OER KNOWLEDGE BITES

Volume 2

A Dialogue on the Nexus of Learning Sciences Research and Practice

LSL Buzz: A Symposium by the Learning Sciences Lab

11 Nov 2016, National Institute of Education

Chair *Looi Chee Kit*
Speakers *Dragan Trninic, Seah Lay Hoon, Roberto de Roock*
Discussants *Choy Ban Heng, Jennifer Yeo, Victor Lim Fei*

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About OER Knowledge Bites

Launched in May 2016 by the Office of Education Research at the National Institute of Education, Singapore, **OER Knowledge Bites** aims to share education research discussions and issues as seen in the Singapore context. It also serves as a platform for researchers to share thoughts and concepts of education research with policymakers, educators and the public.

Table of Contents




Introduction

By *Looi Chee Kit*

THE INAUGURAL Learning Sciences Lab (LSL) symposium on 11 Nov 2016 initiates a dialogue on the nexus of research and practice in the learning sciences. The goal of the symposium is to promote understanding of the research done and sharing of different perspectives at the National Institute of Education (NIE), Singapore. The symposium also aims to encourage collaborative exchanges and joint work among the researchers and participants.

Three colleagues from LSL, a research centre under the Office of Education Research at NIE, will share their perspectives on their respective areas of research in the learning sciences with a view towards articulating and drawing relevance from their research towards informing practice. Invited respondents from the Academic Groups in NIE or from the Ministry of Education (MOE), Singapore, will play the role of discussants, responding from the perspectives of a teacher educator or a classroom practitioner.

The symposium also aims to encourage collaborative exchanges and joint work among the researchers and participants.

– Looi Chee Kit,
Learning Sciences Lab, NIE

This is part of LSL's effort to build a better understanding of emerging research findings among the research community, and work towards creating a strong nexus of research and practice in the institute, pointing towards the gaps and challenges that exist in the nexus. The dialogue is also intended to be mutual in such a manner where research informs practice and vice versa.

Introduction

By *Looi Chee Kit*

Dragan Trninic, a Research Scientist at LSL, will share some of the latest developments in embodied cognition as applied to mathematics education. Recent advances in cognitive science suggest that our embodiment not only influences but constitutes cognition. In short, thinking may be best understood as simulated action. In his talk, Dragan will explore the design of learning environments in which physical actions create opportunities to develop mathematical understanding. In this session, Choy Ban Heng, an Assistant Professor with the Mathematics & Mathematics Education Academic Group, serves as discussant.

Seah Lay Hoon, a Research Scientist at LSL, will seek to situate the nascent field of disciplinary literacy within the larger trend of a curricular shift towards an increasing focus on scientific practices (or more commonly framed as scientific inquiry). With the insights gained from her existing research projects, she will discuss some of the implications teaching disciplinary literacy could entail in the context of local science classrooms. In this session, Jennifer Yeo, an Assistant Professor with the Natural Sciences & Science Education Academic Group, serves as discussant.

Roberto de Roock, also a Research Scientist at LSL, will share his perspectives on digital literacies and how low-progress learners might benefit from digital literacies practices. In this session, Victor Lim Fei, from the Educational Technology Branch at MOE, Singapore, serves as discussant.

Stimulated by this particular dive into the nexus space of learning sciences research and practice, we will also seek some rise-above discussions on the learning sciences themes of learning processes and the design of learning environments. The 3 mini-discussions might serve as boundary objects that highlight possibilities for collaboration amongst research colleagues at NIE, as well as throw up challenges, methodological, practical or otherwise, that hold back such collaborative synergies.

About the Chair

Looi Chee Kit is a Professor with the Learning Sciences Lab, a research centre under the Office of Education Research, at the National Institute of Education, Singapore. His research interests include collaborative learning, mobile learning, and computational thinking. He was an Associate Editor of the *Journal of the Learning Sciences*.

Body of Knowledge: Embodied Cognition and Mathematics Education Research

By *Dragan Trninic*

A NOVEL DIRECTION IN cognitive sciences in general and mathematics education in particular is that of embodied cognition (see Abrahamson & Lindgren, 2014; Kirsh, 2013). Scholars of embodiment pay attention to how perceptions and actions affect knowing and contribute to its development. For example, learning scientists have examined how physical actions, such as gestures performed spontaneously by both students and teachers, provide opportunities for reflection and elaboration (Alibali & Nathan, 2012). As another example, recent empirical findings indicate that spatial and proportional reasoning are fundamentally intertwined with our physical sense of balance, in ways that cannot be explained simply by appealing to general differences in executive functioning or intelligence (Frick & Möhring, 2016).

Meanwhile, efforts to consider embodiment in the design of learning environments are gaining traction in the learning sciences (Abrahamson, 2014), and effective strategies for designing new environments and technologies capable of supporting embodied interactions are beginning to emerge (Lee, 2015). Embodied cognition is of particular use to mathematics education researchers interested in how performance (doing) results in understanding (knowing). In this sense, it can inform the creation of novel learning environments where students' physical actions advance their understanding of canonical mathematical concepts (e.g., Howison, Trninic, Reinholz, & Abrahamson, 2011). While designed to improve students' mathematical understandings, studies with young children suggest that embodied approaches also tend to increase students' general interest in mathematics (Glenberg, Willford, Gibson, Goldberg, & Zhu, 2012). The potential to combine physical exercise with academic learning is yet another advantage of this approach, especially

Body of Knowledge: Embodied Cognition and Mathematics Education Research

By *Dragan Trninic*

given rising concerns of health consequences of a sedentary modern lifestyle.

For scholars interested in adopting principles of embodiment in their work, it is important to note that this, in general, does not mean abandoning existing theoretical frameworks. Indeed, embodied cognition provides a way of looking at the world that is complementary to many existing theoretical frameworks. For example, embodiment has been positioned as an elaboration on Jean Piaget's theory of human development insofar as sensorimotor schemes are understood to contribute to higher psychological processes (Abrahamson, Shayan, Bakker, & Van der Schaaf, 2016). Embodied cognition is also aligned with sociocultural perspectives, as most evident in Vygotsky's striking claim that

"Even the most abstract thoughts of relations that are difficult to convey in the language of movement, like various mathematical formulas, philosophical maxims, or abstract logical laws, even they are related ultimately to particular residues of former movements now reproduced anew." (1997, p. 162)

Furthermore, embodied cognition is broadly aligned with various contemporary perspectives. These include, but are not limited to, approaches such as situated and distributed cognition, cognitive ethnography and archeology, and various complexity, AI and HCI perspectives based on emergence. What is shared across these perspectives—and this is also a central lesson of embodiment—is the belief that, rather than studying cognitive mechanisms in isolation, scholars should strive to establish their relationships with the contexts in which they are embedded and on which they depend (see Barsalou, 2016).

For teachers interested in adopting principles of embodiment in their classroom, one implication is to pay attention whenever they themselves think this way—in dynamical images—so that they might reflect and articulate what these images are. These dynamical images may then be used in classroom conversations and the design of learning activities. This means spending more time on the process of reasoning, rather than discussing its product. More generally, embodiment suggests that pedagogical approaches of direct instruction and discovery-based learning may be thought of as complementary, not antagonistic (Trninic & Abrahamson, 2016). In this interpretation, direct instruction is used to provide students with opportunities to practice, and through practice, gain (embodied) experiences that, in turn, serve as grounding for disciplinary knowing. A corollary is that classroom mathematical practices should include not only drills, but explorative exercises where the aim is not necessarily the attainment of correct solutions, but correct disciplinary understanding (see Kapur, 2014, on productive failure).

Finally, the ubiquity of motion-sensing devices (e.g., smartphones, Nintendo Wii) is worth mentioning here, since these technologies allow the creation of previously impossible learning environments. Furthermore, upcoming technological advances—such as the proliferation of virtual and augmented reality technologies—will enable students to not only visualize Science, Technology, Engineering and Math (STEM) content in the existing curriculum but explore advanced topics (e.g., spherical geometry) through embodied interaction. This opens up a rich set of design possibilities for learning environments that take full advantage of our embodied capacities, no longer bound exclusively to paper and pencil. While we can expect the technological landscape to remain in flux, now is the time to lay foundations for research on the educational potential of immersive, embodied learning of mathematics.

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About the Speaker

Dragan Trninic is a Research Scientist with the Learning Sciences Lab, a research centre under the Office of Education Research at the National Institute of Education, Singapore. His broad interests include mathematics education, embodied cognition, educational design, and the role of unintended consequences in learning. Dragan believes that students' practice should be exploration, not drill.

Embodied Cognition and Noticing in Mathematics Education Research

By *Choy Ban Heng*

TRNINIC (2016) GAVE an overview of embodied cognition and its influence in mathematics education research. He highlighted that cognition is grounded in the tacit enactment of perceptually guided physical motor action even though an onlooker may not perceive the movements. In essence, embodied cognition suggests that knowing cannot be separated from one's physical movements in the environment. This holds two important implications for researchers:

1. Investigating one's understanding of a concept may require researchers to identify the physical movements from which these targeted cognitive structures may emerge.
2. Theoretically, thought is a much broader cognitive function depending for its specificities on the embodied form enacting it (Trninic, 2016).

Despite the promise of embodied cognition to revolutionalize educational research, Trninic (2016) pointed out that "embodiment is not a panacea or a cure-all". Instead of positioning embodied cognition learning as a sequence of logical mental steps, it is positioned as intertwined logical, enactive and emotional processes. These processes, as Trninic (2016) puts it, are poorly understood and they open up new frontiers for researchers to think more deeply and pay attention to the complexity of teaching and learning.

I concur with Trninic's (2016) point that the identification of physical movements related to the targeted cognitive structures may be a fruitful direction of research as indicated by several of his work in this area (for example, see Howison,

Embodied Cognition and Noticing in Mathematics Education Research

By *Choy Ban Heng*

Trninic, Reinholz & Abrahamson [2011]). But it is possible that these physical movements may not be associated with the cognitive structures of interest. For example, it is common for mathematics teachers to use fraction discs as a manipulative for students to compare unit fractions. The physical act of comparing the sizes of fraction discs is often associated with the ability to order unit fractions. However, Choy (2013) highlights that students may still be confused about the sizes of unit fractions even though they may perform the correct physical movements when comparing fraction discs. Although students' limited opportunities to make sense of proportion in their daily lives may have hindered their understanding, what students have met before may be important for us to consider (McGowen & Tall, 2010).

A met-before is a "mental structure that we have now as a result of experiences we have met-before" (McGowen & Tall, 2010, p. 171). Unlike a misconception, a met-before may support or hinder the development of conceptual understanding. For instance, students may see marks written in test as a fraction, i.e., 20/30 (see Figure 1). This may be helpful for students to see fractions as a way to denote a part of a whole. However, they may also have encountered the "adding of marks" (i.e., 10/20 + 20/30 = 30/50) and misapply these ideas to addition of fractions. This could have led to students misapplying the rule that states "add numerator to numerator, denominator to denominator".

However, I agree with Trninic's (2016) point that embodied cognition offers a productive perspective on teaching and learning mathematics. What we think and what we do are closely related as

Section A	10 / 20
Section B	20 / 30
Total	30 / 50

Figure 1. Adding marks as a "met-before"

suggested by Tall (2004) in his model of growth of mathematical thinking. As Trninic has suggested, embodied cognition provides another lens to examine mathematics education. So, this begs the question of where do we go from here?

I suggest three important areas for us to consider: First, task design. Tasks offer students opportunities to be engaged with mathematical activities or processes, which can lead to a better understanding of concepts (Mason & Johnston-Wilder, 2006). However, good task design while necessary may not be sufficient. How tasks are orchestrated in the classroom is also critical. Last but not least, I think what teachers perceive and how they make sense of instructional details to orchestrate learning is important. This brings in the notion of teacher noticing (Mason, 2002; Sherin, Jacobs, & Philipp, 2011)—a kind of professional vision (Goodwin, 1994), into the realm of embodied cognition.

This productive discussion raises more questions than answers and I think the following three questions may point us to productive sites of future research:

1. Task Design: How do we design tasks using the ideas of embodied cognition?
2. Scalability: How do we scale up these practices from the laboratory to the classroom?
3. Gestures: To what extent is our thinking also embodied in the form of gestures? What should we notice about gestures during learning and teaching?

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About the Discussant

Choy Ban Heng is an Assistant Professor with the Mathematics & Mathematics Education Academic Group at the National Institute of Education, Singapore. His research interests include mathematics teacher noticing, task design, and classroom discourses.

The Rationale and Conditions for Teaching Disciplinary Literacy in Science: A Brief Introduction

By *Seah Lay Hoon*

Introduction

WHAT KNOWLEDGE AND skills do reading and writing science entail? Recent research has thrown new light on this question by shifting our focus from content knowledge to include the language and literacy demands that are unique to the discipline. This has led to the emergence of the notion of disciplinary literacy. In this write-up, I will briefly introduce the notion of disciplinary literacy and how it is related to the concept of "scientific practices". Some implications for pedagogy and future research are also discussed.

Disciplinary Literacy

Various definitions of disciplinary literacy abound depending on the scope of the term "literacy". For some researchers and educators, the notion is confined to reading and writing whilst others have a broader perspective that includes oracy and/or thinking skills (see ELIS Research Digest Vol 1, Issue 1 for a concise review). Whatever its reach, this notion fundamentally "emphasizes the unique tools that the experts in a discipline use to participate in the work of that discipline" (Shanahan & Shanahan, 2012, p. 8). One unique tool of science that sets it

The Rationale and Conditions for Teaching Disciplinary Literacy in Science: A Brief Introduction

By *Seah Lay Hoon*

apart from other disciplines is language. Scientific language involves not just the use of linguistic resources but a wide array of representations such as diagrams, graphs, tables, and charts. I will however focus mainly on the distinctiveness of the linguistic resources used in science.

Scientific Language is Unique

Studies utilizing the functional grammar framework have examined the language of science and unpack its distinctive features at different levels. At the lexicogrammatical level, scientific language is characterized by its vast specialist vocabulary, the use of grammatical metaphors (including nominalizations) and the unique use of other grammatical items such as prepositions, conjunctions, and pronouns (Fang, 2005). These lexicogrammatical resources are then put together in ways that fulfill the linguistic norms and requirements of various science genres (Unsworth, 2001). Scientific language also differs from everyday English and other disciplinary languages in features such as its high lexical density and its preference for passive over active voice (Fang, 2005).

Why Focus on Disciplinary Literacy?

It is important to note that the distinctive features of scientific language are not arbitrary but have evolved to meet the specific needs of the discipline. Understanding the form-function relations of scientific language enables one to better understand and appreciate how the language operates to construe scientific meanings. It is true that not all proficient readers and writers of science necessarily have explicit knowledge of how scientific language originated. Nonetheless, providing access to such knowledge *about* scientific language can help learners who are struggling with the language be better equipped with the means to unpack scientific texts. Empowered with such tools, they stand a higher chance of developing into independent and critical readers and writers in science.

Relation to Scientific Practices

The ability to use the language of science is crucial if students are to be proficient in engaging in the various literacy practices of science. The latter can be considered as a sub-set of scientific practices, that is, established processes scientists engage in as they construct models and theories to explain the natural phenomena in the physical world. For example, among the list of scientific practices highlighted in the Next Generation Science Standards (NGSS) developed in the United States, "asking questions", "constructing explanations", "engaging in argument from evidence" and "obtaining, evaluating, and communicating information" directly invoke the use of scientific language. Indeed, some researchers would assert that 'nothing resembling what we know as western science would be possible without

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>
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The Rationale and Conditions for Teaching Disciplinary Literacy in Science: A Brief Introduction

By *Seah Lay Hoon*

[scientific] text", and that "reading and writing do not stand only in a functional relationship with respect to science" but are 'constitutive parts of science" (Norris and Phillips, 2003, pp. 224–226).

Pedagogical Implications

In light of the importance and uniqueness of scientific language, there is a need for science instruction to focus not just on learning science through language but also learning the language of science (i.e. the reading and writing of science) as well as learning about the language itself (such as its form-function relations). Engaging in the three modes of learning does not necessary entail different learning tasks and activities. It is more important that teachers consider the language demands as well as the kinds of opportunities their learning tasks and activities afford in helping learners to see the relations between the language used and the scientific meanings/practices construed by it. Certain tasks and activities have greater potential for generating discussion about the form-function of scientific language than others, which in turn could deepen students' integrated understanding of both the content knowledge and representational means of science. Such tasks would usually entail the elicitation of students' use of language and provide opportunities for students themselves to compare and evaluate the different ways in which language is used by them and the scientific community.

Future Research

As disciplinary literacy is a relatively new area of research, more work is required to identify the principles for designing such integrated learning tasks and activities. Executing such tasks would also demand more of the teachers' knowledge and skills than they are currently trained for. Such knowledge would include knowledge about scientific language, knowledge about students in terms of their use of language and knowledge about strategies for teaching disciplinary literacy. Further research about what these various domains of knowledge constitute and how they shape teachers' instruction would be crucial if we are to leverage on the notion of disciplinary literacy in empowering our students to become more proficient and critical readers and writers of science.

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About the Speaker

Seah Lay Hoon is a Research Scientist with the Learning Sciences Lab, a research centre under the Office of Education Research at the National Institute of Education, Singapore. Her current research work focuses on students' use of linguistic resources in science classrooms and how teachers can enhance students' use of the scientific language.

Disciplinary Literacy: Its Value and Implication to Pre- and In-service Science Teacher Education

By *Jennifer Yeo*

AS A PHYSICS teacher, I would hear my students commenting that "there is a physics graph, a chemistry graph and a math graph" or about how values are written differently in math and physics. These comments suggest that students perceived the same modes of representation in math and science to be different. I used to wonder why this was so. Isn't a graph a graph, regardless of whether it is used in physics, chemistry, biology or mathematics? And isn't a number a number, regardless of the discipline in which it is used? Seah Lay Hoon's (2016) presentation on Disciplinary Literacy can perhaps shed some light into these comments.

Lay Hoon's presentation puts the spotlight on the distinctive features of language specific to different disciplines. Expanding on the traditional notion of (scientific) literacy as encompassing reading, writing and talking (science), the added component of *scrutinizing scientific language* in her framework of disciplinary literacy highlights an often neglected or taken-for-granted component of science learning—learning *about* the language used in science (e.g., words, drawings, graphs, tables). This neglect could perhaps be explained by common perspectives in science education on what counts as learning science.

Science learning has traditionally been perceived as conceptual change (Posner, Strike, Hewson, & Gerztog, 1982), and more recently as participation in the social activities of science. The conceptual change perspective views science learning as a

Disciplinary Literacy: Its Value and Implication to Pre- and In-service Science Teacher Education

By *Jennifer Yeo*

change in one's mental model, and language as an externalization of that mental model. The latter views science learning as an enculturation into the practices of science, which includes participating in inquiry practices of science (Roth, 1995), talking science (Lemke, 1990) and making meaning with the various modes of representations of science (Kress and van Leuwen, 2006). While language might feature in these various perspectives, it is regarded as a mere tool for giving insights into students' learning, rather than an object of science learning in itself.

The learning of scientific language is often taken for granted; it is assumed that students will "pick it up somehow". The anecdotal recount of comments made by students (as mentioned in the early part of the article) suggests that understanding the language of science is not automatic. Learning *about* the language of science needs to be made explicit. Drawing from Gooding's (2004) and Latour's (1999) analyses of representations in scientists' work, Prain and Tytler (2013) found that theory-building invariably happens through a series of transformations from one representation to another, representation refinement, and improvisation in a bid to develop a plausible explanation for an observed phenomenon. If learning science should involve authentic practices, then this should include understanding why and how discipline-specific and generic literacies are used to build and validate scientific knowledge; in other words, the epistemological and ontological purposes of the modes of representations with which knowledge is constructed should be included in the learning of science.

The representational approach developed by Tytler, Hubber, Prain, & Waldrip (2013) is one example of learning about the language of science. For example, the approach shows how it is not sufficient to just learn the conventions of using arrows to draw free-body diagrams to think about the forces acting on a body. Rather, authentic science learning should entail the exploration of different representations in modeling the phenomenon and consideration of the affordances and aptness of the pictorial representation of an arrow in conceptualizing an explanation for changes in motion.

> Learning *about* the language of science needs to be made explicit.
>
> – Jennifer Yeo,
>
> *Natural Sciences and Science Education Academic Group, NIE*

Implication to Pre-service and In-service Science Teacher Education

To help students learn the form and function of scientific language, teachers need to understand the epistemological and ontological purposes of the modes of representations with which knowledge is constructed (Prain & Tytler, 2013). This goes beyond merely knowing how to draw magnetic field patterns with arrows and its conventions; it should include understanding that the use of arrows to represent a magnetic field is derived from the pattern produced by iron filings when they are sprinkled around a magnet—a representation that has been found useful when thinking about the effects of magnetism. In this sense, signs/representations in the scientific system

Disciplinary Literacy: Its Value and Implication to Pre- and In-service Science Teacher Education

By *Jennifer Yeo*

of language (e.g., the arrows used to represent magnetic fields) are not arbitrary; rather, they reflect one's reasoning expressed in a form thought to be most appropriate in communicating meaning for that particular context.

Studies by Tytler, Hubber, Prain, and Waldrip (2013) on representation-oriented pedagogies show that the biggest hurdle for teachers in working with students on representations is the epistemological shift in viewing science knowledge as consisting of resolved, declarative concepts to one which is contingent and expressed through representational use. Nevertheless, awareness of this can potentially help to address misconceptions such as the relation between concepts and representation. For example, conceptual change studies have shown that students often mistake the representation for the "reality" of a concept. By explaining how the language system of science is a product of a long historical tradition that informs present use of these various symbols, teachers can help students learn to use these representations of science more effectively.

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About the Discussant

Jennifer Yeo is an Assistant Professor with the Natural Sciences & Science Education Academic Group at the National Institute of Education, Singapore. Her current research focuses on how students produce explanation in science, in particular, the role of representations in mediating the process of thinking and reasoning.

Why Not Digitize the Status Quo?

Low Achieving Students, Technology Use, and the Importance of Cognitively Demanding Activities

By *Roberto de Roock*

BRINGING TECHNOLOGY INTO the classroom is a wonderful idea. The reality, however, is much more complex, particularly when examining research literature and trends over the last 30 years. Decades of research on the use of technology in the classroom indicate we are "digitizing the status quo." Introducing digital devices like laptops has tended to preserve and often accelerate tendencies already present in the classroom and educational systems. This is not always a good thing. For example, it tends to preserve and reproduce ineffective pedagogy and inequitable educational structures, especially when assumptions about technology go unexamined. Here, I present ways technology can be used to improve learning as supported by research, specifically for Singapore's lower-achieving students. I argue for a focus on challenging students through technology rather than on simple notions of engagement.

Digitizing the Status Quo

There is evidence that technology is exacerbating inequalities globally, including within and between schools. Well-resourced schools and classrooms have become even better resourced, while poorly resourced ones are at a further disadvantage. Furthermore, educational technology policy plays on the possibility and desirability of "teacher-proof" classrooms. The ways we talk about technology are powerful and tied to Eurocentric notions of progress, where the "centers" of innovation are implicitly seen as the future. These notions can potentially blind us to what is really happening in classrooms. Technology use therefore requires a critical perspective.

At the root of much ineffective use of technology are a number of questionable assumptions. Although research shows improvements to learning are not

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By *Roberto de Roock*

increasing over time despite changes in technology and student facility with it, the myth of the "digital native" persists—the idea that kids are more inclined to benefit from technology than in previous decades. However, youth do not have inherent interests in or capacity with digital technology in the classroom; we cannot expect their interests in out-of-school contexts will automatically transfer to the classroom and that students will be instantly motivated. Furthermore, many students, especially from lower-income households, do not have the same exposure to digital media as others and thus may be at a disadvantage in technologized classrooms. There is also an assumption that new technologies have the inherent capacity to equalize the educational playing field, but (as discussed above) it seems the contrary is the case. At the heart of these misconceptions is a "technologist perspectives"—the idea that what technologies *can* do is more important than how they are actually used.

When are Computers Effective?

Compared with other technologies, there is ample research on the effective use of computers in the classroom. Research shows that overall, their use is no more beneficial than having a good teacher, although there is a wide range—so using them in different ways can greatly harm or improve learning (Hattie, 2008). There are also slight differences across abilities or subjects, so computers can be equally beneficial (or harmful) for all classrooms.

Computers are used effectively when there is a diversity of teaching strategies, when there is a pre-training in the use of computers as a teaching and learning tool, when there are multiple opportunities for learning (e.g., deliberative practice, increasing time on task), and when feedback is optimized. Importantly, they are effective when the student—not teacher—is in "control" of learning and when peer learning is optimized, rather than computers being used individually. Additionally, the learning itself should be clear and relevant to student. Technology might *catch* interest, but appropriate use of the computers along with good pedagogy will *hold* it; technology may open many possibilities but its power is *contextual*.

Technology integration should encourage us to examine our notions of student engagement. Simplistic motivation frameworks are problematic, especially when the burden is on the students and their families. In the *expectancy–value theory of achievement motivation* (Wigfield & Eccles, 2000) two criteria determine motivation for achievement.

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The first is the expectation of success, which refers to confidence. The second is relevance, basically the

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value proposition; kids do cognitively demanding things when relevant to them. Therefore, basing the use of technology on the idea that it is inherently more motivating to students is risky. Instead, it is more accurate to assume that it might create additional off-task behavior unless the teachers build up students' confidence level and make the content more relevent.

Finally, it is counter-productive to use computers unless they are used for *cognitively* challenging tasks. Research shows that challenging tasks are consistently beneficial to learning and unchallenging ones actually harm learning.

Equitable Innovation

The prospect of "digitizing the status quo" and the prevalence of the above misconceptions in schools particularly concerns me when it comes to the Normal Technical (NT) curriculum, which continues to be simplified and reduced in content. NT students are a diverse group but are generally in need of support in academic English through engaging and authentic tasks. Cognitively low-level tasks such as memorizing facts, developing isolated skills, studying decontextualized knowledge (such as grammatical forms), or engaging in skill and drill practice has been shown to be ineffective when it comes to learning, especially with already disengaged students (Morrell, Duenas, Garcia, & Lopez, 2013).

Studies indicate that NT students can perform like students from other streams in "non-academic" capabilities and in collaborative problem-solving despite radical differences in PSLE performance (Kapur & Bielaczyc, 2011). NT students show a stronger tendency for social power (working hard to be put in charge of a group) and affiliation (preferring to work with others rather than alone) (Mclnerney, Liem, Ortiga, & Qi, 2008). They also benefit from the valuing of their personal, experiential and intellectual assets that they bring with them, from the cultivation of emotional competence, and from challenging and meaningful tasks.

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However, they are typically presented with lowered expectations, as many teachers think they are only capable of mastering basic content and skills, and are not expected to master the same depth of materials or reach the same levels of educational attainment (e.g., attending ITE instead of junior colleges). Finally, while ethnographic studies in other countries have shown that low-achieving students are capable of cognitively demanding tasks beyond what is expected of them, few studies of this nature in Singapore have been published. However, it seems safe to assume that our local lower-achieving students are similarly quite capable when the tasks are relevant, interesting and achievable.

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My own research looks at making the use of technology all about collaborative, creative and critical thinking, beginning with the wonderful things NT students already do inside (and outside) the classroom. I see this (and all good research) as a research-practice partnership with teachers and administrators who already understand the context far better than I do. While I focus on NT classrooms, I expect it will be applicable to students at all levels. A focus on equitable innovation might mean pulling away from standard ideas of novel technological innovation and a move to solid, collaborative research-based pedagogy and systemic equity innovations.

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About the Speaker

Roberto de Roock is a Research Scientist with the Learning Sciences Lab, a research centre under the Office of Education Research at the National Institute of Education, Singapore. His work brings together literacy studies, learning sciences, and anthropology to study the meaning-making practices of diverse students.

Research Informing Practice

By *Victor Lim Fei*

ONE OF THE most meaningful contributions in the field of learning sciences, and by extension, educational research in general, is that it promises research-informed practices in the classroom. This compares with the "folk-inspired practices", where there may not be any strong evidential bases on the practices, but they are propagated nonetheless, as they meet specific local teaching and learning needs.

How then can research inform practice? There are two simple ways in which this can be done.

The first is when research in learning sciences challenges the prevailing ways in which teaching and learning is done. For instance, learning sciences may provide evidence to show that the certain dominant pedagogies incline the teachers to "teach to the middle", and as a result, neglect the needs of both the very strong and very weak students in the class.

Research may also convince us that the current ways of teaching does not encourage the deepening of learning, that is, sound epistemological understandings with a strong foundation in disciplinary literacy, supported by inquiry-based learning in authentic environments and texts. Instead, they only breed the mastery of procedural knowledge and reinforce the perpetuation of superficial rote learning. In addition, understandings from learning sciences research may also highlight the disproportionate emphasis on content learning, at the expense of nurturing 21st century competencies. In other words, the value of learning sciences research is demonstrated to the extent it challenges, or affirms, the present ways of teaching and learning in the classroom.

The second way in which research can inform practice is when research develops new ideas and strategies that have compelling value-add to the pedagogical repertoire of our teachers. There is no doubt that as we continue to push the boundary of knowledge and learning sciences, better ways of teaching and learning will emerge. For instance, the work in disciplinary literacy highlights that language and other multimodal resources are used differently across subjects, such as in Science and History. As such, an intrinsic part of learning the subject is learning the language and the other multimodal resources privileged in the representation of knowledge within the subject.

The question of evidence is relevant whenever a new practice promises to be superior to the existing ways of teaching and learning. For value to be established, it is important for a persuasive case to be made out for the new practices informed by evidence-based research. Often, caveats may have to be made to qualify the practice. For instance, it is only effective for students of a certain profile, with specific interests or for teachers with the requisite skill sets. This is understandable, particularly, as the learning sciences have notably emphasized, context is key. Nonetheless, it must also be recognized that the *less* that is needed to qualify the practice or principle, the *more* compelling is its value.

Having discussed the value of the learning sciences to the classroom, what are some considerations researchers need to have to ensure that their research-informed understandings and practices developed have utility? There are two key considerations.

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The first consideration is the shift in teachers' practice required. This has to do with understanding the current state of teachers' capability. When the research-informed practice places a significant demand on the teachers' ability to implement the lesson in specific ways in order to have fidelity, it is expected that the spread of such a practice will be limited. At best, it can bring about transformation in the teaching of a small and select group of strong and committed teachers. At worst, it is navel-gazing for the researcher.

This, however, does not mean that the research-informed practice cannot be challenging and paradigm-shifting. A research-informed practice of value is often aspirational in nature. It articulates a cogent vision of how teaching and learning can be improved and presents a practical way forward of how to get there. As such, a research-informed practice of value must be inspirational, and not daunting; it should motivate teachers to adopt and adapt because it is within their present ability to do so. A research-informed practice can be made accessible to teachers through a succinct presentation of its design principles, the provision of lesson resources and exemplars, as well as support from a community.

The second consideration is the extent of classroom orchestration needed to implement the research-informed practice. This has to do with understanding the current state of the classroom environment. Classroom orchestration refers to the interaction and integration of multimodal resources to design specific learning experiences for the students. When a research-informed practice or innovation requires the introduction of new-fangled technologies and sophisticated tools that are logistically demanding and natively unfamiliar to the current classroom environment, it intrudes upon and interrupts the learning ecology. This places a superfluous burden on the teacher's classroom orchestration. Students also need time to learn and be fluent with the new introduction of technologies and tools.

Again, it is a straw man fallacy to suggest that in consideration of the classroom orchestration needed, research-informed practice or innovation should avoid the introduction of new technologies and tools into the classroom. Far from it, as it should be fairly plain by now, that the effective use of educational technology can improve teaching and learning. The appropriate use of technology can enhance classroom practices and enable new practices for teaching and learning, for example, the affordances of technology to provide timely feedback, allow for collaborative annotations, and facilitate extension of learning. The case to be made here is that educational technology which is intuitively simple, reliable and scalable, reduce the complexity required in the teacher's classroom orchestration. When the research-inspired practice and innovation can be skilfully integrated into the normal classroom environment and learning ecology, its utility is at its best. Ironically perhaps, often it is the simplest innovation that is the most elegant and useful - think paperclip.

For research to inform practice, upstream explorations must continue to be encouraged, so as to develop research-informed understandings and practices of value. As these are developed, it is also equally important for downstream applications to be considered, so that the research-informed understandings and practices developed have utility. The nexus of research and practice is the promise of value and utility.

About the Discussant

Victor Lim Fei is a Deputy Director and Lead Specialist with the Educational Technology Division at the Ministry of Education, Singapore, where he has experience in translational research, policy formulation and programme development, with a focus on how educational technology can improve learning in the classroom. He is passionate about education and its value in improving both personal and societal well-being.

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