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Teacher Development and Teacher Readiness in Five East Asian Education Systems: Evidence from TIMSS 2007

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Abstract: Numerous research studies have shown that the quality of teachers is the single important school-level contributor to student achievement. This study aims to investigate teachers' professional development experience and its relationship with their readiness to teach mathematics in Chinese Taipei, Hong Kong SAR, Japan, Korea, and Singapore. The data were taken from TIMSS 2007 at eighth grade level. Responses of mathematics teachers to the questionnaires pertaining to their highest education level, educational emphasis on mathematics and teaching, participation in professional development in mathematics, collaboration among colleagues, and readiness to teach the TIMSS curriculum topics are the focus of the analysis. The results show that teachers' readiness was influenced by many factors that functioned interactively. While some practices were consistently found to be helpful in enhancing teachers' readiness (e.g., receiving training in both Math/Science and education, participation of professional development activities related to pedagogy/instruction), some functioned differently across education systems (e.g., length of teaching experience, observation of others' lessons and/or being observed).

Keywords: TIMSS 2007; Teacher development; Teacher readiness; Teacher quality; Chinese Taipei, Hong Kong, Japan, Korea, Singapore

Role of Teacher Quality and its Complexity

It has been widely acknowledged that the success or failure of school education depends to a large extent on the quality of its teachers, in particular, teachers' ability to motivate and facilitate students' learning. Numerous research studies from the US have suggested that the quality of teachers and teaching is the single important school-level contributor to student achievement (e.g., Banicky & Foss, cited in Miller, Kim, & Herbert, 2009; McCabe, cited in McEwin, Dickinson, & Anfara, 2005; Rice, 2003). Hanushek (1992) found that the difference between having a good teacher and a poor one can exceed one grade-level equivalent in annual educational progress. Some researchers argue that teacher quality is a more powerful and consistent factor influencing educational outcomes than the learner's socioeconomic status (e.g., Darling-Hammond, 2000; Reeves, 2000).

In fact, the important influence of teachers is not limited to only students' cognitive achievement, but it also affects students' affective and behavioral outcomes (Rowe & Rowe, 2002). In this sense, the quality of teachers and teaching plays an important role in shaping the learning and growth of students (Cochran-Smith, Feiman-Nemser, McIntyre, & Dembers, 2008). Teachers also play key roles in initiating and changing schools and in implementing changes and reforms (e.g., Fullan, 1993; Lieberman, 1995).

On the other hand, there is no consensus about what factors would enhance teacher quality despite decades of research (Aarnson, Barrow, & Sander, 2007; Harris & Sass, 2008). As Greene (2005) suggested, one difficulty is to sort out a variety of possible factors and then to determine which ones are consistently related to better learning outcomes. Furthermore, not every potential factor can be easily measured and evaluated, such as teacher enthusiasm. Nevertheless, several factors are often cited. For instance, the California Teachers Association (CTA, 2007) listed three important factors, including pre-service preparation, professional development, and the occupational environment in which teaching occurs. The National Center for Education Statistics (NCES, 2000) proposed the following factors: having academic skills, teaching in the field which the teacher received training, having more than a few years of experience, and participating in high-quality induction and professional development programs. In 2005, the International Association for the Evaluation of Educational Achievement (IEA) initiated its first study in tertiary education, namely, the Teacher Education and Development Study in Mathematics (TEDS-M), focusing on the training of teachers of mathematics at the primary and lower secondary levels. The study also considered the links between teacher training policies, practices (e.g., characteristics of teacher educators and teacher education programs), and outcomes about the knowledge and beliefs of these future teachers in 17 countries (Tatto, Schwille, Senk, Ingvarson, Peck, & Rowley, 2008). These factors may be classified into two broad categories based on the time teachers join the profession: (i) teachers' educational qualifications and pre-service professional training, and (ii) in-service professional development and informal training through on-the-job experience.

Aim

The present study aims to investigate the relationship between professional development experience (before and after, formal and informal) of teachers and their readiness to teach mathematics in five East Asia education systems, i.e., Chinese Taipei, Hong Kong SAR, Japan, Korea, and Singapore. One important reason why the analysis includes these five systems is that students in these systems have sustained excellent performance in international comparison studies (e.g., PISA and TIMSS) continuously, and high quality of teachers has been suggested as a key reason for their strong performance. It is hoped that the findings will be useful for gaining a better understanding of the state-quo about teacher training in order to further explore a more effective model for teacher preparation and professional development.

Research Methods

Teachers

The data[1] for this study were taken from the TIMSS 2007 eighth grade mathematics study (http://timss.bc.edu/TIMSS2007/idb_ug.html). A total of 59 education systems around the world participated in TIMSS 2007, but only five systems were selected for this study. There were 152 mathematics teachers from the Chinese Taipei (who taught about 4046 students), 145 from Hong Kong SAR (3470 students), 216 from Japan (4312 students), 243 from Korea (4240 students), and 357 from Singapore (4599 students).

Measures

TIMSS 2007 measured students' achievement in mathematics and science, together with background questionnaires for students, teachers, and principals. The background information allows cross-national comparison of educational contexts so as to investigate the differences found in students' academic performance. The focus of this study is about teachers' professional development experience and their readiness to teach mathematics topics. The relevant information was collected from teacher background questionnaire, including teachers' highest education level (BT4GFEDC), major area of study, participation in five types of professional development activities in mathematics, number of years of teaching (BT4GTAUT), and collaboration among colleagues. The frequency of collaboration was measured on a 4-point Likert scale: 1= never or almost never, 2 = 2 or 3 times per month, 3 = 1-3 times per week, and 4 = daily or almost daily. The teachers were asked to rate their readiness to teach 18 TIMSS mathematics curriculum topics across four content domains (five in Numbers, four in Algebra, six in Geometry, and three in Data & Chance) on a 3-point Likert scale in a *descending* order (2 = very well prepared, 3 = somewhat prepared, and 4 = not well prepared).

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[1] The data from the bridge booklets were not used in the present study, as students' performance on these booklets did not contribute to the overall score for TIMSS 2007; it was used in the trend scaling that placed the 2007 results on the same scale as previous TIMSS assessments (Gonzales, Williams, Jocelyn, Roey, Kastberg, & Brenwald, 2009).

Data analysis

Some variables were first re-categorized into a smaller number of groups. Actual years of teaching as given by the teachers were rescaled into three classes: “less than 5 years”, “5 to less than 10 years”, and “10 years and above”. The TIMSS questionnaire measured teachers’ “highest education level” on a 6-point Likert scale, and this variable was regrouped into three levels: “without university”, “university”, and “master or higher”. Information about teachers’ “major area of study” was collected from six separate items (i.e., BT4MPSMA, BT4MPSEM, BT4SPSSC, BT4SPSED, BT4GPSEG, and BT4GPSOT) in the TIMSS study. For summary purpose, four categories were created as follows: “Math/Sci + Edu”, “Education only”, “Math/Sci only”, and “Others”. For teachers’ readiness to teach, the 3-point scale was first downgraded one point, followed by reversing the original descending order, and finally taking the mean of the teachers’ responses to all the 18 topics, resulting in a single variable about readiness.

After the above recoding, descriptive statistics, where appropriate, were used to provide a general picture about the teachers by gender, years of teaching, education background, and professional development experience across the five education systems. Next, the association between teachers’ characteristics (including experiences) and their readiness to teach were explored using *t*-tests and ANOVA. Given the large sample sizes in the TIMSS study, effect sizes using *d*-value for *t*-tests and ω^2 for *F*-ratios were computed from these tests to measure the magnitude or significance of any differences found. Since the teachers in TIMSS were teachers of the representative samples of students assessed rather than representative samples of the teachers in each education system, the following analyses using teacher data were weighted by the variable MATWGT, which weighted mathematics teachers in relation to their students, i.e., dividing the sample weight for the student by the number of teachers that the student has. These analyses were performed separately for each individual education system.

Results and Discussions

Profile of eighth grade mathematics teachers

Table 1 presents the profile of eighth grade mathematics teachers in each system by gender, years of teaching, highest education level, and major area of study. Since TIMSS was designed to use individual student as the unit of analysis, the data were reported in terms of percentages of students whose teachers reported various characteristics; this approach is used for all the results in this paper. In Chinese Taipei, Korea, and Singapore, a majority of the students were taught by female teachers, whereas students in Hong Kong SAR and Japan were more likely to be taught by male teachers. A majority of the students in four systems (other than Singapore) were taught by teachers with at least of ten years of teaching experience, with highest percentage in Japan. In contrast, most students in Singapore were taught by mathematics teachers with less than 5 years of teaching experience.

Table 1
Profile of Eighth Grade Mathematics Teachers in Five East Asian Education Systems (% of Students sampled in Each System)

Profile Factors	**Chinese Taipei**	**Hong Kong SAR**	**Japan**	**Korea**	**Singapore**
Gender					
Female	57.0	40.3	42.8	63.6	64.0
Male	43.0	59.7	57.2	36.4	36.0
Number of Years of Teaching					
Less than 5 years	24.1	27.1	18.8	24.6	57.0
5 to < 10 years	25.5	14.0	12.8	18.8	19.4
10 years and above	50.5	59.0	68.3	56.6	23.6
Highest Education Level					
Without university	6.0	12.6	2.2	0.0	4.4
University	71.9	61.9	89.5	67.7	89.5
Master or higher	22.1	25.5	8.3	32.3	6.1
Major Area of Study					
Math/Sci + Edu	61.1	57.8	46.0	2.7	46.2
Education Only	11.2	15.1	8.5	68.9	10.2
Math/Sci Only	23.9	17.1	38.0	25.0	30.3
Others	3.9	10.0	7.5	3.3	13.2

In all the five systems, nearly 90% of the students were taught by teachers who had completed university study and slightly more students in Hong Kong SAR were taught by teachers who did not have university degree. In Korea, all teachers had university degree and nearly one third of the students had teachers with master or higher degree. The corresponding percentages were relatively lower in Japan and Singapore.

A majority of the students in Chinese Taipei (61.1%) and Hong Kong SAR (57.8%) were taught by teachers who majored in both Math/Science and education, while only about 2.7% of the students in Korea were taught by teachers with similar education background. Instead, in Korea, most students (68.9%) were taught by teachers who majored in only Education and the corresponding percentages in the other four systems were around 10%. Furthermore, more than 70% of the students in Korea did not have teachers who specialized in Math/Science. It appears that teacher preparation in Korea emphasizes more on pedagogical knowledge than subject content knowledge, while the reverse is found in the other systems.

Professional development activities and collaboration

The TIMSS questionnaire asked teachers to report on their participation in five professional development activities in the past two years: mathematics content, mathematics pedagogy/instruction, mathematics curriculum, integrating information technology into mathematics, improving students' critical thinking or problem solving skills, and mathematics assessment. The results in Table 2 show that in all the five systems, there were more students whose teachers participated in activities related to mathematics content and pedagogy/instruction compared to critical thinking and assessment. Teachers in Japan and Korea participated less in activities about the integration of IT compared to those in the other three systems.

Table 2
Participation in Professional Development by Mathematics Teachers (% of Students sampled in Each System)

PD Activities	Chinese Taipei	Hong Kong SAR	Japan	Korea	Singapore
Content	84	78	74	48	81
Pedagogy/Instruction	79	71	76	50	88
Curriculum	84	72	31	41	65
Integration of IT	73	63	27	31	74
Critical Thinking	40	60	39	22	63
Assessment	52	56	39	33	61

In addition to attending formal professional development activities, informal collaboration among colleagues is another important means for career development. Four types of collaboration were investigated in the TIMSS study: discussions about how to teach a particular concept, working on preparing instructional materials, observations of other teachers' teaching, and informal observations by other teachers. The results in Table 3 show that teachers were involved in observing or being observed less frequently than the other two types of collaboration.

Table 3
Mean (Standard Deviation) of Frequency of Collaboration among Mathematics Teachers

Types of Collaboration	Chinese Taipei	Hong Kong SAR	Japan	Korea	Singapore
Concept	2.41 (0.71)	2.33 (0.66)	2.17 (0.78)	2.06 (0.70)	2.31 (0.71)
Material	1.75 (0.72)	1.98 (0.72)	2.59 (1.02)	2.52 (0.83)	2.35 (0.88)
Observe Others	1.37 (0.59)	1.49 (0.55)	1.51 (0.77)	1.21 (0.43)	1.23 (0.51)
Being Observed	1.16 (0.42)	1.39 (0.56)	1.47 (0.85)	1.14 (0.38)	1.36 (0.55)

In Chinese Taipei and Hong Kong SAR, teachers discussed with colleagues more frequently about how to teach a particular concept, while teachers in Japan and Korea tended to focus more on preparation of instructional materials. Teachers in Singapore were involved in the two types of collaboration at a similar frequency.

Teachers' readiness to teach mathematics: Levels and factors

Table 4 reports results about teachers' readiness to teach mathematics in four content areas. In general, teachers from all the five systems gave relatively high ratings, above 2.50 on a 3-point scale. They reported least ready to teach Data and Chance, followed by Geometry (except Japan). Indeed, Japanese teachers felt most ready to teach Geometry. Singapore teachers gave the highest ratings in all the content domains, but Japanese teachers consistently gave the lowest ratings.

Table 4

Teachers' Readiness to Teach TIMSS Mathematics Curriculum Topics: Means (SD)

Curriculum Topics	Chinese Taipei	Hong Kong SAR	Japan	Korea	Singapore
Number (5 topics)	2.83 (0.34)	2.67 (0.40)	2.48 (0.43)	2.68 (0.48)	2.88 (0.29)
Algebra (4 topics)	2.81 (0.35)	2.72 (0.38)	2.57 (0.40)	2.70 (0.47)	2.83 (0.32)
Geometry (6 topics)	2.69 (0.36)	2.65 (0.40)	2.61 (0.41)	2.68 (0.47)	2.80 (0.31)
Data & Chance (3 topics)	2.63 (0.41)	2.59 (0.43)	2.21 (0.56)	2.54 (0.53)	2.70 (0.37)
Overall (18 topics)	2.75 (0.34)	2.66 (0.37)	2.50 (0.38)	2.66 (0.45)	2.81 (0.27)

Table 5 compares teachers' readiness to teach mathematics by gender, years of teaching, and education background. The results from the effect size (d or ω^2) show that gender was the only factor that did not impact on teachers' readiness.

With the exception of Korea, the length of teaching experience had some impact on teachers' readiness to teach mathematics, being moderate in Hong Kong SAR and Singapore. In Hong Kong SAR, teachers became more ready with more teaching experience. A similar pattern was also observed in Chinese Taipei and Singapore, though the difference between teachers with "5 to less than 10 years" of experience and those with "10 years and above" was small. The pattern was slightly different in Japan; the difference in teachers' readiness was greater between teachers with "5 to less than 10 years" and those with "10 years and above" than difference between teachers with "less than 5 years" and those with "5 to less than 10 years". The results suggest that while teachers' confidence level generally increases when they gain more teaching experiences, the benchmarks for a competent mathematics teacher vary across the systems. For Korea, the relationship between teachers' readiness and number of years of teaching is unclear; in particular, teachers with "5 to less than 10 years" of teaching experience were less ready than their junior and senior colleagues. A further exploration found that these teachers majored in either Education only or Math/Science only and they were less ready than those with the other two types of education background.

Table 5
Teachers' Readiness by Gender, Years of Teaching, and Education Background

Profile Factors	Chinese Taipei	Hong Kong SAR	Japan	Korea	Singapore
Gender					
Female	2.74	2.66	2.53	2.67	2.80
Male	2.75	2.66	2.48	2.64	2.82
t	-2.71**	-1.22	76.2***	22.4***	-6.88***
d	0.01	—	0.14	0.06	0.06
Number of Years of Teaching					
< 5 years	2.65	2.53	2.38	2.66	2.75
5 to < 10 years	2.79	2.61	2.41	2.54	2.86
10 years and above	2.77	2.74	2.55	2.69	2.90
F	3825.9***	2443.8***	22582.9***	5339.4***	1472.4***
ω^2	0.03	0.06	0.04	0.02	0.06
Highest Education Level					
Without university	2.53	2.77	2.49	—	2.94
University	2.74	2.61	2.50	2.66	2.80
Master or Higher	2.81	2.73	2.48	2.64	2.82
F	5109.850***	1354.8***	202.4***	320.6***	253.1***
ω^2	0.03	0.03	0.00	0.00	0.01
Major Area of Study					
Math/Sci + Edu	2.76	2.66	2.53	2.76	2.83
Education Only	2.64	2.66	2.45	2.66	2.78
Math/Sci Only	2.80	2.77	2.53	2.60	2.79
Others	2.64	2.45	2.27	2.93	2.78
F	2203.5***	1202.7***	12222.0***	4017.6***	119.9***
ω^2	0.02	0.05	0.03	0.02	0.01

Note. (1) ** $p < 0.01$; *** $p < 0.001$ (2) A d-value (for t-tests) of 0.20 indicates a small effect size, 0.50 moderate effect, and 0.80 large effect. (3) A ω^2-value (for F-tests) of 0.01 indicates a small effect size, 0.06 moderate effect, 0.16 large effect; 0.03 as a threshold.

In Japan and Korea, teachers' readiness to teach mathematics was not differentiated by their highest education level, whereas it is clear in Chinese Taipei that the more education the teachers received, the more ready they were in teaching mathematics. Interestingly, in Hong Kong SAR and Singapore, teachers without university degree reported a higher level of readiness than those with a degree. A further investigation about these two systems found that in Hong Kong SAR, about 92.5% of the students whose teachers did not have a university degree had at least ten years of teaching experience. This percentage is much higher than the percentage of students with teachers having university degree (51.1%) or higher (65.2%). Similarly, in Singapore, the percentage of students taught by teachers without university degree but with at least ten years of teaching experience (48.0%) was almost double that for students with teachers having university degree (20.3%) or higher (21.1%) with similar teaching experience. Compared to Singapore (M = 7.2, SD = 8.3), teachers having university degree or higher in Hong Kong SAR (M = 11.4, SD = 8.7) had longer teaching experience. As discussed earlier, the length of teaching experience contributed to teachers' higher level of readiness in a positive way in both Hong Kong SAR and Singapore.

Teachers' readiness was differentiated by their major subjects in all the five systems, though the differences in Chinese Taipei, Korea, and Singapore were very small (ω^2 < 0.03). In Chinese Taipei, Hong Kong SAR, and Japan, teachers who majored in Math/Science but not education reported the highest level of readiness, whereas teachers with such education background in Korea were least ready. Among teachers who majored in education, those also specialized in Math/Science generally reported a higher level of readiness. In all systems except Korea, teachers who majored in subjects irrelevant to Math/Science and education reported lowest level of readiness. Further exploration is needed for this group of teachers in Korea, which, however, is out of the scope of this study. Table 6 compares teachers' readiness by professional development experience in the past two years.

Table 6
Teachers' Readiness by Participation in Professional Development Activities

PD Activities	**Chinese Taipei**		**Hong Kong SAR**		**Japan**		**Korea**		**Singapore**	
	t	*d*	*t*	*d*	*t*	*d*	*t*	*d*	*t*	*d*
Content	2.56*	0.01	35.75	0.31	38.95	0.08	61.31	0.15	13.07	0.15
Pedagogy/ Instruction	51.76	0.23	30.65	0.25	159.1	0.35	148.8	0.36	4.68	0.07
Curriculum	63.88	0.38	45.92	0.37	223.2	0.45	8.13	0.02	21.14	0.20
Integration of IT	31.09	0.13	4.72	0.04	62.73	0.13	95.51	0.25	3.85	0.04
Critical thinking	6.77	0.03	27.84	0.21	55.34	0.11	216.4	0.63	23.52	0.22
Assessment	19.66	0.07	13.99	0.11	220.3	0.42	153.5	0.40	22.88	0.21

Note. All t-values (except one *) were statistically significant at p < 0.001.

In general, teachers who participated in professional development were more ready than those who did not, especially in Hong Kong SAR and Korea, though the differences were small. The only difference at a moderate effect size was observed in Korea between teachers participating in activity about critical thinking and those who did not. Participation in activities related to mathematics pedagogy/instruction and mathematics curriculum had some impacts on readiness.

In general, teachers' collaboration with colleagues did not have much impact on their readiness; see Table 7. Among the five systems, collaboration had the largest albeit moderate impact among Chinese Taipei teachers when they had chances to discuss mathematics concepts with colleagues. Among Chinese Taipei teacher, collaboration to produce curriculum materials also had moderate impacts. In Japan, both types of observation helped teachers to improve their readiness, with observing others' lessons having greater impact than being observed. As there are no data from TIMSS about how teachers conducted the observations and were themselves observed, particularly what unique observations occurred in Japanese classrooms, it is hard to know what makes this type of collaboration contribute significantly to Japanese teachers' readiness but not teachers in the other systems. In this sense, more in-depth examinations are needed for a better interpretation. Similarly, teachers' collaborations focusing on concepts and materials in Chinese Taipei also call for more investigations.

Table 7
Teachers' Readiness by Types of Collaboration among Teachers

Types of Collabo-ration	**Chinese Taipei**		**Hong Kong SAR**		**Japan**		**Korea**		**Singapore**	
	F	ω^2	*F*	ω^2	*F*	ω^2	*F*	ω^2	*F*	ω^2
Concept	7898	0.07	590.3	0.02	891.4	0.00	170.2	0.00	390.6	0.02
Material	5692	0.05	411.4	0.02	3275	0.01	661.1	0.00	208.5	0.01
Observe others	3510	0.03	648.3	0.02	22992	0.06	1776	0.01	55.76	0.00
Being observed	1095	0.01	524.6	0.01	15288	0.04	2939	0.01	92.39	0.01

Note. All *F*-values were statistically significant at $p < 0.001$.

Conclusions and Implications

Given the importance of teacher quality in improving students' academic performance and experiences of schooling, this study used the TIMSS 2007 eighth grade mathematics data to investigate how teacher characteristics and professional development experiences are related to their readiness to teach TIMSS mathematics topics among five East Asian education systems. Teachers in these systems generally reported a relatively high level of readiness, although they were less ready to teach topics in Data and Chance. While Japanese teachers felt most ready to teach Geometry, teachers from the other four systems rated it as their second less ready to teach topic. Teachers' lack of readiness in these two content domains requires more attention from teacher educators, who need to find ways to strengthen teachers' teaching ability in the relevant topics.

Several factors were investigated to identify those that might enhance teachers' readiness to teach mathematics. A majority of students sampled in TIMSS in four of the five systems were taught by teachers with at least ten years of teaching experience, the exception being Singapore, where a majority were taught by teachers with less than five years of teaching experience. In general, readiness to teach was positively associated with years of teaching. Some researchers argue that while differences exist between teachers with at least five years of experience and those less experienced, the differences appear to level off after five years (e.g., Barton, 2003; Darling-Hammond, 2000). The current analysis found that the differences were found in Hong Kong SAR and Japan, but in Singapore, those with the least teaching experience reported the highest level of readiness to teach all the four content areas. Thus, in most cases, the length of teaching experience plays an important role in teachers' professional development, particularly for novices. However, the finding about an opposite pattern in Singapore calls for further in-depth investigations.

In terms of qualifications, higher education level in general was associated with greater readiness to teach. However, this was not so for Hong Kong SAR and Singapore, and teachers' teaching experience may partially explain this inconsistent pattern for these two systems. Similarly, teachers' major area of study, in particular in Math/Science with Education, was found to play some roles in their readiness to teach in four of the five systems, Korea being the exception. Additional education training did not benefit teachers in Hong Kong SAR, since those without university degrees reported the highest level of readiness to teach mathematics. In contrast to teachers' education background, involvement in professional development (formal/informal) had consistent impact on teachers' readiness level. Professional development activities on pedagogy/instruction and curriculum appear to be more helpful in enhancing teachers' readiness compared to those involving integration of IT and mathematics contents. Thus, it is encouraging to note that teachers in the five systems tended to participate more in activities related to pedagogy/instruction and less in IT. Korean teachers who participated in development activities on critical thinking felt significantly more ready than those who did not, and this could be an area for further investigation for the other system. In general, collaboration among colleagues had weak impacts on teachers' readiness, with the exception of Chinese Taipei and Japan, where different types of collaboration had differing impacts. Thus, teachers with different backgrounds may benefit to different degrees from various types of professional development activities. It is important for teacher educators to consider the teachers' background in order to plan more effective programs to prepare classroom teachers.

To summarize, teacher quality is a complex attribute. This study shows that teachers' readiness to teach is influenced by many factors, which interact with one another. While some practices may consistently enhance teachers' readiness (e.g., receiving training in both in Math/Science and education, participation of professional development activities involving pedagogy/instruction), others function differently in different education systems (e.g., length of teaching experience, observation of others' lessons and being observed). Thus, no unified model would be applicable for all the education systems. Nevertheless, it is important for teacher educators and teachers themselves to have a better understanding of what influences teacher quality and performance which in turn may benefit students' learning experience. The many unclear patterns and contradictory findings reported above call for more research efforts before a more effective model can be established to guide teacher development.

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