LEARNING FIRST

Teaching our teachers: a better way
Connecting teacher preparation and practice

Paper 1 in a series on improving initial teacher education drawing on the work of a global Community of Practice

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Learning First is a global organization of researchers, consultants, policy advisors and teachers. We work closely with education leaders in Australia and around the world to tie policy reform at the highest level of government to deep change in the classroom. 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 analyzed.

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Series preface

In September 2015, Learning First formed a Community of Practice (CoP) to tackle the obstacles that undermine reform of initial teacher education (ITE). The CoP bought together teams of providers and system leaders from Brazil, Finland, Australia, and the United States, including the Florida and Tennessee Departments of Education, Relay Graduate School of Education, the National Center for Teacher Residencies, TNTP, and USPREP/Texas Tech University.

Over a two-year period, each team piloted an ITE reform and had access to international convenings, experts, research, and case studies to assist them. The pilots examined various aspects of teacher preparation and early career development, including induction and mentoring, program site reviews, building teacher content knowledge, use of data for program improvement, partnerships between districts and providers, and teacher educator pedagogies and professional development.

All teams focused on a specific element of teacher preparation that concerned their daily work. All believed that working in partnerships with stakeholders was the way to get the most improvement. No one believed they could do this alone. Partnerships are not easy, and the experiences of all teams in the CoP highlight that reform in teacher preparation is complex work. We have learned lessons that reflect the challenges of ITE reform around the world.

This set of papers both sets out what we have learned about creating partnerships to reform teacher preparation, and combines these lessons with global best practice and research on teacher development. An introductory paper, *Connecting teacher preparation and practice*, looks at how to form partnerships to improve the learning of beginning teachers. It recommends that partnerships develop:

1. A common language and approach that explicitly connects *how teachers learn* in initial teacher education, how they learn in professional development, and what they do every day in classrooms;
2. A shared understanding of *what new teachers need to learn* that comes from K-12 curriculum

The second paper, *Developing partnerships to improve teacher preparation*, provides a continuum for the development of partnerships and the role districts and providers play in creating them. It explains that what we already know about good adult and teacher learning and K-12 curriculum provides a clearer starting point for productive collaboration than is often realized.

The third and fourth papers go further into the detail of developing partnerships to improve the learning of beginning teachers. *Using K-12 curriculum to improve teacher preparation* explores how K-12 curriculum can be used to deepen partnerships and improve beginning teacher learning. *Continuous improvement in teacher education* discusses how providers, partners, and systems can use data and improvement cycles to improve how they train prospective teachers. The papers include examples that describe the work, and lessons from each CoP team's pilot.

We hope these lessons will help others to improve initial teacher education in the United States and around the world. These papers are not blind to the barriers to reform, but they also highlight the great opportunities that now exist to produce lasting, beneficial change to relationships between teacher educators, districts and schools and, through these partnerships, to teacher development and student learning.

Overview

Nearly two-thirds of United States teachers say their initial teacher education left them inadequately prepared for the classroom.[1] Many pre-service and beginning teachers in Australia and other countries also feel that their training lacks practical applicability, and that they are not ready when they start teaching. There are many reasons for this, but they mainly stem from fragmentation: a disconnect between what a teacher learns in teacher preparation and what she does in a classroom, and then what she learns in her professional development.

Fragmentation has produced many responses, but most are inadequate. For example, educators have often tried to reduce the disconnect between theory and practice by focusing on the length of school practicum experiences. Success will only come, however, when both theory and practicum are connected to what teachers do in classrooms. Another source of disconnection is a broad focus on general competencies rather than the pedagogical content knowledge required to teach the K-12 curriculum.

The problems seem large because they are in part structural. Responsibility of preparing teachers is split between university-based providers for coursework, and districts and schools for pre-service practica, induction, and in-service professional development. Little wonder the learning experience for teachers can be disconnected from their daily practice.

Yet the world's top-performing systems have found ways to bridge teacher preparation and professional development, creating learning pathways that are better connected to the daily practice of teachers. It is not seamless, and the learning pathways in places like Singapore and Finland are far from perfect, but these systems have learned that agreement on two fundamental elements can have a large pay-off.

First, stakeholders work together to develop a common language and approach to beginning teacher learning that explicitly connect how teachers learn in their preparation, how they learn during professional development, and what they do in the classroom. Finland, Japan, and British Columbia are very different systems, yet they have the same approach to improving teacher preparation and to teacher professional development once in schools.

In Finland, as part of practicum experience, candidates undertake collaborative research using the same process they are expected to use when they become teachers. Similarly, teaching candidates in Japan use the lesson study method not only to build their pedagogical content knowledge but also to begin participating in the professional learning approach they will use for their entire careers. A similar story is true for British Columbia, although a slightly different inquiry approach to improving teaching is used.

Second, these systems' understanding of what new teachers need to learn is grounded in the K-12 curriculum. In Singapore, Finland and others, teacher preparation and professional development is designed to prepare teachers to deliver the K-12 curriculum. Only when these two elements are in place does teacher learning embody the global research on how teachers learn best, and how they change and continually improve their classroom practice.

Improving teacher preparation and the early careers of teachers is not easy. This paper attempts to show a way forward. It illustrates approaches in the world's best systems and shows how these approaches mirror improvement in some US districts, states, and providers, which are building partnerships that seek to enable a new teacher to make an impact on student learning from her first day on the job, and throughout her career.

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[1] Levine, 2006

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1 The problems that face beginning teacher learning

OECD data show that in the United States and Australia, the gaps between the content knowledge, pedagogy, and practice of new teachers and experienced teachers are wider than they are in many other OECD countries.[2] Research also shows that teachers who have poor preparation and early career support leave teaching at much higher rates than those who had higher-quality preparation and support.[3]

Systems have introduced many reforms to better connect preparation and practice.[4] But many focus their efforts too narrowly – on longer and better practice or placements, for example.[5] These reforms may be beneficial, but they are often an add-on.[6] A 2015 European Commission report argues, "ITE needs to be considered as the first part of a longer and dynamic process, not as a stand-alone and complete phase".[7] Teacher preparation studies and reviews from the United Kingdom and Australia support this position.[8]

Complicating reform efforts further is the fact that states, districts, schools, and providers tend to exist in different and poorly connected systems. Most traditional ITE providers operate in tertiary education, whereas states, districts, and schools operate in the K-12 school system.[9] Expectations, incentives, language, and principles all diverge, making it difficult for players to collaborate on learning experiences for beginning teachers.[10]

Most districts and schools see teaching children as their core business and do not have the time or expertise to train new teachers from scratch.[11] Most teacher educators[12] are academics, with strong incentives to prioritize publishing research over practical training of new teachers.[13] Many state and system leaders, for their part, are unsure of their role in improving ITE. All players feel they have little influence over what others do.

1.1 Fragmented learning

Naturally, this fragmentation affects the learning experience of beginner teachers. Topics covered in coursework are often not practiced during school-based training. School-based mentors may contradict university-based instructors. Induction may cover topics already covered during practicum.[14] It all leaves beginners with a jumble of learning experiences and concepts that they must try to shape into a meaningful and useful whole, when they are the people least equipped to do so.[15]

The lack of connections among ITE, induction and early career professional development (PD) is a missed opportunity to set teachers up for continuous learning.[16] ITE should be a first stage that induction and early career PD subsequently build upon – not something to forget once

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[2] OECD, 2017

[3] R. Ingersoll, Merrill, & May, 2014

[4] See Cochran-Smith & Zeichner, 2005; European Commission, 2015; Kosnik & Beck, 2009; and Musset, 2010 for examples

[5] Various researchers have documented the trend for teacher preparation to become more field-based, for example, Goodson, 1993, and various bodies have called for preparation to be more focused on practical experiences, for example National Council for Accreditation of Teacher Education, 2010 and TEMAG, 2014.

[6] Kosnik, Beck, & Goodwin, 2016

[7] European Commission, 2015, p.4

[8] See for example Donaldson (2010) and Studying the Effectiveness of Teacher Education project team (2015).

[9] This paper uses districts to refer to clusters of schools, which might be referred to as regions or networks in some systems. States are referred to as the main system policymaker but the analogue may be national education ministries in smaller countries without a federal system of government.

[10] A number of researchers have documented the challenges of diverse stakeholders in ITE, see for example, Cochran-Smith & Zeichner, 2005; Handscomb, Gu, & Varley, 2014; Greany, Gu, Handscomb, & Varley, 2014; Grossman, Ronfeldt, & Cohen, 2011; Kosnik & Beck, 2009.

[11] Feiman-Nemser, 2001

[12] Teacher educators can be used to refer to any person form a provider or school that supports a candidate during their preparation. In this paper, 'teacher educator' refers to faculty instructors that are employed by providers unless otherwise stated.

[13] Feiman-Nemser, 2001

[14] A number of researchers have documented the fragmented learning experiences of beginning teachers, see Hammerness & Klette, 2015; Feiman-Nemser, 2001; Grossman, Hammerness, McDonald, & Ronfeldt, 2008; Kosnik & Beck, 2009.

[15] Bain, 2012

[16] Musset, 2010

teaching begins. For example, during initial coursework, elementary teacher candidates should learn strategies for teaching 10-year-olds to multiply fractions, practice these strategies, and learn how to assess whether their teaching is effective. New teachers' practicum and induction should help them to enact these strategies in a classroom, and their PD should help them to continuously improve their teaching over their careers. Building a bridge between a teacher's preparation, classroom teaching, and in-service professional development not only creates overall coherence but is also the best way to improve the effectiveness of each.

1.2 Lack of focus

The large number of topics that ITE attempts to cover in Australia and the United States is one reason why teachers are inadequately prepared for the classroom. The US Interstate Teacher Assessment and Support Consortium Model Core Teaching Standards, for example, contains a list of 174 things that teachers need to be able to do.[17] According to Kosnik & Beck (2009):

because coverage of educational theory and practice is so extensive it is necessarily superficial, and so student teachers do not gain a clear grasp of what the theories and practices mean. The breadth of coverage militates against depth of understanding.

With more topics to cover than could ever be taught in depth, teacher educators can default to teaching abstract theories and general pedagogy, and give only cursory attention to the content that teachers need to teach and the deep, subject-specific teaching skills required to teach it. In the United States, Australia and England, many programs do not teach subject-specific content that is relevant to the complete K-12 curriculum.[18] This is the opposite of teacher

preparation in high-performing systems such as Singapore and Finland.

These systems understand that when teachers enter the classroom, they will teach content from student achievement standards and K-12 curriculum. As Kosnik, Beck, & Goodwin (2016, p.39) point out:

pedagogy must largely be learned in the context of subject teaching, since teachers spend almost the whole day teaching subjects. If we just teach 'general methods' and broad educational ideologies, teacher candidates will neither understand what [the concept] means nor be able to apply it in practice.

Programs that try to cover everything a new teacher needs to know inevitably provide a shallow coverage of the complex skills needed to improve student learning. Candidates get little time to explore critical concepts in depth and practice them to mastery. Focusing on fewer topics in greater depth, as opposed to covering more material, is more likely to induce teachers to use that knowledge in their teaching.[19]

A connected learning journey enables providers and candidates to prioritize foundational skills during ITE, then to build on them during induction and early career PD. In the Netherlands, for example, when feedback from candidates, teachers, and principals showed that differentiating instruction to students was a complex skill that many candidates struggled with, the professional requirement to master this skill was moved from ITE to the end of a new teacher's induction period. Knowledge, skills, and practice related to differentiation are still covered in ITE, but now more time is devoted to developing them during induction.[20]

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[17] The Council of Chief State School Officers' Interstate Teacher Assessment and Support Consortium developed standards to describe what effective teaching across all content areas and grade levels looks like. A full list of the standards can be found here. The Council for the Accreditation of Educator Preparation (CAEP) standards require that candidates demonstrate an understanding of the ten InTASC standards in certain categories.
[18] Carter, 2015; Greenberg, Walsh, & McKee, 2014; TEMAG, 2014

[19] Jansen, Berk, & Meikle, 2017; Jensen, Hunter, Sonnemann, & Burns, 2012; Jensen, Roberts-Hull, Magee, & Ginnivan, 2016
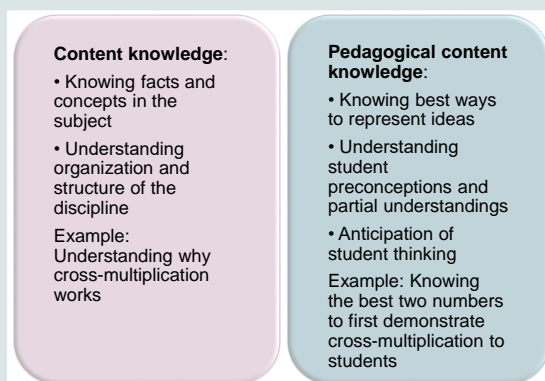[20] Learning First interview at University of Applied Sciences Amsterdam, March 2017.

Box 1: Why teachers need subject-specific teaching expertise

A teacher needs more than a solid understanding of the concepts she is teaching (**content knowledge**). She also needs to know how to explain concepts to students of varying ages, and to understand how students might think about these concepts as they progress towards understanding. This amalgam of knowledge of subject matter and of students and teaching is not knowledge most adults have, and it takes years to acquire. It requires skills in assessing and understanding student learning (formative assessment) and how to best teach concepts in specific subject areas (**pedagogical content knowledge**).

Because content knowledge and pedagogical content knowledge can mean different things in different countries, we have defined them below (see Figure 1).

Figure 1: Two types of subject expertise

Content knowledge:
• Knowing facts and concepts in the subject
• Understanding organization and structure of the discipline
Example: Understanding why cross-multiplication works

Pedagogical content knowledge:
• Knowing best ways to represent ideas
• Understanding student preconceptions and partial understandings
• Anticipation of student thinking
Example: Knowing the best two numbers to first demonstrate cross-multiplication to students

Teaching children to multiply fractions involves more than being able to explain how to multiply two fractions by doing the steps of multiplying the numerators and then the denominators. What if a student is confused because she was previously taught that multiplying numbers always results in a bigger number? What if she asks why the result is smaller? In order to address these questions, the teacher must think about student thinking, including what they were previously taught, what pre-requisite knowledge they need, any partial understandings they have and how to address them by explaining where they are going wrong, and why the topic is important.

The teacher may use models to explain what multiplying fractions means and why half of one quarter represents one eight of the whole.

$$\frac{1}{2} \times \frac{1}{4} = \frac{1}{8}$$

She may then design a series of formative assessment questions to work out if her students understood the underlying concepts.

How can we calculate the area of the striped rectangle?

○ $\frac{5}{4} x \frac{3}{7}$

○ $\frac{5}{7} x \frac{3}{4}$

○ $\frac{5}{28} x \frac{3}{28}$

The area of the entire figure below is 1 square unit

She needs to know how to analyze incorrect answers to work out why they are wrong and whether she needs to reteach the concepts a different way (which she might do in collaboration with other teachers).

Sources: Ball, 1990; Ball, Thames, & Phelps, 2008; Jensen, Roberts-Hull, Magee, & Ginnivan, 2016; Shulman, 1987

2 What a connected learning journey looks like

Ideally, a connected learning journey for a beginning teacher starts on her first day of ITE and extends through her early career, building her depth of learning as it unfolds. Behind the scenes, her ITE provider, local district, and the school where she is placed collaborate closely to turn her various training experiences into a path toward high-quality teaching. Box 2 below sets out how that journey might look for a fictional teacher, Amy.

More connected teacher preparation and development does not mean that every learning experience must be the same or perfectly aligned. Nor that coherence takes priority: the quality of programs matters most. Connecting teacher preparation and development to the work of teaching simply means that all aspects of early career teachers' learning are improved when they are embedded in what they must do when they reach the classroom. Grossman, Hammerness, McDonald, & Ronfeldt (2008, p.282) call this "coherence" – or "a shared vision regarding teaching and learning, conceptual and logistical organization of coursework around those aims and goals, and courses and clinical experiences designed to support, reinforce and reflect those shared ideas".

Box 2: Amy's journey along a new teacher pathway

Hometown University and Smithfield District spent the last three years working together to strengthen the connections between a teacher's preparation, classroom teaching, and professional development. One product of that partnership is Amy, an elementary education major at Hometown.

Amy comes from a family of teachers, and from a young age, she dreamed of teaching. She has always done well at school, but because she preferred humanities classes over math and science, she is apprehensive about standing in front of a class unprepared to teach math. Where should she begin to teach concepts like fractions? She knows that multiplying fractions involves multiplying the numerator and then the denominator, but how will she be able to explain that in a way that will make any sense to a fourth grader?

Pre-practicum semester

Amy is relieved to find that her Mathematics Methods 1 class helps her to learn not only how to do operations with fractions, but also to see how several high-quality curriculums teach fractions. She gets to examine real students' work to reconstruct the different pathways they take to understanding fractions. Guided by their professor, she and her classmates pull apart different patterns of student misunderstandings and discuss the relevant research about how to help students attain proficiency, as described in the state achievement standards, in operations with fractions.

Remembering warnings from her mother and older brother that her university coursework would be completely disconnected from the two days a week she was spending in a school, Amy is pleasantly surprised that in her classes she is looking at student work from Smithfield District, where she will be placed. The district uses one of the curriculum materials she is studying in Mathematics Methods 1, Eureka Math. Part of her homework is to bring her observation notes from her pre-practicum and share with her classmates teaching strategies she has observed, and notes about how students responded.

Practicum semester

During the winter break, Amy's mother and brother tell her to expect her practicum semester to be intense. They say that student teaching will be more challenging than teaching her own class because of all the coursework she will have to do on top of the preparation for teaching. But when Amy returns to school, she finds that her Mathematics Methods 2 class makes her teaching much easier. Class time is devoted to preparing for upcoming math lessons; she watches and discusses videos of expert math teaching; she learns how to design assessments and differentiate learning in math teaching; she plans lessons using different curriculum materials, and she rehearses, reflects on, and receives feedback on video-taped lessons.

In addition to collaborating with her peers in her methods classes at the university, Amy gets to work with in-service teachers as part of a school-based Professional Learning Community (PLC) focused on fractions. She felt unsure of herself when she first joined the group because the experienced teachers' understanding of teaching fractions was so much greater than her own, but she quickly learns that she has already practiced in several university courses the research, student work analysis, and reflection skills that the other teachers are using. She also finds ways, even at her level of understanding, to help the group, and she begins to contribute student observation notes as evidence of the group's work. After a few weeks of taking part in the PLC meetings, she feels more comfortable talking to teachers other than her mentor teacher and asking them for advice about lesson planning and delivery.

On a rainy Saturday in April of her senior year, Amy takes her state's teacher licensure exam. She is part of the first cohort of candidates taking the test since it was updated to reflect the new state standards. Amy is relieved and grateful at how well-prepared she feels, not only to answer the mathematics questions, but also to analyze student work and plan interventions to address their misunderstandings of fractions. "I never could have done this a year ago, and it's actually kind of fun," Amy thinks.

In-Service Teaching

Thanks to excellent recommendations from her principal and colleagues at her practicum site, Amy secures a fourth-grade teaching position in Smithfield District. She knows that even if she had not found a position in the same district or in another district that also used Eureka Math, she would have been prepared to teach competently with another curriculum, but it is a relief to have one fewer thing on her mind during her first year. She is also relieved that she had the opportunity to participate in a PLC at her practicum site because her new school also has one, and she feels comfortable contributing to team discussions.

Amy misses her colleagues from her practicum and wishes that there had been an opening at that school, but she keeps in close touch with them and looks forward to catching up at district-wide first-year teacher induction and professional development sessions.

In her second year of teaching, Amy is honored when her principal invites her to join a school-based research project on Eureka Math. She collaborates with colleagues from her school as well as professors from her university as they push one another's understanding of what excellent math instruction could look like in their district. Amy continues to build her expertise as a math teacher. Amy's mother smiles and shakes her head when she hears that her formerly math-phobic daughter is considering pursuing an additional qualification to become an elementary math coach.

Many of the experiences Amy had on her learning journey already exist in Singapore, Finland, Japan, and British Columbia. These high-performing systems connect teacher preparation and development in different ways. Yet their approaches share two key elements that connect preparation to practice: a common way of improving in pre-service and in-service training; and a shared understanding of what new teachers need to learn that comes from K-12 curriculum.

Examples of best practice from each system are set out below.

2.1 Singapore

Singapore has an easier job building a connected learning journey than most systems since it has only one teacher preparation provider, the National Institute of Education. Nevertheless, its Ministry of Education continues to foster connections between preparation and practice through significant investments in feedback loops, action research projects, K-12 school curriculum, and incentives for academics to conduct school-based research.

The Singaporean Ministry of Education, the Institute, and schools engage in frequent, structured collaboration. In these formal feedback loops they discuss system policies, teacher evaluation, and school curriculum. They set priorities for teacher training and create shared principles and language for preparation

and practice. Both the Institute and schools must show how they use feedback and evaluation to help each other improve teacher preparation. Five years ago, after hearing from schools that its graduates lacked practical skills, the Institute significantly revised its program to prioritize the development of core classroom teaching skills over theoretical subjects such as the philosophy and history of education.[21]

Connections are reinforced by regular secondments – job rotations or short-term placements – of staff, including classroom teachers, to the Ministry, the Institute, and schools, as well as rewards for academics who conduct school-based research. Promotion of education faculty staff is based not only on their publication records but also on the impact of their research and teaching on schools. That encourages staff to focus much more on improving schools and building their understanding of what works in teacher and student learning.[22] The NIE also offers education courses and programs for experienced teachers, enabling them to explicitly connect preparation to ongoing development. [23]

More recent reforms in Singapore have focused on ensuring that candidates learn in their preparation in similar ways to how they will learn on the job. Action research projects in teacher preparation build teachers' skills as researchers who evaluate their own practice. [24] Candidates conduct their own inquiries into a problem in school practice and, guided by faculty mentors, draw conclusions based on evidence of student learning. One current Singaporean candidate, for example, is studying speech patterns of low-progress learners in a secondary school and designing potential interventions to help them.[25] This kind of work involves subject-specific student assessment skills, as well as the ability to examine the impact of different teaching strategies. Later in their careers, teachers can

use these skills and learning experiences in professional learning communities and when training to become school leaders.[26]

Coursework in Singapore's ITE programs provides deep grounding in the subject-specific teaching competencies that will help candidates to undertake their practice-based research projects (see Box 3 and Box 4 for examples from Singapore's four-year ITE program and how that compares to an American four-year program). Coursework is tightly linked to the school curriculum: courses in subject expertise cover the content knowledge that teachers need, while courses in curriculum studies cover the ways they should teach that content (pedagogical content knowledge).

By implementing feedback loops among the Institute, schools, and the Ministry, rewarding academics who do research in schools, and aligning coursework with the curriculum that teachers will teach in schools, the Singaporean government creates connections between teacher preparation and development across the system.

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[21] Jensen et al., 2012
[22] Jensen et al., 2012
[23] Jensen et al., 2012
[24] Center on International Education Benchmarking, 2016b; Singapore National Institute of Education, 2016
[25] Learning First interview with Singapore National Institute of Education, March 2017

[26] Jensen, Sonnemann, Roberts-Hull, & Hunter, 2016; Jensen, Downing, & Clark, 2017; Singapore National Institute of Education, 2016

Box 3: Singapore ITE coursework example

Singapore's four-year bachelor program for elementary teachers prepares candidates to teach math through two streams of coursework. One stream comprises courses in math subject knowledge. The second (curriculum studies courses) focuses on the teaching, learning, and assessment of math. These courses, set out below, build the subject-specific expertise required by the Singaporean Primary Mathematics Curriculum.

Mathematical subject knowledge courses

- Fundamental Principles of Primary Mathematics I
- Fundamental Principles of Primary Mathematics II
- Number Topics
- Geometry Topics
- Further Mathematics Topics

Curriculum studies (methods) courses

- **Teaching and Learning of Primary Mathematics I** covering the Singapore Primary Mathematics Curriculum, preparation of unit and lesson plans, pedagogical strategies, teaching of key topics such as whole numbers, fractions, decimals, percentages, ratio and proportion, rate and speed, and algebra.
- **Teaching and Learning of Primary Mathematics II** covering the teaching of measurement, geometry, statistics, and microteaching, where candidates showcase their teaching approaches for the topics covered in the course and cater to different pupils.
- **Teaching and Learning of Primary Mathematics III** covering the teaching of problem solving and constructing student assessments.
- **Assessment Literacy for Primary Mathematics** covering assessment in the primary mathematics classroom, holistic and alternative assessment, and formative assessment with an emphasis of diagnosis and remediation.

Source: National Institute of Education [handbook for Bachelor of Arts (Education) and Bachelor of Science (Education)](#)

Box 4: US ITE coursework example

Coursework from a typical four-year undergraduate degree program in elementary education in the US involves general courses in math plus one math teaching course. These courses are rarely aligned with each other or with K-12 curriculum.

General education courses in math offered by the mathematics department that cover **math subject knowledge** include:

- **Contemporary Mathematics** covering problem solving and the application of mathematics covering topics such as geometry, statistics, probability, and finance
- **Foundations of Mathematics for Teachers** covering the structure and properties of the real number system including numeration systems, patterns of numbers, models and algorithms for operations, number theory, probability and statistics and the use of tools (manipulatives, calculators and computer software) to develop mathematical concepts
- **Foundations of Geometry for Teachers** covering the study of synthetic, analytic, vector and transformational geometrics including geometric figures, measurement, construction and the use of tools to develop mathematical concepts

The one course offered by the college of education on the **methods of teaching math** in elementary schools covers diagnosis of skill level development, teaching basic math skills, and individualizing instruction in math for elementary and middle school programs.

Source: University of Missouri [Elementary Education program guide](#)

2.2 Finland

Finland produces high quality teachers by connecting preparation and practice in teacher training schools, in school-based research projects, and in K-12 school curriculum.

In the 1970s, Finland consolidated its teacher training providers into eight universities.[27] Each university has at least one teacher training

school, in which candidates learn how to apply research and theory in practice. The training schools are public schools, subject to the same national curriculum and teaching requirements as other municipal schools. Like teaching hospitals in medicine, they are staffed by expert practitioners who can connect research to

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[27] Aho, Pitkanen, & Sahlberg, 2006

practice and develop candidates in authentic settings.[28]

While it may be impossible to consolidate providers in the United States or Australia, these systems can still learn from Finland. During teacher training school placements, Finnish candidates undertake collaborative research, planning, action, evaluation, and problem solving, and they are expected to continue this process once they become teachers.[29] In other words, training is designed to reflect the way they will operate and learn on the job.[30] Like their counterparts in Singapore, Finnish candidates are expected to conduct school-based projects that use research and inquiry skills to examine a problem of practice, and to draw conclusions based on analysis of student work.

Also as in Singapore, Finnish teacher educators prioritize pedagogical content knowledge to give teacher candidates the skills to design, deliver, and evaluate their own practice. Candidates dive deeply into a subject, studying pedagogical methods and theory (see Box 5 below for an example).

Curriculum materials are also important: they strengthen the focus on applied teaching skills to support candidate learning and to connect preparation and practice. Finnish teachers rely heavily on high-quality textbooks, especially during their first few years of teaching.[31] Subject expertise courses familiarize candidates with the curriculum and textbooks, and candidates use these materials during their practice. For example, in tutorials in a literacy course at the University of Helsinki, candidates are introduced to textbooks, learn how to use them as cognitive tools, and explore why the books were composed in particular ways in order to understand how to use them in practice. [32]

Finland's Ministry of Education has formal annual meetings with providers to share practices. It also funds providers to build capacity in specific areas, such as developing second language teachers. [33] The close involvement of teacher educators and researchers in the 10-yearly revision of national school curriculum standards helps to create a common understanding among researchers, teacher educators, and experienced teachers of what teachers need to know in order to teach students.[34]

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[28] Center on International Education Benchmarking, 2016a; Center on International Education Benchmarking, 2016b

[29] Center on International Education Benchmarking, 2016a; Sahlberg, 2010

[30] Ministry of Education and Culture, 2014

[31] While there is an open market for the publication of curriculum materials in Finland, in practice there are just a few key trusted publishers who hire expert teachers to write the materials. Publishers are members of the national government curriculum steering group and align materials to systemic expectations for teaching and learning. See Jensen, Roberts-Hull, et al. (2016) for further details.

[32] Jensen, Roberts-Hull, et al., 2016

[33] Jensen, Roberts-Hull, et al., 2016

[34] Center on International Education Benchmarking, 2016a

Box 5: Subject expertise courses at the University of Jyväskylä

Finnish elementary teachers have a wide learning program to teach. It comprises Finnish language and literature, history and social studies, religion and ethics, art, physical and health education, mathematics, music, technology education, as well as technical handicraft, handicraft education and textile handicraft, and environmental and natural science. Candidates at the University of Jyväskylä take two courses in each subject they will teach, as well as minors in which they can develop specialist expertise.

The basic course includes content and teaching topics related to the subject. It focuses on developing pedagogy but also considers the topics from a theoretical standpoint and includes extensive out-of-class reading.

The other, applied, course focuses on practice and the pedagogical content knowledge and interdisciplinary approaches needed to teach the curriculum.

An example of topics in a basic course for mathematics:

- Geometry
- Calculation with large numbers
- Fractions
- Pre-algebra
- Using manipulatives
- Introducing number system to students
- Fears and feelings about mathematics
- Hypothetical situations from the classroom
- Computer software for mathematics instruction
- Inquiry-based mathematics.

Source: Adapted from Jensen, Roberts-Hull, et al., 2016

2.3 Japan

Japan has a large number of ITE providers and programs, with 80 percent of all four-year colleges and universities offering accredited teacher education programs.[35] The country has a common method of developing teachers across preparation and practice, known as lesson study. It also has strong curriculum materials, university-affiliated schools, and an employment exam to support connections between preparation and practice.

Lesson study involves teams of teachers collaborating to research, plan, teach, analyze, observe, and reflect on lessons. A typical lesson study cycle focuses on a subject-specific topic and takes at least five weeks to complete. Because it involves experienced and beginning teachers working together, it is an excellent form of professional development for everyone involved, and both providers and schools in Japan use it during training, induction, and ongoing PD.[36] Box 6 contains more information.

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[35] R. M. Ingersoll, 2007

[36] Takahashi & McDougal, 2016

Box 6: How the Japanese use lesson study during practical training

Japanese lesson study is a collaborative process used to develop teachers' skills over their careers. Prospective teachers are introduced to lesson study during preparation, when they take part in group-based learning, curriculum-informed lesson design and delivery, and analysis of real teaching and student learning.

During their final practical teaching placement, student teachers are separated into groups of five to 10 to observe each other's lesson plans and classes, and provide feedback to each other using the lesson study process, as the following example describes:

- Before a fourth-grade math class, a group of student teachers works together to anticipate student thinking for a fractions lesson. One student teacher teaches the lesson, while the others and a math subject expert observe and take notes on student behavior;

- At the end of the class, a group discussion of how well they anticipated student responses helps them to improve their pedagogical content knowledge. They now know more about student thinking in this topic, and they have new ideas about how to present the curriculum material and assess student learning. They will write a short reflection on the class as part of assessment for the practicum.

An experienced teacher guides group discussions. Novice teachers do not have to rely on their own curriculum knowledge and subject expertise to design the lesson; instead, they are expected to call on subject experts for feedback and advice.

At the end of the placement, experienced teachers watch the prospective teachers teach demonstration lessons, which are closely linked to the evaluation of a candidate's practicum. The evaluation considers how a candidate interacts with students, designs lesson plans based on the curriculum, delivers lessons, participates in extra-curricular activities, communicates with colleagues, and performs in the classroom.

Sources: Jensen, Roberts-Hull, et al., 2016; Takahashi, 2011; Takahashi & McDougal, 2016

Japanese teacher educators introduce lesson study during coursework, because it ensures that candidates understand how to continuously build subject expertise once they are in the classroom. Candidates take part in lesson study during their school-based practical training and induction year, and use it over their career.[37]

Lesson study is grounded in the content that Japanese teachers will teach their students. The content comes from the comprehensive national curriculum, which includes everything from goals for each school subject and the content of instruction down to standards for the number of hours of instruction and what government-approved textbooks to use. Teachers investigate and use these carefully designed achievement standards and curriculum materials, not only to avoid "reinventing the wheel" but also to add to the knowledge base about what works in student learning.[38] ITE programs in Japan often teach the curriculum and accompanying teacher guides

as part of subject expertise courses.[39] Box 7 contains an example of how one preparation program uses lesson study to develop deep and specific teaching skills in candidates.

While the Ministry of Education sets a minimum number of content and pedagogy courses, many providers offer two to three times that amount to ensure that their candidates perform at the top of the Japanese teacher employment exam and secure full-time teaching positions. At Tokyo Gakugei University, for example, candidates take two courses for each of the nine subjects they will teach as elementary school teachers. These courses help them to build the content and pedagogical content knowledge that they will need to begin teaching, and their knowledge will continue to develop once they are in schools through practicum, induction, and ongoing PD.[40]

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[37] Jensen, Roberts-Hull, et al., 2016; Takahashi, 2014
[38] Takahashi & McDougal, 2016

[39] Jensen, Roberts-Hull, et al., 2016
[40] Jensen, Roberts-Hull, et al., 2016

**Box 7: How one Japanese ITE program uses lesson study**

Tamagawa University is a private university and K-12 school in Tokyo. Like most Japanese schools and teacher preparation providers, it uses lesson study to develop deep, subject-specific, and applied competencies in its teachers.

The early stages of its preparation program involve courses in the basics of teaching and subject contents aligned with the Japanese school curriculum, as well as placements to observe professional teaching. Later stages involve increasingly deeper professional and practical skills in teaching subject content and working as teachers, followed by an extended student teaching placement (practicum).

In pre-practice and post-practice courses, students prepare for and reflect on the practicum experience, which creates strong connections between theory and practice. The sequence goes like this:

- Candidates doing general coursework are taught the basics of lesson study theory, curriculum, and the pedagogical content knowledge they need to design lessons;
- Before the practicum, candidates attend fifteen 100-minute classes, during which practicing teachers explain life in the school (including lesson study steps). They help candidates to make and practice mock lesson plans in specific subjects, discussing questions such as *How to develop the lesson from curriculum? How to predict how children might react? How to identify signs of children learning in the classroom?*
- During the practicum, groups of candidates take part in lesson study with more experienced teachers (as outlined in Box 6 above);
- After the practicum, candidates attend classes to review their practice at the school and reflect with peers on the teaching and student learning experience.

Figure 2: Tamagawa University's four-year teacher preparation program outline
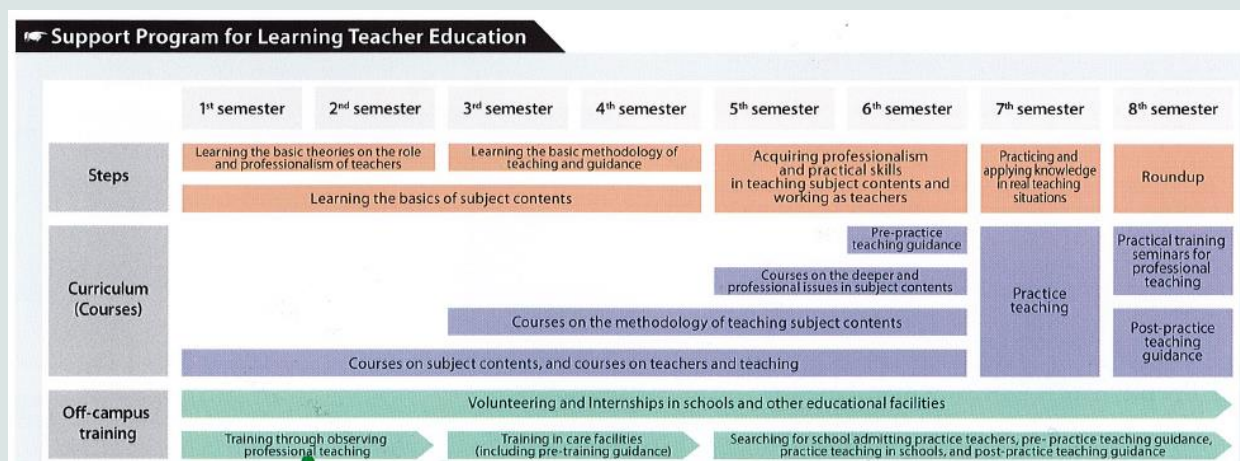
The process of lesson study, coupled with pre-and post-practicum coursework, comprises the core of an effective beginning teacher learning process that builds deep and subject-specific teaching skills. It is embedded in the work of teachers, connected to student learning, scaffolded by curriculum and mentor teachers, and repeatable over a teacher's career.

Source: Tamagawa University Education Programs Brochure, 2016

Box 8: Example questions from Saitama prefecture's employment exam for elementary teachers

Question: Select the correct order of A to D, which describe the characteristics of sodium hydroxide aqueous

A. A red litmus paper turns blue.

B. Phenolphthalein solution turns red.

C. BTB solution turns yellow.

D. A blue litmus paper turns red.

    1. ABC   **2.** BCD   **3.** AB   **4.** BD

Question: Choose one from the next 1 to 4 as the right value for $-2^2 - (-3)^3$

    1. -31   **2.** -13   **3.** 5   **4.** 23

Question: When the decimal part of $\sqrt{5}$ is χ, choose one from the next 1 to 4 as the right value for $\chi^2 + 4\chi + 4$

    1. 5   **2.** 10   **3.** 16   **4.** 25

Source: Appendix to Jensen, Roberts-Hull, et al., 2016 [41]

In most prefectures, the employment exam consists of a written component that tests subject expertise (see Box 8) and an oral component that can include interviews or lesson simulations.

The exam rewards providers who produce high-quality graduates because candidates are ranked, rather than simply marked as passing or failing. Only the top-ranked candidates are offered full-time positions, and each provider must publish in its annual report the number of their graduates who secure them. The hiring exams are notoriously competitive – in 2013, for example, 180,000 candidates took hiring exams but only 31,000 – 17 per cent of the total – were hired.[42]

In addition to the lesson study learning approach, strong curriculum materials, and employment exam incentives, several Japanese teacher preparation providers have affiliated schools to strengthen connections between preparation and development. Affiliated schools provide innovative education programs, conduct educational research in co-operation with the university faculty, and help candidates to practice teaching. The schools conduct large research-based lesson study sessions and open them to the public.

2.4 British Columbia, Canada

The education systems of Singapore, Finland, and Japan are strongly directed by their ministries of education. Canadian education, by contrast, is very decentralized. For the most part, government has stayed out of teacher preparation, and individual programs have driven reform efforts.[43] Yet there is a shared view, set out in the pan-Canadian Deans' Accord on Initial Teacher Education, that preparation must promote an awareness of the interconnected nature of theory, research, and practice in the profession, and be the first stage of continuing professional development.[44]

In British Columbia, a high-performing Canadian province, a number of ITE programs work closely with districts and schools. They use a learning

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[41] For more sample questions from the written component of the employment exam for the Saitama prefecture (translated by Learning First), refer to the Not So Elementary toolkit.

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

[43] Kosnik et al., 2016

[44] Refer to the Association of Canadian Deans of Education's Accord on Initial Teacher Education for more information.

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process that is taken from the dominant approach to professional learning used in schools, and is known as the Spiral of Inquiry.

The Spiral of Inquiry involves collaborative teams undertaking a disciplined inquiry process to collect evidence on student learning, to pinpoint a specific improvement area, and then to research and implement a new teaching practice (see Box 9 for the steps involved). Teachers work together to evaluate and improve the practice using lesson observation, co-teaching, feedback, and collection of student learning data.[45]

The inquiry cycle process in schools and in ITE is supported by the province's high-quality curriculum guidance about what students should know and be able to do.[46] Over time, the Ministry of Education, in collaboration with teachers, has developed learning progressions to support the implementation of the achievement standards in reading, writing, numeracy, and social responsibility.[47] The learning progressions help new and experienced teachers to understand what students should be able to do at four different levels, leading up to proficiency at each grade level. The progressions are important scaffolds to enable new and experienced teachers to scan, design, and assess student learning, as the Spiral of Inquiry steps set out.[48]

ITE programs in British Columbia are using the Spiral of Inquiry from the start of teacher preparation, and place candidates in schools that use the process well. Candidates do not need a level of foundational knowledge to take part, because they learn from more experienced teachers how to develop and apply formative assessment, research, collaboration, and evaluation skills.[49] Faculty from the programs participate in the process in schools, either through co-teaching classes with candidates, or collaborating with groups of teachers to evaluate practice.[50]

The University of British Columbia has a number of partnerships with local school districts to reinforce this disciplined inquiry approach to candidate learning. Using a form of inquiry cycle, these district schools demonstrate the principles and pedagogies that are central to program coursework. One partnership is used for the Community of Inquiry into Teacher Education (CITE), a post-baccalaureate program that involves candidates, teacher educators, and school-based teachers and teacher mentors working together on studies of existing and possible teaching practices. The Community was established to create a dialogue between university and school staff, to find common ground between theory and practice, and to

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Box 9: A framework for professional inquiry and learning used in British Columbia

There are six steps in the Spiral of Inquiry framework:

- Scanning: collect evidence about what is going on for learners;
- Focusing: use the evidence to decide on the highest priority;
- Developing a hunch: critically appraise how teaching is contributing to the issue;
- New professional learning: decide what the team needs to learn, and plan how to do it;
- Taking action: take multiple attempts to apply learning and try changes to practice;
- Checking: analyze evidence of student learning progress.

Source: Halbert & Kaser, 2013

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[45] Halbert & Kaser, 2013; Jensen, Sonnemann, et al., 2016

[46] The achievement standards are referred to as 'learning outcomes' in British Columbia.

[47] The learning progressions are referred to as 'performance standards' in British Columbia.

[48] Magee & Jensen, Forthcoming

[49] Learning First interview with Linda Kaser, June 2017

[50] Learning First interview with Linda Kaser, September 2017

prepare candidates with the skills to work with others to improve their practices for the rest of their career.[51] Candidates are placed in a district, with practical training in schools, after-school professional learning sessions, and a school-based methods course is typically delivered by a mix of university faculty and district staff.

For ten years the Ministry of Education has distributed small grants to encourage such collaborations.[52] It also funds joint provider-district partnerships to improve in-service learning for first year teachers. For example, the University of British Columbia and select school districts and teacher associations are funded to undertake a teacher mentoring project. One site uses the partnership to enable educators to collaborate on implementing a new mathematics curriculum.[53]

3 Preparation and practice in another discipline: medical training

While practicing medicine and teaching a class of schoolchildren differ in many ways, both require the practical application of academic knowledge in order to achieve an outcome – either improved patient health or improved student learning.[54]

A beginning teacher might understand both fractions and theories of child development, but does he know them deeply enough, and can he combine them, in order to be able to help a frustrated eight-year-old make sense of a problem and choose a strategy to solve it? Similarly, a junior doctor might be able to recite the risks and benefits of an anti-clotting medication, but she won't be judged as competent if she can't then advise, prescribe, interpret tests, and communicate with patients and their families.

Building the right kind of practical skills and academic understanding is a challenge for both teacher and medical education. Just as no doctor can learn all that must be known in a lecture theatre, expertise in teaching comes from experience. Both medical and teacher education programs are under pressure to fit more into a short few years. Both must make trade-offs about what is essential to teach early on and what can be learned on the job.

While medical training is far from perfect, it is widely seen to prepare new doctors more effectively than ITE prepares new teachers. Much can be learned from it.

3.1 Working together over the long term

Medical schools have deep, co-operative, and long-term partnerships with hospitals. Modern medical education shows that providers (universities) can work closely with practitioners (hospital staff) to create learning experiences for

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[51] Farr Darling, 2001; Farr Darling, Erickson, & Clarke, 2007. For more information refer to the CITE program website.

[52] Jensen, Sonnemann, et al., 2016

[53] Refer to the University of British Columbia's description of The New Teacher Mentoring Project and the Mentoring BC website for more information.

[54] Partly adapted from a Learning First blog post by former Learning First associate and current medical student Leah Ginnivan.

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beginners that combine strong practical preparation with academic rigor.

This was not always the case. Abraham Flexner's 1910 report for the Carnegie Foundation criticized North American doctor preparation as fragmented, too theoretical, and separate from the professional environment of medicine. [55] Amongst other things, the report recommended the establishment of teaching hospitals and the joint ownership of medical education between universities and hospitals.

In the past century, medical schools have developed close relationships with teaching hospitals, thereby creating links between training and patient care.[56] A key premise of teaching hospitals is that candidate doctors learn from all clinical staff, not just university-based staff. [57] Training and development are integrated with daily hospital practices and patient care.

Medical education contains specialized positions for university faculty who work in practical settings. Generally called clinical professorships, these roles encourage educators to work at hospitals, ensuring a strong connection between research, training, and practice. These specialized academic staff see patients, teach candidates, and conduct peer-reviewed research in a practical setting.

Medical practitioners are recognized for training new doctors as part of their own career progression, and nearly all medical school lecturers are practicing doctors while they teach. Academic research into medical education is a thriving field, with ongoing attempts to refine what constitutes effective education both at the initial level and throughout a medical career. These positions and research opportunities provide important rewards and recognition for university faculty and practitioners to connect training and practice.

3.2 A common way of improving, in preparation and in practice

Australian medical schools develop foundational knowledge through a mix of lectures, practicals, and clinical exposure. Candidates are given many opportunities to consolidate knowledge and skills through supervised practice and feedback in authentic settings. Skills such as differential diagnosis are taught in group work and in clinical, classroom, and seminar settings. Medical students apply their skills in a holistic, reflective, and active manner: they access and critically appraise information, actively engage in problem solving, and respond to feedback. [58] They build skills and experience in a progression, from university training into early career internships and residencies. In early training, they spend time in hospitals for observation, then take an internship year that includes practicing medicine with close supervision and no decision making. Finally, a residency involves practicing as a doctor with supervision.

These applied and scaffolded learning experiences begin in coursework and are expanded upon during clinical training and residency programs. This approach is an effective way to create coherence in learning over a doctor's early career, and some teacher education residency programs are beginning to apply lessons from it.

3.3 Shared understanding of what to learn that comes from curriculum

A strong training curriculum, and tools such as developmental learning frameworks and evidence-based curriculum materials, ensure that medical education successfully incorporates theory and research into clinical training. [59]

Curriculum guidance documents set out clear learning goals and experiences that create coherence among academic educators, clinical teachers, and students. University-based medical training specifically draws on students' clinical

[55] Flexner, 1910
[56] Ash, Walters, Prideaux, & Wilson, 2012
[57] Ash et al., 2012

[58] Conn, Lake, McColl, Bilszta, & Woodward-Kron, 2012
[59] Conn et al., 2012

experiences during coursework, and clinical teachers use formal curriculum materials in practical settings, as well as guides to prioritize content and promote discussion and reflection. [60]

An example of curriculum guidance is the Australian Curriculum Framework for Junior Doctors, which helps medical education providers, clinical teachers, and employers to provide a structured and planned program of education for prevocational doctors (interns). [61] The Framework is like a national curriculum that shapes the focus of a final practical placement or an induction year program for beginning teachers. Such curriculum support is critical for connecting universities and practitioners in early career development.

4 The elements of high-quality beginning teacher learning

What do nearly all the world's high-performing school systems have in common in their teacher preparation? They provide candidates with a basic teaching repertoire that ensures beginning teachers are familiar with a small set of high-quality curriculum materials, learn several general and subject-specific strategies for teaching, and explore approaches to assessment that capture student understanding.[62]

Across high-performing systems the forms of teacher preparation, development, and practice range widely, from lesson study in Japan, to action research projects in Finland and Singapore, to inquiry cycles in British Columbia. But they all they share two essential elements:

1. A common language and approach that explicitly connects *how teachers learn* in initial teacher education, how they learn in professional development, and what they do every day in classrooms;
2. A shared understanding of *what new teachers need to learn* that comes from K-12 curriculum.

4.1 A common language about and approach to teacher learning

It is often said that the development of beginning teachers suffers from too much theory and not enough practice. Examples from high-performing systems and many years of research and practice in adult and teacher learning shows that this is a simplistic answer, one that leads to misguided remedies.[63] If a teacher preparation program receives feedback that its courses are too theoretical, the solution may not be to shorten coursework in favor of a longer practicum. Instead, the provider could consider what theory will best equip candidates for the classroom.

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[60] Conn et al., 2012
[61] Refer to the Australian Curriculum Framework for Junior Doctors for more information

[62] Feiman-Nemser, 2001
[63] Jensen, Roberts-Hull, et al., 2016; Jensen, Sonnemann, et al., 2016

In Singapore, when various data sources and stakeholder feedback suggested that the National Institute of Education taught too much theory that was not applicable to classroom practice, the provider responded not by teaching less theory but by changing the theory it taught. Out went much of the sociology and philosophy of education, and in came more on the theoretical foundations of how to teach the national curriculum: the pedagogical content knowledge of how to teach fractions, for instance. The connections among teacher preparation, schools, and teacher professional development enabled what was already a world-class teacher preparation institute to become even better.[64]

Singapore's reforms reflect what we know about effective adult learning and development: learning is only effective when it is connected to practice, and when it takes into account the prior experience of a learner.[65] Effective adult learning recognizes that adults change their practices by collaborating and doing, rather than simply reading and observing others work. In powerful adult learning experiences, participants work towards learning goals and drive their own process of improvement.[66]

Therefore, effective teacher learning in high-performing systems is:

- Authentic and specific: teachers are given many opportunities to enact K-12 curriculum in a classroom;
- Guided: teachers are guided by high-quality K-12 curriculum materials and expert mentors;
- Coherent: learning is approached in a similar way across preparation, development and on the job; it builds on previous knowledge and experience;
- Committed to building continuous learners: teachers are trained to use and evaluate research, curriculum and

teaching strategies, in order to drive their own learning over their career.[67]

In other words, effective teacher learning incorporates active, authentic, and relevant learning activities. It supports teacher collaboration and peer and mentor observation while providing coaching and expert support. It uses models of effective practices, plans and student work, and it provides time for feedback and reflection. Above all, its effects are sustained over the course of a career.[68]

A recent study in New York confirms that candidates who engage in activities that are closely related to the practices they will use as teachers are more likely to be effective in their first year of teaching. These practices include examining local curriculum, analyzing student work samples, and conducting reading assessments of students.[69]

This kind of approach to teacher learning breaks down artificial distinctions between what teacher candidates learn in university compared to school – the divides between theory and practice. Coursework should provide candidates with opportunities to examine and rehearse good teaching. [70] Practical training should help candidates to build subject knowledge. Effective collaboration between university-based providers and districts is likely to make it easier for schools to support teaching candidates. As Amy's journey shows (see Box 2), candidates can join Professional Learning Communities during their placements alongside any other teacher in the school.

Collaboration among providers and districts and schools helps to create a common language and understanding of how new teachers learn and develop. The University of Michigan, for example, uses a "rounds" approach to ensure that candidates can integrate learning from both coursework and practical training. Candidates

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[64] Jensen et al., 2012
[65] Knowles, Holton, & Swanson, 2015
[66] Chi, Bassok, Lewis, Reimann, & Glaser, 1989; Knowles et al., 2015

[67] Jensen, Sonnemann, et al., 2016
[68] Darling-Hammond, Hyler, & Gardner, 2017
[69] D. J. Boyd, Grossman, Lankford, Loeb, & Wyckoff, 2009; D. Boyd, Grossman, Lankford, Loeb, & Wyckoff, 2006
[70] Grossman, Hammerness, & McDonald, 2009; McDonald, Kazemi, & Kavanagh, 2013

present a video of their teaching practice and analyze it in-depth with peers, mentor teachers and teacher educators from all subject areas. The University extended this approach to include "grand rounds" to bring together teaching professionals of all levels of expertise to present and discuss cases of instructional practice and to learn from one another.[71]

The University of Washington also takes a common approach to learning across ITE and PD through its Teacher Education by Design (TEDD) community and its Learning Cycle model. The cycle helps candidates to build and apply their teaching knowledge and skills in a collaborative process. It can be applied in a university-based course, in settings where teachers and teacher educators work together, or in the classroom. It can be applied across subject areas, and incorporate student achievement standards and curriculum materials. University of Washington teacher educators and researchers say the Learning Cycle is essential to prepare and develop teachers in both the knowing and doing of teaching.[72] The cycle and its associated tools are used in preparation programs and schools around the United States, including the Seattle Teacher Residency.[73] Box 10 gives an example of how it works.

4.2 Shared understanding of what new teachers need to learn that comes from K-12 curriculum

K-12 curriculum is a critical part of how high-performing systems train their teachers, a feature that policymakers in the US and Australia often overlook.[74] In high-performing systems such as Finland, Japan and Singapore, rigorous K-12 curriculum is integrated into teacher learning approaches in ITE and ongoing PD.[75]

High-quality curriculum supports, such as learning progressions, textbooks, and exemplar lesson plans, help both beginning and experienced teachers to prioritize, sequence, and break down what they need to teach in their classrooms.[76] They ground preparation in the work of teaching and provide a frame of reference for teacher preparation stakeholders to agree the specific subject knowledge, strategies and resources that teachers must learn and practice.

High-performing systems use K-12 curriculum to better connect preparation and practice in two ways:

- To inform shared learning priorities for preparation – that is, to build understanding of the deep competencies that candidates must learn and practice during coursework and practical training;
- As a tool to accelerate beginning teacher learning and develop deep competencies.

Shared learning priorities for preparation

Rigorous student achievement standards and high-quality curriculum guidance documents and materials enable all stakeholders to share a vision and a language of teacher and student learning. High-performing systems use this shared vision and language to focus ITE content on the deep, subject-specific competencies that beginning teachers must acquire.[77]

[71] Bain, 2012

[72] McDonald et al., 2013

[73] For more information refer to the Seattle Teacher Residency description of their residency year and the TEDD website that outlines the network of programs and schools using the Learning Cycle.

[74] The companion paper *Using K-12 curriculum to improve teacher preparation* contains a more detailed discussion about K-12 curriculum and teacher preparation, including definitions for achievement standards (student learning goals articulated in documents like college- and career-ready standards in the US), curriculum guidance documents (which help teachers understand and apply what is in the

achievement standards), and curriculum materials (e.g. textbooks, lesson plans, assessment rubrics).

[75] R. M. Ingersoll, 2007; Jensen, Roberts-Hull, et al., 2016; Ota, 2000; Sahlberg, 2010

[76] Ball & Cohen, 1996

[77] Jensen, Roberts-Hull, et al., 2016

Box 10: How the Learning Cycle builds connections between preparation, professional development, and what teachers need to do in the classroom

Omar is in his second year of a Masters of Elementary Teaching that combines two days of coursework a week with a three-day placement in a partner elementary school. Both his current coursework and placement are focused on how to teach fractions. His program uses teacher education pedagogies from the Learning Cycle as the way to build skills and knowledge in candidates. During coursework he:

- Examines and discusses student achievement standards and curriculum materials and videos of expert teachers showing children how to multiply fractions; and

- Reviews sample student work and formative assessment item answers that show what the students in his placement school currently know and understand about fractions.

Omar's coursework helps him prepare and rehearse the activity. With a small group of fellow candidates, he:

- Researches and plans a lesson (aligned with achievement standards and using curriculum materials where appropriate) to teach students how to multiply fractions; and

- Rehearses his part of the delivery of the lesson with his group of peers and gets feedback from his teacher educator;

At his school placement, he:

- Teaches his part of the lesson, is filmed, and observed by his mentor, teacher educator, and other candidates;

After his school placement, he:

- Analyzes videos of his and his peers' teaching with mentor teachers, teacher educators, other candidates; and

- Writes a reflection on what partial understandings student had, where his students are performing in relation to achievement standards, and how he could improve his teaching.

Figure 3: The Learning Cycle

Source: McDonald, Kazemi, & Kavanagh (2013)

Achievement standards and curriculum guidance documents define expectations of what students need to know and provide a framework and common reference point for what teachers need to teach. The framework is strong because it is specific, concrete, and grounded in the daily work of teachers. It guides programs to focus on deep, specific, and applied competencies such as subject matter knowledge and pedagogical content knowledge. In this way, using K-12 curriculum in preparation ensures the close connection between teacher and student learning. As discussed earlier, Singapore, for example, designs teacher preparation using student achievement standards and K-12 curriculum (see to Box 3 for an ITE mathematics course that is guided by standards and curriculum, and focuses on building deep and applied subject matter knowledge and pedagogical content knowledge).

Use of achievement standards and K-12 curriculum sets up common expectations and creates a shared vision for instruction and student learning across providers and schools.[78] It enables candidates, teachers, and teacher educators to discuss student learning in the same language, and it creates a benchmark of what student learning and progress "looks like" at each developmental stage. It helps to align candidates', teachers,' and teacher educators' professional judgements and to hold each other to account for evidence of students' progress against the standards.[79]

A tool to accelerate teacher learning

Beginning teachers in high-performing systems are rarely expected to develop lessons from scratch, but they are well versed in how to evaluate, adapt and use K-12 curriculum materials in a classroom. [80] Materials are introduced and analyzed in coursework, not left for new teachers to figure out for themselves once they are in schools. Programs use sample curriculum materials, such as textbooks and student work samples, for candidates to and analyze. They provide examples of what student

achievement standards mean in practice and how to use them in lessons with students.

Candidates and early career teachers get many opportunities to enact K-12 curriculum in a classroom, with feedback from mentors. That helps them to quickly develop deep, subject-specific, and applied teaching competencies, such as pedagogical content knowledge. OECD data show that beginning teachers in systems such as Finland and Japan are well-prepared in the content knowledge, pedagogy, and classroom practice required to teach school subjects, with little difference in the proportions of new and experienced teachers reporting they feel prepared to teach in subject fields.[81]

5 Conclusion

Creating links between theory and practice, researchers and practitioners, universities and schools is not easy, but as this paper illustrates, it is possible. It is also urgently needed. We hope the examples in this paper inspire states, districts, schools, and providers with a vision for how they can work together to connect preparation and practice, and ways to achieve it. The goal is to create teachers who have the skills, knowledge and commitment to make a difference to the learning and the lives of their students.

We discuss ways to implement this vision in our companion papers: *Developing partnerships in teacher preparation; Using K-12 curriculum in teacher preparation;* and *Continuous improvement in teacher preparation.*

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[78] Hammerness & Klette, 2015
[79] Magee & Jensen, Forthcoming
[80] Jensen, Roberts-Hull, et al., 2016

[81] OECD, 2017

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