Educational Knowledge Mobilization and Utilization in Singapore

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1. Introduction

This paper outlines how knowledge is mobilized (i.e. produced, mediated and applied) to improve education practice and policy in Singapore. It pays specific attention to the distinctive institutional relationships that link the National Institute of Education (NIE), the Ministry of Education (MOE) and Singapore's school system and their respective roles in the development of a unique nexus between research, policy and practice in Singapore's education system.

The paper begins with an introduction to Singapore and Singapore's education system, highlighting the constraints faced by Singapore as a small economy with limited human capital, research expertise and research funding. It then describes how we have framed the problem of knowledge mobilization theoretically, its key differences with traditional knowledge utilization frameworks, and how and why Singaporean researchers, policy makers and practitioners have attempted to mobilize knowledge through development of a strategically focused national Research, Development and Innovation (RD&I) Program. This framework is carefully calibrated to heighten the likelihood that education research will produce knowledge that is both rigorous and relevant to policy and practice (*production*), that knowledge will be shared in a timely and appropriate manner (*mediation*) among all stakeholders, and that it will be adopted, internalized and socialized by users in ways that impact policies and school practices (*application)*. The paper then ends with a discussion of how the Singapore experience,

notwithstanding its unique context, may contribute to the international education research community's drive to increase its impact on policy and practice.

2. The Organization of Education in Singapore.

Singapore is a small and highly urbanized city state. It has a total population of 4.987 million with a population density of 7,022 per sq km in 2009 (DOS, 2010). Its per capita GDP of S$53,143 (or US$36,537) is one of the highest in Asia. Today, based on the latest official estimates, Chinese, Malays and Indians make up 74%, 13% and 9% of the Singapore resident population respectively. The remainders are classified as 'Eurasians' (i.e. from European and Asian descent) or 'Others (Immigration and Checkpoints Authority Singapore, 2010). In 2009, the non-resident population of Singapore was estimated to be about 25% of the total population.

The diversity and size of the Singapore population are mirrored in its education system. Singapore has a small education system with a relatively short history, and an ethnically diverse school population. There are about 180 primary schools (grades1-6), 170 secondary schools (grade 7-10) and about 20 junior colleges, centralized institute and specialized schools that offer academic pre-university curriculum (grades 11-12). All these publicly funded schools employ English language as the medium of instruction and cater to almost all Singaporean students of school-going age. Prior to 1978, besides English medium schools, there were vernacular schools where lessons were instructed primarily in Chinese, Malay and Tamil. All the 300+ publicly funded schools are organized into 28 school clusters, each with 10-12 schools. Each Cluster is headed by a Cluster Superintendent who supervises and advises the school principals. Currently, Principals have substantial autonomy in managing the learning programme of the schools within MOE guidelines. The typical size of each primary 1 cohort is about 40,000 and the enrolment of a typical Singapore school is approximately 1,300. Schools are relatively well resourced. The pupil to teacher ratio is 19.6 in primary schools and 16.4 in secondary schools (MOE, 2010). The Singapore government's total expenditure (both recurrent

and development) on primary, secondary and pre-university education in FY2009/2010 was S$4,924 million or about 2% of Singapore's annual Gross Domestic Product (GDP). This compares with the typical OECD figures of 5.5% of GDP in Nordic countries and approximately 3% in Japan, Luxembourg and the Slovak Republic (OECD, 2010).

The Singaporean educational system is highly centralized and regulated following three decades of reorganization, rationalization, consolidation and reformation (Gopinathan, 1985). Over the last four or five years, however there has been a significant decentralization of administrative and pedagogical authority to individual schools. Virtually all Singaporean students study in one of the publicly funded schools, and virtually all the school leaders and teachers in these schools (except a small number of Independent Schools and Specialized Schools) are recruited, paid and managed (in terms of appointment and promotion) by the Ministry of Education. The highly centralized school system allows it to leverage substantial economies of scale which may partly explain the lower education expenditure as a percentage of GDP relative to other OECD countries.

Almost all Singaporean school teachers receive their pre-service teacher training from the National Institute of Education (NIE) within an agreed policy framework between NIE and MOE. Approximately 94% of Singaporean Secondary School and Junior College teachers and 62% of Singaporean primary school teachers are college graduates, while the remainder have acquired a 3-year Diploma-in-Education training after completing high-school.

NIE is also the only institution in Singapore that has a research focus on education, although it also supports research in most major disciplines (Gopinathan and Hung, 2010). As at Feb 2011, NIE has a total of 255 professorial staff members on the tenure track, 81 lecturers (non-tenurable) and 7 research scientists. Most of these NIE staff members are research active and are involved in one or more of the funded education research projects.

Internationally, Singapore is a top academic achiever based on the student performance in international studies such as PIRLS, TIMSS and PISA. In 2007, the McKinsey Report identified Singapore's educational system as one of the top ten in the world, noting in particular its strategic approach to educational reform and the provision of a support system to sustain reforms. A second McKinsey Report (Mourshed, et al, 2010) further identified Singapore as one of the top five systems and sustained improvers that had moved from "good to great". Yet despite – or perhaps because of -- these successes and its international profile, Singapore has not been willing to rest idly on its laurels. As early as 1997, at the height of the Asian financial crisis in 1997, the then Prime Minister, Goh Chock Tong, announced that while the Singaporean people should celebrate their educational accomplishments, the world had changed dramatically since 1979 when the then government established the basic architecture of the contemporary educational system in Singapore. It was timely, therefore, to adjust its educational system accordingly:

> We cannot assume that what has worked well in the past will work for the future. The old formulae for success are unlikely to prepare our young for the new circumstances and new problems they will face. We do not even know what these problems will be, let alone be able to provide the answers and solutions to them. But we must ensure that our young can think for themselves, so that the next generation can find their own solutions to whatever new problems they may face.
>
> (Goh, 1997)

For the past decade or so since the launch of *Thinking Schools, Learning Nation (TSLN)* in 1997, educational policy in Singapore has been dominated at the broadest level by a vision of "a nation of thinking and committed citizens capable of meeting the challenges of the future, and an education system geared to the needs of the 21st century."[1] Not the least of the consequences of this fundamental resetting of policy priorities has been a very substantial commitment to developing a wholly new system of knowledge production and utilization in Singapore to support the efforts of the government to improve the quality of teaching and learning in ways consistent

[1] http://www.moe.gov.sg

with its long term policy priorities and the changing character of 21st century institutional arrangements.

3. The Organization of Education Research in Singapore.

Apart from being the main provider of school education, the Singapore Government (through the MOE) is also the main sponsor and funder of educational research in Singapore. Almost all education research in Singapore is conducted by NIE academics. NIE has well over 300 academics, most of them engaged in both teacher education and research. In addition, it customarily has a significant number of MOE seconded staff, currently standing at 68, many of whom are also involved in both teacher education and research. This brings the total number of teacher educators at any one time close to 400, of whom a high percentage are engaged in research.

In addition, over the past decade, the Ministry, keen to keep Singapore at the leading edge of the international education landscape, has introduced a separate career track for a core group of around 200 education officers to build knowledge and skills in specific areas of education – while working within MOE headquarters. These officers are expected to spend about 20% of their time carrying out research and development work in their respective areas and playing the role of knowledge brokers to bring cutting edge research to impact on policy and practice. In addition, in each publicly funded school, MOE has taken steps to train teacher researchers to undertake practice-oriented action research. Since 2006, MOE has put in place the Research Activist (RA) scheme to provide additional professional training to selected teachers beyond their pre-service training. These teachers are expected to conduct action research and to scrutinise how the prototypes they introduce to their schools contribute to meaningful learning and teaching. The objective of the RA scheme is to build capacity, heighten appreciation of research in all Singapore schools, and support development of the schools as professional learning communities (PLCs).

While NIE (and its predecessors) have conducted education and pedagogical research for decades (Koay, 2010), dedicated and regular funding for education research was only made available by MOE to NIE in 1999 in the form of the Education Research Fund (EdRF), with an annual budget of SGD $1 million. This initiative was in response to the *Thinking Schools, Learning Nation* policy of 1997 (Gopinathan & Hung, 2010). However, following an MOE decision to establish NIE as a research-intensive Institute focused on generating primary research findings from the local context to inform education policy and practice in Singapore, the Ministry of Education - in January 2003 - announced the award of SGD $47.29 million to NIE to establish the Centre for Research in Pedagogy and Practice (CRPP).

From its opening in March 2003 through to 2011, CRPP has pursued five key objectives: (Luke, Freebody and Lau, 2004; Luke, Freebody, Lau & Gopinathan, 2005; Luke & Hogan, 2006; Hogan, 2011):

1. describe & measure patterns of classroom pedagogy in Singaporean schools;
2. measure the impact of pedagogical practices on student outcomes controlling for student characteristics;
3. design technologically enriched learning environments & support their integration into classroom pedagogy;
4. identify opportunities for the improvement of pedagogical practice through a carefully designed & evidence-based intervention strategy; and
5. support evidence-based policy formulation and instructional practice to meet the challenges of 21st century institutional environments.

Another NIE research centre, the Learning Sciences Laboratory (LSL), was set up in 2005 with the aim of incorporating ICT more fully into existing pedagogies to better engage students physically, emotionally and cognitively so as to improve learning outcomes. The LSL advocated the transformation of existing pedagogies into inquiry-based learning activities and student-centered interactions through the innovative use of ICT. LSL's efforts have resulted in more

than 70 projects including knowledge-building communities, new media and new literacies, mathematics and problem solving, science inquiry, and productive failure.

NIE's track record in both building up research and mobilizing the knowledge generated to enrich policy deliberation and to suggest new possibilities to improve classroom practice created the opportunity for CRPP to apply for a second five year grant in 2007/08. This was based on a strategically-focused research, development and innovation (RD&I) proposal that built upon the findings of the first 5 years and took into account MOE policy priorities, international research findings and the changing institutional landscape of education in Singapore (Hogan, 2007). The RD&I Framework set out the following priorities:

1. Developing a comprehensive baseline database on teaching and learning in Singapore classrooms in order to evaluate the impact of policy initiatives and to support evidence-based interventions and policy development;
2. Deepening understanding of the logic of teaching, classroom interaction and student learning in Singapore classrooms;
3. Identifying and mapping the nature of the skills, understandings, dispositions and values that young people are likely to need to effectively negotiate 21st century institutional environments, and identifying and developing curricular frameworks and pedagogies that are likely to cultivate them;
4. Strengthening the intellectual quality of knowledge work in classrooms by strengthening the quality of the enacted curriculum and organizing classrooms as epistemic communities with a clear focus on participating in high quality knowledge work and the development of appropriate skills, understandings and dispositions;
5. Supporting the development of schools as professional learning communities that support strong knowledge management and instructional systems;
6. Expanding the use of formative assessment and summative school-based assessment to improve the quality of teaching and learning, and
7. Developing pedagogical resources, including technologically enriched learning environments, to enhance the quality of teaching and learning.

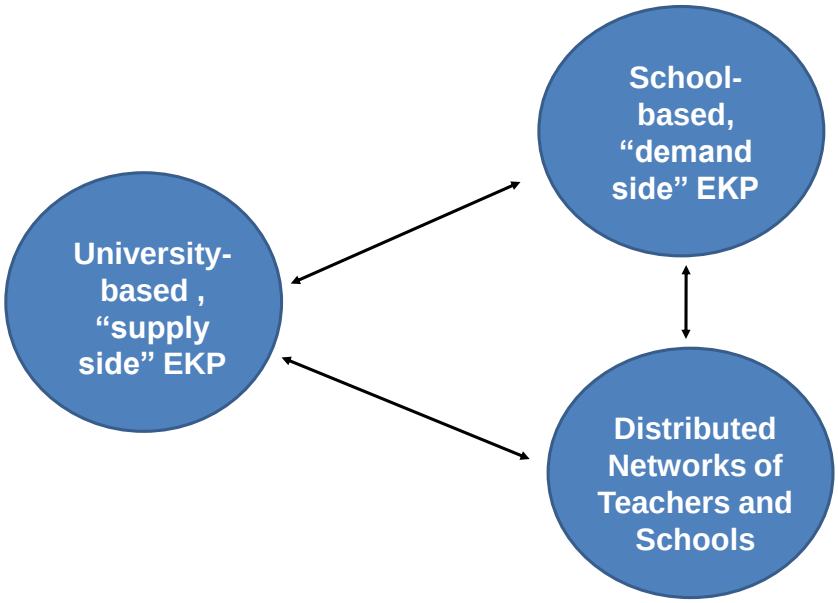
MOE responded with a substantial grant of SGD $96.6 million. To expand education research within NIE beyond CRPP and LSL, a new Office of Education Research (OER) was set up in April 2008 to chart directions for NIE education research, manage and ensure the qualities of education research projects, and to enhance the linkage between NIE researchers, school practitioners and MOE policy makers. To date, five calls for proposals have been issued to NIE staff. These proposals direct, encourage and support submissions on topics which are directly relevant to issues faced by the Singapore education system and which are likely to result in improvements in learning and teaching. From the beginning of the second grant cycle (April 2008) to Dec 2010, 100 ERFP projects had been approved at a grant value of SGD $23.3 millio. A total of 185 NIE faculty members have been involved in these projects.

4. Theoretical Context: Knowledge Production, Mediation and Utilization.

The problem of knowledge utilization in education is often framed in terms of an entrenched hiatus between research and practice. This hiatus in turn is typically traced to a well established institutional division of labour that splits research and practice into independent social practices: academics do research and teachers teach. The former specialize in knowledge production, the latter in knowledge transmission. Universities focus on theoretical problematics and research methodology, schools on practical problems and practical solutions. The resulting institutional hiatus between knowledge production and knowledge application means that research has limited relevance and limited impact on practice and policy to the detriment of both.

Not everyone though is convinced that this is the complete story. David Hargreaves (2000), for example, writes that this account ignores the fact that there is substantial knowledge production in schools that takes at least three forms: lots of informal “tinkering,” “chatting” and action research; some development of professional learning communities focused on solving local practical problems within schools, and the rapid expansion of networks of teachers and schools in distributed professional learning communities. On this revisionist account of knowledge production in education, knowledge production in education is multi-modal, not uni-modal:

Figure One.
Modes of Educational Knowledge Production (EKP)



We think this revisionist account is substantially more accurate than the conventional wisdom and helps account for persistent evidence of what we might term "vernacular innovation" in schools in highly localized contexts, particularly at the individual classroom level by committed teachers, sometimes at the behest of energetic (and/or ambitious) principals. Overwhelmingly though, the great bulk of knowledge production is formalized and conducted by and for university researchers with very little transfer to policy and practice, let alone sustainable impact on practice. Yet despite this considerable investment in supply-side research, relative to medicine and engineering, as David Hargreaves (2000) has pointed out more than a decade ago in an important OECD publication, educational researchers have failed to provide a strongly validated social scientific foundation for professional practice in schools. Moreover, educational systems have not been especially good at codifying and disseminating the tacit knowledge that expert teachers develop in the course of their professional practice (Hargreaves, 2000; Fullan, Hill and Crevola, 2006). This raises a host of challenges to educational systems, but two are particularly

important: "they need to learn how to become more effective at learning and innovating than they have been in the past," and they need to integrate R&D and knowledge management into educational systems (OECD, 2000, p. 98). We agree with this judgment, but achieving these outcomes will require a radical rethink of the relationship between knowledge production and knowledge utilization. In particular, it will require a dramatic shift in the locus of knowledge production from university to schools (specifically, classrooms) and networks of schools, and it will require teachers to abandon privatized forms of professional practice in favour of strategically-focused, evidence-based, collaborative partnerships with fellow practitioners and researchers. This in turn will require abandonment of conventional linear models of off-line, supply-side, knowledge production and codification and utilization in place of newer models that balance supply-side and demand-side (on-line) knowledge production, codification, dissemination and application of the tacit knowledge of expert teachers (OECD, 2000, p.74).

This is a lot easier said than done, and it will need to be implemented in a way that reconciles rigor, relevance, strategic focus, sustainability and scalability. Drawing upon a framework developed by Donald Stokes (1997) for use in a very different context, we might describe some university educational research as rigorous but not relevant, some university educational research as neither relevant nor rigorous, some university educational research as relevant but not rigorous, and some as both rigorous and relevant. School-based knowledge production (for example, by teachers utilizing action research frameworks) is generally relevant but rarely rigorous, not always useful, effective or consequential, rarely strategically focused, rarely codified, validated or disseminated, and rarely sustained or sustainable. We can formalize this taxonomy in 2x2 matrix borrowed from Tushman and O'Reilly (2007) and reported in **Table One**.

Table One.

Relevance and Rigor in Educational Knowledge Production

Rigor	Relevance / Utility	
	No	**Yes**
Yes	**Bohr's Quadrant** *High quality "basic" disciplinary research (e.g., cognition and learning,)*	**Pasteur's Quadrant** *High quality "basic" research (eg., cognition and learning); high quality policy related research; high quality "partnership" innovations; high quality school-based action research*
No	***Merlin's Quadrant*** *Small, non-representative, under-theorized, methodologically sloppy "mickey mouse" research studies*	**Edison's Quadrant** *Informal, practical "tinkering" by classroom practitioners; semi-formalized action research by classroom teachers; some university research*

Clearly, in order to tighten the nexus between research and practice, educational knowledge production needs to take place in Pasteur's quadrant – the quadrant that captures knowledge production that is both rigorous and relevant. But while these are desirable criteria, rigorous and relevant research is not always strategically focused, or capable of both sustainability and scaleability. All of these criteria need to be satisfied. Critically, while we believe that some very carefully specified research might satisfy these *desiderata*, we also believe that it is more likely to occur when university researchers work in collaboration with teachers in professional learning communities, and in carefully designed, evidence-backed, strategically-focused projects that have a clear focus on investigating and improving the quality of instruction and learning *in situ.* Moreover, we believe that such research is more likely to be focused and effective when it is embedded in a national (or least jurisdictional) strategic research, development and innovation program. But while a knowledge mobilization program of this kind will help, it is by no means a sufficient condition to close the gap between research, on the one hand, and policy and practice, on the other. In order to understand why, we need to probe the research literature on knowledge utilization in some detail.

For the past 40 years, the dominant framework used to understand how knowledge utilization can improve practice and policy in education has been known, reasonably enough, as the Knowledge Utilization (KU) framework, dating back to the seminal work of Eidell and Kitcher (1968) and Short (1973). Since then, a voluminous literature has accumulated. A keyword search of 'knowledge utilization' in ERIC yielded 2,663 results. These studies are embedded in an even larger literature of work done in other disciplines that span engineering, information technology, health sciences, management, marketing, sociology and psychology. In the early 1990s, Baker (1991) reported that there were more than 10,000 citations of knowledge utilization in all fields, although related terms are often used -- dissemination, diffusion, technology transfer and others -- with a similar meaning (see Levin, 2004).

Comprehensive reviews of the literature in KU in education more than two decades ago can be found in Short (1973) and Love (1985). Key recent studies were reviewed by Hood (2002), Hemsley-Brown and Sharp (2003) and Levin (2008). The literature is also referred to extensively in two CERI/OECD publications, namely, *Knowledge Management in the Learning Society* (OECD, 2000) and *Evidence in Education: Linking Research and Policy* (OECD, 2007). In this section, we will highlight a few key differences between the more traditional KU model and the more contemporary understanding of knowledge mobilization in the light of developments in related fields, such as knowledge management, professional development and knowledge creation. We contend that these developments have undergirded the strategies that NIE and Singapore have adopted to promote the more effective and timely use of knowledge to improve practice and policy in education.

Traditional Knowledge Utilization Framework vs Contemporary Knowledge Mobilization or Knowledge Continuum Framework

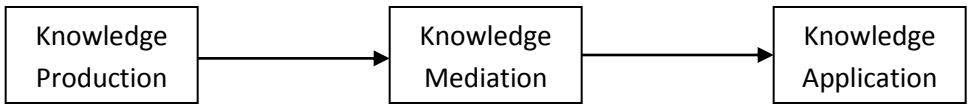
The traditional framework of KU draws extensively from studies of how knowledge and innovation in natural and engineering sciences have affected practices in their respective fields, in particular, the diffusion of innovation (Rogers, 1964). Studies conducted using this

traditional framework often examine how the extent of knowledge use is affected by some dimensions of knowledge utilization. The four most common dimensions are: a) *users* of the knowledge, b) *context* of the users, c) *communication* of the knowledge and, d) *knowledge* itself (Love, 1985). This approach is important because, instead of examining each dimension independently, it recognizes the multi-dimensional nature of the utilization process, and that KU is both a psychological (intra-person) as well as a sociological (inter-person) process, and hence has to be understood from multiple perspectives (Kroeber, 1940; Rogers, 1964; Hägerstrand, 1967). However, traditional KU models generally construe the process between knowledge production (research), mediation (dissemination) and application (use) as a linear and sequential process in which research and use happen independently, in both a temporal and spatial sense (see **Figure Two**). This linear model stems from the belief that science (or knowledge) can be objective, value-neutral and independent of the contexts from which it is derived and subsequently used. In the linear KU model, since the knowledge can be produced using scientific methods and the reasons to use the knowledge can be objectively and empirically established, the key challenge is for researchers to efficiently disseminate the knowledge produced to users. As stated, these two groups may be separated geographically, temporally and sometimes culturally, resulting in little or no coalescence between the points of knowledge production and knowledge use .

Figure Two.

A Linear Model of Knowledge Utilization

(OECD, 2000; Hood, 2002)

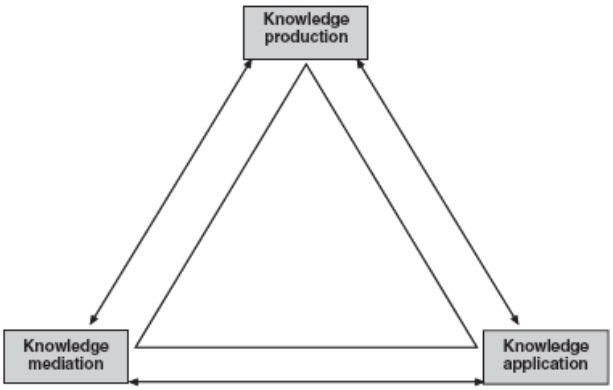


Despite the popularity of the linear KU model during the 1970s and 1980s, its critics were convinced that it was far too simplistic and that the process of knowledge utilization needed to be rendered significantly more complex and iterative. During the 1990s, the volume of criticism grew, generating, for example, a publication by OECD (2000) that decomposed the knowledge utilization process into seven distinct processes that often had complex, non-linear relationships: 1) production, 2) validation, 3) collation, 4) dissemination, 5) adoption, 6) implementation and 7) institutionalization. The OECD further noted that not all of these sub-processes may be involved, but if they are, they are often iteratively present. Critics also insisted that in fields such as education where much of the knowledge is less explicit and more tacit in character (Polyani, 1967), the process whereby knowledge and innovation is 'transferred' and 'use' made of it can be dramatically different from fields such as manufacturing and engineering, and even health sciences (e.g. see Murnane and Nelson, 1984; Hargreaves, 2000). Under the weight of these criticisms, the linear model was gradually replaced by a more iterative model in which researchers, policy makers and practitioners, and other knowledge brokers, played important roles in the production, mediation and application of new knowledge. Not unreasonably, the iterative model soon became known as the Knowledge Mobilization model (Levin, 2004) (See **Figure Three**).

Figure Three.

An Iterative Model of Knowledge Utilization

(OECD, 2000)



What happens prior to Knowledge Production

In the traditional knowledge utilization framework, the utilization process begins with knowledge production, which is usually supply-driven and is dominated by pure research initiated and undertaken by university researchers. In Gibbons et al's (1994) seminal work, this mode of knowledge production is termed as Mode 1. More recently, there is a recognition that knowledge users, and not just researchers, can and should play an important role in knowledge production and shaping innovation (Hippel, 1988). Qi and Levin (2011), citing Furlong and Oancea (2005), further noted that in applied fields like education, how well a research project responds to the demands of policy and practice may be more important than the more traditional indicators of research qualities (such as trustworthiness, contribution to knowledge, ethical propriety and careful reporting) in determining whether the resulting findings are disseminated and used. This is the shift away from Mode 1 to Mode 2 knowledge production according to Gibbons et al (1994), where Mode 2 knowledge production is characterized as 'applied, problem-focused, trans-disciplinary, hybrid, demand-driven and embedded in network'.

In supply-driven Mode 1 knowledge production, the researchers often single-handedly identify the problems encountered in their field, the causes of these problems and their effects, and produce new knowledge to address these problems based on accepted research methods. Little effort is expended to understand how the users perceive the problems or indeed, what new knowledge might help them overcome the problems. However, Mode 2 knowledge production, which is applied, problem-focused, supply-driven and use inspired (Stokes, 1996), foregrounds the involvement of users (be it policy makers and/or practitioners) and other stakeholders in the process of problem identification and knowledge production that is most likely to solve the problems. This is particularly relevant in education and the social sciences where consensus about how to identify problems, understand them, and how to go about seeking solutions is difficult to establish and often ideologically charged. Many education researchers, for example, still cannot agree whether education research is able to provide solutions in the form of generalisable treatments and interventions - analogous to those in engineering and health sciences - or whether it is only able to offer highly-context specific interventions to solve or address local educational problems.

These considerations suggest that a lot more attention be given to what happens before knowledge production occurs to increase the likelihood that new knowledge, painstakingly produced, will be meaningfully used. It is therefore important to invest effort and resources to create opportunities for researchers, practitioners, policy makers and other stakeholders to enter into an informed dialogue prior to the process of knowledge production (Reimers and McGinns, 1997). This is especially important in education, given the lack of rigorous understanding about the relationship between teaching and learning in highly variable contexts. This informed dialogue must be based on robustly gathered data using multiple methods and disciplines to provide valid and accurate information on the current state of an education system (Luke and Hogan, 2006). Based on such information, researchers, practitioners, policy makers and other stakeholders can then co-construct the evidence *in situ*, i.e. in the light of local beliefs, knowledge, values and problems (Spillane and Miele, 2007) and

engage in collective deliberation to establish precisely what are the problems that knowledge users face and to identity what knowledge innovations are congruent with the practitioners' practical theory/knowledge, beliefs, values and norms (Dewey, 1904; Hirst, 1966, Sternberg, 2006).

In effect, when a collective sense-making process - utilizing robust research findings, and involving researchers, practitioners and policy makers (and other stakeholders) - leads to agreement on the nature of, and the relevant knowledge to address, the problems, knowledge production will be genuinely demand-driven and the chance of successful knowledge use heightened.

All Types of Relevant Knowledge must be Mobilized

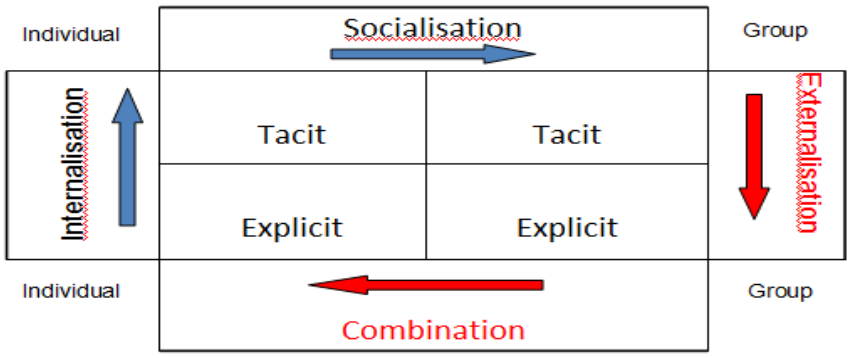
Scholars have created a rich literature in reviewing the type of knowledge that is relevant to education practitioners (e.g. Short, 1973; Love, 1985; Fenstermacher, 1994; Hargreaves, 1996; Hemsley-Brown & Sharp, 2003). Lundvall and Johnson (1994) classify knowledge into: 1) know-what, 2) know-why, 3) know-how, and 4) know-who. Know-what and know-why are often associated with research-based, formal and codified knowledge, while know-how and know-who are associated with practitioner, informal and personal knowledge. However, the traditional knowledge utilization framework often focuses on knowledge that is researcher-based (thereby excluding practitioner knowledge), thereby weighting in favour of the know-what and know-why questions. For example, Short (1973) and Love (1985) excluded practical, craft, common knowledge from their reviews for reasons such as - 'because it is of an entirely different character than scientific knowledge, and generalizations regarding its transfer and utilization may not directly apply to the transfer and utilization of scientific knowledge' (Love, 1985). They also add as a further reason for excluding this type of knowledge that 'practical theories are not associated with knowledge production in education research for use in educational situations' (Short, 1973). Even within contemporary literature, there is a tendency to place greater focus on codifying tacit knowledge into explicit form and then disseminating it

through the conventional channels (including ICT systems). There is less discussion about how to facilitate the use of knowledge which is 'tacit by nature' (Cowan et al., 1999) and which cannot easily be codified and made explicit.

Other researchers insist that all knowledge categories are needed to improve education policy and practice, referring in the process to Polanyi's concept of tacit knowledge (1967) as a way of framing the distinction between codified and personal knowledge and underscoring the importance of the latter to the improvement of practice. Polanyi argues that there is a tacit dimension to all knowledge (even in hard sciences) and that knowledge acquired explicitly can become useful to practice only after one has personalized that understanding, and acquired the tacit dimension of the knowledge. The interplay, transfer and integration of knowledge between the tacit and the explicit dimensions is further discussed by Nonaka and Takeuchi (1995).

Figure Four:

Nonaka and Takeuchi's Knowledge Transmission Cycle



A knowledge user needs both 'tacit and explicit' knowledge to function effectively and efficiently. Codified knowledge supports an individual by expanding beyond his/her immediate horizon, overcoming the limitation of time and space, and tapping on the experience and knowledge created by others. However, the codified knowledge which the individual acquires is derived 'then and there' and has to be personalized and overlaid with a tacit dimension

before it can be used productively 'now' and 'here'. Within the individual and groups of practitioners, Nonaka and Takeuchi envisage that there is a constant 'transfer' or 'transformation' of 'explicit knowledge' to 'tacit knowledge', and vice versa, which is how they believe meaningful and genuine learning takes place.

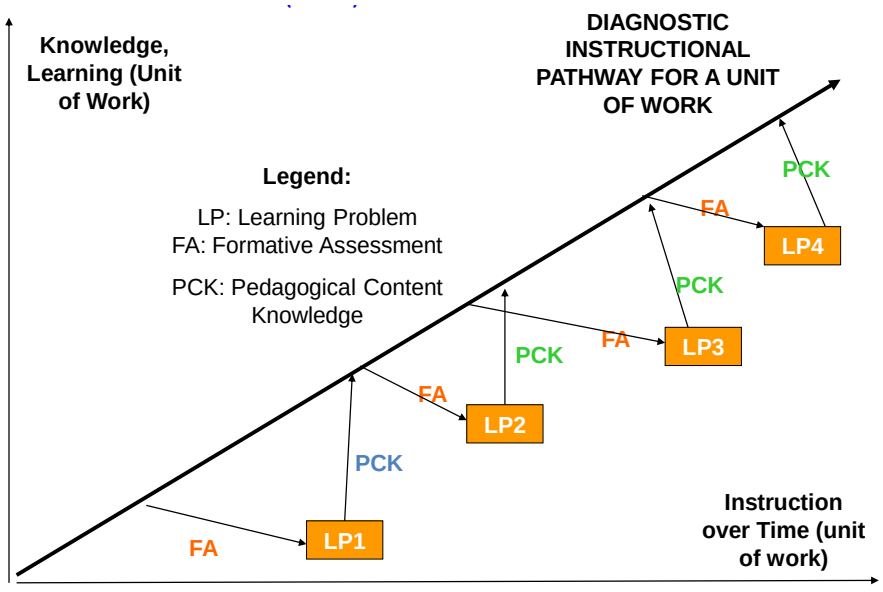
It is our view that the exclusion of practical know-how and the tacit dimension of knowledge in the discussion of knowledge utilization in education results in suboptimal forms of knowledge production and utilization. For instance, there is considerable empirical evidence that the tacit dimension of knowledge is important in predicting success in academic, pure science and professional practice, even though there is little empirical direct study of tacit knowledge in education in general (Sternberg & Wagner, 1986; Sternberg & Horvath, 1995; Wagner et al, 1999). It is apparent that education is 'socially messy'; that is, human interaction is central to all teaching activities, and learning outcomes result from teaching which can be affected by very small variations in learner and teacher characteristics and the context they are in. In such circumstances, the importance of know-how (especially the portion which is difficult to codify) can only be effectively acquired through personalized learning or learning through doing, either individually or in a community (Lave and Wenger, 1991, Wenger, 1998). Educational researchers therefore need to go beyond focusing on formal researcher knowledge alone in their study of knowledge mobilization if they want to improve their chances of influencing the use of knowledge by practitioners to improve policy and practice.

A promising extension of this argument has recently been developed by a number of senior researchers arguing for the codification, validation and dissemination of the tacit knowledge of expert teachers. Fullan, Hill and Crevola (2006, p47) for example, argue that "We see classroom instruction as an activity that can be improved by making expert knowledge available to all teachers…We believe that there is such a thing as expertise in teaching: that the nature of this expertise can be made explicit, so that it is capable of being replicated and validated; and that expert teaching translates into improved learning." We agree and believe that it is now possible to draw on both formal content and cognitive research and the tacit knowledge of

expert teachers to begin developing what we might call "diagnostic instructional pathways" for specific units of work. These capture what we have learnt about the optimal learning paths for students faced with learning a specific topic, the specific forms of misconceptions and errors that they are likely to have or make identified by the constant monitoring of student learning, and the most effective corrective measures (including scaffolding) informed by the pedagogical content knowledge of expert teachers, that might be employed to get students back on track (see **Figure Five**). In effect, diagnostic instructional pathways represent an important application of Lee Shulman's (2005) argument that it is now time to begin developing "signature pedagogies" in education.

Figure Five

Diagnostic Instructional Pathways



Professional Learning as the Model for Knowledge Mediation and Application

In the traditional model, knowledge mediation is the only link between knowledge production and knowledge application. Knowledge mediation is often considered to comprise two

elements – translation and dissemination (Commission of the European Communities, 2007). First, knowledge is translated so that it better meets the users' needs and is more understandable. Next, it is disseminated in a form that is easily accessible and understandable by the users through networks, platforms or websites. Knowledge mediation, especially when the dissemination is through conventional platforms, such as print or web-media, seminars or briefings, is appropriate when the knowledge to be transmitted is formal and codified, the reason for its use is compelling, and when the corresponding change needed in user behavior is manageable. However, where these conditions do not hold, this particular model of knowledge mediation has to contend with two challenges for knowledge use to be meaningful and to have a sustained impact.

First, successful translation and dissemination of formal codified knowledge to the users does not ensure that the formal codified knowledge is meaningfully used. Scholars in innovation diffusion have long recognized that an individual's decision to embrace an innovation is a complex process. For instance, Rogers' (2003) innovation-decision process consists of five stages, namely, 'knowledge', 'persuasion', 'decision', 'implementation' and 'confirmation' (p. 169). While successful translation and dissemination of knowledge can ensure the first stage (that is, users are exposed to the knowledge) or even the second stage (that is, users form a favorable attitude towards the innovation), the one-off exposure to the new knowledge is not likely to have a significant influence over the next three stages, where the users decide to adopt the new knowledge, take concrete steps to implement it, and, more importantly, sustain the knowledge use.

Second, as we discussed in the previous section, not all knowledge useful to practitioners and policy makers can be comprehensively codified and effectively communicated through conventional channels and platforms. The concept of 'sticky information' (Hippel, 1994) helps clarify why users face great difficulties receiving the knowledge they need to improve practice and policy from external sources. 'Stickiness' is proportional to the resources and effort needed to get the required knowledge from the providers to the users. It may be a feature of

the knowledge (e.g. 'tacit' knowledge is stickier), the intended users (e.g. unprepared to receive the knowledge) and the transfer process (e.g. a lack of incentive to transmit the knowledge). In the business sector, companies often facilitate the mediation of extremely 'sticky' knowledge by employing the person that possesses the knowledge and dispensing with any attempt to transfer the knowledge through their own resources. The mediation of sticky knowledge is therefore likely to involve extensive interaction over an extended period of time between those who possess the knowledge and knowledge users. We contend that much of the knowledge needed to improve education practice is sticky knowledge which is 'tacit by nature'.

In the context of improving teachers' practices, it has been recognized that the traditional one-off knowledge dissemination represented by the traditional and prevalent professional development mode of one-off workshop, seminar or discussion, is ineffective. Newer accounts stress that professional learning is optimized when it treats teachers as active learners engaged in concrete tasks of teaching, assessment, observation and reflection *in situ;* when it is grounded in participants' questions, inquiry and experimentation, as well as research on effective practice; when it is focused on specific aspects of instruction; when it is iterative and extended over time and supported by follow-up activities; when it is properly scaffolded by expert teachers who know the context, know the teachers and have their trust and respect; when it is collaborative, involving sharing of knowledge among educators; when it is embedded in schools functioning as collections of communities of learners and communities of inquiry; when it is focused systematically to instructional innovation and cultural change at the school level; when it pays sustained, substantial attention to the implicit (often uncontested) conceptions of, or *beliefs* about, teaching, learning, knowledge, assessment and epistemic authority that teachers hold; and finally, when it is focused on developing teacher expertise in content knowledge, pedagogical content knowledge, assessment literacy, classroom inquiry, curriculum knowledge, and pedagogical judgment (Ball and Cohen, 1999; Elmore, 2004; Fullan 2007; Bransford, et al, 2005; Lewis, 1997; Hogan and Gopinathan, 2008; Hogan, et al, 2011).

This kind of professional learning is obviously very difficult to achieve, let alone sustain on an ongoing basis. It is particularly unlikely to happen, let alone be sustained, in conventional forms

of professional development (one-off workshops, courses) and most likely to occur when schools are organized into clusters of professional learning communities, and when professional development is focused on highly interactive and authentic forms of *in situ* professional learning (Elmore, 2004; McLaughlin and Talbert, 2001; Fullan, et al, 2006). And even then it will not necessarily result in mode 2 knowledge production and utilization, let alone achieve scalable dissemination and application, unless there is a commitment to iterative knowledge production, knowledge mediation and knowledge application. Teachers as the knowledge users must play an active role in deciding what knowledge is produced -- whether produced through experimentation or reflection, individually or collaboratively -- and the 'providers of explicit knowledge' also play an active role in the use and the transformation of the knowledge through mentoring and coaching. Hence, instead of the traditional translation/dissemination process of mediation, we believe that professional learning is a superior model to ensure knowledge mediation and knowledge application, and the production of tacit knowledge.

Although the gaps between the traditional and the contemporary models of knowledge utilization have been recognized in theory, in practice, the planning and implementing of knowledge mobilization efforts often revert to the traditional linear model where the knowledge to be disseminated is produced without active involvement from the users, where codified knowledge is disseminated in a one-off manner and where there is little active effort to follow up with the users to check if the knowledge is used meaningfully and productively. Acknowledging these challenges, NIE has made some attempts to actualize an iterative knowledge mobilization process between researchers, practitioners and policy makers. In this regard, we describe three strategies adopted by NIE in the next section.

5. NIE's Strategies to Tighten the Theory-Practice Nexus to Actualise Iterative Knowledge Mobilization

We have highlighted three key elements of an iterative knowledge mobilization effort which we believe will increase the likelihood of producing useful knowledge and its meaningful use by practitioners and policy makers. The iterative knowledge mobilization effort is termed by NIE

as 'Strengthening the Theory-Practice nexus', which is the over-arching idea behind NIE's Teacher Education 21, TE21, (National Institute of Education, 2010) framework and also NIE's Strategic Research, Development and Innovation framework (Hogan, 2007). In this section, we will describe three NIE strategies that are cornerstones of the NIE-MOE-school partnership.

Substantial Investment in the Development of Baseline Databases to support Informed Dialogue among Researchers, Practitioners and Policy Makers

As we discussed above, informed dialogue of an extended and iterative nature between researchers, practitioners and policy makers increases the likelihood of reaching a consensus about the key problems encountered by the education system and the knowledge which the system needs to address these problems. Having a consensus helps mobilize the necessary resources needed to produce the knowledge, and heighten the likelihood of the knowledge, once produced, being adopted and implemented by practitioners and policy makers. This makes the knowledge production process significantly closer to Mode 2 (demand-driven) than Mode 1 (supply-driven).

A necessary component of this informed dialogue is the construction of a rich and robust database which comprehensively describes the status of teaching and learning in Singapore classrooms, and leadership and organization practices in Singapore schools. The substantial investment on CRPP's Core 1 and Core 2 baseline studies demonstrates NIE and MOE's commitment to build this database. In addition, NIE and MOE have also approved a million dollar project to collect baseline data on school leadership and organizational change. This school leadership baseline research is still in its planning stage and more information will be shared with the international research community once ready.

The breadth and the depth of these baseline research studies illustrate the amount of tangible resources which NIE and MOE have made available to the Core research teams. Almost 25% of all Singapore primary and secondary schools, and 10% of the teachers were involved in the

Core 1 and 2 projects. The leadership baseline study has an even wider reach covering all the Singaporean principals and vice-principals, and approximately one third of the middle management and classroom teachers respectively. Perhaps more importantly, these school practitioners are not only involved in the baseline data collection exercise as 'research subjects'. The CRPP research teams have also invested substantial time and effort in sharing the research findings with school practitioners in multi-modal platforms such as teacher forums and sharing sessions at the national and School Cluster level. Besides involving teachers in the research endeavours, the purpose of such sessions is to engender a level of consensus among a large number of Singaporean teachers and school leaders with regard to what is happening in Singapore schools and classrooms, and to signal possible directions for further improvement of classroom practices.

Extensive dialogue - based on the baseline findings - between NIE researchers and MOE senior and middle-level policy makers are also initiated by NIE's Office of Educational Research and MOE's Planning Division. Through these dialogues, NIE researchers and MOE policy makers share their views based on cutting edge research conducted world-wide and on policy imperatives grounded in the Singapore context. This information has formed the evidence-base from which NIE's educational research agenda and MOE's innovation programmes have been developed. While these dialogues and discussion sessions are still far from the desired situation, namely, one where the different stakeholders enter into an equal partnership to co-develop a common plan for action, we believe that positive and concrete steps have been taken towards this end.

Besides dialogue between NIE, MOE and schools, the Core research teams regularly convey key research findings that bear on the design and delivery of the pre-service program and in-service teacher professional development. NIE staff members in turn review, scrutinize and interrogate the Core findings during annual NIE-wide platforms and deliberate on the refinements needed to ensure that NIE's pre-service and in-service programmes can better serve the needs of Singapore school practitioners.

In short: The rigor of the Core research programmes, the extensive involvements of school practitioners and the in-depth discussions among the various stakeholders on the Core findings, strengthen the relationship between research, policy, programme design and delivery, and practice, within the educational community in Singapore.

Design Research as a research approach to incorporate rich contextual information and practitioner knowledge

Besides involving practitioners and policy makers in the development of the NIE research agenda and the planning of research projects, NIE has also taken concrete steps to ensure that during the conduct of the research studies, there are close partnerships between researchers and practitioners. This ensures that teachers and students are not merely research subjects, but research is also honed and informed by classroom practice (Wagner, 1997).

An important approach adopted by NIE researchers is design research to intervention work in schools, although not all of NIE's intervention studies are design research based. The goal of design research is to conduct rigorous and reflective inquiry to test and refine innovative learning environments as well as to refine new learning-design principles (Brown, 1992; Collins, 1992; Cobb, diSessa, Lehrer& Schauble, 2003; Design-Based Research Collective, 2003). Design-based research is iterative as researchers and practitioners collaborate to engage in the design of the interventions in classroom settings. This process ensures research takes place in context, that theories of learning are developed and refined, and that researchers and teachers engage in re-design and continue the cycle of design and implementation. Design research is therefore often characterized as interventionist, iterative, process-oriented, utility-oriented and theory-oriented (den Akker, Gravemeijer, McKenney and Nieveen, 2006). The close collaboration of researchers and practitioners throughout the course of the research enhances and facilitates the incorporation of the tacit dimension of practitioner knowledge in the systematic explication of the research process.

While design research is still considered an emerging research method, NIE's (particularly LSL's) experience over the past 5 years suggests that it is an approach that meets the needs of the practitioners because it supports co-design, learning design, curriculum development, technology development and professional development – thereby actualizing the iterative knowledge mobilization cycle. Many of the LSL interventions have reported success in terms of positive changes in student outcomes and teacher competency and satisfaction (see Looi, et al, 2011; Kapur, 2009; Pathak, 2011; Wong, et al, 2011;). Given that design research studies are highly labour-intensive, executed *in situ* and typically involve a small number of teachers and classrooms, it is premature to judge whether the success or otherwise of design research based interventions is as much a result of the pedagogical innovation *per se* or the intensive and prolonged interactions between researchers and practitioners.

Professional Learning as a Strategy to ensure Knowledge Mediation and Application

A third NIE strategy to mediate knowledge, support its application and increase the impact on practice in a sustained manner is to leverage on NIE's pre-service and in-service programmes which have been increasingly modelled after the professional learning framework we described in an earlier section.

Like many other university departments, NIE has a dedicated publication unit (housed in the Office of Education Research) to translate and disseminate its research findings through regular print and online media. NIE also organizes regular academic conferences which are well attended by Singaporean teachers. Moreover, these conferences hold special sessions that are designed to reach out to school practitioners. NIE's experience has been that while these efforts may generally be effective in raising awareness among practitioners about the new knowledge produced by NIE, there is little assurance that the knowledge will be retained, adopted and implemented in practice.

As NIE is the single source of initial teacher education and provides 70-80% of professional development courses for Singapore teachers, these pre-service teacher education and in-service professional development programmes are an effective avenue to ensure that knowledge is used by practitioners in a sustained manner. NIE has taken two steps to make this happen. The first, mentioned earlier, is to strengthen the theory-practice nexus between teacher education and cutting edge education research. In NIE, this is made easier because more than 80 to 90 percent of NIE faculty members are both active researchers and teacher educators. NIE has also been creating additional institution-wide platforms (e.g. colloquiums and sharing sessions) to disseminate research findings from the core research programmes and intervention projects so that these form the knowledge-base of NIE teacher education programmes.

Second, NIE is also strengthening the theory-practice nexus within Singapore classrooms with the adoption of TE^{21}, a new NIE teacher education model (National Institute of Education, 2010). Within TE^{21}, the Initial Teacher Preparation programme and in-service Teacher Professional Development programmes have adopted a structured mentorship model to increase the likelihood of teachers adopting new practices based on explicit knowledge received from the programme and feedback from their mentors. The model also advocates and supports the development of the tacit dimension of knowledge through the NIE Reflective Teaching Model and involvement in PLCs. As TE^{21} incorporates many of the features which are in line with the new theory of professional learning described earlier, we believe that it will be a more effective way to ensure that practitioners learn the relevant knowledge and its application to improve practice in a sustained manner. However, as this new model is in its early stage of implementation, we do not have empirical evidence of its impact to report.

6. Discussion

Singapore is a highly urbanized city state with a more 'tightly coupled' system of instructional governance than many other systems (Hogan and Gopinathan, 2008; Hogan 2011). Since its independence in 1965, the Singapore government has exercised continual and substantial political, bureaucratic and professional authority over the organization, funding and administration, and distribution of instructional practices within schools (Gopinathan, 1985, 2007; Hogan and Gopinathan, 2008; Hogan 2011). Also, given the small size of the Singapore education system and the fact that NIE is the only teacher training and education research institution in Singapore, it is also not uncommon for NIE researchers, MOE policy makers and administrators, and school practitioners to play more than one role in the iterative knowledge mobilization process. For example, the most senior MOE official, the Permanent Secretary, also chairs the NIE Governing Council. The Director of NIE attends regular policy meetings with senior MOE policy makers and officials. NIE researchers and faculty members are routinely seconded to MOE to take on senior administrative positions. School practitioners (at all levels of seniority) also spend 2-4 years in MOE Headquarters as MOE officials, and both school practitioners and MOE officials are also posted to NIE to become involved in teacher education, education research and research management. And perhaps most important in relation to a strong theory-practice nexus, as stated earlier, at least 80-90% of all NIE faculty members partake in both educational research and pre-service or in-service teacher training.

While this duplication of roles can have its drawbacks, it does have other positives, not the least of them being that key actors, particularly those in senior leadership roles, develop an understanding of the process of knowledge production, mediation and application from more than one perspective. This opportunity to develop a broad understanding of the institutional perspectives and interests of multiple stakeholder groups has very substantial benefits for the system as a whole, in terms of the systemic alignment of institutional goals and practices, but also for the policy and funding environment in which research, policy and practice take place. In turn, this facilitates the alignment of the institutional goals of NIE, MOE and schools, and

gives all stakeholders the confidence that, while everyone is working to secure their respective institutional interests, the wider mission to improve learning and teaching in Singapore schools to meet the challenge of the 21st century is not ignored. This is perhaps a key contributing factor behind the stable and substantial source of MOE research funding to NIE over the last decade, and the willingness of key NIE researchers to dedicate much of their research effort to strategic, policy-directed research (rather than individual researcher initiatives) and the increasing impact of NIE research on teacher classroom practices.

We want to emphasize that we are in no way suggesting that the duplication (or confusion) of roles among knowledge producers, mediators and users, is *necessary* to facilitate a close theory-practice nexus. But we do believe that high levels of articulation at a policy and planning level across institutions are necessary to the design of a national knowledge mobilization strategy that is strategically focused, sustainable and scalable as well as rigorous and relevant. What we are highlighting is rather the need for researchers, practitioners and policy makers to recognize their specific (often conflicting) institutional interests and to work out a national (or jurisdictional) knowledge mobilization strategy that simultaneously supports high quality knowledge production in the form of research publications and also *usable knowledge* that is relevant to policy makers and/or that is owned by teachers seeking to improve the quality of teaching and learning in their classrooms. But it is important not to understate the difficulties of pursuing such a strategy successfully. Our sense is that in Singapore, where circumstances are especially favourable to a high level of policy, research and practice articulation and alignment, to date we have been a lot more successful in conceptualizing what we think it would be good to do than we have been in putting in place a system that institutionalizes what should be done. This is not to say that we have not had some wins: in particular, we have been very successful in developing a number of strategically-focused research projects (particularly the Core research program) that have had a very substantial impact on policy and program development at the national level and will increasingly impact practice at the school and classroom level. Moreover, we have been able to support a number of projects that range from fairly conventional experimental design projects

to design research projects that have had a considerable impact on a small number of schools. But we have been less successful in demonstrating (let alone securing) the sustainability of these projects or taking them to scale in partnership with the Ministry and schools. More broadly, we have not been especially successful in institutionalizing a model of knowledge production, mediation and utilization that is strategically focused, responsive to local school priorities and needs, and which supports development of collaborative partnerships between academic researchers and classroom teachers across the system. And we have made no progress at all in setting up procedures that would support the codification, verification and dissemination of expert teacher knowledge. There are many reasons for our lack of success in these matters, but that's a matter for another time and place. Meanwhile, it remains our goal that knowledge mobilization efforts - such as they are – will be located in Pasteur's Quadrant.

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