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German Teacher Education in the international context

Summary of core results in TEDS-M[1]

The „Teacher Education and Development Study: Learning to Teach Mathematics (TEDS-M)" was carried out under the supervision of the *International Association for Evaluation of Educational Achievement* (IEA).[2] TEDS-M examined primary and lower secondary teacher education in 17 countries looking at how teachers of mathematics were trained and what kind of competences they have at the end of their training. More than 20,000 future teachers were assessed in terms of their knowledge of mathematics, of mathematics pedagogy and of general pedagogical knowledge (for more details about the study design see Tatto et al., 2008).

TEDS-M is the first comparative study that focuses on the outcomes of tertiary education with standardized testing. Representative Samples of primary and lower secondary mathematics teachers of 17 countries in Africa, America, Asia, and Europe were examined as well as representative samples of teacher educators and institutions. TEDS-M had to follow IEA's

[1] For more details see the two German reports Blömeke, S., Kaiser, G. & Lehmann, R. (Eds.) (2010), TEDS-M 2008. Professional Competences and Opportunities to Learn of Future Primary Teachers in the International Context. Münster: Waxmann, 402 pages; Blömeke, S., Kaiser, G. & Lehmann, R. (Eds.) (2010), TEDS-M 2008. Professional Competences and Opportunities to Learn of Future Mathematics Teachers at Lower-Secondary Schools in the International Context. Münster: Waxmann, 378 pages. Both books are in German and have the same structure:

1) TEDS-M 2008: Mission, Study Design, and Core Results
2) Cultural Context, Educational Policy, and School Structure in the17 TEDS-M Countries
3) Types of Teacher Education Programs in the17 TEDS-M Countries
4) Characteristics of Teacher Educators in the17 TEDS-M Countries
5) Opportunities to Learn of Future Teachers in the17 TEDS-M Countries
6) Demographic, Motivational and School Background of Future Teachers in the17 TEDS-M Countries
7) How to Measure Mathematics Content Knowledge and Pedagogical Content Knowledge: Theoretical Framework and Testdesign
8) Mathematical Content Knowledge and Pedagogical Content Knowledge of Future Teachers in the17 TEDS-M Countries
9) How to Measure General Pedagogical Knowledge: Theoretical Framework and Testdesign
10) General Pedagogical Knowledge of Future Teachers in the17 TEDS-M Countries
11) Beliefs of Future Teachers in the17 TEDS-M Countries
12) Technical Appendix: Sampling, Data Collection, Scaling, Weighting und Unit of Analyses

[2] TEDS-M was funded by the IEA, the National Science Foundation (REC 0514431), and the participating countries. In Germany, the German Research Foundation funded TEDS-M (DFG, BL 548/3-1). The analyses prepared for this report and the views expressed are those of the authors' and editors' but do not necessarily reflect the views of the IEA, the DPC, the NRCs of the participating countries, the JMC or the funding agencies NSF or DFG. All analyses are based on the data set 3.0 that was provided by IEA's DPC on December 9, 2009. All data analyses were done at least twice independently from each other at Humboldt University of Berlin where the full responsibility for this report is located. An international report will be published by the IEA in October 2010. We are grateful that IEA lifted the embargo by April 15 so that countries could publish national reports and meet their obligations with funders and policy makers.

quality control of sampling, data collection, coding and data analyzing. Therefore, the results give a precise representation of the professional competences of future mathematics teachers who were in 2008 in their final year of teacher education.

Germany took part in TEDS-M with representative samples of primary (grades 1 to 4) and lower secondary teachers (identified through grade 8) licensed for teaching mathematics from all 16 federal states as well as with a representative sample of teacher educators. Like in many countries, in German primary school students are taught by generalists in the role of head teachers. Therefore, on this level the full range of future teachers is examined (no matter what subjects they focus on) since they all have the license to teach mathematics.

For sampling purposes and with respect to the chance to get more sophisticated results, four types of mathematics teachers were distinguished in Germany on the primary level and three on the lower-secondary level. The primary teaching force consists of

1) pure primary teachers without specialization in mathematics
2) pure primary teachers with specialization in mathematics
3) primary and lower secondary teachers without specialization in mathematics
4) primary and lower secondary teachers with specialization in mathematics

The lower secondary teaching force consists of

1) primary and lower secondary teachers with specialization in mathematics
2) pure lower secondary teachers with specialization in mathematics
3) lower and upper secondary teachers with specialization in mathematics

German Primary Teacher Education in the international context

Structure of Primary Teacher Education

Primary school consists in many TEDS-M countries of grades 1 through 6. Germany is an exception as primary school in most federal states covers only four grades. In principle, teacher education can be organized in a concurrent or consecutive way. Also in this respect Germany is an exception as its teacher education system combines important features of both approaches ("hybrid system").

Features of Incoming Students

Seen across all TEDS-M countries, at the end of teacher education a typical primary teacher is at the age of 24 and female. Her parents have a degree on ISCED level 3 or 4 and there are between 26 and 100 books in her parents' homes. Typically these have a computer as well. The typical teacher's prior knowledge from schooling is high: 12 years of mathematics classes and good or even very good grades compared to her age cohort. The language of teacher education fits to the language spoken at home. Intrinsic pedagogical motives dominated the decision to become a teacher much more than extrinsic status motives but also more than intrinsic intellectual motives.

Not surprisingly there is huge variation between countries with respect to these characteristics of primary teachers. It seems as if teachers from consecutive programs are older on average than those from concurrent programs. And whereas future teachers in the Philippines and Georgia are on average only 21 years old at the end of their training, teachers from Germany are already 27 years old. This high age is an accumulated consequence of many different societal, schooling and teacher education features. In none of the TEDS-M countries males represent the majority of finishing primary teachers. However, there seems to be a tendency that their proportion increases if their program requires more mathematics or if they have to teach higher grades.

In many TEDS-M countries the educational background of the teachers' mothers and fathers is roughly equal. This does not apply to all countries though. In Germany, Switzerland and Spain mothers on average do have a lower, in Russia, Poland and Georgia mothers do have higher degrees than fathers. These differences are probably related to the role of women in these societies.

The cultural capital of the future primary teachers is measured by several indicators. These point pretty much to the same direction: In Germany and Norway the teachers' cultural capital is especially high. Strikingly high is also the cultural capital of teachers in Georgia and Russia given their rank on the UN's Human Development Index. We hypothesize that this result reflects high educational aspirations in these societies. In general, one has to notice that the teachers' cultural capital is much higher in most countries than the capital of their students (see e.g. the teacher survey in TIMSS). This result points to a selection effect.

With respect to the language spoken at home compared to the official language in teacher education (i.e. the test language of TEDS-M), there is a distinct difference between two groups of countries. In one group which consists of Botswana, Malaysia, the Philippines and Singapore, future teachers were tested in English whereas this is the language spoken at home only for a minority. We find substantial proportions of teachers speaking a different language at home compared to teacher education in Thailand and Taiwan as well. In contrast, we have many countries where almost every teacher speaks the official test language at home – although we sometimes have substantial proportions of language diversity in these countries as well (e.g. in Germany).

Primary teachers in Germany indicate lower grades during their schooling than teachers in other countries – however, this is probably an artifact. Germany has a highly stratified school system. Therefore, the reference group is more selective than in most other countries. Important in this context is the grade point average of their "Abitur" which is about 2.6. This is important to note because there are discussions about allegedly worse entrance characteristics of teachers in Germany than of other professions. The TEDS-M data do not support this assumption. A GPA of 2.6 is roughly the mean of all German "Abiturienten" (i.e. graduates of the "Gymnasium", the type of high school that leads to a license for university entrance).

With respect to motivation we have again to notice differences between countries. If one looks at the relationship of the full set of motives presented in TEDS-M (i.e. at so called ipsative means), future teachers in the US, Switzerland, Norway, Germany, Spain, and Chile state specifically high pedagogical motives in relation to intellectual or extrinsic motives. We assume that this is due to the very long tradition of child orientated pedagogy in these countries (see e.g. the reception of Ellen Key's famous book). In contrast, future teachers in the Asian and Eastern European countries specifically stress the intellectual challenge of teaching. Here we assume that this is due to the high value of mathematics in these countries (and in the case of some Asian countries in addition due to their Confucian heritage and its value of teachers). Overall it seems as if with the teaching of higher grades and the study of more mathematics the intellectual motive is more strongly supported by teachers.

The future teachers were asked to what extent they felt limited by financial or familial constraints during their studies. The result is once again striking because there is one more split between countries: On the one side, we have countries where future teachers stress family obligations more strongly than financial worries. This relationship of limitations applies to all Asian countries in TEDS-M as well as to Botswana and Chile. On the other side we have the Western countries and Poland where financial limitations dominate in relation to familial issues. It is probably not far fetched to relate this result to cultural differences as they are expressed by the dichotomy of collectivism and individualism.

Opportunities to Learn in Primary Teacher Education

The extent of opportunities to learn mathematics varies a lot between the TEDS-M countries. In Thailand where they train specialists for this school subject, primary teachers have covered the most topics. Germany is one of the countries where the extent of OTL to learn mathematics is significantly below the international average. This result is mainly a function of one program type in which mathematics is strongly neglected (primary and lower secondary teachers without specialization in mathematics). Graduates from the other three types covered significantly more mathematical topics than these during their training.

It is possible to identify an international profile of OTL in mathematics which applies to Germany as well: Number is a dominant field of study in primary teacher education followed by data and within certain limits geometry. Calculus is in most countries of significantly lower importance. Another communality across countries is the relatively high amount of OTL taken in general pedagogy and this with respect to theoretical as well as practical topics. There seems to be a consensus that this is a vital part of teacher knowledge. Less agreement exists with respect to mathematics pedagogy, specifically with its theoretical part. Germany is one of the countries with the lowest extent of OTL in this field.

Teacher Educators

On average more than half of the teacher educators in the TEDS-M countries are female. This applies to Germany as well – only that the educator force here is subdivided into two distinct groups. Whereas only 20% of the German teacher educators at university are female, the majority of German educators in the second step of teacher education at practical training institutions (“Studienseminare”) is female.

The proportion of teacher educators with a degree on ISCED level 6 (at least PhD) varies a lot between the TEDS-M countries: between 0% in Botswana and 82% in Georgia. In Germany, the proportion roughly represents the international mean (45%). It has to be pointed out though that once again there is a distinct difference between German university educators who usually have a PhD and German educators at the state institutions who usually do not have a PhD.

Outcomes of Primary Teacher Education

One important focus of TEDS-M is the measurement of teacher education outcomes. Here we have to distinguish between an evaluation of national education systems and an evaluation of types of teacher education programs within countries. Both approaches have their benefits – and their limits. Because of the traditional policy orientation of IEA‘s and OECD‘s large scale assessments, TIMSS, PISA, and PIRLS focus on the national level. This is a valuable approach because it stresses the overall educational efficacy of a nation regardless of the structure of its school (or in the case of TEDS-M of its teacher education) system.

In Germany, we have been struggling for a long time with this perspective because of our highly stratified lower secondary school system. The presentation of a national mean has caused a lot of concerns: What does it actually represent in a situation where we have distinct types of schools with distinct OTL? However, the public has finally come to an agreement that this approach is necessary with respect to international competitiveness. In this perspective it is important to consider what a nation accomplishes as a whole.

Still, it is obvious that for academic and within-country reasons additional information is to be gained by looking into program types. Only then it is possible to learn about pathways to success without confounded variables like cultural or societal features or the economic status of a country. Yet, this approach has to be used only very carefully: The already small sample sizes

Mathematics Content Knowledge of Future Primary Teachers	
Country	Mean (S.E.)
Taiwan	623 (4.2)
Singapore	590 (3.1)
Switzerland*	543 (1.9)
Russia	535 (9.9)
Thailand	528 (2.3)
Norway*	519 (2.6)
USA*	518 (4.1)
Germany	**510 (2.7)**
International	500 (1.2)
Poland*	490 (2.2)
Malaysia	488 (1.8)
Spain	481 (2.6)
Botswana	441 (5.9)
Philippines	440 (7.7)
Chile*	413 (2.1)
Georgia	345 (3.9)
IEA: Teacher Education and Development Study	© TEDS-M Germany

Pedagogical Content Knowledge of Future Primary Teachers	
Country	Mean (S.E.)
Singapore	593 (3.4)
Taiwan	592 (2.3)
Norway*	545 (2.4)
USA*	544 (2.5)
Switzerland*	537 (1.6)
Russia	512 (8.1)
Thailand	506 (2.3)
Malaysia	503 (3.1)
Germany	**502 (4.0)**
International	500 (1.3)
Spain	492 (2.2)
Poland*	478 (1.8)
Philippines	457 (9.7)
Botswana	448 (8.8)
Chile*	425 (3.7)
Georgia*	345 (4.9)
IEA: Teacher Education and Development Study	© TEDS-M Germany

* Reduced Coverage, Combined Participation Rate < 75% or other Limitations (see explanations on the last page of this report)

in the case of teachers (compared to students) are even smaller when types of programs are examined, the precision of estimates is probably lower because the sampling target was mainly the national level, and the sets of countries with similar programs are smaller while the comparability is still limited. Against this background and with these precautions in mind, we document results on two levels of aggregation:

1) on the level of nations (i.e. an evaluation of the teacher education *systems*) and
2) on the level of types of teacher education programs (i.e. a within-country evaluation)

With respect to mathematics content knowledge, the achievement of German primary teachers is only slightly above the international mean. The difference to Taiwan and Singapore is huge – about one standard deviation which is a highly relevant difference. German teachers perform significantly lower than Swiss teachers, too. If one takes into account the *Human Development Index* used by the UN, the high performance of teachers from Russia and Thailand is striking.

With respect to pedagogical content knowledge, the achievement of German teachers is only around the international mean. The difference to Singapore and Taiwan is again about one standard deviation and therefore highly relevant. The achievement of German primary teachers is significantly lower than the achievement of primary teachers in Switzerland, the US and Norway as well as the mean of the European countries in TEDS-M.

Interesting differences exist with respect to achievement in MCK and PCK which require more research. Whereas Singapore is behind Taiwan in MCK, the countries are on the same level in PCK. With respect to PCK, Norway and the US are only one half of a standard deviation behind the two East Asian countries whereas the difference is up to one standard deviation with respect to MCK. Malaysia scores around the international mean in PCK whereas the country scores below the mean in MCK. Russia, Thailand, and Germany perform significantly lower in PCK than in MCK. These differences are worth to be examined in detail. They may point to specific strengths and weaknesses.

With respect to achievement of primary teachers coming from different program types[3], PCK is taken as an example in this summary. Not surprisingly specialists show the best performance. No PCK mean of any program type is significantly below the international mean of 500 test points. Single results of teachers from other programs are more striking though. In Taiwan, Singapore, and Norway future teachers from non-specialist programs show high achievement in PCK, too. At the same time we have to notice huge differences within countries. Poland and Germany are examples of this phenomenon. In these two countries it is possible to teach mathematics in primary schools either with a license from a generalist or a specialist program. The average PCK achievement of these programs differs by about a full standard deviation.

A brand new field of research is pedagogical knowledge of teachers.[4] TEDS-M is the first study which tries to address this dimension. Germany, Taiwan, and the US assessed knowledge about lesson planning, classroom management and motivation, dealing with heterogeneity, and assessment – each dimension once again subdivided into three cognitive tasks (recalling, understanding, and creating). The main result on the primary level is that German teachers significantly outperformed US teachers. The difference is about one standard deviation overall as well as within respect to each subdimension and it is therefore highly relevant. Within Germany graduates from pure primary programs perform significantly better than students from combined primary and lower secondary programs.

Specialists	**PCK Mean**
SGP 1-6 SPEcs	601 (7.1)
POL 4-9 MAT_FT*	562 (6.6)
GER 1-10 PS_M	**552 (6.8)**
International	545 (2.2)
USA 4-9 SPEcc*	543 (5.3)
THA 1-12 SPEcs	542 (8.6)
MAL 1-6 SPEcc	505 (3.0)
THA 1-12 SPEcc	503 (2.7)
MAL 1-6 SPEcs	496 (8.1)

Generalists up to grade 10	**PCK Mean**
NOR 1-10 ALU_M*	564 (5.5)
NOR 1-10 ALUoM*	539 (2.9)
International	467 (3.3)
BOT 1-7 GEN_M	448 (8.8)
CHI 1-8 GENoM*	425 (3.7)

Generalists up to grade 4	**PCK Mean**
GER 1-4 P_M	**529 (9.2)**
SWZ 1-3 GENoM*	519 (5.6)
RUS 1-4 GEN_M	512 (8.1)
GER 1-4 PoM	**507 (7.3)**
International	461 (2.5)
GER 1-4 PSoM	**461 (6.2)**
POL 1-3 PED_PT*	435 (3.1)
GEO 1-4 BEd_4	347 (5.2)

Generalists up to grade 6	**PCK Mean**
TWN 1-6 GEN_M	592 (2.3)
SGP 1-6 GEN_M	568 (5.8)
USA 1-5 GENoM*	544 (2.9)
SWZ 1-6 GENoM*	539 (1.8)
International	532 (2.0)
SPA 1-6 GENoM	492 (2.2)
PHI 1-6 GENoM	457 (9.7)

* Reduced Coverage, Combined Participation Rate < 75% or other Limitations (see explanations on the last page of this report)

Finally, beliefs were captured as teacher-education outcomes in TEDS-M. There is huge variation between and within countries – however, it is possible to identify profiles which seem to be influenced by cultural features, specifically on the Hofstede continuum of individualism and collectivism. In individualistic countries like Germany future teachers specifically stress dynamic

[3] The first three letters of a program's label indicate the country (e.g. SGP = Singapore), the following numbers indicate the grade span in which teachers from this program will have to teach mathematics, the final 3-5 letters indicate specific features of this program (e.g. SPE = specialists, cs = consecutive, GENoM = generalist without extensive training in mathematics.

aspects of mathematics in relation to static aspects and constructivist principles of teaching and learning in relation to transmission orientated principles. In contrast, in collectivistic countries the support of static and transmission aspects is relatively high. Countries which seem to be moving from collectivism to individualism according to Hofstede's index are positioned in the middle of the TEDS-M countries as well. If a country deviates in TEDS-M from Hofstede's index (e.g. Poland), the special tradition of mathematics may be an explanation. Within Germany the profile of beliefs varies according to program types. The more mathematics a future teacher had taken, the more she supported dynamic and constructivist beliefs.

German Lower Secondary Teacher Education in the international context

Structure of Lower Secondary Teacher Education

Lower secondary school consists in many TEDS-M countries of grades 7 through 9. Germany is an exception as lower secondary school in most federal states covers grades 5 through 10. In principle, teacher education can be organized in a concurrent or consecutive way. Also in this respect Germany is an exception as its teacher education system combines important features of both approaches ("hybrid system").

Features of Incoming Students

Seen across all TEDS-M countries, mathematics teachers for lower secondary schools are very similar to primary teachers and correspondingly there is a similar variation between countries. One difference applies to Germany where future lower secondary teachers are already about 30 years old when they finish teacher education. Another difference applies to university entrance characteristics of German lower secondary teachers. In many respects we have to distinguish between types of programs. Future teachers at the "Gymnasium" – trained in longer programs than other lower-secondary teachers, prepared for teaching in grades 5 through 13 (in contrast to grades 1 or 5 through 10), and employed as senior civil servants whereas other lower-secondary teachers are employed as junior civil servants – had on average better grade point averages in their high-school exit exam "Abitur" and they had to a higher extent taken advanced mathematics classes in high school. Even if the features of non-Gymnasium teachers correspond with the features of German high-school graduates on average, it is important to notice that it seems to be easier to recruit Gymnasium teachers from the upper half of the achievement distribution.

Opportunities to Learn in Lower Secondary Teacher Education

The extent of opportunities to learn mathematics, mathematics pedagogy and general pedagogy varies a lot between the TEDS-M countries but it is possible to identify an international profile of OTL with respect to the relationship of mathematics on the one side and the two pedagogy dimensions – as OTL typical for teachers in contrast to other university students – on the other side (i.e. ipsative measures). At the end of teacher education, lower secondary mathematics teachers in Poland, Russia, Georgia, Taiwan, and Oman as well as within limitations those in Germany and Thailand had specifically extensive OTL in mathematics compared to OTL in mathematics pedagogy and general pedagogy. In contrast, lower-secondary teacher education in Norway, the US, Chile and Botswana is more strongly dominated by pedagogical topics than common in the international context. One could say that in the first set of countries the content and in the second set of countries the teaching of the content is stressed.

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[4] This part of TEDS-M was done beyond others with support of Jere Brophy who passed away too early.

Mathematics Content Knowledge of Future Lower Secondary Mathematics Teachers	
Country	**Mean**
Taiwan	667 (3.9)
Russia	594 (12.8)
Singapore	570 (2.8)
Poland*	540 (3.1)
Switzerland*	531 (3.7)
Germany	**519 (3.6)**
USA*	505 (9.7)
International	500 (1.5)
Malaysia	493 (2.4)
Thailand	479 (1.6)
Oman	472 (2.4)
Norway*	444 (2.3)
Philippines	442 (4.6)
Botswana	441 (5.3)
Georgia*	424 (8.9)
Chile*	354 (2.5)
IEA: Teacher Education and Development Study	© TEDS-M Germany

Pedagogical Content Knowledge of Future Lower Secondary Mathematics Teachers	
Country	**Mean**
Taiwan	649 (5.2)
Russia	566 (10.1)
Singapore	553 (4.7)
Switzerland*	549 (5.9)
Germany	**540 (5.1)**
Poland*	524 (4.2)
USA*	502 (8.7)
International	500 (1.6)
Thailand	476 (2.5)
Oman	474 (3.8)
Malaysia	472 (3.3)
Norway*	463 (3.4)
Philippines	450 (4.7)
Georgia*	443 (9.6)
Botswana	425 (8.2)
Chile*	394 (3.8)
IEA: Teacher Education and Development Study	© TEDS-M Germany

* Reduced Coverage, Combined Participation Rate < 75% or other Limitations (see explanations on the last page of this report)

Compared to other countries, German teachers from all types of programs stated a relatively low extent of OTL in mathematics, mathematics pedagogy and general pedagogy. This is probably due to the guiding principle that teachers have to major in two subjects in order to avoid out-of-field teaching.

With respect to subdimensions of mathematics it is interesting to look at the relationship of ÓTL in number, calculus, data, and geometry (i.e. to look at ipsative means). The largest variation exists in the field of calculus. Whereas in Botswana, Singapore, Georgia, Malaysia, Oman and Taiwan this field dominates in relation to the other three fields which probably implies an orientation of teacher education at higher grades of lower secondary school, its extent is specifically low in Norway, Switzerland, the US and Chile which probably indicates an orientation at the lower grades.

Overall, future teachers licensed for mathematics teaching also in upper secondary school had significantly more OTL than future mathematics teachers in lower secondary grades only. Besides Norway and Chile where lower secondary teachers were trained as generalists, a specifically low amount of OTL is reported in Germany and Singapore where lower secondary teachers are trained in two subjects.

Outcomes of Lower Secondary Teacher Education

With respect to mathematics content knowledge, the average achievement of German lower secondary mathematics teachers is significantly above the international mean. The difference to Taiwan is still huge though – about 1.5 standard deviations which is a highly relevant difference. German teachers perform significantly lower than teachers from Russia, Singapore, Poland, and Switzerland, too. If one takes into account the *Human Development Index* used by the UN, the performance of lower secondary mathematics teachers from Russia and Poland is remarkable.

With respect to pedagogical content knowledge, the achievement of German teachers is well above the international mean. Even if the difference to Taiwan is still big, the gap between Germany and Russia is of lower practical relevance and the difference to Singapore and Switzerland is not significant.

Also on this level, a lot is to be learned by distinguishing between program types in addition to a pure evaluation of teacher education system. However, the same caution has to be applied as on the primary level: relatively small sample sizes, lower precision of estimates, smaller sets of countries but still limited comparability. Again, pedagogical content knowledge is taken as an example (with respect to MCK see Blömeke, Kaiser & Lehmann, 2010).

Across all TEDS-M countries, at a first glance a striking result exists with respect to the relative small difference of average achievement between the two types of programs. Based on the difference in the length of the two program types (modal value in case of teachers up to grade 10 = 4 years, in case of teachers up to grade 13 = 5 years), we had hypothesized a significant difference of practical relevance. The difference is of low relevance though. This contra intuitive result is probably at least partly a function of different group compositions. If one looks into different program types from the same countries (e.g. in Germany or the US), the expected difference becomes visible.

German lower secondary teachers who will get a license to teach mathematics also in upper secondary show an outstanding pedagogical content knowledge. Its level is on average on the same level as the PCK of Russian teachers and significantly higher than the PCK of teachers from Singapore with licenses to teacher in lower and upper secondary grades. German mathematics teachers with a license up to grade 10 do less well. Their average achievement in PCK is only slightly higher than the international mean of comparable programs.

Some general remarks are possible with respect to other outcome features of teacher education: The TEDS-M data do not necessarily support the hypothesis that teachers from consecutive program do better than teachers from concurrent programs (see the case of the US). In contrast, the TEDS-M data fully support the hypothesis that more mathematics leads to better results (see the cases of Chile and Norway).

With respect to general pedagogical knowledge it is possible to state that future mathematics teachers from Germany and Taiwan have significantly more knowledge than those from the US. Relatively speaking (i.e. ipsative measures) do German teachers show higher knowledge in the subdimension “Dealing with heterogeneity” than in the other subdimensions. This strength mainly goes back to mathematics teachers up to grade 10.

With respect to beliefs, there is again huge variation between and within countries but it is possible to identify profiles similar to those on the primary level which supports our hypothesis of cultural influences.

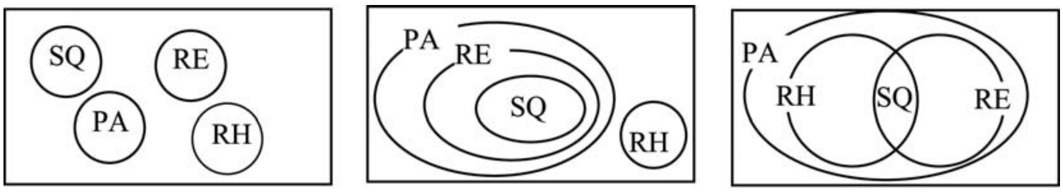
Mathematics teachers up to grade 10	**PCK mean**
Taiwan	649 (5.2)
Switzerland*	549 (5.9)
Singapore	539 (6.1)
Poland (Bachelor, Full time)*	520 (4.6)
Germany (5-10)	**518 (6.3)**
Germany (1-10)	**513 (11.6)**
International	498 (1.7)
Norway (with extra mathematics)*	480 (6.2)
USA (concurrent)*	470 (4.0)
Norway (without extra mathematics)*	455 (4.1)
Philippines	450 (4.7)
Botswana	436 (8.5)
Chile (with extra mathematics)*	407 (7.9)
Chile (without extra mathematics)*	392 (4.1)
Mathematics teachers up to grade 13	**PCK mean**
Germany (5-13)	**586 (6.7)**
Russia	566 (10.1)
Singapore	562 (6.1)
USA (concurrent)*	544 (6.9)
Poland (Master, Full time)*	536 (5.3)
USA (consecutive)*	535 (10.3)
International	505 (2.8)
Thailand (consecutive)	495 (12.2)
Norway*	495 (17.7)
Oman (University)	485 (12.6)
Malaysia (BEd)	476 (6.4)
Thailand (concurrent)	474 (2.6)
Oman (College)	473 (4.3)
Malaysia (BScEd)	471 (3.7)
Georgia (Bachelor)*	437 (11.5)
Botswana	409 (15.6)
IEA: Teacher Education and Development Study	© TEDS-M Germany

* Reduced Coverage, Combined Participation Rate < 75% or other Limitations (see explanations on the last page of this report)

If one tries to summarize the main aspects we learned from TEDS-M, there are methodological and substantive aspects to be mentioned. TEDS-M showed that studies in the field of higher education are challenging and difficult to do. Several levels of aggregation are to be considered – and each one has its own benefits and limits. From a substantive point of view, we learned that achievement in different domains of teacher knowledge (content knowledge, pedagogical content knowledge, general pedagogical knowledge) can differ a lot. And the achievement of teachers from different programs within a country can differ a lot as well. Here we can learn the most for policy efforts within countries to improve the efficacy of a system. Overall, teacher knowledge does not seem to be an exclusive function of societal features, of features of incoming students or of length/structure/content of teacher education only but a complex amalgam of these characteristics.

Exemplary items of TEDS-M

Three students have drawn the following Venn diagrams showing the relationships between four quadrilaterals: Rectangles (RE), Parallelograms (PA), Rhombuses (RH), and Squares (SQ).



[Tian] [Rini] [Mia]

Which student's diagram is correct? *Check <u>one</u> box.*

A.	[Tian]	o_1
B.	[Rini]	o_2
C.	[Mia]	o_3

Prove the following statement:
If the graphs of linear functions

$$f(x) = ax + b$$

and

$$g(x) = cx + d$$

intersect at a point *P* on the *x*-axis, the graph of their sum function

$$(f + g)(x)$$

must also go through *P*.

When teaching children about length measurement for the first time, Mrs. [Ho] prefers to begin by having the children measure the width of their book using paper clips, then again using pencils.

Give **TWO** reasons she could have for preferring to do this rather than simply teaching the children how to use a ruler?

Technical Appendix

TEDS-M was a comparative study done under the supervision of the IEA. The TEDS-M International Study Center at Michigan State University coordinated all international activities including the development and pilot-testing of survey instruments. The Study Center also established sampling guidelines and procedures for the National Research Centers of the participating countries. The NRCs provided the sampling frames while the sample selection, weighting, participation rate determination and adjudication were conducted by the IEA Data Processing Center (DPC) in Hamburg, Germany. The NRCs were responsible for data collection and the DPC was responsible for processing and assemblage of the international dataset released to NRCs in December 2009 (for more details see Tatto et al., 2009).

Because of the complex sampling design, standard errors were estimated using Balanced Repeated Replication (BRR) (Dumais & Meinck, 2009). Weights were determined according to the sampling design, adjusted for non-participation and non-respondents. The data were processed by the DPC and sampling weights were computed by Statistics Canada, the sampling consultant for TEDS-M.

The TEDS-M quality standards require minimum participation rates for all target populations of the survey. The aim of these standards is to ensure that bias resulting from non-response is kept within acceptable limits. Data collection procedures and response rates were evaluated by the IEA DPC Sampling Team. This resulted in adjudication comments and recommendations with regard to the reporting of the data: “Reporting without any annotation” – this comment was used if all participation rate requirements were met, the exclusion rate was below 5% and full coverage of the target population was observed. “Annotation because of low participation rates” – this comment was used if the participation rate was below the requirement. Annotations were also advised if the exclusion rate exceeded 5% or reduced coverage of the target population was observed. “Unacceptable (move to appendix)” – this comment was used if the combined participation rate dropped even below 30%. Whereas Canada had to be excluded from the study because of the latter reason, five countries on the future primary teacher level and six countries on the future lower secondary teacher level have to be annotated:

Chile	Combined Participation Rate < 75% (Primary and Lower Secondary)
Georgia	Combined Participation Rate < 75% (Lower Secondary)
Norway	Combined Participation Rate < 75% (Primary) Combined Participation Rate < 60% (Lower Secondary) Sample meets only partly the TEDS-M definition of the target population (for more details about the complex situation see Tatto et al., 2009)
Poland	Institutions with concurrent teacher education programs Combined Participation Rate < 75% (Primary and Lower Secondary)
Switzerland	Colleges of Education in German speaking parts of the country
USA	Public Institutions Combined Participation Rate < 75% Substantial proportion of missing values