LEARNING FIRST

Australia's primary challenge: how to lift teacher quality in early school years

Australian Edition

April 2017

This is the Australian edition of the 2016 report, *Not So Elementary: Primary School Teacher Quality in Top-Performing Systems.*

The international version of the report is available at http://ncee.org/elementary-teachers/*.* It is one of a series of reports on teacher quality systems in top-performing countries commissioned by the Center on International Education Benchmarking® (CIEB) of The National Center on Education and the Economy® (NCEE). In addition to these reports, researchers have collected authentic tools used by the systems highlighted to assist policymakers and practitioners interested in adapting lessons learned for their own context and culture. Funding for this report came from NCEE. Marc Tucker, NCEE's President and Betsy Brown Ruzzi, Director of CIEB provided guidance and direction to the research and policy analysis.

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Learning First is a global organisation of education researchers, consultants, policy advisors and teachers committed to education reform. We use research, consulting and development to help improve education systems in Australia and around the world. For more information, please visit www.learningfirst.com.

Learning First conducted the analysis presented in this report. The interpretations of how these systems operate are the authors', and do not necessarily represent the views or official positions of governments or officials in the systems analysed.

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Overview

Australian students have not improved their achievement on international tests for a decade, and are falling behind students in many other advanced nations. In maths, the proportion of high performers in PISA has halved to 11 per cent over the past 14 years, and low performers outnumber high performers two to one.

As public alarm over these results has grown, discussions have focussed on the need to strengthen teacher skills to improve student learning. This report shows how four of the world's highest-performing school systems -- Hong Kong, Japan, Finland, and Shanghai -- place a strong emphasis on teacher subject expertise, even in early year schooling. In these and other systems, the most effective teachers do not just know their subjects (content knowledge) they also how to teach them (pedagogical content knowledge). Acquiring both forms of knowledge is more important and more difficult than many people realise. Yet opportunities for Australian teachers to do so, particularly in primary teacher education and primary schools, are scarce.

Concerns that primary teachers have inadequate subject expertise have been well documented. Problems exist at every step along the teacher development pathway. In particular:

- Because teacher education programs are unselective, the science, literacy, and maths expertise of prospective primary teachers is generally not strong.
- Primary teacher education programs have few quality courses in each subject area. Students therefore spend minimal time developing teacher subject expertise. Assignments often lack rigour and the bar for course completion is low.
- When prospective primary teachers apply for jobs, adequate subject expertise is often not important in the hiring process.
- In the classroom, teachers often lack support, meaningful subject-specific professional learning and high-quality instructional materials -- all of which help them to develop subject expertise.

There are many exceptions to this narrative but overall, the development of primary teacher knowledge in key subject areas is inadequate. In a downward spiral, teachers with low subject expertise teach students who learn less, who then become teachers with even less subject expertise. Acquiring on-the-job subject expertise is particularly difficult for primary teachers, who often teach five or more subjects.

Hong Kong, Japan, Finland and Shanghai are known for emphasising high standards in primary teacher subject expertise. This report shows how Australian systems can begin to apply similar policies to ensure that such expertise reaches our classrooms.

One thread that unites all four systems is that primary teachers specialise, enabling them to develop deep knowledge in just one or a few subjects. In Shanghai and Hong Kong, primary teachers teach fewer subjects. In Finland and Japan, they teach all subjects, but in training and development focus deeply on just a few. This specialisation allows the deep subject expertise development that is necessary for great teaching.

Success in these systems is driven not by one simple reform, but by many policies combining to reinforce and support teacher knowledge. Becoming a primary teacher requires meeting a high bar of subject-specific knowledge. Initial teacher education includes rigorous content in each subject. In-school professional learning is also subject-specific, allowing access to subject experts and quality instructional materials.

The quality of teaching and learning in primary school significantly affects later academic and life outcomes, as well as the economic health of the nation. Australia needs to get its approach right.

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Part I

Teacher subject expertise

1 Teacher subject expertise

While the concepts and skills taught in primary school can appear straightforward, they are not necessarily simple or easy. Primary school mathematics, for example, requires teachers to not only know strategies to reach correct answers, but also to understand how those strategies work and how students might misunderstand them. Scientific concepts taught to children, such as ideas about life cycles or evolution, are often complex and many adults and children alike only partially understand them (see below sections for further descriptions of the required knowledge in maths, science, and literacy teaching).

These are complicated matters, and it shouldn't be assumed that adults have the required knowledge to teach them. All teachers need a specific body of knowledge known as subject expertise. It is not the same as the knowledge held by the average adult because most adults have procedural knowledge without understanding much about why those procedures work.

For example, most adults know how to read fluently. They do not have to focus on the sounds and parts of each word as they are reading, so they can think about the meaning of a sentence rather than about individual words. However, teachers need to be able to "unpack" the mechanisms involved in reading and notice and work with phonemes, the building blocks of words. This unpacked knowledge helps teachers understand how to best teach the subject and understand how students learn.[1]

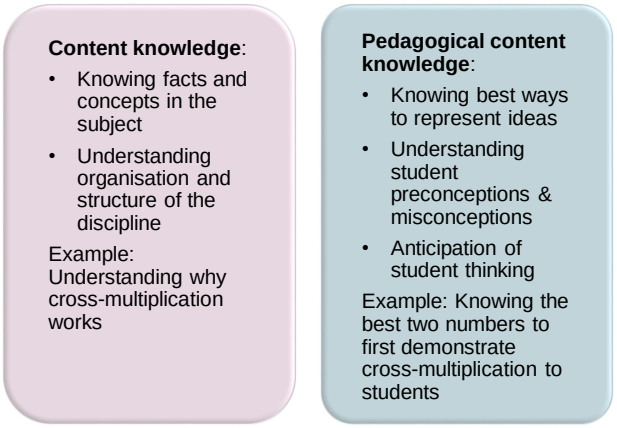
Teachers also need to know how students develop understanding of different subjects. This is not knowledge that adults generally have. For example, science teachers need to know at what age students can conceptualise ideas such as outer space, and how new lessons will interact with their prior knowledge about the world to develop connections and meaning.

There is a growing consensus that two types of subject expertise are necessary to teach well:[2]

- **Content knowledge**: a deep foundation of factual knowledge about the subject being taught
- **Pedagogical content knowledge**: understanding of how to best teach the subject

Though content knowledge and pedagogical content knowledge can be measured separately,[3] in practice they are woven together since pedagogical content knowledge draws on a base of content knowledge, plus an understanding of pedagogy and student learning.

Figure 1: Two types of subject expertise:



Source: Shulman, 1986

While the importance of subject expertise is well-known, less is known about how it is developed and less still about what policies support the preparation of effective teachers.[4]

Research is improving, but many studies have used poor indicators to gauge subject expertise and have therefore struggled to make definitive conclusions about how best to improve it. Research cannot yet say exactly how initial

[1] Phelps & Schilling, 2004
[2] National Research Council, 2010; Allen, 2003; Coe, Aloisi, Higgins, & Major, 2014
[3] Jüttner, Boone, Park, & Neuhaus, 2013
[4] Greenberg & Walsh, 2008; National Research Council, 2010; S. M. Wilson, Floden, & Ferrini-Mundy, 2002

teacher education and in-school supports can most effectively develop this knowledge in teachers.

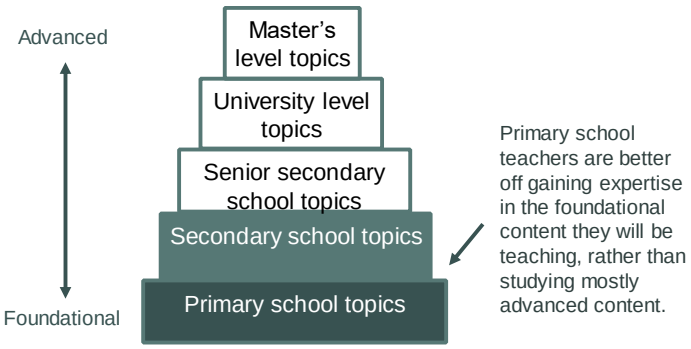
Therefore, this report summarises the small evidence base of required primary teacher knowledge in three subjects: maths, literacy, and science. It also examines four systems (Shanghai, Hong Kong, Japan, and Finland) that are known for having highly knowledgeable teachers, and shows how these systems have created structures to prepare teachers with strong subject expertise. The report seeks to help policymakers generate ideas for new policies to pilot and evaluate in their own systems.

1.1 Content knowledge

Primary school teachers should have a deep, flexible, and accurate knowledge of the content they will be teaching. Without strong conceptual understanding of the content, teachers are not well equipped to help students. A range of reports and studies since the 1980s[5] shows what may seem obvious: that the most effective teachers generally know more than others do about the subjects they are teaching.[6] They have a "profound understanding" of the concepts taught in primary school; in other words, they understand *the content they are teaching* in-depth, accurately, and without confusion.[7]

Compared to this foundational expertise, knowledge of advanced science topics is not as directly useful to student learning in primary school.[8] For instance, primary teachers may not need to know much about advanced science concepts such as spectroscopy, but they should be experts in the concepts taught to young students, such as states of matter.

Figure 2: Primary teachers need expertise in the foundational content taught in primary school, not necessarily in advanced content.



The concept of a profound understanding has been extensively investigated in mathematics and, to a lesser extent, science and literacy.[9] Nevertheless, many efforts to build teacher knowledge have focused on advanced concepts education rather than a profound understanding of the fundamental content taught in primary school.[10]

Yet simply requiring teachers to take more subject courses or hold advanced degrees will not necessarily lead to a stronger content knowledge relevant to primary teaching.[11] Required courses focused on content taught in schools – aligned to the primary school curriculum – are likely to produce better outcomes.[12]

1.2 Pedagogical content knowledge

Pedagogical content knowledge is knowledge of *how to teach* the content of a specific subject. Like content knowledge, greater teacher pedagogical content knowledge is correlated with greater student learning.[13]

Pedagogical content knowledge differs from content knowledge in that it involves an understanding of how students learn, how to translate a conceptual understanding into

[5] National Research Council, 2010; Darling-Hammond & Bransford, 2005; Coe et al., 2014; Allen, 2003
[6] Campbell et al., 2014; Harris & Sass, 2011; Metzler & Woessmann, 2012; National Research Council, 2010
[7] Ma, 1999
[8] Floden & Meniketti, 2005; Harris & Sass, 2011
[9] Ball, Hill, & Bass, 2005; Deborah Loewenberg Ball et al., 2005
[10] Ball et al., 2008
[11] Kilpatrick, Swafford, & Findell, 2001; Allen, 2003
[12] Duschl, Schweingruber, & Shouse, 2007, p. 298
[13] Evens, Elen, & Depaepe, 2015

compelling examples for students, how to identify and correct student misconceptions, and how to explain how new concepts relate to previous learning.

Pedagogical content knowledge is also specific to a given subject.[14] To teach reading, teachers should deeply understand the process of learning to read and have an array of strategies to help young readers. In maths, pedagogical content knowledge includes an understanding of how maths knowledge develops in students and the ability to anticipate student thinking as students approach maths problems. Science teachers need to understand which instructional approaches are best for the different types of science content they are teaching.

Figure 3: Different types of subject expertise

Pedagogical content knowledge differs from content knowledge in that it requires the interaction of content with the knowledge of students and the knowledge of teaching. Teachers must be able to:

- Anticipate student thinking
- Choose the best representations
- Analyse the challenge or ease of tasks

	Content knowledge	Pedagogical content knowledge
Maths	Understanding that 1⅔ is the same as 5/3 and how to prove that that is true.	Anticipating that students might confuse the numerator and the denominator when converting fractions.
Science	Understanding the fundamental concepts of natural selection (genetic variation, heritability).	Knowing which examples best illustrate of genetic diversity and anticipating questions students may have.
Reading	Knowing what phonemes are (units of sound that make up words).	Knowing ways to improve student phonemic awareness for literacy (the ability to notice how sounds in words work).

1.3 What teachers should learn in initial teacher education versus on the job

There is no single place in which teachers gain all the subject expertise they need. Both the knowledge gained in initial teacher education and through in-school professional learning are important. A teacher's content knowledge can develop along a continuum, starting with their own education in primary and secondary school, right through to professional learning activities they might undertake as a classroom teacher.[15] Pedagogical content knowledge can develop similarly, starting with an introduction to concepts in initial teacher education courses and much more learning with students in schools. The development of knowledge is not a linear process -- understanding can be revised, deepened, or corrected at many points.

Nevertheless, the learning environment teachers work in strongly affects how much they develop expertise once they are teaching. Many schools in Australia do not have a strong professional learning environment in which to develop subject expertise. That environment requires teachers collaborating with subject experts, observing lessons and being observed, receiving feedback, and continually researching best teaching methods for the subjects they teach.

In Australia, initial teacher education may be a critical place to develop content knowledge because teachers may have knowledge gaps from secondary school and won't have much chance to close them once teaching in schools.

While teachers develop the highest levels of pedagogical content knowledge by interacting with student thinking, it can also be developed during initial teacher education. Teachers should have a base of good pedagogical content knowledge before they are responsible for their own classrooms.

[14] National Research Council, 2010, p. 2

[15] Grossman, 1990; Kleickmann et al., 2013; Roberts-Hull, Jensen, & Cooper, 2015

1.3.1 Initial teacher education and the development of content knowledge

Initial teacher education is not the only place for beginning teachers to develop content knowledge. Yet because many entrants into primary initial teacher education programs have poor maths or science skills, teacher education is an important point of intervention.[16]

A seminal 1999 study by Liping Ma, comparing mathematical knowledge in primary teachers in the US and China, showed that while many of the Chinese teachers had only a ninth-grade education, they had much stronger maths knowledge than the college-educated American teachers, partially because their primary and secondary maths education was much stronger. In systems with weaker primary and secondary education, initial teacher education can "break the cycle" and improve subject expertise before candidates become teachers. Ma wrote:

> *"In the vicious cycle formed by low-quality school mathematics education and low-quality teacher knowledge of school mathematics…teacher preparation may serve as the force to break the circle."*

For many teachers, initial education may be one of the few opportunities in their careers where they have the time, support, and resources to learn content in a comprehensive way. While the empirical base is weak, some studies suggest that in-service teachers do not continue to substantially develop their content knowledge once they are in the classroom, because the teaching environment is not sufficiently conducive to learning content.[17]

In teacher education, by contrast, false beliefs, areas of weakness, and uncertainties can be explicitly addressed. A substantial body of research, mainly conducted by teacher educators teaching content courses, suggests that specific content courses in initial teacher education can vastly improve teacher knowledge.[18]

There is good evidence that targeted interventions can dramatically improve teacher content knowledge, at least in the short term.[19] Yet there are few longitudinal studies of how well knowledge acquired in a single initial teacher education course is retained over time.

Ideally, teacher professional learning policies in schools will also foster the development of deep content knowledge. Indeed, Ma's study found that much of the Chinese teachers' strong knowledge was developed through intense professional learning in school.[20]

1.3.2 Exposure to student thinking builds pedagogical content knowledge

There is limited agreement about how much *pedagogical* content knowledge can be developed in initial teacher education. It seems that new teachers rapidly develop this kind of knowledge in the early years of teaching, as they are exposed to the way students think. Some may also benefit from exposure to the professional learning community within their schools and between their school and other schools. In these early years of teaching, teachers also gain general pedagogical skills, such as classroom management.

Nevertheless, there have been substantial efforts to build pedagogical content knowledge into initial teacher education. These include the use of practicums, microteaching (intense focus on an aspect of teaching), video lesson observations and discussion, and mock lesson planning. Many of these methods have successfully increased preservice teacher pedagogical content knowledge.[21]

[16] Ward, Grudnoff, Brooker, & Simpson, 2013
[17] Kleickmann et al., 2013
[18] Kleickmann et al., 2013; Liston, 2014; Superfine, Li, & Martinez, 2013
[19] LeSage, 2012
[20] Ma, 1999
[21] Evens et al., 2015

Box 1: An example of how subject expertise improves teaching

Two primary school teachers, Ms. Keating and Ms. Smith, are planning a lesson on two-digit subtraction with regrouping. Ms. Keating's maths subject expertise is relatively underdeveloped: the maths courses she completed during her recent undergraduate program were mostly focused on advanced topics (e.g., pre-calculus) and not primary school content. She's received some general classroom management advice from more experienced teachers at her school but hasn't had much conversation about the best way to teach subtraction.

Ms. Smith, on the other hand, has strong subject expertise. In her initial teacher education program, she completed a minor in primary school maths, in which she took courses aimed specifically at foundational content knowledge and pedagogical content knowledge. She has also had five years of experience teaching in a school with a strong culture of subject-specific professional learning. She takes part in a teacher research group where she collaborates with others to analyse student learning. She also has a mentor teacher with maths expertise.

Both teachers begin the lesson with the example 62−37.

Ms. Keating shows the steps to the subtraction with regrouping procedure by explaining that "you can't take a bigger number (7) away from a smaller number (2), so you need to borrow from 2's next-door neighbour (6) to complete the equation." She knows that manipulatives (physical objects used as teaching tools) are important, so she asks students to explore this new learning by completing an activity using marbles. She has the students start with 62 marbles and take 37 away, to see how many are left. Unfortunately, this use of manipulatives does not actually show the process of regrouping.

Ms. Smith takes a different approach. Using the same example, she has students attempt the problem based on their previous experience with simpler subtraction. When they realise they can't subtract 7 from 2, she asks students whether it is possible to subtract a number in the 30s from a number in the 60s. Students agree that it is possible. Then Ms. Smith makes a connection for students that for this problem, there aren't enough ones, but for other problems, there are too many ones. The students remember doing addition with carrying, and Ms. Smith explains that just as they have previously learned to compose ones into tens, for this problem they will learn to decompose tens into ones.

Ms. Smith also uses manipulatives but chooses bundled popsicle sticks to explain how 10 is 1 ten or 10 ones. She shows how 5 tens and 12 ones is the same as 6 tens and 2 ones, even though nothing has been added or subtracted yet. She has the students use the sticks to try to solve the problem of 62−37 and then leads the class through a discussion of each student approach, with the class selecting the strategies they believe are the most appropriate to help solve the problem.

The different approaches to teaching this topic leave students with different levels of understanding. Some students in Ms. Keating's class are confused by the term "borrowing": they have learned that when you borrow something, you need to return it later, and they wonder when this happens in subtraction. Others have an incomplete understanding: they think you can arbitrarily change the value of a number when you need to, or that the two digits that make up a two-digit number are "neighbours" – and not actually part of the same number. In subsequent classes, they struggle when they try to apply the regrouping procedure to more advanced problems (e.g., larger numbers). They are also confused when later learning about negative numbers because they believed larger numbers could not be subtracted from smaller numbers (since this was part of Ms. Keating's explanation for the regrouping procedure).

Students in Ms. Smith's class, by contrast, have a more appropriate conceptual understanding of decomposing units of higher value (e.g., 1 ten into 10 ones), and they are able to apply this to larger numbers in subsequent lessons (e.g., 1 hundred into 10 tens). They understand how this concept relates to previous topics they have encountered, including addition. Ms. Smith's students are also able to generate other ways to regroup than the standard procedure – e.g., subtracting 30 from 62 (instead of 37) to get 32, and then adding back 7. This helps them learn to solve problems in multiple ways and become more fluent in subtraction.

Example adapted from Ma, 1999

2 What is known about mathematics, science, and literacy teacher knowledge?

2.1 Mathematics

2.1.1 Content knowledge

The US National Mathematics Advisory Panel states: "It is self-evident that teachers cannot teach what they do not know."[22] Teachers need a strong, coherent grounding in fundamental mathematics as it is taught in primary school.[23] Unfortunately, this is not being reliably taught in many initial teacher education programs.[24]

In primary school, students generally learn the basics of two branches of mathematics: arithmetic and geometry.

Ideally, primary school teachers would take courses to develop a deep understanding of these areas of maths rather than mainly taking advanced maths courses (e.g., calculus) that may not be directly relevant to primary curriculum. This would mean a focus on using mathematical expressions such as number equations and other visual representations to show the relationships among quantities in a problem and the steps in a solution. The use of visual representations should be developed into ever deeper understanding of number lines from which graphing is built in algebra. The properties of operations (commutative, distributive) that govern number equations are the same for whole numbers, fractions, and variables in algebra; teachers should understand this deep coherence between arithmetic and algebra.[25]

A focus on these areas would better enable teachers to understand primary mathematics to a level where they can explain *why* a certain thing is so.[26] Frequently, this means having an understanding of the underlying mathematics, rather than merely being able to show steps and give examples.[27]

For instance, understanding that a fraction is a number means that the properties already understood for whole numbers extend to fractions. The arithmetic of fractions is a coherent extension of whole number arithmetic and extends, in turn, to expressions with variables in algebra. Teachers who understand that a fraction is a number with the same properties as other numbers can help students understand this idea.[28] In order to use precise mathematical language in the classroom, teachers need a strong grounding in the underlying conceptual framework of primary mathematics.

Box 2: Teacher confidence & maths learning

Weak mathematical skills are sometimes manifested in "maths anxiety," where individuals fear learning and teaching mathematics, often as a result of poor maths education in their own schooling.[29] Teachers who are not confident in teaching mathematics also teach it less, and therefore students learn less. There is substantial evidence that well-designed maths courses can help lessen maths anxiety, and build solid mathematical understanding.[30]

In Australia and the US, there is a strong gendered element to maths anxiety, where female teachers' beliefs about their mathematical ability may negatively affect girls' mathematical learning, creating an unfortunate cycle of low maths knowledge.[31] This is a particular issue in primary schools, where most teachers are women. Hence, it is important to find ways to improve primary teacher maths confidence before teachers enter the classroom.

[22] US Department of Education, 2008
[23] See Conference Board of the Mathematical Sciences, 2010; Kilpatrick et al., 2001
[24] Greenberg & Walsh, 2008
[25] Discussion with mathematics teaching expert, Phil Daro, February 2016
[26] Kilpatrick et al., 2001
[27] See Tchoshanov, 2010
[28] Discussion with mathematics teaching expert, Phil Daro, February 2016
[29] Bates, Latham, & Kim, 2013
[30] Hadley & Dorward, 2011
[31] Beilock, Gunderson, Ramirez, & Levine, 2010

2.1.2 Pedagogical content knowledge

In primary mathematics, there are often dozens of ways to conceptualise and perform the same kinds of procedures. Therefore, teachers need to grasp the underlying rationale behind a range of these concepts and be able to interpret whether students are understanding what they are learning.

For instance, there are dozens of ways of correctly doing multidigit multiplications, yet not all illuminate the mathematics at work. A teacher should be able to check whether students' methods for solving a problem work, and to identify how going through one particular example would improve or impede student learning in a given situation.[32]

For example, a teacher introducing multidigit multiplication for the first time might present the problem 52 × 14 and ask students for ideas on how to solve it based on their previous learning. Prior to the lesson, the teacher should be able to list the different approaches students might take and decide which ones work and which do not, and why. In class, the teacher should be able to decide which approaches she should dive deeper into to improve whole-class understanding, and which approaches might be less useful or confusing to discuss with the whole class.

Teachers need to not only ensure student success in the current year, but teach for deeper understanding that prepares students for more advanced content in later grades. They must therefore know when teaching a shortcut or trick is likely to hinder later student understanding.

For example, most primary school students learn the order of operations, sometimes known as BODMAS (brackets, order, division, multiplication, addition, subtraction). These are memorised rules that remind students which maths procedures to perform first. BODMAS may help students carry out procedures, but it doesn't help students understand the underlying mathematics behind the rules. This makes it a potentially misleading shortcut. If a student encounters the problem 10-4+3, they may apply BODMAS to do the addition first and the subtraction second, which would yield the wrong answer of 3. However, students who understand the concept that subtraction is the same as adding a negative number can visualise the problem as 10+(-4)+3 and find that the correct answer is 9.

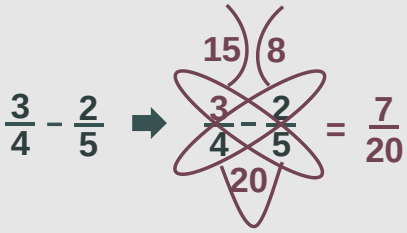
BODMAS is just one example of how procedures to generate correct answers often fail with different applications of maths.[33] As one review put it, "students often are taught computational procedures with fractions without an adequate explanation of how or why the procedures work."[34]

Primary school maths sets up the foundations of mathematical understanding for the rest of a student's life. If teachers do not have a strong understanding of why formulas work, then it is unlikely students that will develop this important understanding. This significantly limits the ability to apply knowledge and understand advanced mathematical topics. Unfortunately, many studies of teacher maths knowledge find that it is limited to performing procedures and does not extend to deep conceptual understanding.[35]

[32] Ma, 1999
[33] Daro, 2014
[34] National Center for Education Evaluation and Regional Assistance, 2010
[35] Ball, 1988; Browning, Edson, Kimani, & Aslan-Tutak, 2014; Kastberg & Morton, 2014; Ma, 1999; Olanoff, Lo, & Tobias, 2014; Strand & Mills, 2014; Thanheiser, Browning, et al., 2014; Thanheiser, Whitacre, & Roy, 2014; Southwell & Penglase, 2005; Beswick, Ashman, Callingham, & McBain, 2011

Box 3: Example of the importance of pedagogical content knowledge in mathematics

Teachers often teach early maths with easy-to-remember formulas. One example is the 'butterfly' method[36] (pictured below) to teach fraction subtraction. Teachers like methods like these because they produce the right answers, but few can explain why the procedure works.[37] The butterfly method has students follow a series of steps which lead them to find a common denominator, although students do not necessarily realise that this is what they are doing.

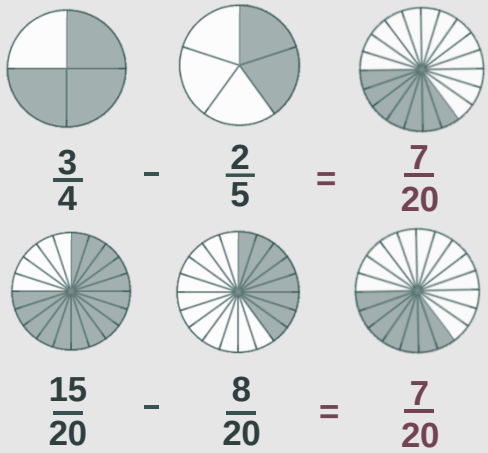


Procedure steps:

1. Draw two wings along the diagonals made by the numerator of one fraction and the denominator of the other fraction and draw an antenna on each wing.
2. Multiply the numbers in each wing and put the product in the antenna for the wing.
3. Connect the bottom parts of the wings with a body-like loop and multiply the two denominators it connects, putting the product inside the body.
4. Subtract the numbers in the antennae and put the result over the number in the body.

With this method, students are taught a procedure that generates an answer but has no connection to the underlying mathematical concept of whole numbers.

A better approach to adding fractions is to use representations to aid student learning.[38]



In this approach, students still need to find a common denominator, but they can clearly see what they are trying to do.

An example with a representation like this could have a real-world example that would help students conceptualise dividing the pieces to create a common denominator.

Many teachers are not currently equipped with this knowledge or related skills.[39] For example, a small Western Australia study tested teacher conceptual knowledge with an assessment originally used for Year 6 students, and not one teacher scored every item correct.[40] Another study in New South Wales tested pre-service teacher knowledge after the conclusion of a maths course and found many unaddressed foundational maths skills issues. For example, less than half of the pre-service teachers could think of more than one method for a simple multiplication problem, which indicates inflexible understanding of standard procedures.[41]

[36] For an example, see: http://www.moveitmaththesource.com/realfractions/butterflyfractio.html
[37] Ball, 1988; Olanoff et al., 2014
[38] National Center for Education Evaluation and Regional Assistance, 2010
[39] Browning et al., 2014; Strand & Mills, 2014; Thanheiser, Browning, et al., 2014
[40] Hurrell, 2013
[41] Southwell & Penglase, 2005

2.2 Science

2.2.1 Content knowledge

At the primary level, science typically involves both an introduction to scientific reasoning (such as experimentation and the scientific method), and a broad variety of content. Concepts such as patterns, cause and effect, and stability and change are introduced. Many topics, including organisms, planets, and energy, are covered.[42]

The concepts taught are broad and span a variety of disciplines. Teachers need grounding in a wide range of scientific content as well as an understanding of how scientific knowledge is hypothesised, generated, and interpreted.

Teachers must be able to go beyond common sense ideas about the world as many fundamental and essential scientific ideas (such as states of matter, gravity, evolution, space, atomic structure) resist simple observational and inferential methods. Incomplete beliefs resulting from untutored observation persist across society. These include the idea that some things are inherently cold or hot, or that evolution is the result of species "trying" to adapt, or that when a substance burns or evaporates it disappears.[43]

The specific content knowledge required by primary science teachers has been less researched than that required by mathematics teachers. Yet as with maths, a strong understanding of the core ideas in primary science appears important[44] and is often lacking among new teachers.[45] Proxy measures such as number of courses taken or teacher self-confidence are often poor measures for actual knowledge.[46]

2.2.2 Pedagogical content knowledge

Student performance in science is higher when teachers have more science pedagogical content knowledge.[47] So teachers with weak science pedagogical content knowledge cannot teach as well. This affects some students more than others. Teachers with weak science pedagogical content knowledge often give priority to students enjoying science; they also conduct activities without a connection to scientific thinking that will truly deepen student understanding. The effects can be profound: some students do not advance to higher levels of performance, and many fall behind as they do not truly understand the foundational scientific concepts required to be successful during middle and high school.

If primary teachers feel unprepared with science knowledge, there is also a risk that they will reduce science teaching overall. While maths and literacy subjects are part of national accountability programs, science is more likely to be overlooked. Unfortunately, there is evidence that many primary teachers have a form of science anxiety, potentially developed as a result negative experiences with science in their own education.[48]

For students to advance their understanding, teachers need to understand the breadth and diversity of students' science conceptions (and misconceptions) in their classrooms and implement pedagogies to deepen conceptual understandings and unpack misconceptions. These pedagogies include engaging students in scientific reasoning and practices, using a range of instructional practices (i.e. not only inquiry approaches, but also explicit instruction), employing high-quality formative assessment, and including the scientific method as one approach among others for inquiry.[49] More broadly, science teachers need to use approaches to learning science that are

[42] National Academies Press, 2012; Next Generation Science Standards, 2015
[43] Gregory, 2009; Gregory & Ellis, 2009; Liston, 2013
[44] Hanuscin, Lee, & Akerson, 2011
[45] Burgoon, Heddle, & Duran, 2010; Liston, 2013
[46] Diamond, Maerten-Rivera, & Rohrer, 2013
[47] Lange, Kleickmann, & Möller, 2011
[48] Watters & Ginns, 1995; Moscovici & Osisioma, 2008
[49] Duschl, Schweingruber & Shouse, 2007

themselves scientific, such as forming hypothesis, developing the right questions to ask, and analysing data.[50]

Understanding and confronting student preconceptions

An understanding of student scientific conceptions is an important component of pedagogical content knowledge and perhaps the aspect that has been most studied. Many studies show that teachers share similar incomplete understandings to students.[51]

For example, adults and children often share incomplete understandings about basic aspects of lunar phases and the causes of the seasons. Commonly, people believe that the moon's phases are the result of the earth's shadow on the moon.[52] Many also believe that seasons are caused by the distance of the earth from the sun due to an elliptical orbit (rather than the earth's axial tilt).

The best way to combat misconceptions like these is to:

- design and implement activities that explicitly confront the misconception[53]
- choose texts and materials that promote productive cognitive conflict
- encourage students to revisit their conceptions.[54]

Strong pedagogical content knowledge will allow teachers to set up a line of questioning that reveals and completes the partial understandings.[55] For example, a teacher could ask what the difference is between an eclipse and a new moon, or why it can be summer in some parts of the world and winter in others.

Inquiry-based methods

Science pedagogical content knowledge is particularly important in the context of inquiry-based pedagogy. While inquiry-based pedagogy is often emphasised in primary school science education, teachers who use it when they are not prepared with enough subject expertise may limit student learning.[56] In order to be effective, inquiry methods must be strongly connected to the content; teachers must have the pedagogical content knowledge to set inquiry up in a way that drives students to the learning goal. Pedagogical content knowledge also helps teachers lead reflection discussions after inquiry to ensure that students have the opportunity to consolidate their learning and complete any partial understandings.

One issue that makes inquiry instruction difficult is that many aspects of science are not obvious purely through observation. Teachers need to be aware of which topics suit inquiry-based teaching and which require more explicit instructional methods.

For instance, the idea of gravity is easily understood in reference to an object falling to the ground, but it is less obvious that gravitational forces exist when objects are not in motion. Teachers need to not only understand the idea of gravity at a theoretical level but to be able to explain that it is always present and affects everything with a mass, and find ways to show this.[57] It may sound obvious, but to teach it well requires extensive primary science pedagogical content knowledge.

[50] Next Generation Science Standards, 2015
[51] Burgoon et al., 2010; Gregory, 2009
[52] Bursal, 2012; Kavanagh, Agan, & Sneider, 2005
[53] Gomez-Zwiep, 2008
[54] Lucariello & Naff, n.d.
[55] Sneider, Bar, & Kavanagh, 2011; Thomas, 2011; Wilcox & Kruse, 2012
[56] Hanuscin, Lee, & Akerson, 2011; Nowick et al., 2013
[57] Nowicki et al., 2013.

2.3 Literacy

Teacher knowledge in reading and literacy is not as well studied as it is in maths and science.[58] Yet while there is not a strong research base for deciding the necessary components of teacher knowledge for teaching reading, there is growing consensus around many of the key elements that can provide a starting point.[59]

This report briefly summarises the existing evidence about teacher subject expertise in literacy. For in-depth information, see these publications:

- C. Snow, Griffin, & Burns, 2005
- National Institute of Child Health and Human Development, 2000
- International Reading Association, 2007

2.3.1 Content knowledge

Many might assume that all teachers know how to read, so have the knowledge to be reading teachers. Yet as with maths and science, teaching reading requires considerable content knowledge and pedagogical content knowledge.[60] Adults can be fluent readers without the deep knowledge of language and reading process that is necessary for reading instruction.

For example, understanding how letters can sound differently in different words helps teachers choose which words are best to present in a lesson and to identify student errors. Most adult readers would not normally recognise that the *t* in *little* can sound like a *d* and is different than the *t* heard in *top* and *hit*, but a teacher must know this in order to be able to anticipate student spelling and reading problems.[61]

Competent reading requires a fluency – or smoothness – that doesn't allow most people to stop and think deeply about word sounds and language patterns. In all subjects, strong teacher content knowledge requires an unpacking of ideas that makes knowledge that seems easy quite complicated.

What teachers need to know

Teachers need to develop knowledge across a number of dimensions to teach reading instead of just having general reading skills. The type of knowledge required has two categories: language comprehension knowledge and word analysis knowledge.[62]

Language comprehension: Comprehension is the ability to read text and understand its meaning. It is complicated and requires not just explicit knowledge but also skill in metacognition (awareness and monitoring of understanding).[63] Understanding reading comprehension requires knowledge of things like vocabulary, morphology, genre, and reading fluency.[64] It also requires text analysis skills – being able to identify what background knowledge is needed to understand the text.

Word analysis: Readers benefit from opportunities to learn about language and the text elements that make up words.[65] Teachers must have this knowledge if they are to best help students. It includes things like phonemic awareness, letter sound relationships, and the ability to decode unfamiliar words.[66]

Teachers also need to be familiar with the technical terms for literacy that feed into word analysis and language comprehension knowledge.[67] These terms provide good examples of the types of content knowledge that are specific to teaching reading and that are not

[58] Phelps & Schilling, 2004
[59] National Research Council, 2010
[60] Moats, 1999
[61] Example adapted from Phelps & Schilling, 2004
[62] National Institute of Child Health and Human Development, 2000; Phelps & Schilling, 2004; Snow, Griffin, & Burns, 2005
[63] Snow, Griffin, & Burns, 2005
[64] Phelps & Schilling, 2004
[65] National Institute of Child Health and Human Development, 2000
[66] Phelps & Schilling, 2004
[67] Snow, Griffin, & Burns, 2005

typically known by other adults. The term *phonology*, for example, describes both word analysis and the system of sounds that make up language. Similarly, the term *orthography* refers to understanding the conventions of how to write a language – including spelling, capitalisation, and punctuation. Literacy teachers with strong content knowledge can use these conventions to help students with comprehension and writing.

2.3.2 Pedagogical content knowledge

Literacy pedagogical content knowledge builds on teachers' content knowledge and requires knowledge of the process of learning to read, difficulties students may encounter, and research on the effectiveness of various pedagogical strategies. For example, teachers need pedagogical content knowledge to understand what words or expressions in text might be unfamiliar to students. They need to know that some words – such as *who* -- do not follow the rules of phonics and cannot be sounded out. Teachers also need to understand that some children may be experiencing learning difficulties, such as dyslexia, and how to identify them.[68]

Pedagogical content knowledge for literacy includes understanding when students should be expected to develop certain literacy skills. Teachers might recognise that being able to count syllables in a word is a first-grade milestone, and using roots to infer word meanings is accomplished in third grade. This type of knowledge helps teachers accurately identify when student mistakes are normal for their age, when the teacher should plan an intervention to prevent students from falling behind, or when a student might require specialist assistance because of a learning disability.[69]

Along with knowledge of student development, pedagogical content knowledge also involves understanding which instructional approaches are helpful for students at each developmental level.

In 2000, the US-based National Reading Panel published a report that reviewed more than 100,000 reading studies on how children learn how to read. Although the evidence was sparse[70], the report made clear that teachers need to know the following best approaches to reading instruction:[71]

- **Systematic teaching of phonemic awareness**: teaching students that words are made up of smaller sounds (phonemes)
- **Explicit phonics instruction**: making sure that students connect sounds with letters; are able to sound out words
- **Guided oral reading to improve fluency**: monitoring how easily students read words; helping them read with speed, accuracy, and expression
- **Teaching vocabulary words** directly and indirectly through text or separately
- **Comprehension**: giving students strategies to understand what is being read across multiple text genres; e.g., having students summarise what they've read

Worryingly, many primary teachers do not have the requisite knowledge about these foundational approaches. Even teachers who self-assess their phonics skills as great often cannot actually demonstrate their knowledge.[72] Although teachers generally know skills like phonemic awareness are important, they struggle to correctly identify the number of phonemes in

[68] Correspondence with literacy expert Catherine Snow, January 2016

[69] Examples taken from Snow, Burns, & Griffin, 1998

[70] The report looked at all studies from 1966 through 1999, and only 11 initial teacher education studies met the criteria to be included in the analysis for the report. The panel found no studies that followed pre-service teachers as they moved into teaching positions, so while the studies may measure improvements in teacher knowledge, none could say how this affected teaching and student learning.

[71] National Institute of Child Health and Human Development, 2000

[72] Stark, Snow, Eadie, & Goldfeld, 2016

simple words.[73] There is evidence that teacher educators – the people who teach teachers – lack a good understanding of basic language constructs, and that this may be one reason for poor teacher understanding.[74]

English language learners and struggling readers

One of the most concerning aspects of teacher literacy knowledge is that teachers report not feeling confident in teaching reading to at-risk students.[75]

It is critical for teachers of English language learners and struggling readers to have specialised knowledge of how to best help them. Given that most primary school teachers will have some students with specialised learning needs, it seems clear that all teachers should be prepared with this knowledge.

For example, the following knowledge may be important for teachers of English language learners:[76]

- Knowledge of second language development
- Understanding individual differences among the wide range of English language learners
- The connection between language, culture, and identity

While most teachers teach students with disabilities, few feel well prepared to meet their needs.[77] Teachers may subscribe to certain myths about students with disabilities, such as the idea that their reading instruction needs to be significantly different. However, the instructional needs of struggling readers are very similar to any reader, and studies have found all students can reach higher levels of reading achievement with quality instruction.[78]

More generally, it is important that teachers pay close attention to the texts students are exposed to and the background knowledge these texts presuppose. Teachers need to critically review texts to determine whether they contain words or expressions that are likely to be unfamiliar to all or some students, or used in unfamiliar ways.[79]

[73] Fielding-Barnsley, 2010
[74] Binks-Cantrell, Washburn, Joshi, & Hougen, 2012
[75] Mahar & Richdale, 2008
[76] August & Shanahan, 2006; National Research Council, 2010; Lucas & Grinberg, 2008
[77] Lewis et al., 1999
[78] Snow, Griffin & Burns, 2005
[79] Correspondence with literacy expert Catherine Snow, January 2016

2.4 Conclusion to Part I

There is surprisingly little high-quality research on the kind and level of knowledge that primary teachers need. What emerges from the limited research landscape is that teachers need to have strong subject expertise, consisting of a deep understanding of the concepts they are teaching and the ability to teach this content to students.

With the limited empirical base, policymakers cannot make decisions on literature alone. Therefore, it is helpful to look to systems that are known for having a high level of teacher subject expertise for policy insights. Part II of this report looks at how Japan, Finland, Hong Kong, and Shanghai ensure that their primary teachers have a high level of both content knowledge and pedagogical content knowledge.

The point of looking at these systems is not to make causal inferences about whether or not certain policies contributed to high student achievement outcomes. Instead, these systems can act as tangible case study examples of how to practically implement new models for teacher education and development.

These systems are not identical, but they share many common approaches to how they carefully select, prepare, and continually equip teachers with some of the strongest subject expertise in the world. The next section examines policies to support primary teacher learning during and after initial teacher education, and how schools, policymakers, and teacher education institutions can develop greater teacher subject expertise.

Part II

Policies: Lessons from Japan, Finland, Shanghai, and Hong Kong

3 Selection

One way for systems to improve teacher subject expertise is to assess candidates and select only those prepared with the greatest knowledge.

Initial teacher education programs in Australia are not consistently selective so are not trusted as putting up a high barrier to entry to the profession. New literacy and numeracy tests for teacher candidates have recently been introduced as a way to raise the bar. Early reports show that around 5% of teacher candidates are failing these tests.[80] At the moment, even teachers who failed are still entering the classroom with provisional registrations.

Beyond the point of registration, a teacher candidate rarely has her subject expertise assessed. Most schools do not assess teacher knowledge when making hiring decisions.

High-performing systems look very different. Finland has a challenging initial teacher education admissions exam that assesses both current expertise and potential to learn. Japan has comprehensive employment exams that test teacher subject knowledge with a paper exam as well as with a demonstration lesson. In these systems, teacher candidates must meet a high standard of cognitive ability, academic preparation, and subject expertise before they are accepted as full classroom teachers.

Selection assessments must be rigorous

Having rigorous tests of teacher subject expertise is not a new idea. In the US, subject expertise assessments have been used for more than 100 years and they used to be quite rigorous. One primary teacher exam from 1875 tested 20 subjects, including mental arithmetic, physics, orthography, and even industrial drawing.[81]

Today hundreds of teacher licensure exams in the US try to assess subject expertise, but the bar for passing these exams is often very low.[82] The problem is not always the assessment design itself but the cut scores (the minimum score necessary to pass) that are set by school systems. These exams, like the Australian assessments, are setting the minimum bar for entry into the profession. They are not meant to be a method to identify the best talent. Systems tend to worry about raising the minimum standard too high in fear of teacher shortages, even though primary school teachers tend be oversupplied.[83]

Most high-performing systems do not focus so much on licensure exams but on assessments elsewhere on the teacher development pathway. These systems have rigorous assessments at points such as admission to initial teacher education or employment, where spots for candidates are limited. While there is no limit to the number of teachers who can be licensed or registered, there is a limit to the number that can be employed or admitted to a teacher education program. This creates a forced ranking system with naturally more rigorous standards, where only the candidates with the greatest subject expertise are admitted or hired.

Selection can occur at multiple points along the teacher development pathway

Many in Australia and the US are worried about declining expertise of primary teachers. While there are few measures of teacher expertise (knowledge and skills), there are examples of declines in the standard of graduates being accepted into teacher education. It has been much discussed that while some systems such as Finland only let top high school graduates into teacher education, teacher education in Australia is less selective and teachers generally come from the lower half of university graduates.[84]

[80] Cook, 2017
[81] Shulman, 1986
[82] Hiler & Johnson, 2014
[83] Weldon, 2015
[84] Trounson, 2016; Balogh, 2016; Cook, 2016

But it is a mistake to therefore assume that the only place to put in entrance hurdles is at the point entry into initial teacher education. Effective reform is much more nuanced. There are multiple points to assess potential teachers along their development pathway and each has its pros and cons.

Points along the pathway where assessments of teacher knowledge can be used for selection:

- **Entrance to initial teacher education** – using results in high school, exams, and interviews for admittance to initial teacher education
- **Exit from initial teacher education** – exams and demonstrations of teaching ability before graduation
- **Licensure and certification** – requirements to be licensed or certified as a teacher (usually set by a government)
- **Hiring** – schools using their own assessments of pedagogical content knowledge and content knowledge to select teachers to be hired
- **Induction** – Probationary periods and requirements for full teacher status

Assessments of teacher subject expertise should assess actual expertise, not proxies

How primary teachers' subject expertise is assessed is vitally important for effective reforms to teacher development. Too many past efforts have focused on the wrong things: teachers' degrees held or years of experience, rather than testing their actual skills and abilities. It is not always the case that teachers doing more subject courses (i.e. maths) improves their subject expertise. Not all courses are equal, and degrees with the same name can vary widely in quality.

There are much better ways to more directly assess teachers' subject expertise. High-performing systems show how these assessments can be used to ensure that only high-quality teachers enter classrooms *and* to lead to improvements throughout the system of teacher education and development.

3.1 Selection early in the pathway

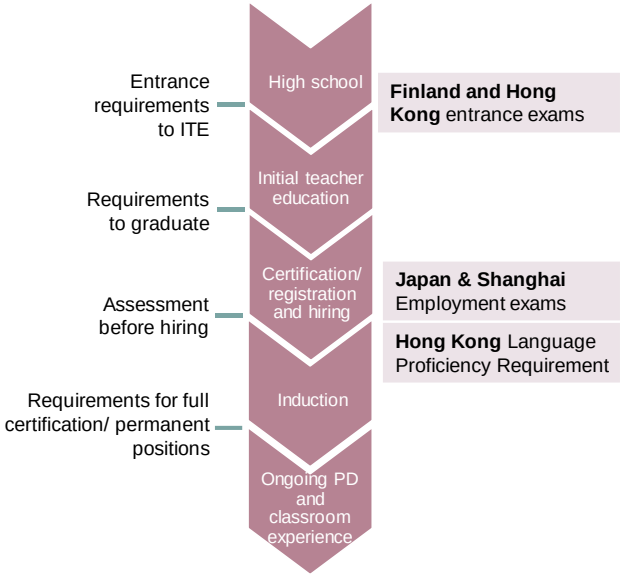
Many education systems, including Finland and Hong Kong, have a rigorous process for selecting only the best candidates early in the teacher development pathway. These systems usually set a high bar for entry into initial teacher education but conduct fewer assessments of teacher knowledge further down the pathway.

A strong emphasis on early pathway selection seems to work well in systems in which government-funded initial teacher education places are limited to demand for new teachers – a process also described as quotas or "capping" of initial teacher education places. In Hong Kong and Finland, the number of initial teacher education providers and teacher education places are mostly centrally controlled.

Finland has only eight teacher education providers, and Hong Kong has four that are government-funded (one other initial teacher education provider is self-funded). Each country has capped admissions based on government projections of the required teacher workforce.

When the supply of new teachers is limited in this way, it essentially forces the selection to the front of the pathway in initial teacher education. With limited initial teacher education spots, it is inevitable that entrance to initial teacher education will be much more selective.

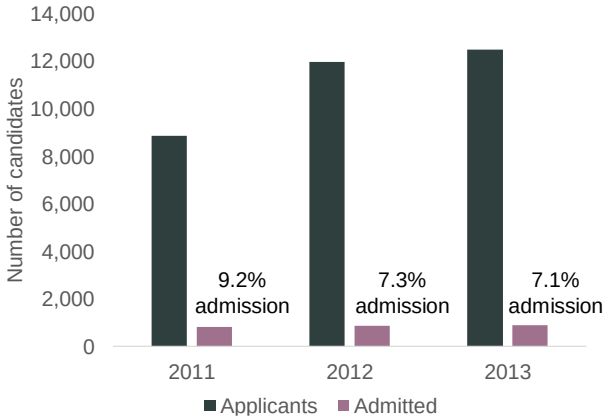
Figure 4: Selection points along the teacher development pathway



3.1.1 Finland has a comprehensive initial teacher education admissions process

Finnish teachers have some of the highest cognitive skills in both literacy and numeracy in the world.[85] They come from the upper part of the skill distribution, with a highly competitive admission process – less than 10 per cent of applicants are admitted each year.[86]

Figure 5: Applicants vs admissions for primary initial teacher education programs in Finland[87]



Source: Ministry of Education and Culture, 2014

Selection process

Teacher candidates go through a rigorous, multistage admissions process. Each of the eight initial teacher education providers is authorised to decide its own selection criteria. Yet there is coordination, especially for the first parts of the admission process.

Aspiring teachers can apply simultaneously to multiple universities through a selection cooperation network of universities, called VAKAVA. Since candidates are selected before they have taken any teacher education courses, selection assessment is focused on candidates' potential to learn, not just on their current knowledge.

Teacher education programs do look at subject expertise through analysis of high school grades, but they do not have a paper test of skills in each subject. Instead, most candidates must take the VAKAVA exam, which requires reading various research studies and answering test questions about the literature. This exam primarily tests research skills, which shows the potential of students to learn during initial teacher education.

The exam also indirectly tests literacy, science and maths skills. It poses a series of multiple-choice questions based on academic material published approximately six weeks before the exam. The material and examination are highly challenging, with points deducted for incorrect answers or nonresponses. Content on the 2015 exam included (among other topics):[88]

- distinguishing between methodological approaches in social research
- education theory
- interpreting regression analyses

[85] Hanushek, Piopiunik, & Wiederhold, 2014
[86] The Finnish National Board of Education, 2014
[87] Applicants who took part in phase 1 entrance test for Finnish-language class (primary) teacher education and those selected for class teacher education. Excludes Finland's Swedish-language university.
[88] A translated copy is available in the Appendix

- analysing psychological research, among other topics.

The next phase of admissions varies by university, but generally candidates will do a sample lesson and participate in an interview.

See sample VAKAVA exam questions on next page and in the Appendix.

Attraction to the profession

Admission standards are one form of selection into teaching but self-selection by candidates is also important. Many high-performing education systems that have selective entry requirements into initial teacher education have made teaching a highly attractive profession that can compete for the best students with law, medicine, and other highly regarded professions.

Critically, higher pay relative to other professions is correlated with higher teacher skills throughout the OECD.[89] Yet other factors aside from pay, including good working conditions and high status can influence the attraction of the profession.[90] Without raising salaries, working conditions or the status of teaching, admission standards will only eliminate the very bottom candidates, rather than improve the overall pool.

Much of the reason why Finnish initial teacher education programs can be so selective is because the profession is highly attractive. Teachers in Finland do not earn a particularly high salary, but it is not low either. Finnish teachers earn 73 per cent of what similarly educated workers make, which is just below the OECD average of 78 per cent for teachers, but above the US, where teachers earn between 65 and 70 per cent of what college-educated workers earn.[91] Other factors, such as the social prestige of the profession and professional autonomy, might matter more for those choosing to enter a teaching career in Finland.[92]

[89] Hanushek et al., 2014
[90] Schleicher, 2012
[91] OECD, 2015a; OECD, 2015b
[92] Sahlberg, 2010

Box 4: Sample VAKAVA exam question

The VAKAVA exam includes a series of multiple-choice questions based on academic material published approximately six weeks before the exam. Candidates read academic journal articles and answer questions.

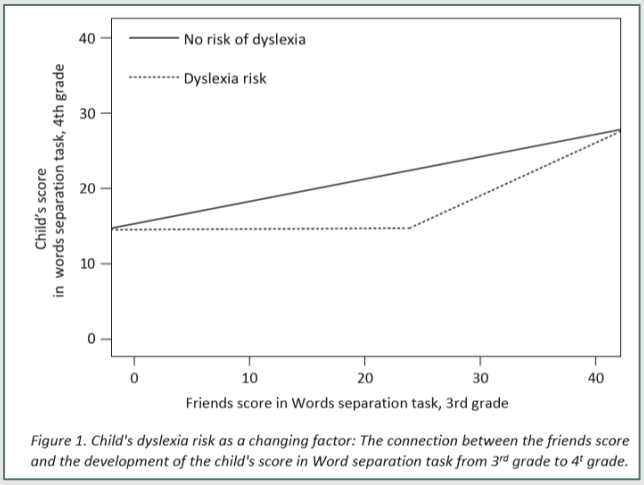


Figure 1. Child's dyslexia risk as a changing factor: The connection between the friends score and the development of the child's score in Word separation task from 3rd grade to 4t grade.

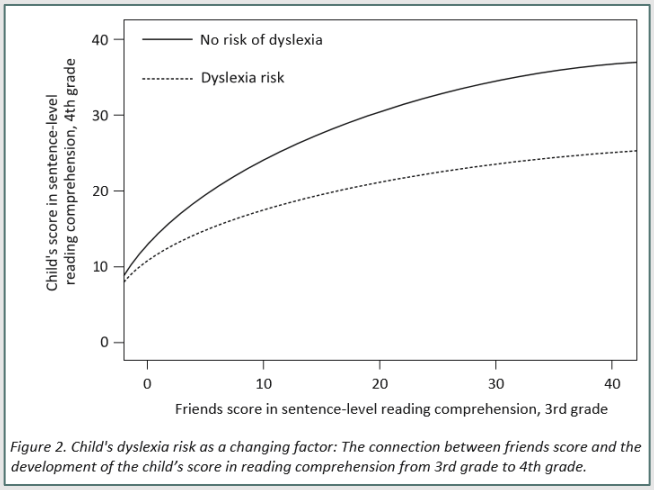


Figure 2. Child's dyslexia risk as a changing factor: The connection between friends score and the development of the child's score in reading comprehension from 3rd grade to 4th grade.

Sample question: Figures 1 and 2 have been obtained by a study by means of regression analysis. Below are statements relative to the interpretations. Select one of the following options for each interpretation:

1. Children with a dyslexia risk develop more slowly from third grade than those who do not have a dyslexia risk, according to a test measuring the separation of words. When entering fourth grade, the difference between groups has evened out.

   A) Compatible only with figure 1
   B) Compatible only with figure 2
   C) Compatible with both figures
   D) Not compatible with either figure

2. The difference between children with dyslexia risk and without dyslexia risk in children's reading comprehension increases strongly when entering the fourth grade.

   A) Compatible only with figure 1
   B) Compatible only with figure 2
   C) Compatible with both figures
   D) Not compatible with either figure

3. The higher the score in understanding sentence-level reading a child's friend has in the 3rd grade, the less the friend's score affects the child's own sentence-level reading comprehension.

   A) Compatible only with figure 1
   B) Compatible only with figure 2
   C) Compatible with both figures
   D) Not compatible with either figure

More sample questions available in the appendix.

Source: "VAKAVA exam – Questions and correct answers," 2015
Answers: 1.D, 2.D, 3.B

3.1.2 Hong Kong has high admission standards for each subject

Hong Kong's five teacher education providers are able to set their own admissions criteria and process.

At the Education University of Hong Kong[93], where 84 per cent of primary school teachers have studied,[94] there are several methods in place to select high-quality entrants.

First, the university sets minimum high school scores for entrance into its undergraduate programs, but usually selects students with scores much higher than the minimum.

In 2015, the entering cohort of prospective teachers seeking to major in English, Chinese or mathematics required a top score in the selected subject.[95] English majors had to be in the top 10 per cent, Chinese majors in the top 8 per cent, and maths majors in the top 14 per cent of all high school students.[96]

Academic results are supplemented with a test and, in many cases, an interview. For instance, as of 2015, applicants for the Bachelor of Education in English Language (Primary) undertook a one-hour written test and a 15-minute interview with two lecturers (in a group of three prospective students).[97]

The university also has language exit requirements for all teachers, with students needing to demonstrate proficiency in both English and Chinese (Mandarin).[98]

3.1.3 Hong Kong Language Proficiency Requirements

In the mid-1990s, Hong Kong businesses and the government became concerned that students were not graduating with appropriate language skills and started plans to step up language skill requirements for all teachers. Proficiency in Mandarin (also called Putonghua) and English is a major goal of the Hong Kong primary education system. In 2000, the government announced that all teachers must meet requirements for these languages.[99]

All existing in-service teachers of Mandarin and English were asked to meet a Language Proficiency Requirement (covering various aspects of proficiency in these languages) by 2007.[100] New teachers joining the profession were asked to meet the requirement within two years. Those that didn't meet the requirements could not teach language subjects.[101]

The requirement can be met by passing the Language Proficiency Assessment for Teachers, administered by the Education Bureau. It can also be met by graduating from an approved program

[93] Formerly known as the Hong Kong Institute of Education

[94] The Hong Kong Institute of Education, n.d.

[95] Hong Kong Institute of Education, 2015a

[96] High school students can receive a score of 1, 2, 3, 4, 5, 5*, or 5** for each senior secondary subject – higher scores are better. The Hong Kong Institute of Education set minimum scores for entry into undergraduate places at a 3 for Chinese and English (attained by 60.2% and 52.5% of high school completers) and a minimum score of 2 in mathematics (attained by 80.1% of high school completers). In 2015, the entering cohort had a total score of 20-21 across their 5 best subjects, and prospective teachers seeking to major in English, Chinese or Mathematics required at least a 5 in that subject at a high school level. In 2015 a level of 5 or above was attained by 9.2% of students in English, 7.4% in Chinese Language, and 13.6% in mathematics.

Source: Census and Statistics Department of Hong Kong, 2015; Hong Kong Institute of Education, 2015a

[97] Hong Kong Institute of Education, 2015b

[98] Hong Kong Institute of Education, 2014

[99] In Hong Kong, the primary language spoken is Cantonese, so English and Mandarin are often second languages for teachers. In primary schools, language learning takes between 42%-51% of total class time, generally with more Mandarin classes per week. The Education Bureau suggests between 25%-30% of class time for Chinese Language education (about 200-235 hours per year), and 17%-21% of class time for English (about 135-155 hours per year). Source: Education Bureau, Hong Kong, 2014

[100] Director of Education, Education Bureau, Hong Kong, 2000

[101] Lin, 2007

in a university that has provided sufficient assurance of language proficiency.[102]

The Education Bureau says the language proficiency levels 'provide an objective reference against which teachers' proficiency can be gauged to help them pursue continuous professional development'.[103]

Content of the assessments

The assessment for English comprises tests in reading, writing, listening, and speaking. For Mandarin, it consists of tests in listening and recognition, pinyin (transcription of Chinese characters into the Latin alphabet), and speaking. After meeting the Language Proficiency Requirement in these areas (typically before being hired), beginning Mandarin and English teachers also complete a Classroom Language Assessment, which consists of a lesson observation to observe their language skills in the classroom.[104]

The tests are rigorous and demanding, requiring nuanced understanding of the language. For instance, in the two-hour writing component of the English Language Proficiency Assessment, teachers are asked to write a 400-word narrative, rewrite a student composition, and write explanations of frequent errors.

The assessment is challenging, with variation between its different parts. Among prospective teachers, the 2015 proficiency rate for English reading was 87.8 per cent, and for English speaking it was 54.8 per cent. In Mandarin, speaking ability was stronger with 72.5 per cent meeting proficiency, but listening was comparatively worse, with only 53.7 per cent meeting this benchmark.[105]

Box 5: Example of the minimum standard in English language proficiency

The following example, drawn from the Education Bureau's annual report, provides what is considered to be a minimum standard in writing to meet the English requirement in response to the prompt below.[106]

Task: *You have been asked to write a short article of about 400 words for a youth club magazine describing different relationships you have encountered as a young professional. Describe at least three people in your life with whom you have very different relationships. Explain how these relationships are different.*

Exemplary teacher response: *"There are different roles we have to play in our whole lives, such as 'student,' 'brother,' 'daughter,' or even 'mother' in the future. It is impossible to have the same kind of relationship with every person that you meet in your daily life. As a young professional, I would like to share my experiences, talk about three people in my life whom I have very different relationships and explain how they are different.*

The first person that I am going to talk about has a very close relationship with me. She is my elder sister. My sister is only two years older than me, so we have no communication problems at all. We have similar friends, similar hobbies and even the same idol. We were in the same primary and secondary school, thus at that time, we always chat with each other for hours after school, talking about what had happened that day and what funny jokes the teachers had said. We share secrets, happiness and also things that upset us. Therefore, we have very close relationship…"

[102] Education Bureau, Hong Kong, 2015a
[103] Education Bureau, Hong Kong, 2015b
[104] Education Department Bureau, Hong Kong, 2015
[105] Education Bureau, Hong Kong, 2015b
[106] Education Bureau, Hong Kong, 2015b

3.2 Selection later in the pathway

Many countries, including Australia, fund and regulate initial teacher education providers very differently from Finland and Hong Kong. In these systems, open initial teacher education systems allow for unlimited providers and student places. As a result, the provision of initial teacher education in these countries has proliferated in recent years. With hundreds of providers, reforms to increase entry standards or to regulate quality become more difficult, both in terms of policy design and political realities.

Therefore, open initial teacher education systems with many providers might find it easier to structure strong assessments of teacher knowledge later in the pathway – at certification, employment, or once in schools.

Initial teacher education providers are often universities with a large degree of autonomy. They are not easy for governments or systems to control, especially when teacher education is profitable and seen as a "cash cow" for universities. Providers often have an incentive to get as many enrolments as possible. Even if governments can generate the political will to mandate higher entry requirements, providers might develop workarounds to continue to enrol less prepared students.

System leaders might therefore consider targeting assessments of teacher knowledge at later stages of the development pathway. Improving selection criteria at employment might be a particularly effective way to improve the teacher workforce.[107] These assessments not only ensure candidates are well prepared but also signal to initial teacher education providers expectations for graduate teachers.

Selection done through candidate ranking may be more effective than just setting a minimum bar

Many systems, including Australia, invest in candidate assessments at teacher registration or certification. Certification assessments set minimum standards for teachers and ensure that the least knowledgeable candidates aren't in classrooms. This is important, yet the minimum standards approach may have two problems: it does not create incentives for development past minimum standards, and it does not provide differentiating information to the system on teacher candidate quality (aside from binary pass-or-fail data).

When the assessment ensures that teachers (or candidates) meet minimum requirements, no one has the incentive to improve teacher knowledge beyond minimum standards. Teacher candidates prepare themselves to pass minimum standards, and providers design the courses and set quality benchmarks to ensure minimum standards are met. Schools then only employ teachers who meet the minimum standards.

By contrast, an assessment with a continuous measure of teacher expertise (or one that ranks candidates) focuses candidates on developing the strongest expertise possible. In this scenario, initial teacher education providers know they must develop deep expertise in all of their teachers. Schools can more easily differentiate among candidates because they have more information on which have the greatest expertise. Making candidate assessment data transparent creates a serious incentive for providers to pursue quality and helps teacher candidates decide which program to attend.

Teacher certification is the part of the pathway most prone to having assessments based on minimum standards. This is because there is no limit to the number of teachers that can be certified, as long as they meet the minimum bar. But because there are limits to the number of

[107] B. A. Jacob, 2016

teachers employed, rigorous selection assessments at employment that rank candidates can be powerful, particularly when the supply of teachers is greater than the demand.

3.2.1 Japan has rigorous employment exams for all teachers

Japan has an open initial teacher education system with over 1000 providers. Most institutes of higher education – of which there are hundreds – have teacher preparation programs.[108] With so many providers, admissions criteria vary significantly. This poses risks for the quality of courses and candidates. However, Japan has a rigorous process of selection later in the pathway – at the point of teacher employment.

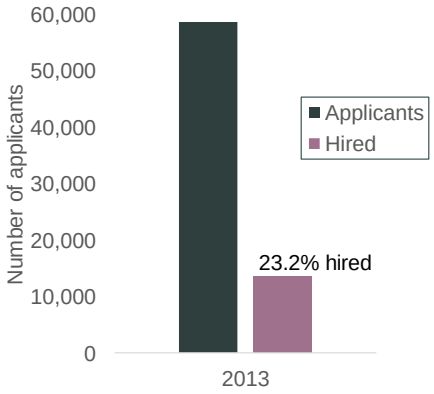
In Japan, graduates of initial teacher education programs must pass one or more employment exams set by the prefectural board of education they are seeking a job with. A team within the prefectural education office usually creates and administers these exams, though some prefectures use external consultants and companies to create the exams.[109] Different aspects of teacher aptitude can be tested, and exams may include demonstrations (e.g., in physical exercise, music, arts and crafts, and in foreign languages), microteaching, and preparation of lesson plans, interviews, essays, as well as written examinations.[110]

For example, the Saitama prefecture prepares and conducts the exam with a staff of about 15 who work on it full-time and many others who are involved part time or as advisers. The employment exam for primary school teachers covers content up to 10th grade in all subjects.[111]

The Japanese employment exams are different from teacher certification exams because these candidates are already qualified teacher education graduates authorised to teach. In Japan, it is relatively easy to become a licensed teacher with no extra steps after receiving a degree. Each year many more people are licensed than will receive teaching jobs. In 2012-2013, there were about 28,300 newly licensed primary school teachers and only about 13,600 public school positions.[112]

The employment exams move the most rigorous assessment of candidate skills to the point of hiring, working to filter out candidates who may not be well-prepared to teach. Each prefecture ranks candidates based on their employment exam score and selects only teachers from the top of the ranks.[113] There is no "passing" score that ensures a position – only top-achieving candidates will be offered a job. The competition for teaching jobs is high: in 2013, there were 4.3 candidates for every primary school teaching job.[114]

Figure 6: Aspiring primary teachers in Japan – examinees and hired teachers (2013)



Source: *Ministry of Education, Culture, Sports, Science and Technology – Japan, 2015*

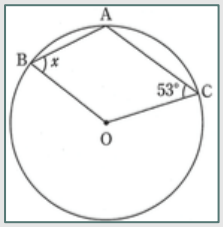
[108] As of May 1, 2008, 582 out of 729 universities (79.8%), 423 out of 597 graduate schools (70.9%), and 277 out of 385 junior colleges (71.9%) had teacher training courses.
Source: National Institute for Educational Policy Research, 2011
[109] Interview at Saitama prefecture.
[110] National Institute for Educational Policy Research, 2011.
[111] Interview at Saitama prefecture.
[112] Ministry of Education, Culture, Sports, Science and Technology - Japan, 2015
[113] Numano, 2010
[114] Ministry of Education, Culture, Sports, Science and Technology - Japan, 2015

The written examination includes a rigorous test of subject expertise in all subjects for primary teachers. It may also include sections on pedagogical theory and methods, educational psychology, and other related topics. Most prefectures also have a personal interview that often includes a demonstration lesson.[115] This process sends a powerful signal not only to teacher candidates but also to teacher education providers: teacher subject expertise is assessed because it matters. Initial teacher education courses know they need to develop deep subject expertise or their graduates will never get high scores in the employment exam. This has much greater impact than a focus of minimum standards.

Box 6: Sample maths and science employment exam questions

1. When the decimal part of $\sqrt{5}$ is χ, which is the right value for $\chi^2 + 4\chi + 4$?
a) 5
b) 10
c) 16
d) 25

2. The quadrangle ABOC is created by marking 3 points A, B and C on the circumference of a circle centred at point O. When $\angle BAC = \angle BOC$, and $\angle ACO = 53^o$, which is the right degree of $\angle ABO = \chi$?



a) 47^o
b) 57^o
c) 67^o
d) 77^o

3. What factor determines if the weather is either clear, fair, or cloudy?
a) The type of cloud
b) The shape of cloud
c) The percentage of steam
d) The ratio of clouds in the sky

4. Select the correct order of A to D, which describe the characteristics of sodium hydroxide aqueous solution.
- (A) A red litmus paper turns blue.
- (B) Phenolphthalein solution turns red.
- (C) BTB solution turns yellow.
- (D) A blue litmus paper turns red.

a) ABC
b) BCD
c) AB
d) BD

Questions are from the 2015 primary teacher employment exam in Saitama prefecture. Saitama Prefectural Board of Education, 2015. More examples from the employment exams can be found in the appendix.

[115] Ingersoll, 2007

4 Specialisation

In Australia, primary school teachers are likely to be generalists, teaching all (or many) subjects. Because they need deep subject expertise to teach well, primary school teachers have a unique problem – how can they develop expert knowledge in each of the many subjects they are teaching?

Specialisation is one way to help teachers develop deep expertise. All four high-performing systems studied in this report have some aspect of specialisation.

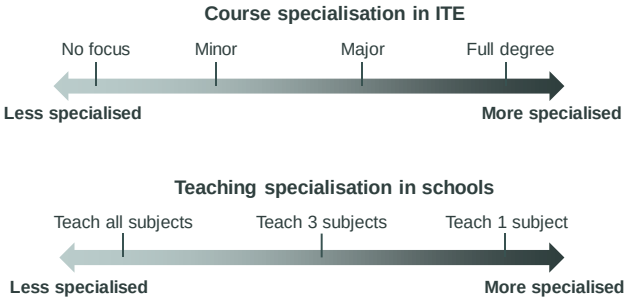
But specialisation in these systems is much more nuanced than what usual debates on the subject would suggest; it is not just about whether or not you only teach 4th grade maths in primary school. It is more helpful to think about the *degree* of specialisation, both in the range of primary subjects taught and in initial teacher education.

Thinking about the degree of specialisation in teaching and in initial teacher education opens up more possibilities for reform. Systems with generalist primary teachers can still help teachers develop specialist expertise without completely changing their job structure.

Specialisation can manifest itself in various ways, which makes it difficult to classify systems clearly as specialised or not. It is more useful to look at specialisation on a spectrum:

1. **In initial teacher education:** Do primary teachers have more training in one or a few subjects rather than equal training in all subjects?
2. **In schools**: Do primary teachers teach one or a few subjects instead of all subjects?[116]

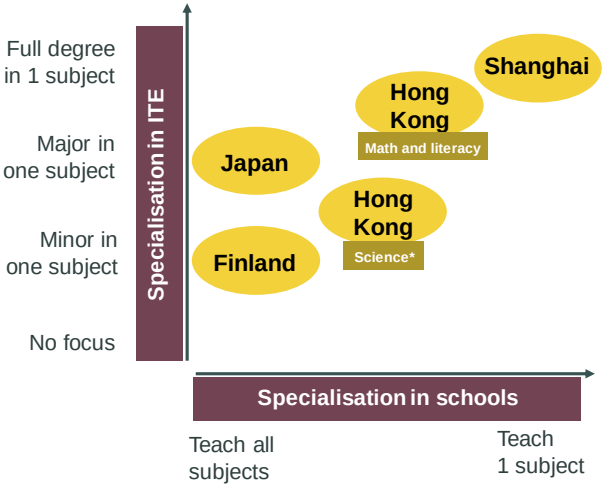
Figure 7: Two ways to map specialisation



While the four high-performing school systems each focus to some degree on teacher specialisation at the primary school level (in initial teacher education or schools or both), each system does this in a different way.

Finland and Shanghai occupy opposite positions on the specialisation spectrum. Primary school teachers in Finland generally teach many subjects, and teachers in Shanghai only teach one or a few.

Figure 8: Each system has a different approach to specialisation



Note: This is generally representative, but individual schools and initial teacher education programs within each system may have different models.
**In Hong Kong, science is included the subject called 'General Studies' which includes other subjects like social studies, but does not include maths or literacy which are each specialised subjects.*

[116] The literature also refers to the idea of specialist vs. generalist teachers as departmentalised vs. self-contained

In both Japan and Finland -- generalist systems[117] -- initial teacher education focuses on all subjects, but teachers choose a subject in which to major or minor. Japanese teachers generally choose one subject specialisation in initial teacher education; Finnish teachers generally choose two.

While teachers in these systems may not have deep subject expertise in every subject they teach upon completing initial teacher education, these systems recognise that subject knowledge is not just developed in a teacher education program. They expect teachers to develop additional expertise through in-school professional learning. And because each teacher has an area of deeper expertise, schools can ensure there is an expert in each subject on staff. (See the induction and professional learning chapters for more information on how these systems develop teacher subject expertise in all subjects.)

Hong Kong and Shanghai primary teachers, by contrast, specialise in both initial teacher education and in their teaching role. Shanghai is more strictly specialist than Hong Kong, where science teachers teach a subject called General Studies, which includes three Key Learning Areas: science; personal, social, and humanities education; and technology education. Because General Studies teachers must cover all three areas, they have a more generalist role than Hong Kong teachers of language or mathematics. In addition, all Hong Kong teachers are likely to teach some subjects outside their specialty, yet they are not full generalists like Finland and Japan.

4.1 Specialisation may help improve subject expertise

Specialisation is not the only way to improve teacher knowledge, but it makes sense logically that teaching fewer subjects allows more time to develop expertise. Currently, there is limited rigorous research on the effects of primary teacher specialisation. However, there are several potential benefits to in-school specialisation, where teachers only teach one or a few subjects:

- **Increased subject expertise**: With fewer subjects to teach, teachers can go deeper into the planning, preparation, and professional learning for their subject(s). They have more time to develop their pedagogical content knowledge and gain more confidence in their teaching abilities.[118]
- **Decreased workload:** Because teachers prepare for fewer subjects, they might work less and worry and burn out less, particularly in the first few years of teaching.[119]
- **Teachers can focus on subjects they are most interested in**: Depending on school need, teachers that have a passion for a particular subject can ideally focus on it more.[120]

Enhancing student-teacher relationships may help alleviate concerns with specialisation

One potential and important downside to in-school specialisation is diminished student-teacher relationships. Teachers who teach only one or two subjects have more students, and do not know their students as well as generalist (i.e. self-contained) teachers do.

A recent study of primary teacher specialisation in Houston found that it had negative effects on student outcomes. The authors discuss that this might be because teachers reported giving less attention to individual students, and because specialist teachers did not necessarily get additional education in their specialist subjects.[121] Opponents of specialisation believe that it

[117] This depends heavily on the size of the school. In smaller schools, teachers are more likely to teach all subjects, but in larger schools, teachers may specialise more in their roles.
[118] Strohl, Schmertzing, Schmertzing, & Hsiao, 2014
[119] Chang, Muñoz, & Koshewa, 2008; Gerretson, Bosnick, & Schofield, 2008
[120] Strohl et al., 2014; DelViscio & Muffs, 2007
[121] Fryer, 2016

reduces focus on the whole child and instead puts too much emphasis on academic subjects.[122] There is evidence that primary teachers in a generalist role have stronger relationships with students and that their students feel more connected to the school.[123] Parent-teacher relationships might also be weaker under specialisation, since teachers have more parents to build relationships with as they teach more classes across the same subject.[124]

One way to ease this concern is to combine teacher specialisation with teacher "looping". Looping is a practice in which teachers follow the same group of students for at least two school years, teaching them from one grade level to the next.[125] Looping has the benefit of improving relationships because teachers see the same students for several years.[126] It can also address some of the whole-child concerns with specialisation: looping may reduce student anxiety, help build student social skills, and improve student confidence.[127] It is common for teachers in Finland, Shanghai, and Japan to "loop" with their students: to follow the same group of students up to the next grade level for at least two or three years, and sometimes throughout every primary school grade level.

"Loopers" may actually have enhanced subject expertise because teachers are more familiar with the full conceptual picture of how student knowledge in one grade leads to learning in the next.[128] While some evidence suggests that random grade switching makes teachers less effective, loopers are typically assumed to not have this problem.[129] This is because of the benefits of improved relationships with individual students as well as the fact that moving one grade level up is not nearly as difficult as larger grade or subject level shifts.

4.2 Generalist teachers can have specialised training and development

Many schools and system do not want to change from a generalist model of primary school teaching, but they can still benefit from teachers having specialised knowledge.

In Japan, primary school teachers teach all subjects, sometimes including physical education, music and art. In many cases in Japan, teachers will even have to take an exam in music ability or physical fitness before they are hired to show that they can teach all subjects well.

Finnish primary school teachers also teach all subjects. In both Japan and Finland, schools are often flexible in how they structure this arrangement: for example, large schools may decide to have some teachers focus on only one or a few subjects. Despite this generalised approach, teachers in both countries are likely to partially specialise during their initial teacher education. In Japan, prospective primary school teachers often choose a major, which allows them to take extra subject expertise courses in one subject. In Finland, it is common for teachers to minor in one or two subjects.

4.2.1 Generalist teachers who specialise can become subject leaders

The benefit of requiring specialised knowledge in initial teacher education is that schools can strategically hire teachers to ensure they have expertise in each subject area. A teacher who trained more deeply in maths can lead the maths curriculum team and help other teachers with less subject expertise in maths.

For example, the Saitama prefecture in Japan recently selected a primary school teacher to take

[122] Strohl et al., 2014; Culyer, 1984
[123] Culyer, 1984; Chang et al., 2008
[124] Epstein & Dauber, 1991
[125] Burke, 1997; Forsten, Grant, Johnson, & Richardson, 1997; Hitz, Somers, & Jenlink, 2007
[126] Hanson, 1995; DelViscio & Muffs, 2007
[127] Little & Dacus, 1999; Hanson, 1995; Bracey, 1999; Gaustad, 1998; DelViscio & Muffs, 2007
[128] Ma, 1999
[129] B. Jacob & Rockoff, 2011; Blazar, 2015; Ost, 2014;

part in one year of specialist training in science. The prefecture had noticed declining student interest in science combined with the fact that not many teachers had a strong background in science. Once trained, the teacher offered science-specific demonstration lessons, feedback, and advice to other teachers in the prefecture.[130]

Saitama also developed a "core" science teacher system to further develop teacher knowledge in each municipality. Each municipality recommended a teacher to be trained at the prefecture and then these teachers were sent back to their local areas to help other primary school teachers in science. The training focused on subject expertise including specific teaching methods, such as conducting experiments.

Box 7: How generalist primary schools use specialist teachers

Sako Primary School (Tokushima, Japan)

At Sako Primary School, a Curriculum Coordinator acts as the main expert teacher for each subject. The 2015 science coordinator has 31 years of teaching experience and organises the monthly science curriculum plan for the whole school. He also mentors novice teachers. During the summer break period, he taught two new teachers how to use science teaching materials.

The principal appointed this coordinator because of his experience and expertise in science. The role may only last for one year – after which he may go back to full-time teaching. The principal believes that appointing teachers to such positions are some of the most important decisions he makes each year. The role of Curriculum Coordinator and other senior teaching roles are not paid significantly higher than other teaching roles, but the role carries prestige.

Source: Interview at Sako Primary School – November 2015

[130] Interview at Saitama prefecture – November 2015

5 Initial teacher education: foundational subject preparation

Initial teacher education is where most teacher candidates begin to develop knowledge specific to teaching. In Australia, where some teachers' own primary and secondary school education may be lacking, initial teacher education provides a critical opportunity to improve candidates' subject expertise before they become teachers.

Primary initial teacher preparation programs in the high-performing systems analysed in this report have three things in common. They:

- Focus on the foundational knowledge that teachers need at the primary school level
- Emphasise pedagogical content knowledge, not just general pedagogical skills
- Closely align training to a national school curriculum

The fact that initial teacher education programs in these countries focus on subject expertise development doesn't mean that primary school teachers all have Master's degrees or PhDs in their subjects. These education systems understand that it is more important for primary teachers to develop a deep and flexible understanding of foundational content rather than just advanced content. This means that, for primary teacher education, expertise in fractions is more valued than expertise in calculus. Advanced content can be helpful, and is incorporated into many courses, but it is not the main focus of primary preparation programs.

These high-performing systems develop subject expertise not just across their courses, but also in practicums and in other program experiences, such as studying abroad for additional language skills.

In Australia, debate about developing subject expertise in primary teachers has focused exclusively on content knowledge, or a lack of it, and rarely on pedagogy connected to that content. High performing countries, by contrast, recognise the importance of subject specific pedagogy and make it central to their training of primary teachers.

These systems also connect teacher training to a national primary school curriculum. All four systems studied in this report have a national primary school curriculum, although there is some ability for districts and schools to adapt it to the local environment. To varying degrees, initial teacher education institutions have based their curriculum on the content knowledge and pedagogical content knowledge that primary teachers will most need in the classroom to teach the primary curriculum. It is common for the curriculum to be updated regularly (every 10 years in Japan, for example) and for the central authorities to consult heavily with initial teacher education providers during the revision process so that their courses reflect the most up-to-date curriculum.

Quality is more important than quantity

The emphasis on subject expertise development in this report does not imply that systems should simply increase the quantity of subject expertise courses in initial teacher education, or regulate which courses teachers should be required to take.

The mere fact that a teacher goes through a course says little about the amount she has learned in that course. And because courses almost certainly vary significantly in quality, there is no clear correlation between the number or type of courses a teacher takes and her performance in a classroom.[131]

It is therefore more important for systems not to overemphasise inputs and instead focus on outputs: the level of subject expertise teachers

[131] Aldeman & Mitchel, 2016

gain and its eventual impact on student achievement. To achieve this result, systems must focus on careful evaluation of changes to initial teacher education programs and policies in order to build the evidence base for how best to develop subject and pedagogical expertise in teachers.

Research on teacher preparation quality is limited

Because of a poor evidence base on "what works" in initial teacher education, policymakers need to emphasise the creation and effective use of evaluative data on new programs and policies in order to build the evidence base. Gaps in research include:

- **Little consistency on how to measure teacher knowledge.** Many studies use proxy measures, such as the number of courses taken, in order to assess teacher knowledge. More valuable direct measures such as exams are less common.[132] Only in recent years have researchers tried to develop more direct tests of relevant subject expertise in preservice and in-service teachers. Much of this work has focused on mathematics.[133]
- **Little data on teacher education candidates.** Very few initial teacher education programs assess teacher subject expertise on entry to programs or at graduation. Few make any attempt to document teachers' existing level of knowledge in a bid to design subject area coursework more effectively.
- **Difficult to isolate the effects of one course or program.** When teachers' knowledge grows, it is often hard to attribute it to one factor among many potential causes. And because few longitudinal studies follow preservice teachers as they move into teaching, studies that measure improvements in teacher knowledge cannot say how initial teacher education affects teaching and student learning.[134]

5.1 Specialisation in initial teacher education can help develop deeper knowledge

Initial teacher education is time-constrained. Because programs only have time for a certain number of courses and learning programs, it can be difficult to create enough opportunities for primary school teachers to develop subject expertise in the many subjects most teach. Systems can partially address this problem by allowing primary school teachers to specialise during initial teacher education. They can either fully specialise and prepare to teach just one subject (just literacy, for example), or they can partially specialise by choosing one to two subjects for a major or minor while still preparing for a generalist role.

There are two types of initial teacher education design in the systems studied: one for teachers who will be generalists (Finland and Japan), the other for teachers who will specialise (Shanghai and Hong Kong). The latter programs leave more time for courses in content knowledge, because prospective teachers are taking most courses in just one subject. For example, a student teacher in Hong Kong who wants to be a specialist primary maths teacher can focus her initial teacher education around building deep maths expertise. Teachers in generalist programs take courses in all subjects, so they naturally spend less time on each.

Nevertheless, the generalist systems analysed in this report (Japan and Finland) have teachers choose one or two subjects for a partial specialisation. Although they still have to prepare to teach all subjects, they take the equivalent of a

[132] Many studies measure changes in teacher beliefs or confidence, which may or may not actually translate to more effective teaching. For instance, Bursal, 2012 studied the impact of a science methods course for primary teachers and found that while almost all participants were confident in their science knowledge at the end of the course, 40% of the class failed a science misconceptions test. See more discussion in Diamond et al., 2013; Hill, Schilling, & Ball, 2004

[133] Kleickmann et al., 2013 Gitomer & Zisk, 2015

[134] National Institute of Child Health and Human Development, 2000

major or minor in a subject they choose. This gives them the opportunity to go deeper in content knowledge and pedagogical content knowledge for that subject, thereby developing subject expertise.

5.2 Specialist systems: Hong Kong and Shanghai

In Hong Kong and Shanghai, teachers often choose a specialised program for the subject they want to teach in primary school. The programs have a relatively large focus on content knowledge, because teacher candidates are mainly taking courses in just one or two subjects. Pedagogical content knowledge is also an important component of these programs.

5.2.1 Hong Kong

Primary school teachers in Hong Kong who teach literary or maths specialise in just one subject. Teacher candidates apply to a maths program or the literacy program, and the majority of courses within the program are focused on that one subject area. This means that maths and literacy teachers are required to take a large number of courses in their one subject area, which helps to develop deep expertise. The teacher education programs have in-depth coverage of the foundational content needed for primary teaching, and have time to cover some advanced content as well.

Primary science teachers in Hong Kong teach science within a "general studies" subject area that covers science; technology; and personal, social and humanities studies. So, science teachers have a more generalist role than other teachers as they prepare for all three general studies subjects in teacher education programs.

Example initial teacher education provider: Education University of Hong Kong[135]

At the Education University of Hong Kong, about a quarter of a five-year primary school maths program focuses on maths content. The students in the program are considered to have majored in maths for primary school.

Box 8: Required courses for a five-year primary school maths program (2015)

Required courses for maths major:

- Geometry and measurement
- Understanding numbers (overview of basic number concepts in primary school maths)
- Primary number theory (e.g., properties of integers)
- Problem-solving
- Recreational mathematics (activity approach of learning/teaching maths)
- Essential mathematical concepts (e.g., logical reasoning and rigorous mathematical language)
- Development of mathematical ideas (overview of origin of important mathematical ideas)
- Mathematical exploration with technology
- Probability
- Learning, teaching, and assessment in primary mathematics
- Curriculum and teaching of selected topics in primary mathematics

Elective courses (must choose one from each pair):

- A) Introduction to analysis or B) Calculus
- A) Statistics or B) Statistical modelling
- A) Vectors and geometry or B) Linear algebra
- A) Modern algebra or B) Plane geometry

Full curriculum available in appendix
Source: Hong Kong Institute of Education, 2015

Prospective general studies teachers also take about 25 percent of courses in their major. But these courses are split among the three subjects within general studies. With more limited course time, the program cannot go as deeply into content knowledge for science as do courses for maths or literacy teachers. Instead, the program focuses less on content knowledge and more on pedagogical content knowledge. For example, the general studies major includes the following core

[135] Formerly known as the Hong Kong Institute of Education

courses related to science (but there are also elements of other general studies subjects):

- Environmental science
- Healthy living
- Children's science learning
- Natural world
- Science, technology, and society

The science taught to teachers in the general studies major at the Education University of Hong Kong is closely linked to the primary school curriculum. It is therefore focused less on typical hard sciences and more on science related to daily life. The courses aim to give teachers strategies to incorporate science into lessons on other topics. The curriculum, like the general studies curriculum in schools, also emphasises interdisciplinary learning.

Students taking the general studies major at the Education University of Hong Kong are usually from an arts rather than a science background. Some, like primary teachers in Australia, might not be particularly interested in science, and may avoid teaching it once in schools.[136]

To generate interest in science and model teaching strategies, the general studies courses are taught with an inquiry approach: teachers design activities for classes with a science component. The approach is hands-on, with discussion and simulation.

5.2.2 Shanghai

Shanghai also prepares teachers to be specialists, so programs have a relatively large focus on content knowledge. During a four-year bachelor's program, up to 20 to 25 per cent of courses build subject expertise in the chosen specialisation area. As in the other systems, the subject expertise courses are focused on knowledge at the primary school level. However, because teachers are being prepared for specialist roles, there is time to include advanced concepts in the program. For primary school teachers, most courses for subject expertise are housed in the education department, which means they are designed specifically for teachers, not a general audience.

While many systems worry about the maths competency of primary school teachers, Shanghai is particularly proud of how it prepares and develops maths teachers. Initial teacher education programs are designed to ensure maths teachers are experts in the subject. A primary maths education professor at Shanghai Normal University said: "In China, the mathematics teacher is like a mathematician."[137]

In Shanghai, as in Finland, all prospective primary school teachers must complete a research thesis. This, along with a collaborative practicum experience, prepares teachers with a research mindset that they will use to continually develop subject expertise after initial teacher education.

Example initial teacher education provider: Shanghai Normal University

Shanghai Normal is a large university that has prepared about 70 per cent of primary school teachers in Shanghai. Prospective primary school teachers can choose one of three specific discipline strands: language-social sciences, maths-natural sciences, and performance or fine arts and crafts.[138]

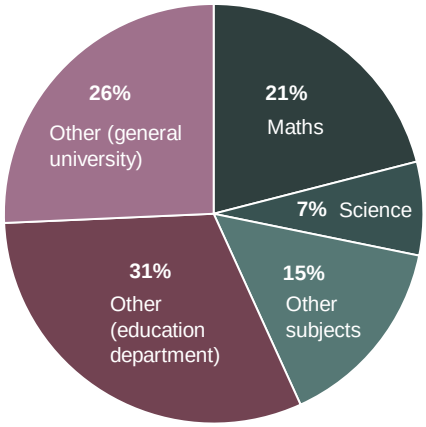
Aspiring primary school maths teachers take the maths-science strand and therefore have a few science courses as well. They also take a few courses in other subjects taught in primary school, such as Chinese character writing and basic music theory.

[136] Interview with professor at Education University of Hong Kong, 2015

[137] Interview with professor from Shanghai Normal University – January 2016

[138] Zhang, Xu, & Sun, 2014

Figure 9: Prospective Shanghai Normal primary maths teachers take about 21 per cent of courses in maths subject expertise



Source: Shanghai Normal curriculum[139]

Student teachers take courses at the foundational primary school level (such as early primary number theory), but they also take courses in advanced maths topics (such as calculus). Almost all maths courses are taught by faculty in the education department.

Figure 10: Maths subject expertise courses at Shanghai Normal University
Foundational content in bold.

Year	Maths courses taken
1	• Advanced mathematics • Calculus • **Early elementary number theory**
2	• **Real numbers** • Linear algebra and analytical geometry
3	• **Probability** • **Mathematical thinking and methods** • **Mathematical culture** • **Primary maths curriculum and teaching** • **Clinical case studies of primary maths teaching**
4	• Thesis

Source: Shanghai Normal University curriculum

Prospective maths teachers are also likely to take the following electives in second and third year:

- Primary mathematics research
- Discrete mathematics
- Combinatorial mathematics
- Primary maths Olympiad counselling
- Probability and statistics

5.3 Generalist systems: Finland and Japan

Finnish and Japanese primary teachers teach all subjects, so they must train in all subjects. Accordingly, programs have a few required courses in each subject that touch on the basics of content knowledge and pedagogical content knowledge but, with limited course time, they cannot go into too much depth. The few required courses for each subject are usually focused directly on the foundational matter needed for primary school teaching.

Nevertheless, as well as taking courses for a generalist subject expertise curriculum, teachers in Finland and Japan also choose a major and/or minor subject in which to specialise and develop deeper subject expertise. In so doing, they develop strong research skills, they learn how to deeply understand student assessment in their chosen subject area, and they develop the skills to evaluate the impact of their own practice on students.

These skills set them up for a career in which they can further develop subject expertise across all subjects they teach. So even though they specialise in only one subject, they develop the research, evaluative and inquiry skills that are fundamental to effective professional learning once they are in schools.

[139] Optional elective courses that were maths were included as part of the maths category, but others were included in the other-education department category.

Teachers can also use their specialised subject expertise to improve their school. After some teaching experience, they may become the expert in their school for their chosen subject, able to lead curriculum discussions and mentor teachers with less subject expertise.

Pedagogical content knowledge (although it is not always called that) is also a big focus of generalist initial teacher education courses in Finland and Japan. Courses teach a range of pedagogical strategies, including how to recognise and correct common student misunderstandings and how to differentiate instruction to ensure learning across the broad range of abilities teachers are likely to encounter in the classroom.

5.3.1 Finnish primary teacher education

Each teacher in Finland must have both a bachelor's and master's degree, and initial teacher education programs comprise at least five years of study that include both degrees. Primary school student teachers only have a few required courses in each subject throughout their study. This is a tiny amount of time to try to pack in subject expertise, so the courses do not focus directly on content knowledge and instead are designed to teach pedagogical content knowledge basics.

Finnish primary teachers are expected to get their content knowledge by:

1. Strong school preparation: The bar is set high for entry into initial teacher education, and the quality of primary and secondary education in general is excellent. So, professors often assume that incoming student teachers are well prepared with the content knowledge needed to teach primary school.

> *"They have been studying it for 12 years already, and if they don't know it, I can't change it in this small amount of time." – Academic staff member, University of Jyväskylä*

Nevertheless, Finnish student teachers do not come in with perfect content knowledge. They have some of the same challenges as Australian teacher candidates, including generally being stronger in literacy skills rather than in maths or science. Professors at the University of Jyväskylä explain that matriculating student teachers have at least some maths difficulties and only 5 per cent have previously taken more than one course in science.[140]

2. Self-study of content knowledge gaps: While there may not be time to directly teach content knowledge in initial teacher education courses, professors trust their students to overcome any knowledge gaps on their own. They supervise student teacher progress and monitor the depth and level of their content knowledge. When gaps are identified, students are directed to further readings.

For example, a literacy professor at the University of Helsinki says that she does not explicitly teach her students parts of speech (such as nouns, verbs, adjectives) because she expects them to already have background knowledge. When students need a review of parts of speech concepts, she recommends a book to read on their own which addresses the gaps in knowledge.[141]

Box 9: Subjects for which Finnish primary school teachers must prepare

As generalists, Finnish teachers must prepare to teach many subjects. Student teachers at the University of Jyväskylä take two courses each in:

- Finnish language and literature
- History and social studies
- Religion and ethics
- Art
- Physical and health education
- Mathematics
- Music
- Technology education and technical handicraft
- Handicraft education and textile handicraft
- Environmental and natural science

[140] Interviews with professors at the University of Jyväskylä in 2015

[141] Interview with a professor at the University of Helsinki in 2015

Finland requires all teachers to complete a master's degree with a thesis. Part of the goal of this is to help teachers develop research skills that they can employ once in schools to help develop their knowledge and practice. Therefore, part of the initial teacher education curriculum is training in research methods. This training not only helps with teaching research skills but also builds knowledge in maths and science topics related to research skills, such as statistical analysis.

As part of the generalist curriculum, primary teacher candidates take a few subject expertise courses in each of the many subjects they teach. These courses are mostly focused on pedagogical content knowledge and cover topics specific to primary school teaching. Because of the many subjects that must be covered, there are usually just two to three courses for each subject (see University of Jyväskylä example below for more detailed information).

Finnish initial teacher education for primary teachers tends to be fairly practical, but that does not mean teacher candidates aren't expected to learn theory. Many courses are structured to require relatively heavy out-of-class reading.

Box 10: One Finnish student teacher's experience studying abroad in the US

At the University of Jyväskylä, some student teachers participating in a special English-language initial teacher education program have studied abroad in the US. These Finnish teachers have had the unique experience of being able to compare teacher education in Finland and the US.

One student teacher explained that one of the biggest differences between Finland and the US was that Finnish initial teacher education felt a lot more practical but also required much more reading of academic texts. She explained that she didn't feel like her Finnish teacher education was more challenging overall but that the work required in the US felt less relevant.

Source: Interview at the University of Jyväskylä – November 2015

How Finnish teachers specialise in initial teacher education

As well as taking a few subject expertise courses in each subject, teacher candidates also choose minors in which to develop specialised knowledge. These minors can represent up to 20 per cent of the total curriculum, so there is significant opportunity to develop deep knowledge in an area of choice.

Depending on the subject, the courses for a minor may exist inside the department of teacher education or in another faculty at the university. For example, teacher candidates may choose to minor in subjects such as special education, physical education, music education, or early childhood education, all of which are in the department of teacher education.

But if a teacher chooses to minor in a science or maths subject, she will likely take courses in the science or mathematics faculties. These courses are for all university students, and they do not address knowledge specific to teaching. The popularity of these types of minors may differ depending on the university. At the University of Jyväskylä, it is fairly rare for teachers to choose minors in these subjects.[142] At the University of Helsinki, by contrast, mathematics, history, and geography are popular minors.[143]

It is becoming more popular for primary student teachers to do dual degrees, in which they take enough subject expertise courses to qualify to teach secondary as well as primary school.[144] This would mean effectively taking the equivalent of a major of subject expertise courses in a chosen subject (such as physics) as well as the courses that make up the generalist core of subject expertise courses.

[142] Correspondence with the University of Jyväskylä, February 2016
[143] Correspondence with the University of Helsinki, February 2016
[144] Correspondence with the Trade Union of Education in Finland, February 2016

Example initial teacher education curriculum: University of Jyväskylä

At the University of Jyväskylä, preservice teachers take two mandatory courses – a basic and an applied course -- in each teaching subject. Classes teach limited content knowledge, yet even though the focus is on pedagogical content knowledge, some content knowledge is taught through the examples discussed in class.

Example: Basic maths course

The basic course involves four lectures and 10 small group seminars (90 minutes each). It includes general teaching topics related to all maths subjects, as well as the specific subjects of geometry, calculation with large numbers, fractions, and pre-algebra. General topics include:

- Using manipulatives
- Introducing a number system as an unfamiliar topic to students
- Fears of and feelings about maths
- Hypothetical situations from the classroom
- Computer software to use for maths instruction
- Inquiry-based maths

The lectures tend to consider these topics from a more theoretical standpoint than the seminars do, though each has a strong focus on developing pedagogy.

The applied course focuses more on practice than on theory and takes a number of interdisciplinary approaches, such as teaching mathematics through inquiry-based design and combining maths with computers or art.

5.3.2 Japan's initial teacher education

In Japan, the Ministry of Education sets a minimum number of content and pedagogy courses that initial teacher education candidates must take. However, many universities design programs that include far more subject expertise courses than the minimum required. Teacher education providers might have an incentive to make sure primary teachers graduate with enough subject expertise because they want to make sure their students can score highly on the employment exam.

For example, Tokyo Gakugei University, a prominent teacher education university, emphasises subject expertise by requiring more than three times the number of subject expertise courses as the minimum set by the Ministry of Education.[145] Prospective teachers study nine subject areas and take two courses for each. Professors acknowledge that the courses give only a glimpse of pedagogical content knowledge, and that most is developed in lesson study once teachers are in schools.

Japan is known for developing teachers through lesson study -- in-school professional learning that is subject-specific and improves pedagogical content knowledge (see professional learning section for more information on lesson study). But lesson study is introduced in initial teacher education and is central to candidates' development, particularly during the practicum.

As in Finland, Japanese primary initial teacher education programs prepare teachers for all subjects but still have specialisation in one or a few. At Tokyo Gakugei University, teachers may specialise in subjects such as maths or science.

Example initial teacher education curriculum: Naruto University of Education

Naruto University of Education in Tokushima prefecture is a relatively small teacher education university that recently redesigned its curriculum. All prospective teachers – primary and secondary – must now take "core" courses for each subject developed in collaboration by a subject expert, a pedagogy expert, and a veteran teacher. The three work together to make sure the courses emphasise pedagogical content knowledge and the combination of theory and practice.[146]

[145] Interview at Tokyo Gakugei University in November 2015

[146] Interview at Naruto University of Education in November 2015

Teacher candidates take three core courses in each of ten subjects: Japanese, English, society, mathematics, science, music, arts, physical education, technology, and home economics. These three core courses cover the basics of the subject, and student teachers then choose one subject in which to specialise.

For example, the compulsory core maths courses explain basics of teaching maths in primary and lower secondary school. They include instruction on:

- The school curriculum (referencing the Ministry of Education's Course of Study)
- How young children learn maths
- Teaching methods for mathematics
- Overview of key content taught in early years, upper primary, and lower secondary
- Practice creating lesson plans and micro teaching

If a teacher candidate decides to specialise in maths, she takes the equivalent of a major. The maths program is designed to have a foundation in arithmetic, but includes courses in more advanced mathematics as well. There are two "fundamental mathematics" courses that are not required, but they are recommended to students who do not have a strong maths background from school. In practice, almost all primary mathematics majors take these two courses.

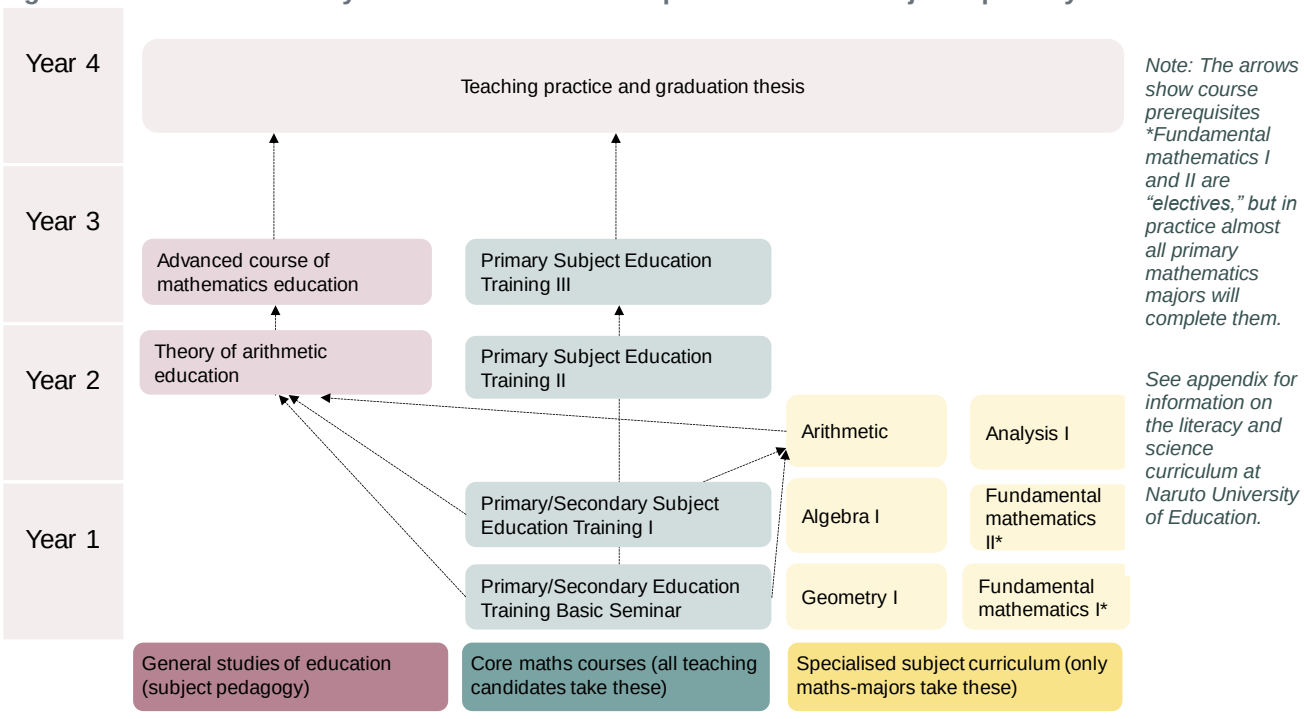
The maths major includes courses focused on both content knowledge and pedagogical content knowledge. Content knowledge courses include:

- Arithmetic I
- Geometry I
- Algebra I
- Fundamental Mathematics I (mathematics learnt in high school, such as quadratic functions)
- Fundamental Mathematics II (bridging high school to university level maths, such as derivatives and integration)
- Analysis I (advanced calculus subsequent to fundamental mathematics courses)

Geometry, algebra, and analysis have subsequent and more advanced elective sections.

Maths majors also take pedagogical content knowledge courses on teaching methods for each key area of primary mathematics. These courses teach the basics of primary mathematics assessment and require sample lesson plan design and a simulated practice lesson.

Figure 11: Naruto University of Education course requirements for a major in primary mathematics

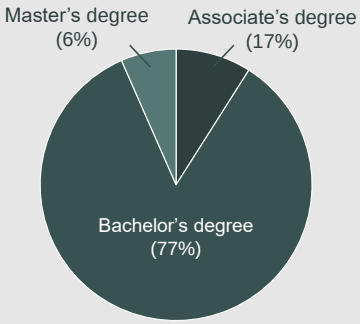


Box 11: In Japan, few teachers have master's degrees

In Japan, completing an initial teacher education program is the only requirement for becoming a certified teacher. Most primary teachers are certified after completing a four-year bachelor's program and few complete a master's. Unlike in Finland, there is no requirement to have a master's, and teachers with one are not more likely to be promoted or better paid.

Prefectural boards of education sometimes select veteran teachers to complete an advanced certification, but few teachers are chosen each year and the process is usually very competitive.[147]

Proportion of primary school teachers with each degree type (2015)



Note: Teachers with an Associate's degree are expected to eventually complete a Bachelor's degree.
Source: Ministry of Education, Culture, Sports, Science and Technology – Japan, 2015

5.3.3 Practicums include strong subject expertise focus

Practicums can be a time to further develop pedagogical content knowledge since teacher candidates are exposed to student thinking and learning. But in many systems, practicums are focused mostly on general pedagogy instead of subject-specific skills. In addition, many student teachers are placed in host schools that have little capacity to provide a mentor teacher with deep subject expertise.[148]

The teacher training schools in Finland (i.e. the school attached to the initial teacher education provider) gradually give students control of the classroom during the practicum and tend to focus on subject expertise during the later stages. First, student teachers observe lessons and have discussions. Then they focus on lesson planning. Lastly, they focus on subject expertise, particularly in teaching the subject in which they have chosen to specialise. Student teachers also begin to get familiar with classroom textbooks during practicums since teachers, especially new ones, tend to rely heavily on these instructional materials, which help with gaps in subject expertise (see more in the chapter on instructional materials).[149]

Box 12: Lesson study is introduced during the practicum as a way to continually develop subject expertise once in schools

At Tokyo Gakugei University, student teachers have short practicums where they are introduced to the lesson study process. The process helps teachers practice anticipation of student thinking, which is a key part of pedagogical content knowledge. The process is also collaborative, so that novice teachers do not have to rely on their own subject expertise to design the lesson, but can call on subject experts for feedback and advice.

Example of lesson study during practicum

Before a second-grade maths class, a group of student teachers work together to anticipate student thinking for a geometry lesson. One is charged with instruction, while others, along with a maths subject expert, observe and take notes.

At the end of the class, they meet to discuss how well they anticipated student responses. They now know more about student thinking in regard to this geometry topic, and they have new ideas about how to best present the material in class. They will write a short reflection on the class as part of their assessment for the practicum.

Tokyo Gakugei University, November 2015

[147] Wang, Coleman, Coley, & Phelps, 2003
[148] Roberts-Hull et al., 2015
[149] Interview at the University of Jyväskylä – November 2015

In Japan, practicums are short, sometimes only three to four weeks. [150] However, initial teacher education programs use them to introduce teachers to lesson study – the method by which teachers develop subject expertise in schools. Since initial teacher education can never fully prepare teachers with all the subject expertise they need, it is important for teachers to understand how to continuously gain subject expertise once they are in their jobs. This is why teacher education providers construct the practicum to introduce the practice of lesson study to student teachers.

5.4 System leaders can work to build the capacity of initial teacher education providers

Without reforms to influence the content, quality, and practices of initial teacher education providers, policymakers have little ability to shape incoming teachers. Building the capacity of providers is difficult. The initial teacher education environment in many systems is often complex, and providers are highly autonomous.[151] Some high-performing systems are overcoming these complexities in three key ways:

1. Evaluation
2. Strategic funding
3. Relationships and dialogue

With these policy reforms, some initial teacher education providers in high-performing systems have also found ways to build their own capacity.

Evaluation

High-quality evaluation is an important part of building capacity and improving performance in all sectors. Government focus on the evaluation of initial teacher education is growing and is reflected in national and sub-national level policies.

This growing focus is a response to increasing global competition[152] and a desire on the part of initial teacher education providers and institutions to comply with the evolving norms of the teaching profession.[153]

Many countries see the need to improve initial teacher education as urgent. The stakes are high: the consequences of ineffective policy and structures to improve initial teacher education flow directly into the classroom, especially when assessments of teacher expertise throughout the teacher education pathway are not strong enough.

High-quality evaluative processes require both adherence to the key features of evaluation in general, and the implementation of meaningful consequences that truly influence providers and support teacher development. A number of systems have committed to investing in evaluation measures with consequences. These consequences include:

- The design and implementation of a plan for improvement
- Changes in funding and/or administrative support
- Implications for reaccreditation
- Publicised evaluation results

Funding

Funding reforms can create incentives for initial teacher education providers to build their capacity in specific areas. Because initial teacher education receives significant public funding in most systems, increases or decreases in funding can be tied to the quality of programs or to targeted areas of strategic development.[154] System leaders can directly fund the development of better courses or improved practical experiences based on evidence, or fund research

[150] National Institute for Educational Policy Research, 2011; Wang et al., 2003
[151] Roberts-Hull et al., 2015
[152] See, for example, Chong, S. & Ho, P., 2009; and Hou, A. Y. C., n.d.
[153] See, for example, World Bank, 2007
[154] Roberts-Hull et al., 2015

into effective initial teacher education, as little evidence exists.

Relationships and dialogue

Regular, meaningful dialogue between governments and initial teacher education providers can lead to more effective policy reform. These relationships can be direct – when government representatives meet with individual initial teacher education providers -- or government can facilitate group dialogue among a number of providers. System leaders can facilitate partnerships to share knowledge, since initial teacher education providers may be able to learn most from other programs that are already producing strong beginning teachers. The group dialogue approach can be very cost effective, as it relies on sharing existing resources.

Both approaches have the benefit of building the capacity of initial teacher education providers without having to rely on heavy-handed regulation. Where initial teacher education providers are in competition, however, the group dialogue approach may not be as successful. In that case, it may make sense to create partnerships among providers that are in different regions or serve different groups of teacher candidates.

5.4.1 Finland's system leaders aim to encourage collaboration

Finland's Ministry of Education and Culture in works closely with initial teacher education providers to build capacity. The initial teacher education system is characterised by a small number of autonomous initial teacher education providers that collaborate with each other and with the Ministry of Education and Culture. The Ministry's close relationship with providers ensures that system leaders have influence over initial teacher education quality without the need to regulate and constrict provider autonomy.

The relationship is possible partially because of the small number of providers and the government's funding (and limiting) of initial teacher education spots. There is not much of a culture of competition among initial teacher education providers. The Ministry has the goal of disseminating quality evenly among providers and does not see a need to rank them in quality or designate "top" providers.[155]

Collaboration with deans helps with initial teacher education enrolment projections

With just eight providers in the country, the Ministry has the opportunity to meet regularly with initial teacher education deans. It has formal annual conversations to discuss disseminating good-quality practices across universities.

The Ministry limits the number of initial teacher education spaces based on workforce projections. It also discusses these projections with providers in order to collect and discuss workforce information relevant to the four-yearly quota negotiation process. The information that feeds into this process includes survey data collected by Statistics Finland and universities' own enrolment data and assessment of their likely future needs.

The Statistics Finland data are highly detailed, including employment data, information on the average retirement age, average class sizes, and the amount and type of professional development teachers have undertaken since the last survey.

Together, these information sources help the Ministry determine how many teachers will need to be trained to meet national demand. The universities have the autonomy to decide their own program allocations within the Ministry's funding allocation, but they typically take the Ministry's advice on whether they are over- or under-producing particular types of teachers.

For example, in 2015, Finnish universities were overproducing history teachers, which has lowered their employment rate. The Ministry is

[155] Interview at the Finnish Ministry of Education and Culture, November 2015

engaging with the universities to decrease their intake of potential history teachers.[156]

Strategic funding

The Ministry also provides strategic funding to providers to build capacity in specific areas (such as developing second language teachers). It does so in a way that respects providers' autonomy, inviting universities to help set the direction for strategic funding. It is typical for one or two universities to take the lead on initial teacher education reform strategy in consultation with the other universities.

The government has also designated 50 million euros for the Ministry to work on initial teacher education reform with the Trade Union of Education in Finland, the universities, polytechnics, the association of Finnish local and regional authorities, and the Teacher Student Union of Finland. A series of forums, which involve around 60 attendees, will be held over two to three years to set goals for specific areas of reform.[157]

Evaluation with the goal of support

Even though initial teacher education providers have ample autonomy, every department of teacher education must have a strategy for improving the quality of their programs.[158]

The Ministry also conducts a comprehensive teacher education evaluation every 10 years, with an evaluation underway from 2016. The evaluation involves researchers looking at the efficacy of initial teacher education and in-service professional education, and it tries to predict the future needs of the teacher workforce. The evaluation is facilitated by the Finnish Higher Education Evaluation Council, an independent body that operates under the Ministry's auspices. The process aims to build provider capacity and is not punitive.

Box 13: Initial teacher education evaluation process in Finland

1. **Upfront collaboration:** The Finnish Higher Education Evaluation Council and initial teacher education providers work together to establish timeframe, targets, and procedures for an audit every decade.
2. **Self-evaluation:** Completed by the provider as a first step.
3. **Site visits:** The Finnish Higher Education Evaluation Council-appointed audit team visits the provider, staying three to five days depending on the size of the institution and the agreed scope of the audit.
4. **Report on strengths and areas for development:** The audit team issues a report outlining the strengths of the initial teacher education provider's practice and areas for further development.
5. **Follow-up:** If there are any major problems, a re-audit may be conducted to see if the provider is improving over time.

Source: Adapted from Tatto, Krajcik, & Pippin, 2013, referencing Finnish Higher Education Evaluation Council (2013)

5.4.2 Hong Kong aims to increase competition to improve initial teacher education

Hong Kong has also moved to build initial teacher education capacity, though in a very different way from Finland. Hong Kong policy makers describe a market-driven initial teacher education system with a goal of creating competition to induce innovation. Initial teacher education providers have both autonomy and academic freedom.

Even with its focus on competition, there are still just five initial teacher education providers in Hong Kong, and four have government-funded places that are limited based on demand for new teachers.

The Hong Kong Education Bureau's relationship with initial teacher education providers is just as

[156] Interview at the Finnish Ministry of Education and Culture, November 2015

[157] Interviews at the Trade Union of Education in Finland and Finnish National Board of Education, November 2015

[158] Sahlberg, 2014

strong as that of Finland's central governing body. The Bureau works closely with providers through several initiatives to help them improve over time.

Special committees for initial teacher education engagement

The Bureau provides professional and secretarial support to the Committee on Professional Development of Teachers and Principals. The Committee focuses on improving teacher professional development across the teacher education pathway.

The Committee also has a subcommittee on initial teacher education that engages in professional exchange with providers to review and develop programs and set goals for initial teacher education graduates. Members of the subcommittee on initial teacher education include principals, academics, parents, and government representatives.[159]

The Committee on Professional Development of Teachers and Principals is developing two key initiatives -- T-dataset and T-bridge[160] -- that aim to improve initial teacher education. These initiatives will collect data, start dialogue with teacher education providers, and issue recommendations based on findings.

T-dataset will seek to build initial teacher education capacity by strengthening feedback loops between initial teacher education providers and schools. The initiative seeks to survey veteran and new teachers, principals, and school-sponsoring bodies to determine the gap between school expectations and the performance of new teachers. The Committee on Professional Development of Teachers and Principals will feed this data back to initial teacher education providers and use it as the basis of meetings aimed at building capacity.[161]

T-bridge has a goal of bridging the theory-practice gap when initial teacher education graduates go from academic learning into practical experiences in schools. The project will facilitate better communication between schools and initial teacher education programs. It will also study ways of improving the practicum experience by looking at practices from overseas, such as internships and clinical models.[162]

Box 14: Hong Kong workforce planning

Hong Kong does workforce planning for four critical professions: teachers, lawyers, social workers, and medical professionals.

Every three years the Education Bureau advises the funding body, the University Grants Committee, on projected demand for teachers. This information enables the University Grants Committee to allocate initial teacher education places to the four institutions it funds. The Committee stipulates a certain number of places and then universities bid for a share.

The projected demand and supply of teachers is created based on information from the Census and Statistics Department's population projections combined with information from relevant divisions in the Education Bureau (for example, Curriculum Development Institution, Special Education and Kindergarten Education Division).

Providers are allocated a certain number of government-funded places, but they can decide on their own admission criteria in selecting candidates. Universities may admit students for places that are not government-funded, but this is less common except for one fully self-funding initial teacher education provider.

Source: Correspondence with Education Bureau – Dec. 2015

[159] Committee on Professional Development of Teachers and Principals, 2015; for more details: http://cotap.hk/index.php/en/sub-committee-on-initial-teacher-education-scite/membership-list-scite

[160] T-dataset and T-bridge are under the overarching project "T-excel@hk", where the 't' stands for the teaching profession.

[161] Committee on Professional Development of Teachers and Principals, 2015, p 34-35

[162] Committee on Professional Development of Teachers and Principals, 2015, p 46-47

Strategic funding

As in Finland, Hong Kong's Education Bureau Kong has a history of engaging in strategic funding to build initial teacher education capacity. Hong Kong has a strong focus on improving teacher language skills and has developed funding initiatives specifically for this subject.

For example, language immersion programs for English and Mandarin teachers are now a part of most initial teacher education programs because of government funding.[163] These programs, implemented in 2002, allow student teachers to study abroad for deeper language learning.

Quality Education Fund

In 1998, the Bureau established the Quality Education Fund with HK$5 billion ($A870 million) to support improvements to education across a wide range of areas.[164] Academics from initial teacher education programs often receive grants from the fund to develop research that will have a direct impact on schools. While the fund is not directly targeted at improving initial teacher education, much research is related to how to improve teachers' preparedness to teach.

For example, the Fund devoted money to research into literacy instruction, as part of Hong Kong's large focus improving reading literacy. "Reading to learn" is one of the new curriculum's four "key tasks." Through the Fund, researchers from the University of Hong Kong developed a new approach to teaching and learning Chinese. The new pedagogy moves away from memorisation of single, isolated characters towards integrating the way students perceive the meaning and structure of Chinese through the process of reading, writing and using language.[165]

The Fund also fosters stronger partnerships between schools and universities to build teacher capacity and conduct research. Research financed through the Fund develops new and innovative ways to implement education reforms within specific school contexts. Schools now have direct access to leading researchers to both develop and spread best practice pedagogy.[166]

Evaluation

Hong Kong also has a centralised process of evaluation for higher education providers. They must undertake a self-assessment using staff and student feedback and referencing any previous recommendations for improvements. The evaluation process also involves reviews of faculty teaching quality and analyses of student progression, as well as feedback from employers regarding the success of graduates in their careers.[167]

5.5 Teacher educator quality is critical to improving initial teacher education

Teacher quality is vital for student learning, so it makes sense that the quality of teacher educators – the teachers of prospective teachers – must shape how much is learnt in initial teacher education.[168]

Nevertheless, little is known about the work of teacher educators and their impact on the development of teachers.[169] Even systems that are doing much to reform initial teacher education have paid little attention to gathering information about the backgrounds of teacher educators.

Teacher educators vary widely in experience and practice. The initial teacher education experiences of prospective teachers within the same institution differ markedly depending on which teacher educators they are exposed to. The term "teacher educator" is itself broad and contested. It can refer to anyone from tenured professors of pedagogy to postgraduate students

[163] Interview at Education Bureau, October 2015
[164] Quality Education Fund, 2014
[165] Jensen, Hunter, Sonnemann, & Burns, 2012
[166] Jensen et al., 2012
[167] Tatto, Krajcik, & Pippin, 2013
[168] Koster & Dengerink, 2001
[169] Lanier & Little, 1986; Howey & Zimpher, 1990; Snoek, Swennen, & van der Klink, 2011; Berry & Driel, 2013

running undergraduate tutorials to school-based staff assisting with classroom-based practicums.

To improve initial teacher education, it is important to consider the backgrounds of teacher educators as well as the structure of their role: how are they supported and what are their incentives to improve teaching?

Box 15: The special role of teacher educators

It is often assumed that someone who is a good teacher can automatically be a good teacher educator.[170] This might help to explain why teacher educators do not receive much preparation or support for their roles.

For example, a few studies of teacher educators in Europe found that most had not received any formal preparation for the role and often had little support from colleagues with more experience.[171]

The problem goes beyond teacher educators in initial teacher education and extends to school-based staff, such as mentor teachers. Systems must begin to recognise that teacher educators need special training and support in order to be best prepared to develop others.

5.5.1 Teacher educators in Finland are both subject experts and experienced teachers

Prospective teachers studying to teach primary school in Finland have almost all their core subject expertise classes within a university education department. In these departments, teacher educators have both teaching experience and strong backgrounds in the subjects in which they teach.

For example, professors in the education department at the University of Jyväskylä have at least a Master's degree in the subject they are teaching, as well as a PhD in education. In this department, professors must have at least two years of classroom teaching experience. Since prospective primary teachers take most subject expertise classes with professors with this dual-background, problems of a disconnection between subject content and the knowledge needed for teaching are relatively rare.

All staff at the University of Jyväskylä are expected to know how to teach university-level students. Staff are able to take a broad-based teacher qualification in university pedagogy studies, which involves 25 credits in basic studies in university pedagogy or basic studies in education, as well as 35 credits in pedagogical studies in adult education.

The breadth and depth of the expertise of teacher educators at the University of Helsinki allows them to comprehensively support the pedagogical development of primary teachers in a way that would not be possible in many other systems.

Box 16: Internal capacity building at the University of Jyväskylä

Teacher educators in Finland have the autonomy to structure their own courses and have significant input into the structure of the degree itself.

Staff at the University of Jyväskylä took the opportunity to build their own capacity during recent development of the new primary teacher curriculum.

Revised every five years, the curriculum sets out what primary teacher candidates will be taught. This time, education faculty staff decided they did not just want a new document – they wanted to fundamentally overhaul their operating culture.

Drawing on student feedback and their own experiences, they decided they wanted to increase collaboration with schools and among faculties to build the capacity of teacher candidates and teacher educators alike.

There is now a strong focus on teacher collaboration and cross-discipline connections, with staff working together to develop curricula. The new curriculum requires teacher educators in all subject areas to work together to deliver integrated content, including through co-teaching.

[170] Zeichner, 2005

[171] Buchberger, Campos, Kallos, & Stephenson, 2000; J. D. Wilson, 1990

The faculty where teacher educators are housed matters

The teacher educator role can look different across systems and institutions depending on how the role is structured. Many initial teacher education programs may have teacher educators in separate faculties, with some in the faculty of education and others in different parts of the university for particular subjects. In fact, some teacher educators may not collaborate with the education faculty at all (for example, a professor who happens to instruct future maths teachers may reside solely in the maths department).

In the high-performing systems studied here, it is common for primary teacher candidates to take most of their subject expertise courses in the education department. This means that the education department houses faculty who are subject experts who have developed their courses specifically for teachers. This structure sometimes arises from the history of normal schools – or colleges solely for teachers – in these countries. For example, Naruto University of Education in Japan still focuses primarily on teacher education throughout the entire university.

Depending on the provider, not all initial teacher education courses are taken in the education department. Primary teacher candidates in Finland often choose a minor in which they take courses in the department for that subject (for example, a biology minor takes courses in the science department). Yet all of the core subject expertise courses are housed in the education department.

When subject expertise courses are not in the education department, there can be problems, as it means that faculty who are instructing teachers may not have a background in the knowledge required for teaching. It also sometimes means that primary teachers are not learning the foundational content most relevant to their level of teaching; instead, they may be taking courses more geared toward advanced concepts needed for general university students.

6 Professional learning: Subject-specific support in schools

While initial teacher education can give teachers a strong base of subject expertise before they enter schools, it is unlikely to fully prepare them for all the realities of the classroom. Therefore in-school supports for teachers are critical. New teachers need to continue to develop subject expertise and fill in knowledge gaps as they adjust to full-time teaching.

Teachers develop a great deal of subject expertise while teaching because they see examples of student thinking and learn from how the students respond to different lessons. However, many beginning teachers enter schools without support or resources to help them improve. It is common for new teachers to enter schools with little access to helpful instructional materials and little ability to learn from experienced teachers through lesson observation.[172]

Finland, Japan, Shanghai, and Hong Kong each have different ways of making sure teachers are supported, especially in their first few years of teaching. Japan and Shanghai schools, in particular, have strong cultures of professional learning that focus on developing subject expertise through a culture of lesson observation and lesson study.

6.1 Induction

Many primary teachers, on their first day of teaching, assume full responsibility for the learning of dozens to hundreds of students in their classes. New teachers often have to individually create assessments and instruction materials, and sometimes even design entire curricula from scratch. This would be hard for any new teacher, but particularly for those who teach four or more subjects. While new teachers may have a base of subject expertise from initial teacher education, even the most prepared still have knowledge gaps that can start to be filled during intensive induction programs.

It is well-established that new teachers are generally less effective at raising student achievement, and that many teachers improve dramatically in their first few years of teaching.[173] Induction programs may have a considerable influence on how fast early career teachers develop.[174]

Box 17: What makes induction effective?

A good induction program is characterised by much more than administrative and social support from a more experienced "buddy." teacher[175] The following components have a positive impact on teacher practice:

- Having a highly effective, trained mentor from the same subject area to support with subject-specific pedagogical practice[176]
- Having the opportunity to collaborate and jointly plan units of work with colleagues in the same subject area[177]
- Seeing effective instruction modelled in a range of settings and being observed by others with feedback[178]

Australian schools often have induction programs, but many of those for primary teachers are focused on general teaching responsibilities and do not involve much subject expertise development. Since the first years of teaching involve getting to know student thinking and learning, guidance in subject-specific issues to improve pedagogical content knowledge can make a big impact. Shanghai, Japan, and Hong Kong provide examples of how induction programs can help teachers develop subject

[172] Chingos & Whitehurst, 2012
[173] Rockoff, 2004; Rivkin, Hanushek, & Kain, 2005; Harris & Sass, 2007
[174] Maulana, Helms-Lorenz, & van de Grift, 2015;Papay & Kraft, 2015
[175] Teacher Education Ministerial Advisory Group, 2014
[176] Rockoff, 2008; Smith & Ingersoll, 2004
[177] Smith & Ingersoll, 2004; H. K. Wong, 2004
[178] H. K. Wong, 2004

expertise and prepare teachers for lifelong professional learning in schools.

Finland's intensive focus on rigorous initial teacher education has meant that induction was not historically a priority. But the country is now working on improving induction and professional learning in schools.

6.1.1 Teacher induction in Japan is systematic and highly structured

Since 1989, each prefecture in Japan has been responsible for developing an induction program for teachers. All newly hired teachers are required to complete these programs.[179] Their content, determined by the prefectural education boards, typically includes a strong focus on subject expertise development through lesson study. Prefectures often use a mix of in-school and out-of-school programs to induct new teachers. Induction is highly coordinated, with principals, municipal boards of education and prefectural education boards each playing a role in encouraging subject expertise development.

For example, the one-year induction program in Tokushima prefecture requires at least 150 hours of school-based training and 19 days[180] of external training. In school-based training, new teachers interact with a home-school training supervisor as well as a hub-school training supervisor. The latter trains four new teachers from various schools and coordinates with the home-school supervisor at each school. All supervisors help new teachers develop subject expertise through lesson observations and lesson advice.

Each school has a home-school training supervisor, selected from its teaching staff. The principal can reduce the training supervisor's class management workload and teaching hours to ensure they can supervise and advise the trainee smoothly. The hub-school training supervisor is appointed by the prefectural board of education.

Both supervisors observe new teacher lessons, give lesson advice, and plan school-based training as part of the induction program. The school-based supervisor is responsible for keeping records of all training, and the hub supervisor is responsible for organising substitute teachers to replace new teachers when they attend external training.

Tokushima also requires principals to establish a school-wide cooperative structure, such as a committee, to manage the induction program. The school-based supervisors hold coordination meetings for every staff member involved, ensuring that new teachers and supervisors have time for ample lesson observation, discussion, and analysis. All of this greatly improves subject expertise.

Box 18: Expert teachers are appointed to help new teachers develop subject expertise

In 2015, two new teachers were inducted at Sako Primary School in the Tokushima prefecture. A senior teacher with 32 years of experience spent three days each week with the new teachers at Sako and two days with new teachers at a different school.

New teachers also had access to school-based mentor teachers who were appointed by the school principal. One of these mentors, the science curriculum coordinator, had 31 years of teaching experience.

These supervising teachers do not get much additional compensation for their role – about 10,000 yen ($A120). But the appointment is very prestigious and signals a recognition of their expertise.

Source: Interview with Sako Primary School, 2015

[179] Ministry of Education, Culture, Sports, Science and Technology - Japan, 2015

[180] 11 days are during school holidays and 8 days are during the regular school year

Tokushima Prefecture Induction Program

Source: Tokushima Prefecture Board of Education, 2015

Figure 12: Tokushima Prefecture induction program with school-based and external training

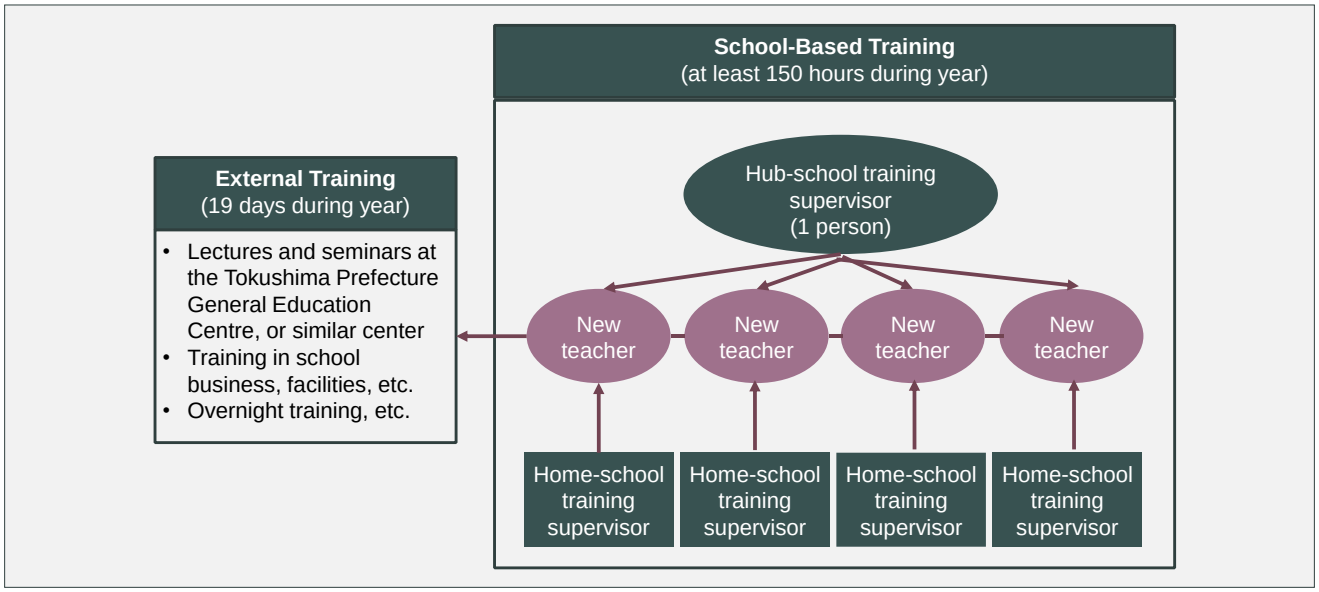
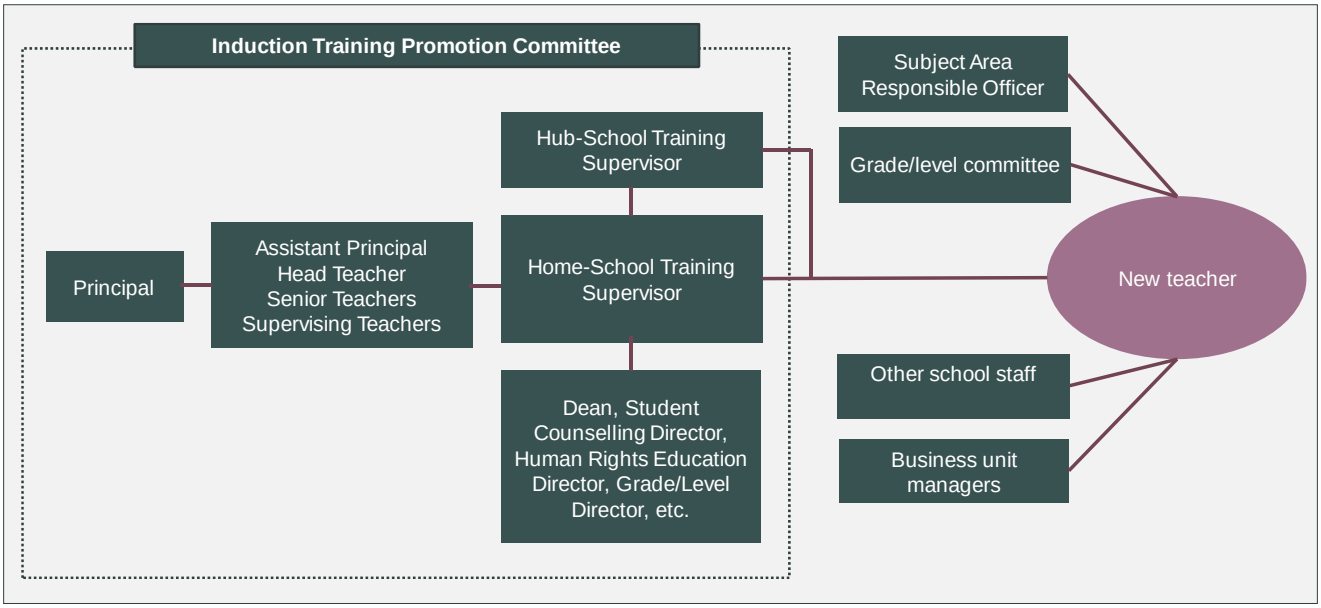


Figure 13: School-based induction committee in Tokushima Prefecture



School-based training follows a rigorous curriculum of lesson observation and analysis to develop subject expertise.

As seen above, Japanese induction programs involve many senior teachers. The detailed induction curricula include many hours for lesson observation and discussion, which helps build subject expertise. While each prefecture can devise programs differently, most require many hours of dedicated school time for new teachers to interact with their supervisors.

In Tokushima, there are two components of the school-based training (which must include at least 150 hours over the year):

- **Lesson Study:** At least 90 hours over the year; about three hours a week
- **General Training:** At least 60 hours over the year; about two hours a week

Lesson study includes a significant amount of time on lesson observation: both the new teacher observing expert teachers and expert teachers observing and giving feedback to the new teacher. For example, the requirements in Tokushima include:[181]

- 20-30 hours of peer lesson observation
- 30 hours of being observed by mentors, with mentors co-teaching as necessary
- A requirement that the new teacher observe 10 per cent of the school's other teachers giving lessons
- 30-50 hours of discussion with a mentor, which may be a time when teachers discuss the lessons they have observed
- Three research classes per year, where the trainee teaches in front of a supervisor and peers.

The amount of time spent on observation and discussion during induction sets teachers up well for continued participation in lesson study -- the main platform of professional learning in Japanese primary schools.

In addition to lesson study, general training requirements include sessions with supervisors on:

- Basic teacher responsibilities
- Subject-specific instructional techniques
- Use of teaching materials
- Facilitating student activities
- Other aspects of the teacher job

More induction program details from Tokushima are in the Appendix.

The training requires much of the new teacher's schedule to be allocated to induction. Teachers are discouraged from having meetings after school, so they must meet all these requirements during school hours. A new teacher might therefore have a few non-teaching days each month to attend external training and will have regular meetings with supervisors scheduled in the school timetable.

As part of the induction program, new teachers (in consultation with supervisors) also create their own development plan, which can be partly tied to subject expertise development.

The prefectural board of education is responsible for monitoring the quality of the induction program, and board staff members have a close relationship with each school principal.

6.1.2 Hong Kong's induction focuses on pedagogical content knowledge through practice, observation, and reflection

Hong Kong's Education Bureau, in conjunction with the Hong Kong Teacher's Centre, provides a three-day induction for new teachers. It consists of both subject-specific topics and general topics such as classroom management and communication with parents.

[181] Tokushima Prefecture Board of Education, 2015

The Education Bureau also provides a detailed Induction Tool Kit for schools to use to induct new teachers. Created through a pilot scheme that involved 47 schools, the Tool Kit provides a recommended schedule for a new (primary and secondary) teacher's pedagogical and professional development. The schedule involves learning to work with students and developing subject expertise. Specifically, the induction year recommendations include:

- Teaching at least 360 periods (or 210 hours) with at least 240 periods (or 140 hours) in the new teacher's major subject.
- Observing at least two lessons in the new teacher's major subject taught by peers or mentors, and having at least two of their major subject classes observed (with pre- and post-observation discussion).
- Conducting at least four reflection exercises on the effectiveness of learning and teaching in the new teacher's classes.
- With mentor support, creating content for at least two areas of student exams in the teacher's major subject and reflecting on student performance in these parts of the exams.
- With mentor support, following at least one case study in depth, then reflecting on one's role in student development, focusing on students' whole-person development or specific aspects of student development.

Importantly, the Education Bureau specifies that the tool kit is not to be used as part of a performance management process: "The entire process of teacher induction as recommended in the Teacher Induction Scheme is to empower beginning teachers rather than regulate them."[182]

6.1.3 Shanghai

The following is based on research from Jensen, Sonnemann, Roberts-Hull, & Hunter, 2016

To become a fully certified teacher in Shanghai, beginning teachers complete an intensive induction program during their first year. Professional learning during induction is heavily related to subject expertise: mentors are subject experts and new teachers participate in collaborative groups observing lessons and developing teacher research skills.

Beginning teachers have two mentors: one for classroom management and one for subject-specific guidance. Mentors may be experienced teachers within the 'home' school, or master teachers who work across the district.[183]

Beginning teachers undertake intensive school-based training not only in their home school, but also at a high-performing school in their district. At the home school, mentees engage in regular lesson observation with their mentor at least once every two weeks. They work with mentors in developing teaching plans and designing assessments. Mentor teachers observe and evaluate beginning teachers' lessons at least three times a year.

A significant portion of beginning teacher induction takes place through collaborative teacher research groups in the school. Beginning teachers are active participants in these groups and must lead discussions once or twice per semester, with mentors and other teachers providing feedback.

Beginning teachers also visit a high-performing school in their district, where an experienced teacher mentors them, up to three times a week. Teachers observe regular lessons and collaborative lessons. The school trains them in how to conduct research and how to write a research paper, which is important for all Shanghai teachers. District training also involves

[182] Advisory Committee on Teacher Education and Qualifications, 2009

[183] Jensen, Sonnemann, Roberts-Hull, & Hunter, 2016

face-to-face seminars and workshops held one weekend a month, and network-based teaching that teachers conduct themselves. The training develops foundational subject expertise and an awareness of how to engage in research and lesson observation.

At the end of the year-long program, beginning teachers must pass an evaluation to become fully certified. The evaluation includes a national written test, an interview, and teaching a sample lesson.

Figure 14: Beginning teacher professional learning in Shanghai

	Activities	Frequency
School-based training at 'home school'	**Training and support within own school**	
	Mentoring	
	• Devise training plan	Once per year
	• Review and modify lesson plans	4-8 per semester
	• Observe each others' lessons	Once every 2 weeks (minimum)
	Lesson observation	
	• Observe others and write report	10 times per year
	• Observe and comment on colleagues' classes	3 times per year
	• Be observed in official 'teaching trials' by home and base school mentor	3 times per year
	Lesson groups	
	• Design and moderate one activity	Once per year
	• Deliver demonstration lesson (under mentor guidance)	2-4 times per year
	Personal reflection on professional experience as a probationary teacher	10 essays per year
	Lesson planning – curriculum and assessment	
	• Analyse one unit of teaching materials and lesson plan preparation	Three times per year
	• Design the homework of one unit and explain	Three times per year
	• Design and quality test unit tests	Once per year
	• Conduct quality analysis of mid-term and final exams	Twice per year
Training at a high-performing 'base school'	**New training component since 2012** • Beginning teachers attend a high-performing school • Assigned a mentor • Activities include shadowing a mentor, participating in research groups and lesson observation	Up to 3 half days per week
District standardised training program	**Details of training program** • Workshops and seminars including lesson preparation, homework design, how to conduct lesson observation, curriculum design • Self-study	Once per month
Evaluation	**Evaluation details** • Evaluation by home and base-school mentors • National written test • Interview	End-of year assessment

Source: Jensen et al., 2016

6.2 Instructional materials

New primary teachers, especially those who teach many subjects, need to be able to rely on quality instructional materials in the same way they rely on quality induction programs and subject mentors. New teachers have not yet developed high levels of subject expertise in every subject, so having quality instructional materials is a useful way to bridge the knowledge gap.

Some teachers use instructional materials as a backup when they are unfamiliar with content; others use them more frequently. A teacher's use of textbooks, for example, varies based on the subject matter being taught, trust in the textbook, and knowledge of the subject matter.[184]

Instructional materials can include curriculum documents, textbooks, teacher handbooks, example lesson plans, and so on. These materials not only influence teachers, but students also directly interact with them, for example with textbooks and problem sets. Multiple large-scale studies have found that the choice of instructional materials can have a big impact on student learning.[185] The effect sizes of better instructional materials may even be large enough to compare to the effects of having a better teacher.[186]

In Japan and Finland, quality textbooks and other instructional materials are widely used, especially by novice teachers. These materials are seen as critical teaching tools, and teachers and schools trust them. The materials lay out key pieces of subject expertise within a progression of lessons so that teachers are not forced to design lessons and curriculum from scratch (although they are free to do so if they feel comfortable). Materials are also linked to a strong, centrally established curriculum and are regularly updated by respected veteran teachers and teacher educators.

> *"The design and spread of curriculum material is one of the oldest strategies for attempting to influence classroom instruction."*
>
> *- Ball & Cohen, 1996*

In Australia, however, there are problems with the quality of instructional materials and school curricula. National and state curricula are very broad and resemble more of a set of standards than the basis for an instructional plan. Therefore, schools must do a lot of curriculum mapping work on their own, leading to varied instruction and inconsistency.

Schools that have specific student learning issues are likely to seek packaged instructional programs created by third-party vendors. Some of these programs are well-designed and evidence-based, but many are not. With limited time, schools do not have time to research these programs in depth, so may rely on word-of-mouth.

6.2.1 Japanese textbooks and teaching manuals

In Japan, teachers are expected to follow the Course of Study issued by the Ministry of Education – which is a set of broad standards for each grade.[187] The Course of Study is revised about every 10 years, with the last revision in 2008. The document itself is succinct, listing just a few objectives and bullet points of content taught for each subject by grade level. The Ministry also prepares teaching guides for the Course of Study, which can be quite detailed.

Through its approval process, the Ministry maintains strict control over textbook quality and content. Textbook standards must be followed for approval, one of which requires textbooks to clearly follow the Course of Study.[188] Japanese textbooks are known for being compact and inexpensively produced.[189]

[184] Freeman & Porter, 1989
[185] Agodini et al., 2009; Bhatt & Koedel, 2012
[186] Chingos & Whitehurst, 2012
[187] MEXT Japan, n.d.
[188] "MOFA: Textbook Examination Procedure," n.d.
[189] OECD, 2011

The prefectural boards of education can select the textbooks and instructional materials for each prefecture (as long as the Ministry has approved them first).[190]

All teachers have access to the instructional materials but are not explicitly required to use them. They can use teaching manuals from the textbook company and the Course of Study guidelines from the Ministry. How they use these materials is up to them. They may refer to them with an unfamiliar topic, or for some lessons not use them at all.[191]

It is common for initial teacher education programs to teach the Course of Study and review accompanying teacher guides as part of maths, science, and literacy units. Tokyo Gakugei University recognises that teachers need to understand how individual lessons fit within the curriculum and how they link to the Course of Study.[192] Mentor teachers also advise new teachers on how to use the teaching materials. For example, the Curriculum Coordinator in Sako Primary School (Tokushima Prefecture) spent summer training time advising new teachers on how to use the materials before they began teaching.[193]

6.2.2 Finnish textbooks

Because teachers in Finland are well-known for having a high degree of autonomy, it might be surprising that they have a strong culture of textbook use in lesson planning. Teachers are not required to follow textbooks, but many – especially new teachers – have a high regard for the available instructional materials and use them frequently. Trainee teachers are encouraged to use their imagination to develop high-quality, curriculum-related teaching and learning materials, and then use the published materials for support when necessary, usually for topics in which teachers have subject expertise gaps.

High-quality curriculum materials are made available to teachers in Finland throughout their career. There is an open market for the publication of materials, though in practice there are just a few trusted publishers of curriculum-related materials and activities. Schools can choose their textbooks from any publisher. Publishers, who hire experienced and trusted teachers to write the textbooks, are members of the government's curriculum steering group so that they can align their materials to what is taught in schools.[194]

The teacher manuals that come with the textbooks often have theoretical and conceptual content knowledge for teachers. For example, a textbook for English instruction includes a chart of how the learning path works for second language acquisition, with examples of how to differentiate in class and sample games for the teacher to use.[195]

In initial teacher education, subject expertise instruction focuses on familiarising teachers with the curriculum and instructional materials. For example, a literacy course at the University of Helsinki includes tutorials in which students are introduced to textbooks and learn how to use them as cognitive tools. Prospective teachers are encouraged to ask why the books were composed in particular ways – to better understand how to use them in a way that supports pedagogical practice.[196]

6.3 Professional Learning

Teacher subject expertise develops over time, improving with each lesson and student interaction. Although it is important for teachers to have a strong foundation of knowledge from initial teacher education, much of their subject expertise

[190] Ota, 2000
[191] Interview at Ageo Primary School in Saitama, November 2015
[192] Interview at Tokyo Gakugei University, November 2015
[193] Interview at Sako Primary School in Tokushima, November 2015
[194] Interview at National Board of Education, November 2015
[195] Interview at teacher training school in Jyvaskyla, November 2015
[196] Interview at the University of Helsinki, November 2015

will be developed in schools. Professional learning programs are critical to the development of knowledgeable teachers.

Unfortunately, many of these programs have failed to bring about much improvement in teacher practice and student learning.[197] This is often because professional learning is provided in isolated workshops that offer little connection to a teacher's actual practice. To develop any skill, targeted and sustained professional learning is important, but it is particularly necessary for the development of subject expertise, which requires many cycles of planning, teaching, and feedback in order to produce deep learning.

Too often, primary schools focus only on professional learning for skills such as general pedagogy. Even when teachers are generalists, there are often one or two subject areas in which teachers can benefit from specialised professional learning.

The systems studied in this report provide subject-specific, targeted, and sustained professional learning for both generalist and specialist primary school teachers.

6.3.1 Japanese lesson study develops subject expertise

Almost all Japanese primary teachers engage in an ongoing professional development project known as lesson study.[198] Lesson study allows teachers to critically analyse teaching to develop knowledge about what works best to help students learn. Its goals are broader than just improving one lesson: teachers engage in discussion and lesson observation to improve their overall subject expertise and particularly pedagogical content knowledge.

Lesson study, which has a 120-year history in Japanese schools, is a shared process, in which teachers work collaboratively to develop, teach, analyse, and refine lessons.[199] It focuses explicitly on student learning goals and is designed to incrementally build subject expertise across an entire teaching staff.[200] Groups of teachers explicitly set goals for student learning and work towards them through a cycle of research, practice and reflection.

Figure 15: Lesson study cycle

Source: Adapted from Lesson Study Research and Practice in Mathematics Education, *2011*

Lesson study integrates various types of teacher knowledge, creating a context in which teachers can simultaneously develop and apply knowledge and skill.[201] Through collaboration with teachers of varying levels of expertise, younger teachers are able to benefit from the subject expertise held by their peers.

Lesson study themes are generally set by a school. One year's study might focus on mathematics. A schedule is set at the beginning or end of the year.[202] The lesson study itself typically consists of a small group of teachers choosing a topic for study after they have analysed current student learning problems. For

[197] TNTP, 2015
[198] Chichibu & Kihara, 2013
[199] Arani, Keisuke, & Lassegard, 2010; Interview at Tokyo Gakugei University. Lesson study is conducted at a national and regional level in addition to the regular in-school process, but the focus here is on the smaller-scale lesson study in schools.
[200] Stigler & Hiebert, 1999
[201] *Lesson Study Research and Practice in Mathematics Education*, 2011
[202] Chichibu & Kihara, 2013

instance, a maths lesson study group might determine that students are confused about whether zero is an even or odd number, which signals that students do not have a precise understanding of the concept of even numbers. This conversation helps develop the teachers' own pedagogical content knowledge in maths, at the same time as they are refining lessons for their students.

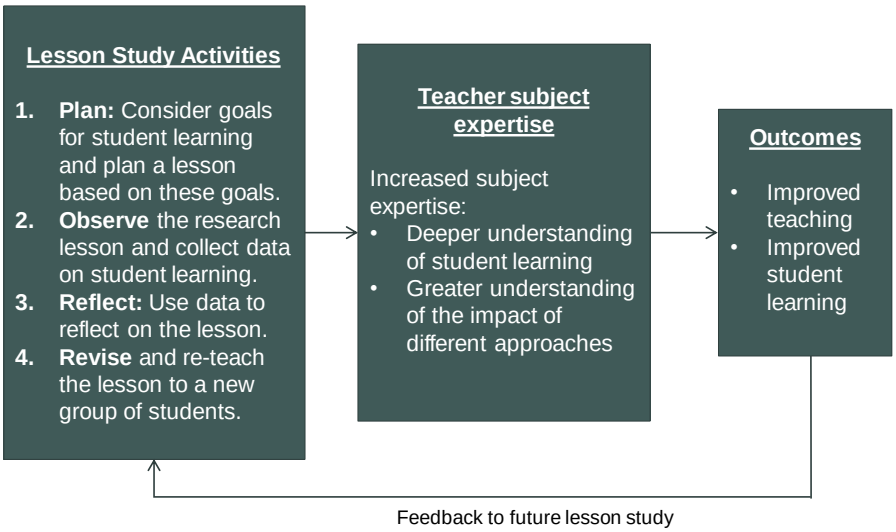
Next, teachers collaboratively plan a lesson that tests a preferred approach to the topic. The goal is not just to create an effective lesson, but to understand *why* the lesson works.[203] Such understanding is part of pedagogical content knowledge. Teachers may read and discuss materials prepared by other teachers outside the school, as well as textbooks and teaching manuals addressing similar problems. A tentative lesson plan might be presented to the whole staff of the school for feedback.[204]

During lesson planning, the group discusses how students might understand the topic and tries to anticipate their approaches to problem solving. Often, the lesson study focuses on the use of a specific example. For instance, teachers might consider which combination of numbers is best to use to start a lesson on subtraction: 13 minus 9, or 14 minus 8, for example. Teachers might propose that 13 or 12 minus are the best examples to introduce students to the basic concept because students can more easily subtract 9 from 10 and then add the remaining numbers. Using an example such as 14 minus 8 might prompt more different approaches in class.[205]

Once a lesson has been planned, one or more teachers teach the lesson while being observed by their peers. The group typically also records the class. Then they discuss and reflect on what might be improved. Another teacher in the group might teach a revised lesson. Lesson study may involve 10 to 15 hours of meetings, spread over a few weeks to a month.[206]

Lesson study is implemented continuously in Japanese primary schools, though the frequency varies. According to a 2010 Ministry of Education survey, 99.5 per cent of primary schools implemented a lesson study process at least once a year, 83 per cent at least five times a year, and 21 per cent least 15 times a year.[207]

Figure 16: How lesson study develops teacher subject expertise in Japanese schools



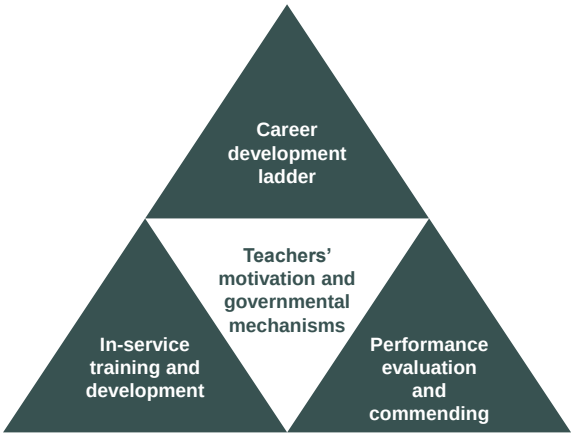
Source: Interviews in Japan, November 2015

[203] Stigler & Hiebert, 1999
[204] Stigler & Hiebert, 1999
[205] Fujii, 2015
[206] Darling-Hammond, Wei, Andree, Richardson, & Orphanos, 2009
[207] Chichibu & Kihara, 2013

6.3.2 Shanghai develops and rewards subject expertise

Shanghai is known for its strong culture of teacher professional learning, which might be one of the reasons for the system's success.[208] Much of its professional learning activities are structured to develop subject-specific expertise. Each teacher has access to a mentor who is an expert in the same subject. Teachers also participate in research and lesson groups that enable them to engage in research that develops pedagogical content knowledge. As teachers develop, they are recognised and rewarded for their increasing expertise. In turn, they have a responsibility to mentor younger teachers in the same subject as they move up the career ladder.

Figure 17: Model of teacher development and progression in Shanghai



Source: Zhang, Ding, & Xu, 2016

Shanghai's teachers develop research skills though learning communities

Two types of learning communities – "teaching and research groups" and "grade groups" – are at the heart of Shanghai's professional learning culture. Teachers meet with both of these groups each week. Research and lesson groups comprise all teachers of the same subject, and grade groups comprise all teachers in the same grade. Since all primary schools all specialised, primary teachers participate in a research and lesson group for the one subject they teach.

The Shanghai research and lesson groups are a good example of a formal professional learning structure that works to improve teacher subject expertise. Of course, many schools in other countries (such as Australia) have time set aside for teachers to meet with other teachers of the same subjects or grade levels. But rarely do these teachers interact as Shanghai research and lesson groups do: with classroom observations, academic research, and critical feedback.

Teachers in research and lesson groups begin by choosing a topic of interest related to improving student learning. To find their topic, they look at school objectives and analyse data on student learning. The topic is usually set for a whole semester or year. Teachers then begin to research teaching methods to address the topic. The topic is very subject specific so teachers are continually developing their pedagogical content knowledge. Teachers read and discuss literature and hold forums with university experts and retired master teachers. Most of the semester is spent testing out new methods while being observed by other members of the group in order to get feedback and collect information on how well the new methods are improving student learning.

The results of these research groups are often formally published as teacher research. A crucial part of teacher career development in Shanghai is public recognition of the development of primary teachers' subject expertise.

Box 19: Two subject-specific groups in Shanghai: research groups and lesson groups[209]

Research groups are comprised of teachers of the same subject across a whole school.

Lesson groups involve teachers of the same subject within one grade level. Lesson groups are basically smaller versions of research groups.

[208] Tucker, 2014; Center for Teaching Quality, n.d.

[209] Jensen et al., 2012

Schools support research and lesson groups by setting aside time for group work. Teachers have physical office space for their research and meetings with the group. Leadership within subjects and of research and lesson groups is important and recognised. Group leaders are paid extra for their role. The leader also coaches more novice teachers. Lesson plans, teaching materials, and research findings are uploaded online for all teachers to access.[210]

Leaders are chosen and evaluated on their subject expertise and contributions to developing subject expertise in other teachers across their school, and across the system. A teacher's contribution to research group activities, as well as the achievements of the whole group, are factors in a teacher's formal evaluation, which is the basis for promotion decisions.[211]

Box 20: Research and lesson groups follow these steps:

1. Set research question based on student learning assessment.
2. Review existing research on methods of teaching the subject, addressing the research question.
3. Prioritise teaching strategies based on discussion with the group.
4. Test strategies in class; observe and discuss each other's lessons.
5. Analyse evidence, identify what worked (and what didn't), and publish results.

Adapted from Jensen et al., 2016

Principals give teachers feedback as well as financial incentives to improve the quality of their research articles. Principals may also provide information about appropriate publishers for the research and develop school-based research book collections for teachers.[212]

Networks of schools share knowledge gained from their research groups. There are also research functions at district and municipal government levels that conduct, publish and promote school-level research.

Subject experts are expected to mentor younger teachers

Shanghai realises the importance of subject-specific mentoring and invests in developing subject experts to lead professional learning. Teachers are assigned subject mentors and they can also access advice from the school subject head or research group leader. This way, a new science teacher on her first day teaching can see a clear line of subject-specific support and expertise in the system.[213] Mentees evaluate the effectiveness of their mentors through 360-degree feedback. Mentors will not be promoted to the next level unless they receive positive feedback from the teachers they have mentored.[214] Career ladders reward subject expertise

In most systems, the only way teachers can get promoted is by moving into school administration on the way to becoming a principal. Developing subject expertise is not really rewarded, and the system has no official subject expert. Shanghai, by contrast, has developed a career path for teachers to become subject experts. Teachers can be rewarded for improving their subject expertise, and as they are promoted, they are responsible for developing the subject expertise of other teachers throughout the system.

In order to be promoted, teachers must display not only teaching competence but also skill in academic research related to teaching. They are expected to publish professional papers or other research results in publications at the district level and above. They must have at least five years of experience before they are promoted, but experience alone doesn't make promotion automatic.[215] Different aspects of subject expertise development and participation in professional learning are included in teacher

[210] Tan, 2013, p. 187
[211] Tan, 2013, pp. 204, 218, Sargent & Hannum, 2009
[212] J. L. N. Wong, 2014, p. 81
[213] Jensen et al., 2016
[214] Jensen et al., 2016
[215] Zhang, Ding, & Xu, 2016

appraisal, which leads to promotion. These include:[216]

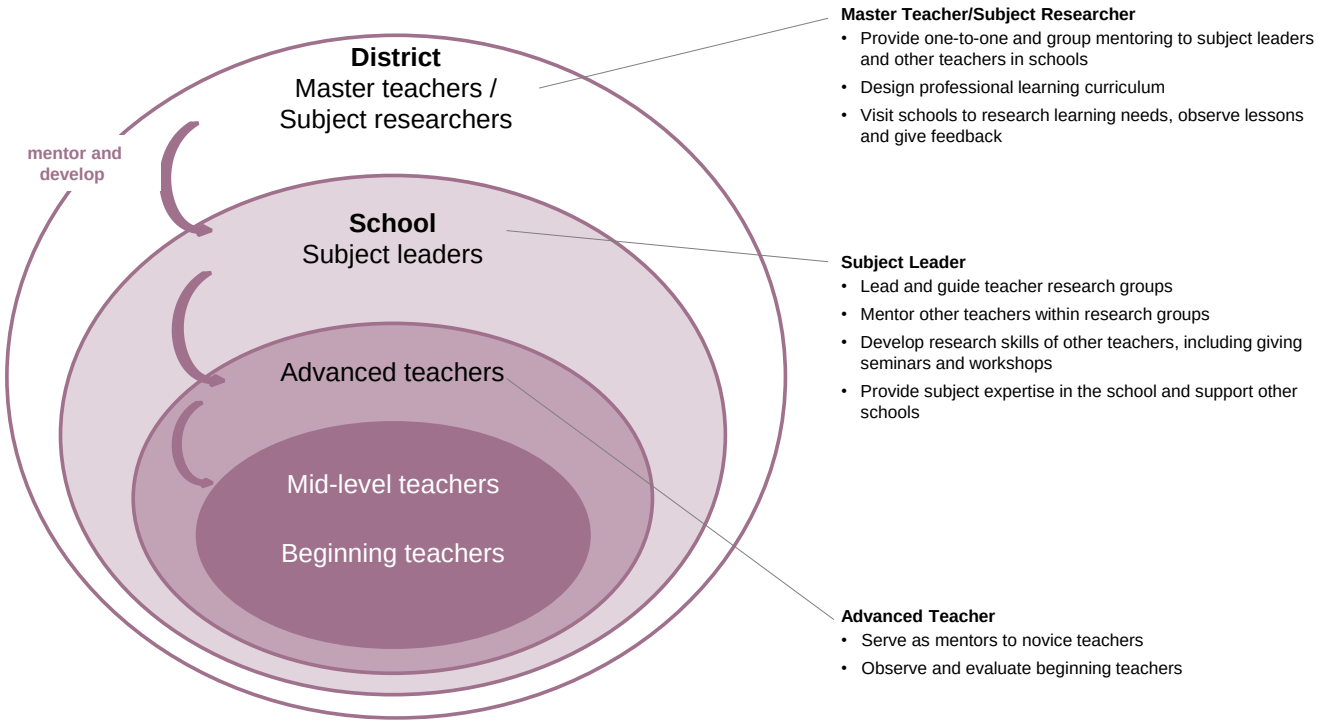
- Input measures of participation in professional learning, such as the number of hours undertaken (district officials inspect schools to check the hours and type of professional learning undertaken across the school)
- Performance in professional learning, especially collaborative learning groups (this is evaluated through observations of professional learning, peer feedback and 360-reviews)
- Professional learning outputs such as published papers, demonstration lessons, awards, and seminars and workshops
- Improvement in teaching evaluated by internal and external observations

Shanghai also has awarded a special status of master teacher to fewer than half of 1 per cent of teachers.[217] Master teachers are leaders of their subject in the system. Teachers are selected for this permanent title after an evaluation by the Master Teacher Title Committee. The committee interviews candidates about teaching practices and observes their lessons. Master teachers must:[218]

- Be active in reforms of curriculum and teaching
- Have published research extensively and received various teaching awards
- Have at least 10 years of subject teaching experience

The municipal government grants winners of the master teacher title, but local policymakers can create additional awards and honorary titles. Examples include "new star teacher," "senior advisor," and "subject leader."[219]

Figure 18: Mentoring roles of subject experts in Shanghai



Source: Jensen et al., 2016

[216] Jensen et al., 2016
[217] Jensen et al., 2016
[218] Zhang et al., 2016; Jensen et al., 2016
[219] Zhang et al., 2016

Figure 19: Roles in Developing Others as Teachers Become More Senior

Source: Jensen et al., 2016

7 Implications for Australia

Australian policymakers, school leaders, and teachers can learn from policies that have worked in Japan, Hong Kong, Shanghai, and Finland. All four systems have structured the preparation and development of their primary teachers to ensure strong subject expertise.

There is momentum in Australia to improve teacher subject expertise by creating better quality initial teacher education programs and overhauling teacher professional learning. It is critical that new policies and programs are based in evidence, and learn from examples of high-performing systems to ensure strong teacher subject expertise.

Below are some key insights for Australian policymakers:

Strengthen employment assessments to ensure quality subject knowledge

Many in Australia would love to make initial teacher education programs as selective as Finland's. But Australia's different structure and governance of initial teacher education may make Finland's selection process hard to emulate.

The number of students admitted into Finland's initial teacher education programs is government-controlled and funded, resulting in fewer candidates throughout the country. This allows Finland to only select the best candidates.

Australian initial teacher education is much less regulated. Colleges and universities accept far more teacher education students than the country needs in any given year. The popularity of these courses provides those institutions with a financial incentive to continue to accept large numbers into programs that are less costly to administer than most other university programs. So, these institutions are not by themselves going to restrict supply.

Major structural changes to how initial teacher education providers are funded and regulated would be necessary in order to create uniformly high admissions requirements in Australia's relatively deregulated systems of initial teacher education. While the Finnish system highlights the importance of selection into teacher education, the Japanese experience may provide an alternative way forward for Australia and other countries with crowded initial teacher education markets.

Japan is an example of an open initial teacher education system, with hundreds of providers. Many in Japan complain that it is too easy to gain teaching credentials, and that there are many more certified teachers than there are teacher job openings. However, the Japanese Ministry can't regulate teacher education providers in the same way that the Finnish government can.

So instead of focusing the strongest selection assessments on entry to initial teacher education, Japan's teacher selection process is rigorous at the point of hiring. All teacher candidates applying for teaching jobs must take an employment exam. The exam tests teacher knowledge and ranks candidates, allowing schools to hire only from the top of the rankings.

The employment exams allow Japanese school systems to test prospective teacher knowledge, which puts pressure on teacher education programs to improve their courses. It works well because the selectivity is controlled by the school systems themselves, and the exams can be adapted over time depending on changing needs.

Consider continuous measures of candidates (or rankings) instead of just setting minimum standards for subject expertise

Much of the policy debate on teacher quality focuses on minimum standards. This is limiting. Experience from high-performing systems highlights the benefits of continually developing and recognising subject expertise at all levels of proficiency. This is especially important when developing criteria for selection into the teaching profession.

The minimum standards approach has two problems:

1. It creates no incentives for development past minimum standards
2. It provides no differentiating information to the system on teaching candidate quality, aside from binary pass-or-fail data

When the assessment ensures that teachers (or teacher candidates) merely meet minimum requirements, actors in the system target minimum standards. Teacher candidates prepare themselves to pass minimum standards; initial teacher education providers design courses and set quality benchmarks to ensure minimum standards are met. And schools then employ any teachers who meet the minimum standards.

On the other hand, an assessment with a continuous measure of teacher expertise (or one that ranks candidates) focuses candidates on developing the strongest expertise possible. Initial teacher education providers know they must develop deep expertise in all their teachers, and then schools can more easily differentiate among candidates, having more information on which teachers have the greatest expertise. Moreover, making candidate assessment data transparent provides a serious incentive for initial teacher education providers and helps teacher candidates decide which program to attend.

This is why rigorous selection assessments at employment that rank candidates can be powerful, particularly when the supply of teachers is greater than the demand, as it often is for primary school teachers.

For example, Japanese employment exams rank candidates, and teachers are selected from the top of the ranks down.[220] This means there is no "passing" score that ensures a position – only top-achieving candidates will be offered a job. Competition for teaching jobs is high: in 2013, there were 4.3 candidates for every primary school teaching job.[221]

This process sends a powerful signal not only to teacher candidates but also to initial teacher education providers: teacher subject expertise is assessed because it matters. Initial teacher education courses need to focus on developing deep subject expertise or their graduates will never get high scores in the employment exam. The effect of a continuous measure of expertise leads to a very different series of behavioural reactions across an education system compared to a focus on minimum standards.

Use specialisation to foster deeper subject expertise in primary school teachers

Teacher specialisation is an attractive way to improve subject expertise because it alleviates constraints on time and resources. Becoming an expert in one subject is considerably easier than becoming an expert in six.

All four systems studied for this report had some form of primary teacher specialisation, but they each took a slightly different approach. Japan and Finland have school structures in which teachers teach all subjects, but these teachers are trained more deeply in one or two subjects during initial teacher education and often become leaders in those subjects in their school. Shanghai and Hong Kong specialise more extensively, with primary teachers having teaching assignments for only one or two subjects. Both approaches increase teacher subject expertise; both can be piloted in Australian schools.

Australian schools interested in full teacher specialisation should look at the lessons from Hong Kong and Shanghai. Although teachers in these systems teach fewer subjects and more students, they also tend to have strong relationships with students through teacher looping. In Shanghai, it is not uncommon for teachers to follow students to different grade

[220] Numano, 2010
[221] Ministry of Education, Culture, Sports, Science and Technology - Japan, 2015

levels for three or more years. Enhancing teacher-student relationships with a policy like looping could be vital to making specialisation work.[222]

Australian schools that want to continue with generalist teachers can follow the approaches of Japan and Finland, and encourage teachers to develop deep knowledge in one subject. Schools should be particular about hiring and developing teachers to ensure there is an expert teacher in each subject.

Focus initial teacher education on foundational content at the primary level

The four high-performing systems have three things in common in their primary initial teacher education programs:

1. A focus on the foundational knowledge that teachers need to effectively teach at primary school
2. Emphasis on pedagogical content knowledge and not just general pedagogical skills
3. A high degree of alignment to school curriculum

Having initial teacher education programs recognise the value of subject expertise doesn't mean that primary school teachers all have master's degrees or PhDs in their subjects. These systems understand that rather than learning advanced-level content, primary teachers should develop a deep and flexible understanding of foundational content taught in primary school.

Because time during initial teacher education programs is limited, subject expertise courses should be aligned to the level of the curriculum being taught. It is more helpful for primary teachers to have a deep knowledge of the concepts taught in primary school rather than a shallow knowledge of advanced concepts taught in a maths faculty in universities and colleges. This might challenge some university-based programs in which content knowledge courses are taken in math or science faculties, instead of within the education faculty. The courses a prospective primary school teacher is taking in the maths faculty are unlikely to be aligned to the primary school curriculum.

Focus on outputs, not inputs

Debate about developing teacher quality and subject expertise becomes skewed when there is an overt focus on inputs: on how many courses teachers have completed or whether they have completed a master's degree or a PhD. This inputs-focused mindset has led to two problems:

1. *A belief that more education is always better*. This leads to ever increasing costs rather than focusing on the subject expertise primary school teachers need to be effective.
2. *Equating qualifications with expertise*. Studies have compared the effectiveness of teachers with different qualification levels (master's degrees, for example) and found that they don't correlate with teaching effectiveness.[223] Higher qualifications do not mean teachers necessarily have more expertise, so these studies cannot accurately predict the impact of increased subject expertise.

This report's emphasis on the development of teacher subject expertise – which is, in part, an output of initial teacher education -- does not necessary imply that systems should increase the quantity of subject expertise courses in initial teacher education or require teachers to take certain courses.

Completing a course says little about the information learnt. Significant variation in the quality of courses might explain why there is mixed evidence on the number or type of courses a teacher takes and his or her performance in the classroom.[224]

It is therefore more important for systems not to overemphasise inputs and instead focus on

[222] Fryer, 2016
[223] Ladd & Sorenson, 2015
[224] Aldeman & Mitchel, 2016

outputs: the amount of subject expertise that potential teachers gain and their eventual impact on student learning.

Ensure all teachers continue to develop subject expertise in schools

Teacher subject expertise is developed over time, improving with each lesson and student interaction. Although teachers need to have a strong foundation of knowledge from initial teacher education, much of their subject expertise will be developed in schools.

Once teachers are in schools, subject-specific professional learning opportunities need to increase in quality and quantity. The first few years of teaching are important to develop pedagogical content knowledge, and an induction program with subject-specific learning opportunities will help. New teachers should participate in subject-specific professional learning communities and have access to research-based instructional materials that help them improve their teaching.

Unfortunately, many professional learning programs have failed to bring about much change in teacher practice and student learning.[225] This is often because professional learning is conducted as a series of isolated workshops or activities that offer little connection to a teacher's practice. To develop any skill, targeted and sustained professional learning is important, but it is particularly necessary for the development of subject expertise, which requires many cycles of planning, teaching, and feedback for deep learning.

High-performing systems make sure teachers have access to a strong induction program, an expert mentor, and collaborative professional learning structures that encourage lesson observation and analysis. Japanese lesson study is one example of a professional learning structure that encourages analysis of student thinking, feedback on practice from a subject expert, and collaborative lesson planning – all of which can improve subject expertise.

Continuous evaluation and monitoring

There is no one way to improve teacher subject expertise, but there are many promising practices. Given the limited evidence on specific ways to improve teacher knowledge, experimentation and innovation should be encouraged and carefully evaluated. Any trials of new policies in initial teacher education or in-service professional learning should focus not just on the content taught but on ensuring that prospective teachers are actually learning and effectively teaching the content.

[225] TNTP, 2015

8 Conclusion: policy insights at a glance

Shanghai, Japan, Finland, and Hong Kong use four main policies to increase primary teachers' subject expertise over the course of their careers. Many of these policies address the same problems that bedevil Australian primary education. They include:

1. Selection of candidates with strong subject expertise. This can happen at various stages along the teacher development pathway, from entry into initial teacher education to hiring and promotion decisions. All four high-performing systems carefully assess teacher subject expertise before teachers enter school.

2. Specialisation. Each of these high-performing systems requires primary teachers to develop specialised subject expertise in one or a few subjects. In Hong Kong and Shanghai, primary school teachers teach fewer subjects so they have time to develop deeper knowledge in those areas. Even the generalist systems of Japan and Finland require prospective teachers to study one or two subjects in depth during initial teacher education. Often, these teachers will become a teacher leader in their subject area, which helps schools ensure that each curricular area is led by a subject expert who can share knowledge.

3. Foundational content preparation in initial teacher education. In these four systems, initial teacher education is structured to emphasise deep subject expertise in foundational concepts. While many Australian initial teacher education courses provide a shallow understanding of advanced content, courses in these four systems focus on developing a deep understanding of subjects taught in primary school. For example, a primary maths program requires a deep understanding of arithmetic – the mathematical concepts and proofs it embodies – and how to teach it, rather than of university-level maths subjects such as calculus, which are not as important for teaching in primary school.

4. Subject-specific support in schools. In these systems, teachers continue developing their subject expertise during induction programs and through subject-specific professional learning communities, quality textbooks and teaching materials, and access to subject experts in the school. Professional learning is strongly oriented to the development of pedagogical content knowledge that is, by definition, subject-specific. As teachers advance their subject expertise, they become professional learning leaders in their specialty subjects and work to improve other teachers' subject expertise across the school, region, and system.

These four policies interact with each other and with other aspects of education policy, such as the curriculum. The interactions signify systems that continually develop and reinforce the importance of subject expertise in primary school teaching.

Education leaders who continually emphasise the importance of subject expertise send an unambiguous message to all parts of the system. Assessments of subject expertise signal its importance to effective teaching. School curriculum that requires students to develop deep understanding of subjects sends a message about what kind of teachers are needed to teach it. And when system leaders provide instructional materials that support teaching containing deep pedagogical content knowledge, it sends a clear signal to those in the profession who train and develop teachers.

Over time, these messages, if delivered consistently, change expectations of what is required to become an effective primary teacher. Districts and regions offer more support to develop primary teacher subject expertise; professional development providers change their focus to gain market share; and universities do the same, especially when they are included in reforms to develop subject expertise across the system.

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