Impact of Teacher Education: Evidence from the IEA TEDS-M

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A long history of development

- Initial discussions around 2003
- A preliminary study known as PTEDS covering a few countries
- Within IEA country members discussion on participation
- Gradual incorporation of 17 countries
- Official start of most of interested countries around 2006
- Not quite concluded as International Report has not been published, but on the way.

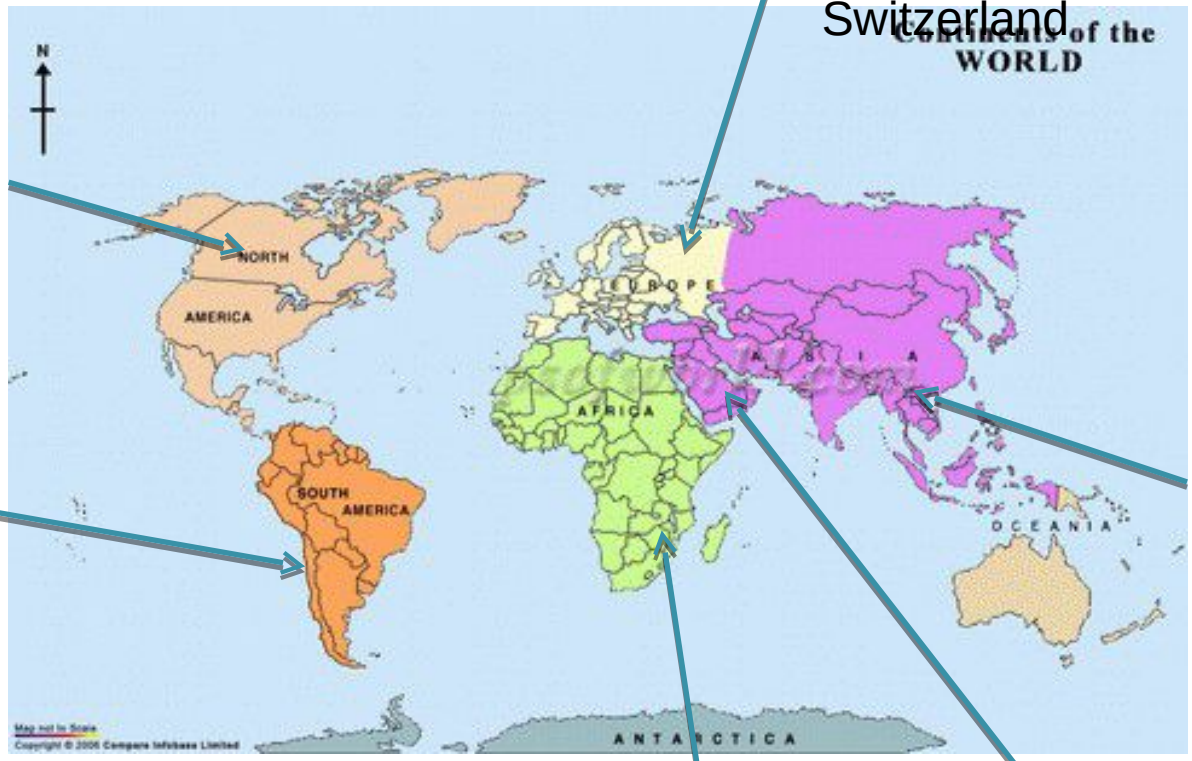
Main questions

- What are the policies that support primary and secondary teachers' achieved level and depth of mathematics and related teaching knowledge?
- What learning opportunities available to prospective teachers allow them to achieve that knowledge?
- What are the level and depth of mathematics and related teaching knowledge attained by prospective primary and secondary teachers at the end of their initial teacher education?

Participating countries

Germany
Spain
Georgia
Norway
Poland
Russia,
Switzerland

Canada
USA



Chile

Malaysia
Philippines
Singapore
Thailand
Chinese Taipei

Botswana

Oman

Variation among participating countries

- Very large population: Russian Federation, USA, Philippines, Germany
- High GDP per head in PPP (69 countries): Singapore (9) USA (12), Canada (19), Germany (29), Spain (35); Taiwan (37) Oman (51).
- GDP per head other countries: Botswana, Chile, Poland (middle), Philippines (low)
- Low primary enrolment: Oman (75%)
- High secondary enrolment: Spain, Canada, Germany
- Highest tertiary enrolment: USA
  - Source: The Economist, Pocket World in Figures 2011.

International coordination

Michigan State University:
M. T. Tatto, International Coordinator;
J. Schwille & Sh. Senk.

Australian Council of Educational Research
L. Ingvarson, R. Peck & G. Rowley

IEA Hamburg. Technical support

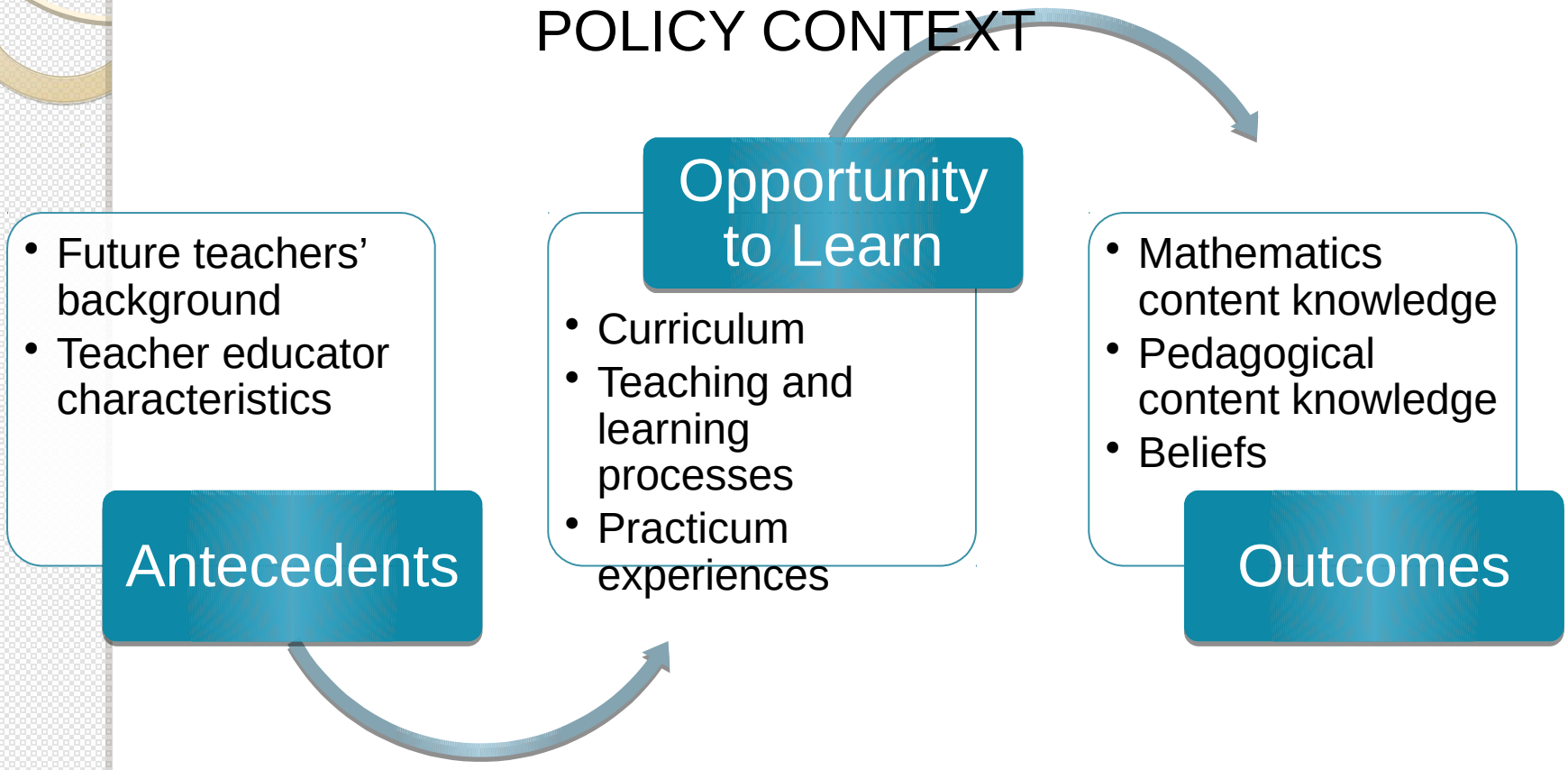
Process

- National & programme coordinators in each country
- International coordination meetings during the study (2006-2010)
- Focused and training meetings: data management, curriculum analysis
- Constant communication (e-mail & web page)
- Constant feedback to national coordinators during process

The key targets of the study

- *Study of context*: to understand the policy environment of each country relating to teachers and teacher education and the characteristics of preparation programmes
- *The opportunity to learn*: to estimate the range of opportunities offered by the curriculum and teaching strategies in teacher education institutions
- *Level of preparation*: To assess the mathematics content and pedagogy knowledge as well as beliefs about teaching of prospective teachers.

The conceptual framework



The programmes and population studied

- Teacher education institutions (500)
- Teacher preparation programmes: primary (349) & lower secondary (226), primary +lower secondary (176)
- Future teachers in each programme: 13,871 (primary), 8,207 (lower secondary)
- Educators in each programme (mathematics, mathematics pedagogy and general education): 5,190
- Curriculum documents

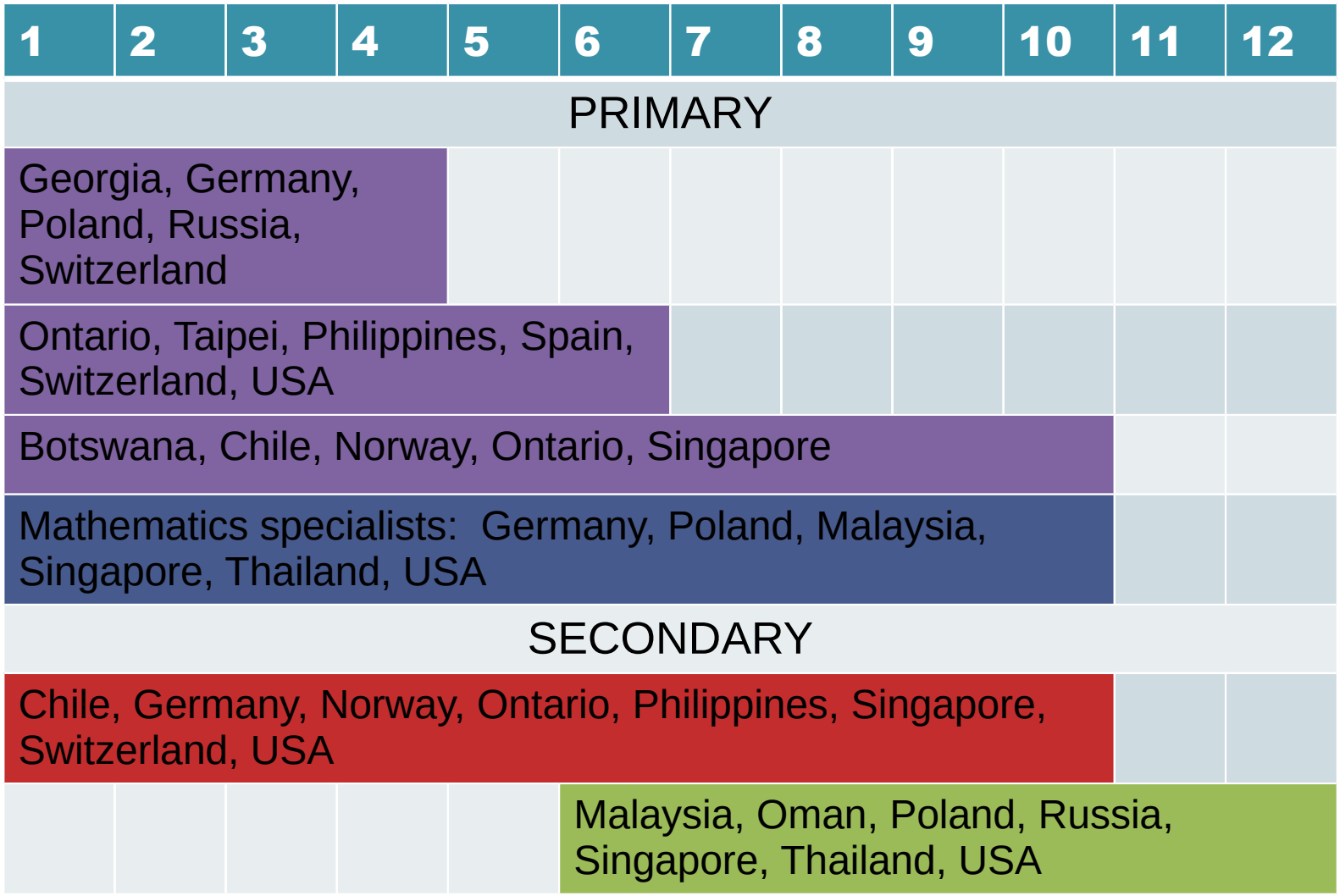
Sampling procedures

- Two-stage sampling design using randomization:
  - Representative sample of teacher education institutions (each country provided universe)
  - Samples of future teachers and educators within each institution
- Special software used in each country to select samples
- Sampling errors were computed using balanced half-sample repeated replication (B.R.R.)

Data collection instruments

- Future teacher questionnaire:
  - Personal background characteristics
  - Opportunity to learn
  - Mathematics content and pedagogy knowledge
  - Beliefs
- Educator questionnaire
  - Personal /academic background characteristics
  - Opportunity to learn
  - Beliefs
- Institutional questionnaire

Variation in Structure of Participating Programmes: Concurrent & Consecutive



Policy Contexts

- *Teacher employment system*: position or career based
- *Teacher working conditions*: critical (Botswana, Philippines); moderate (Chile & USA), Good (Germany, Spain, Switzerland, Chinese Taipei)
- *Salaries*: Very low (Philippines); high (Taipei, Singapore, Germany); compensated with incentives (Thailand, Malaysia)

Attractiveness and entry requirements

- *Selection on entry to T. Ed.* (number of places): Strong, mixed and weak controls.
- *Entry requirements*: secondary school only, secondary school + mathematics; secondary school+ tertiary level studies in maths.
- *Attractiveness and status of teaching profession*: High, mixed, low
- *Primary & lower secondary teachers with Maths specialisation*, more likely in: Canada, Chinese Taipei, Germany, Malaysia, Oman, Poland, Russian Federation and Singapore.

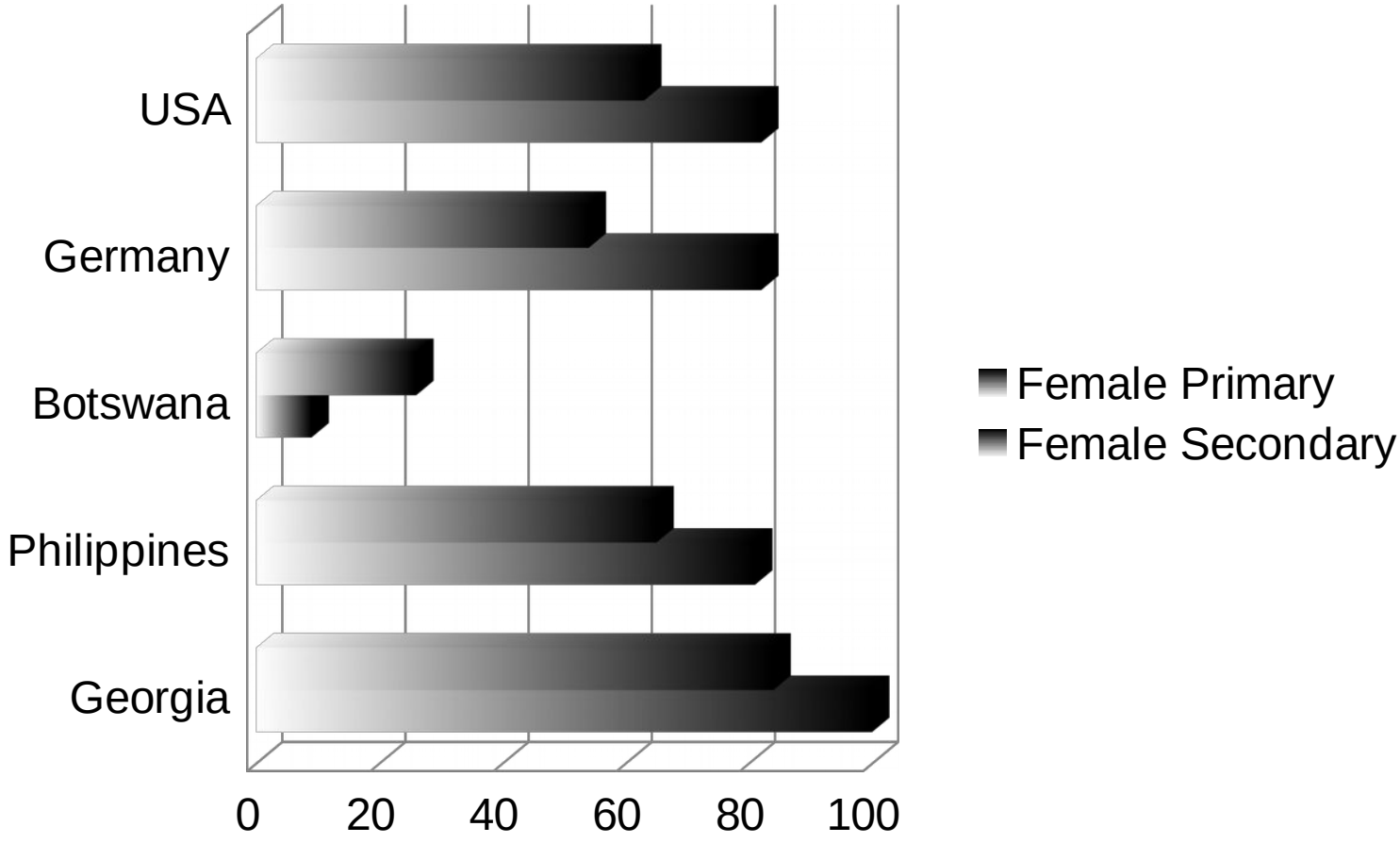
Accreditation/evaluation of Teacher Education Programmes

- Weak regulations or voluntary systems
- Accreditation for higher education institutions, but not for teacher education programmes
- Internal evaluations by institutions: no external evaluations
- Accreditation or evaluation of teacher education by independent, external accrediting agency – can disaccredit

Requirements for entry into the profession

- Graduation only
- Graduation + further tests by external agencies
- Graduation + further tests + probation and assessment of teaching performance

Future teacher characteristics: Gender distribution some countries (%)

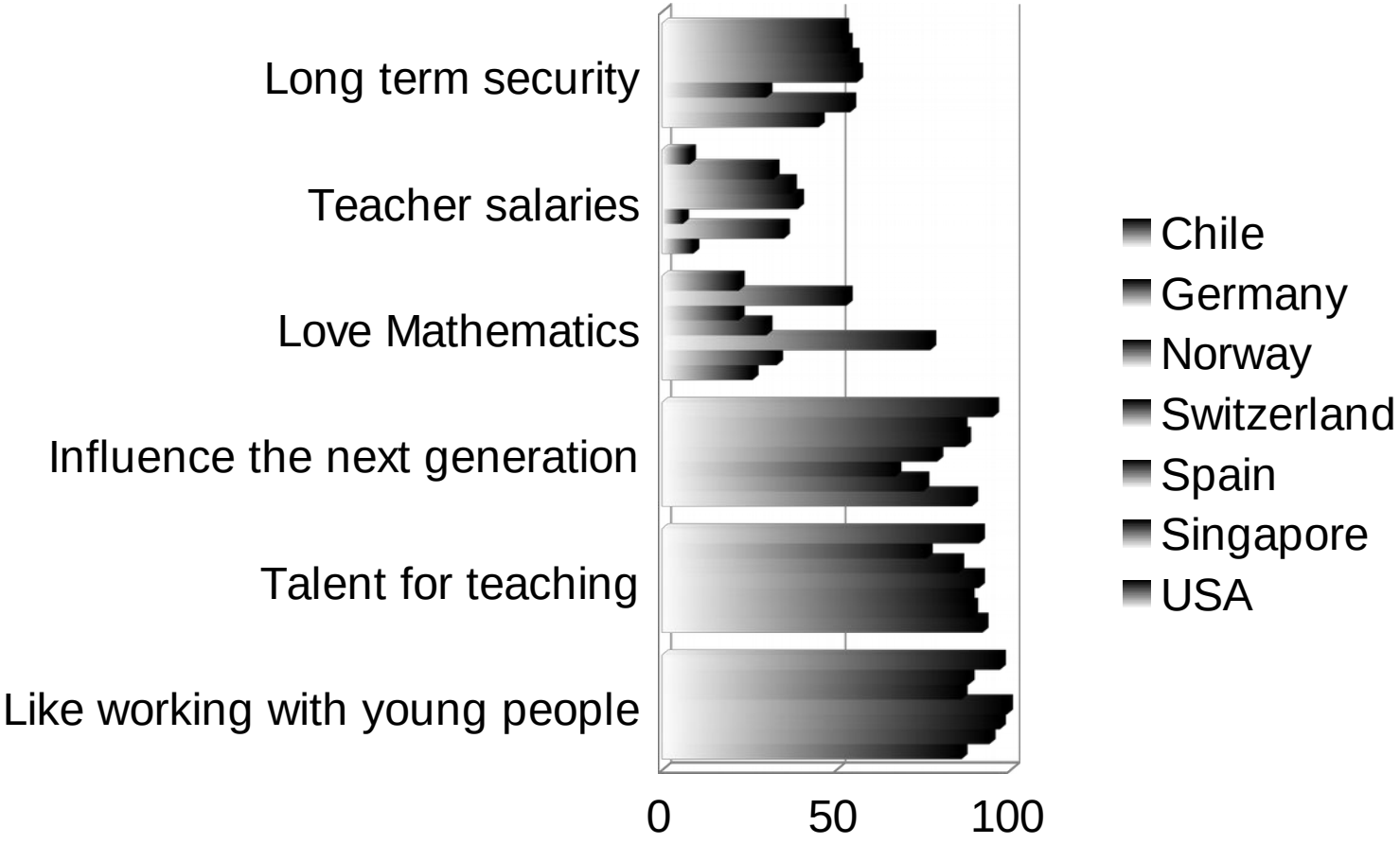


Future Teacher Characteristics: highest education level of father % (some countries)

	Botswana	Chile	Ch. Taipei	Germany	Philippines	USA
Primary	29	10	12	5	26	2
L. Second.	14	12	15	19	8	0,2
U. Second	5	36	37	4	24	34
Post Second	5	11	15	29	11	10
First degree	4	10	17	15	13	18
Beyond	2	4	5	15	2	20

Source: TEDS-M Future Teacher Questionnaire

Reasons for becoming a teacher (%)



Source: Future Teacher Questionnaire

Characteristics of sampled educators

- Three types: mathematics and mathematics pedagogy (41%), only pedagogy (43%), and all three specialisations (16%).
- 60% or more male maths and maths pedagogy educators in Chinese Taipei, Georgia, Oman & Singapore
- 60% or more female pedagogy educators in Georgia, Germany, Philippines, Poland, Russian Federation & Singapore.
- Maths & Maths pedagogy educators: Large proportion of doctoral degrees in mathematics (50%) in Chinese Taipei, Georgia, Germany, Oman and Poland. Lowest: Chile, Malaysia, Philippines & Switzerland.
- Masters degrees in Education: Botswana, Russian Federation, Thailand. Highest number of doctoral degrees in education among pedagogy educators in Chinese Taipei, Georgia, Oman, Poland, Russian Federation.

Knowledge of mathematics:

Contents:

- Number & operations
- Geometry & measurement
- Algebra & functions
- Data & chance

Cognitive Domains:

- Knowing (recall, recognise, compute, retrieve, measure, classify/order)
- Applying (select, represent, model, implement, solve routine problems)
- Reasoning (analyse, generalise, synthesise/integrate, justify, solve non-routine problems

Knowledge domains in mathematics pedagogy

- Mathematical curricular knowledge
- Knowledge of planning for mathematics teaching and learning

- Enacting mathematics for teaching and learning

- i.e. Knowing the school mathematics curriculum
- i.e. Predicting typical students' responses including misconceptions
- i.e. Generating fruitful questions
- Analyzing the contents of students' questions

Presentation of results: Maths knowledge

- *Anchor points (2):* descriptions of performance of future teachers with scores at specific points in the scale:

  - Probability that the person with the score will answer correctly the question (70% & 50%)

- Two sets of anchor points for primary and lower secondary knowledge
- Also standardisation of results: 500 mean and 100 standard deviation.
- Results are presented by programme group

Primary mathematics knowledge results (MCK)

- Wide range of achievement across all countries
- Wide range of achievement within countries
- Within each programme group the difference between the highest mean MCK score and the lowest mean MCK score is at least 100 points
- In programmes preparing generalists for primary and lower secondary, Botswana & Chile had difficulties with MCK items. In Norway scores were higher.

Variability among results by institution in chilE

Primary mathematics pedagogy (MPCK) results

- Most programmes preparing generalist teachers (4 years) scored below the MPCK anchor point, but two of five were above the 500 average.
- In generalist primary-secondary programmes Chile and Botswana scored lower than on MCK, but Norway was more successful

Lower secondary MCK results

- Programmes (primary & secondary) with or without maths specialisation found items difficult. In only three countries were results above the mean.
- Programmes with maths specialisation (lower and upper secondary), tended to score above the international mean (7 out of 12 countries)

Lower secondary MPCK results

- Four out of ten programs with generalist or special preparation for primary & lower secondary achieved mean scores above international mean.
- In programmes preparing for lower and upper secondary, more than 93% of sample achieved above the international mean, and in 5 countries they also scored above the MPCK anchor point.

Some idea of variability of MCK scores across Primary programme types (low & high)

	Programme 1	Programme 2	Programme 3	Programme 4
Georgia	345			
Russian Federation	536			
Philippines		440		
Chinese Taipei		623		
Chile			413	
Norway (2)			553	
Malaysia				488
Poland				614

BELIEFS: Future teachers & Educators

Types of beliefs studied

About the nature of mathematics:

- As a set of rules and procedures (calculational) (*Mathematics involves the remembering and application of definitions, formulas, mathematical facts & procedures*)
- As a process of enquiry (conceptual) (*If you engage in mathematical tasks you can discover new things*)

About learning mathematics:

- Through following teacher directions (direct transmission) (*Pupils learn mathematics best by attending to teacher explanations*)
- Through active involvement (cognitive constructivist) (*Teachers should allow pupils to figure out their own ways to solve mathematical problems*)

About mathematics achievement: Mathematics as fixed ability:

(*To be good in mathematics you have to have a kind of "mathematical mind*)

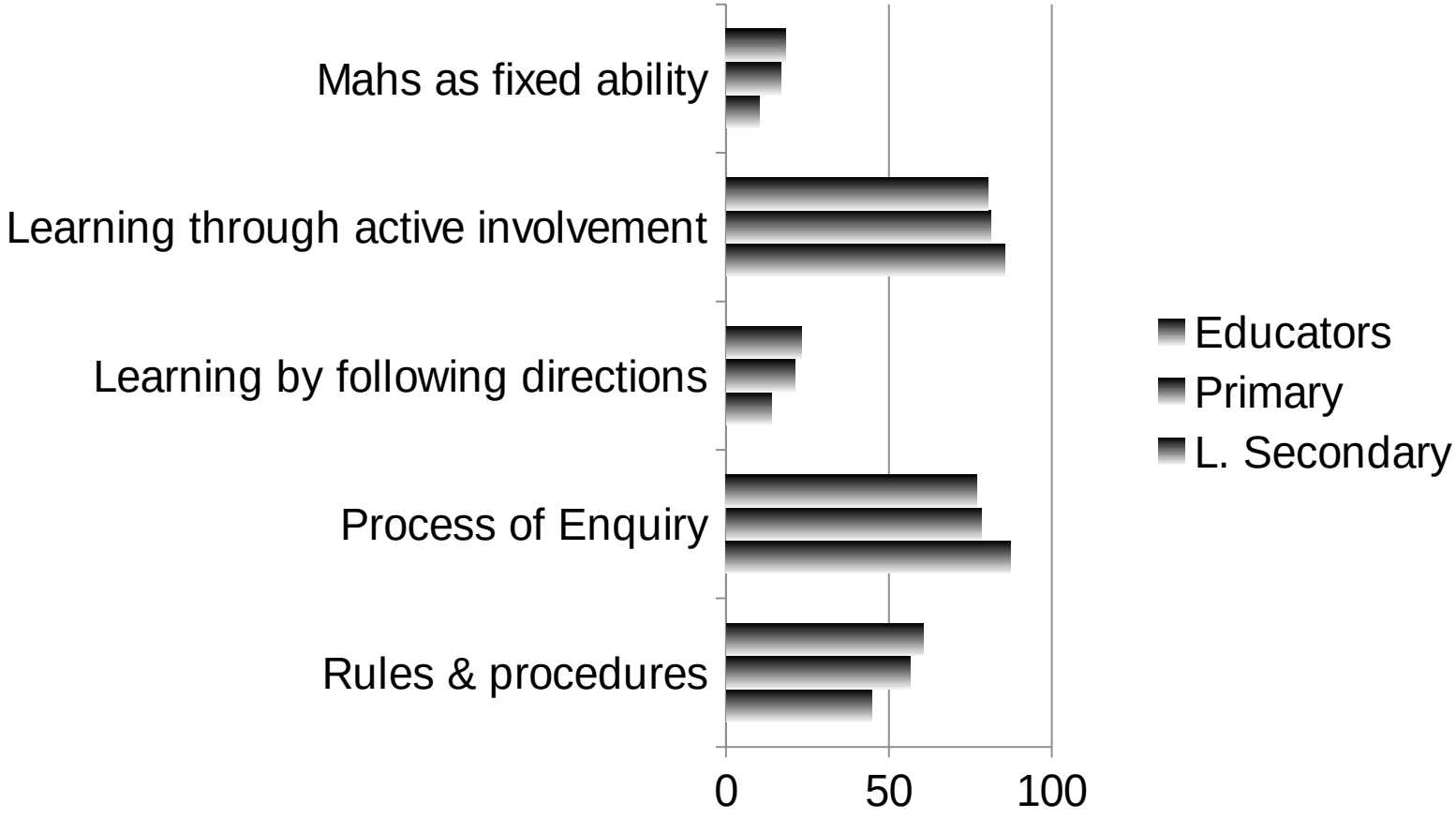
How beliefs were measured?

- Agreement/ disagreement scales (34 items) for future teachers and educators
- Items were scaled using Item Response Theory (IRT): 10 (neutral response)
- Percent endorsement

Some general conclusions about beliefs

- Beliefs consistent with the conceptual orientation endorsed by future teachers and educators in most countries.
- But in six countries beliefs consistent with the calculational orientation were endorsed. In another three countries these beliefs were strongly rejected.
- A group of six countries endorsed the conceptual orientation, but also gave reasonable endorsement to the calculational orientation.

Beliefs among future teachers & educators in Chile



Relationship between beliefs and knowledge

- Correlations within countries show that:
  - Those future teachers who endorse beliefs in maths as a process of enquiry and learning math through active involvement have greater knowledge of MCK and MPCK
  - Those who in general endorse beliefs in maths as a set of rules & procedures, learning maths through following directions and maths as a fixed ability, have lesser knowledge of MCK and

Opportunity to learn

How OTL was examined

- Future Teacher and Educators' questionnaire
- Analysis of syllabuses provided by each participating country
- Information provided in the Institutional Questionnaire

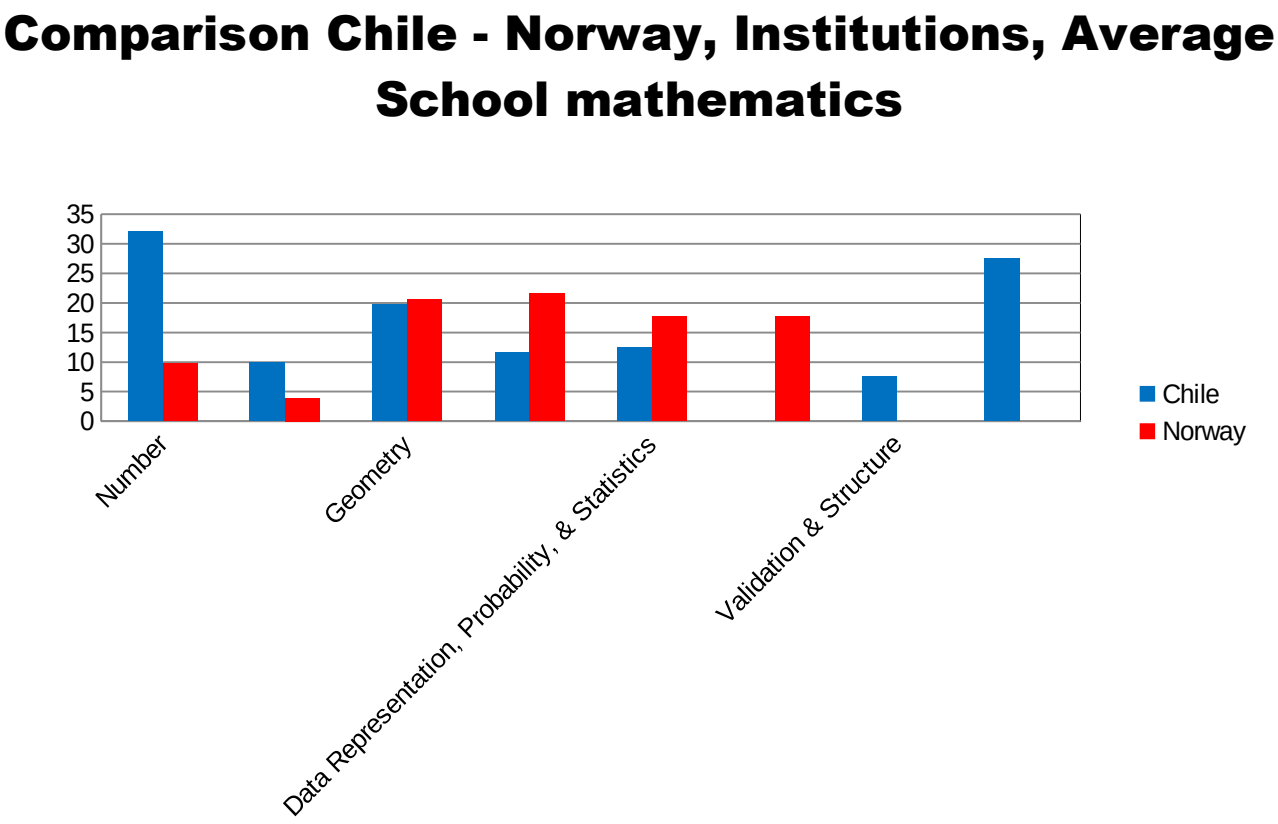
What was asked in the questionnaires? Opportunity to learn:

- Tertiary mathematics (list of topics provided)
- School mathematics (list of topics provided)
- Mathematics education (list of topics provided)
- Instructional practice and planning
- Assessment used and practice
- Education pedagogy
- Teach diverse students
- Reflect on and improve teaching practice
- Teach mathematics in school-based experiences
- Participatory research based and problem oriented pedagogy
- In a coherent programme

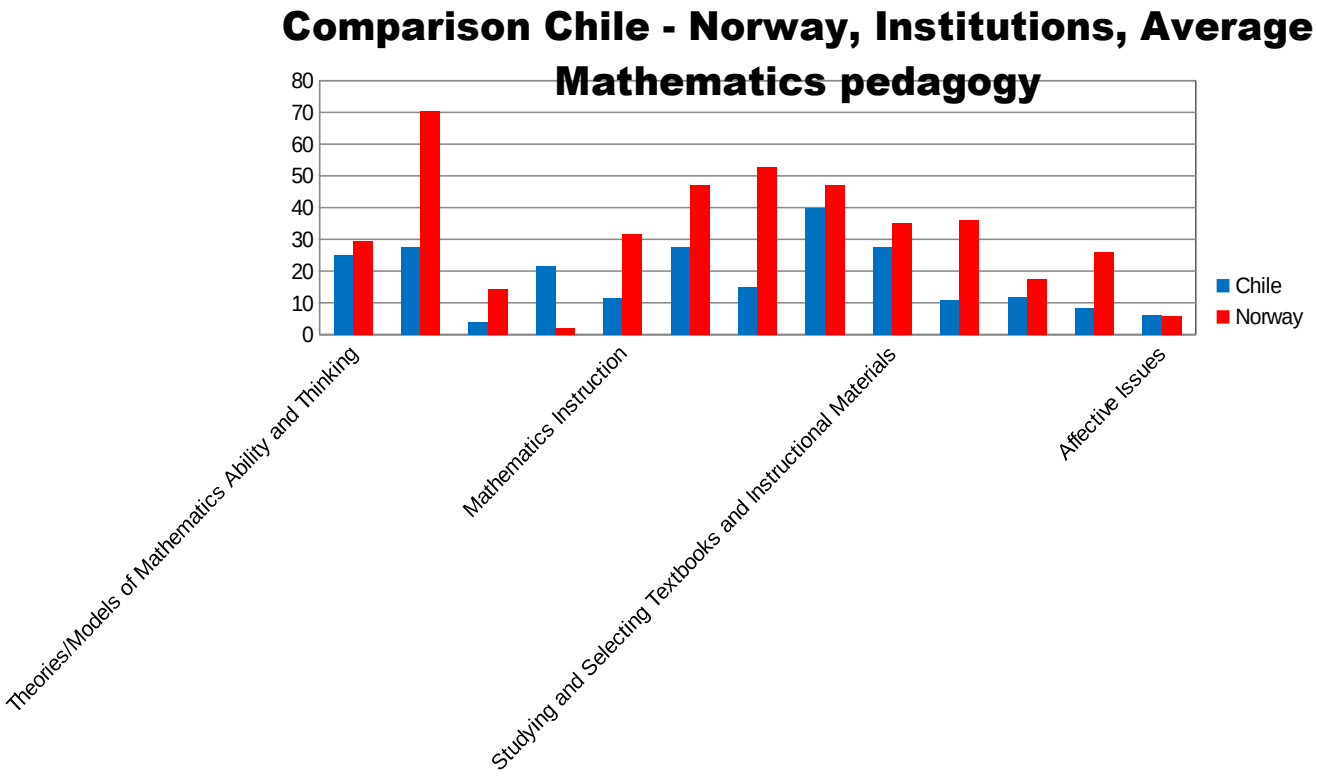
Main conclusions resulting from questionnaire data

- OTL to learn tertiary mathematics varies across programme groups
- OTL to learn school maths highly uniform in numbers, measurement and some geometry, but highly variable in functions, data representation, calculus and validation
- OTL to learn aspects of MPCK such as planning, assessments and learning varied across programme groups
- OTL to teach diverse populations: many countries report rare o no opportunities
- OTL general pedagogy high in all programmes
- Field experience and practice strong in all programmes
- Pedagogy in maths education courses varied
- Coherence varied across programme groups

An example of results of curricular analysis in two countries



MPCK topics covered in two countries



Conclusions: What have we learned from the IEA TEDS-M?

- An incredible achievement in terms of the complexity of the study and the variation in teacher education programmes involved
- Strong influence on results of the policy contexts, very clear in the case of Chile
- Variations among countries, teacher education institutions and programmes speak against league tables – reporting will take this into consideration

Conclusions: Focus on content knowledge matters

- Not surprising: being prepared as specialists in primary programmes yields higher MCK and MPCK than in generalist programmes
- Teachers prepared as lower and upper secondary teachers have better MCK and MPCK than those prepared only as lower secondary.
- The key issue affects the preparation of primary teachers: generalists, some specialisation or strong specialisation – TEDS-M shows that specialisation leads to more knowledge.

MANY THANKS