four studies are awaiting final report approval, and therefore their findings are excluded from this synthesis.

About \$3,655,921 in funding from 3rd tranche ERFP was awarded for the 14 studies included in this synthesis. See Annex B for the table of projects. Six studies were conducted in secondary schools, three studies were conducted in primary schools, with the remainder five studies involved both primary and secondary schools. English Language was the most examined subject (five studies) followed by Mathematics (four studies), Humanities (three studies), Art & Music (three studies), Science (two studies). Most of the projects cover more than one

subject. The subject-domains covered by 11 out of 14 projects include English Language, Mathematics, Science, Art/Music, Humanities, largely the core curriculum subjects in schools, with three projects (OER 12/15 CCD, OER 28/15 ISC and OER 12/16 VS) focusing on Assessment practices, Low progress learners, and Special Educational Needs (SEN), respectively. See Annex C for the distribution of projects by subjects and levels.

ANNEX B

Table of ERF-funded Research Projects Analysed for the LES on Instructional Core

S/N	Project No.	Project Title	Principal Investigator (PI)'s Contact	Tier	Type of Project	Methods	Participants	Project Closure Year
1	OER 12/15 CCD	Perceptions, policies and practices: AfL in the Singapore context	Dr Wei Shin LEONG weishin.leong@nie.edu.sg A/P Christopher Charles DENEEN (Ex-PI) christopher.d@nie.edu.sg	2	Exploratory	Mixed Methods Research	13 Secondary Schools 1119 School leaders, key personnel and teachers 105 Students	2019
2	OER 17/15 TYC	Developing 21CC Through Band: An Exploratory Study of the "Four Cs"	A/P Yuh Chaur Leonard TAN leonard.tan@nie.edu.sg	1	Exploratory	Mixed Methods Research	Primary and Secondary Schools 19 Teachers (9 Primary, 10 Secondary) 190 Band Students (82 Primary, 108 Secondary)	2017
3	OER 20/15 JL	Reforming the English language curriculum in Singapore: An implementation perspective	Dr Kok Khiang Jason LOH jason.loh@nie.edu.sg	2	Exploratory	Qualitative Methods Study	9 Primary Schools 32 Teachers Students from P4	2019
4	OER 16/15 LTW	Culturally Relevant Pedagogy: Exploring the Use of Culture in Singapore's Low Progress Classrooms	A/P Tze-Wei Leonel LIM leonel.lim@nie.edu.sg	1	Exploratory	Qualitative Case Study Research	Secondary Schools 5 Teachers Small groups of low progress learners	2017
5	OER 25/15 KBK	Core Research Programme: Baseline Investigation of Social Studies and Character & Citizenship Education Pedagogies in Singapore Classrooms	Dr Beng Kiat Dennis KWEK dennis.kwek@nie.edu.sg	2	Regular (Baseline)	Qualitative Methods Study	8 Primary Schools and 7 Secondary Schools 30 Teachers (17 Primary, 13 Secondary) 1250 Students	2018
6	OER 29/15 CCY	Core 3 research programme: A quantitative study of learning and teaching in Singapore classrooms	Dr Chee Yeen Melvin CHAN melvin.chan@nie.edu.sg	2	Regular (Baseline)	Quantitative Methods Study	16 Primary Schools, 16 Secondary Schools 229 Teachers (120 Primary, 109 Secondary) 6932 Students (2923 Primary, 4009 secondary)	2019
7	OER 28/15 ISC	Lessons from Resilience-Nurturing Environments: Classroom Practices of Turnaround Teachers	Dr Imelda Santos CALEON imelda.caleon@nie.edu.sg	2	Exploratory	Mixed Methods Research	11 Secondary Schools 111 Teachers 871 Students	2019
8	OER 19/15 TS	Understanding Teachers' Knowledge and Practice of Lower Secondary Geographical Investigations	Dr Ing Chin Dorothy Tricia SEOW tricia.seow@nie.edu.sg	1	Exploratory	Qualitative Case Study Research	4 Secondary Schools 6 Teachers Students from 7 classrooms	2018
9	OER 04/16 LCK	Researching and developing pedagogies using unplugged and computational thinking approaches for teaching computing in the schools	Prof Chee Kit LOOI cheekit.looi@nie.edu.sg	2	Exploratory	Design-Based Research	4 Secondary Schools 8 Teachers 130 Students	2018

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S/N	Project No.	Project Title	Principal Investigator (PI)'s Contact	Tier	Type of Project	Methods	Participants	Project Closure Year
10	OER 03/16 CBH	Portraits of Teacher Noticing during Orchestration of Learning Experiences in the Mathematics Classrooms	Asst Prof Ban Heng CHOY banheng.choy@nie.edu.sg	1	Exploratory	Design-Based Research	3 Secondary schools. 4 Teachers Students from S1 to S4	2018
11	AFR 01/16 SAJ	Learning the Language of Mathematics in the Primary School: An Exploration of the Processes, Practices, Policies, and Curricula of Teaching and Learning English and Mathematics through English in Multilingual, Postcolonial Singapore.	Dr Sally Ann JONES sally.jones@nie.edu.sg	1	Exploratory	Qualitative Case Study Research	3 Primary schools 88 Teachers 227 Students	2019
12	OER 12/16 VS	Differentiated Instruction as a Means to Inclusion (DIMI)	A/P Heng Fook Levan LIM levan.lim@nie.edu.sg Dr Vasilios STROGGILOS (Ex-PI) v.stroggiolos@nie.edu.sg	1	Exploratory	Qualitative Case Study Research	3 Primary schools 5 Teachers, 5 AEDs (LBS), 1 AED (T&L) and 2 LSTs Five Students from SEN classes	2018
13	OER 16/16 SLH	Fostering Science Teachers' Language Awareness: Exploring Impacts on Teachers' Oral Interactions with Students to Support science writing.	Dr Lay Hoon SEAH layhoon.seah@nie.edu.sg	2	Exploratory	Qualitative Methods Study	2 Primary and 2 Secondary Schools 6 Teachers Students from P5, S1 and S4	2019
14	OER 10/17 KBK	Core 3 Research Programme: Baseline Investigation of Subject-Domain Pedagogies in Singapore's Primary and Secondary Classrooms (C3-PP)	Dr Beng Kiat Dennis KWEK dennis.kwek@nie.edu.sg	3	Regular (Baseline)	Qualitative Methods Study	12 Primary & 13 Secondary Schools 191 Teachers (56 Primary, 135 Secondary)	2020

ANNEX D

Glossary of terms: Teaching Strategies (Figure 6)

Term	Descriptor
Tr Comms: Communication of learning goals by teacher	Articulation of the lesson objectives and outcomes verbally or in writing e.g., on the whiteboard.
Tr Checks: Activation of students' prior knowledge by teacher	Tapping on what students have learnt previously and/or checking their pre-requisite knowledge, skills etc.
Tr Recap: Lesson recapitulation by teacher	Revisiting or summarising the lesson content in order to consolidate students' understanding.

ANNEX E

Glossary of terms: Classroom Talk (Figure 9)

Term	Descriptor
Explanatory talk	Teacher/Student gives reasons or explanations for the initial statement made through question-answer exchanges, which involve clarification and negotiation of meaning/s.
Conceptual connections talk	Talk involves teacher/student linking across concepts, representations, arguments, examples, ideas etc., which potentially enables students' understanding.
Reflexive talk	Talk involves engaging students in thinking about their own learning or managing their learning, which facilitates students' metacognitive learning and self-regulation.

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