Results of Empirical Studies on Teacher Noticing with Mathematics Teachers from China and Germany – Analysis of Strengths and Weaknesses

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Research - East-West

Exploring the Eastern and the Western Debate: the Case of Mathematics Teachers' Professional Knowledge and Students' Achievement - A Comparative Study between Germany and China

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The Construct of Teachers' Professional Noticing

Growing body of research in (mathematics & science) education on teachers' professional noticing in the last decades.

Pioneering work by van Es and Sherin (2002, 2008): distinction of **three facets**
Identifying important classroom event;
Making **connections** between classroom events and learning principles;
Using knowledge about the context to **reason** about classroom interactions.

Extensive survey by Sherin, Jacobs & Philipp (2011), pointed out that the conceptualization of noticing is **varied**, but has **two common core facets**, namely **attending to** and **making sense** of events in an instructional setting.

The Construct of Teachers' Professional Noticing

Further development and **extension of this definition** by Jacobs, Lamb & Philipp (2010) by distinguishing three interrelated facets of professional noticing of **students' mathematical thinking**:

- **attending** to children's strategies;
- **interpreting** children's understandings;
- deciding how to **respond** based on the understandings children's strategies.

The Construct of Teachers' Professional Noticing

Common features of most conceptualizations:

- highly selective and multidimensional (Erickson, 2011)
- a process rather than static knowledge
- interrelated and cyclical (Sherin et al., 2011)
- a situated practice (Thomas, 2017)
- strong focus on students' thinking (Jacobs et al., 2010; Sherin et al., 2011)

The Construct of Teachers' Professional Noticing

Various influencing factors identified:

- Teachers' knowledge and belief systems (Meschede et al., 2017; Stürmer et al., 2013)
- Teachers' instruction/working experience (Jacobs et al., 2010; van Es, Hand, & Mercado, 2017)

The Construct of Teachers' Professional Noticing

Cultural aspects:

Societal and cultural values in a specific context shape teachers' attention to issues seen as important or ignored as less relevant; noticing as **"culturally shaped perception"** (Ball, 2011, p. xxi).

The Construct of Teachers' Professional Noticing

Despite this consensus hardly any systematic comparative studies on teachers' noticing from different cultures.

Cultural influences to teacher noticing are "typically neglected" (Louie, 2018, p. 61).

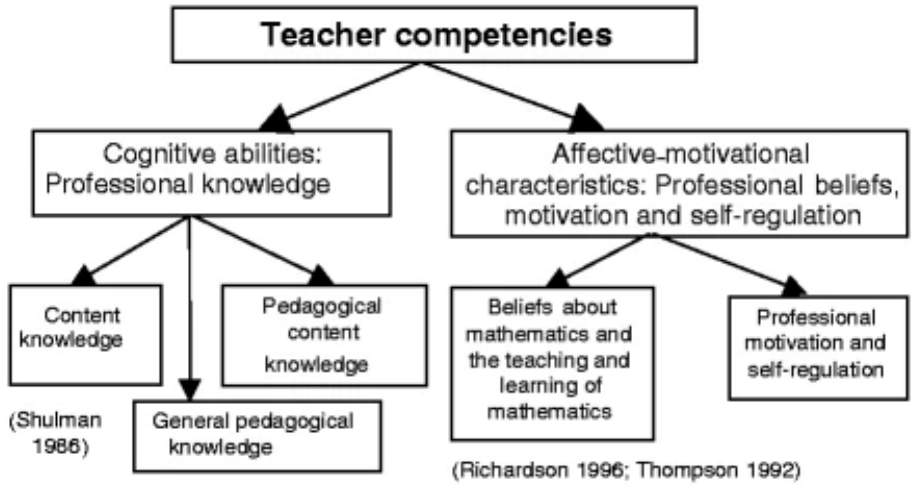
Only **isolated** case studies, e.g. Miller and Zhou (2007) comparing American and Chinese primary teachers' noticing of classroom videos. Identification of striking differences:

- American teachers focusing on pedagogical issues and teachers' personalities;
- Chinese teachers focusing on mathematical content of the lessons.

Theoretical Framework of the Study

Departure point of theoretical framework:

teachers' noticing as **situated** or **situation-specific** skills complementing the knowledge-based construct of teachers' competence (**cognitive aspect** of teachers' professional competence);



(Döhrmann, Kaiser, & Blömeke, 2012, p. 327)

Theoretical Framework of the Study

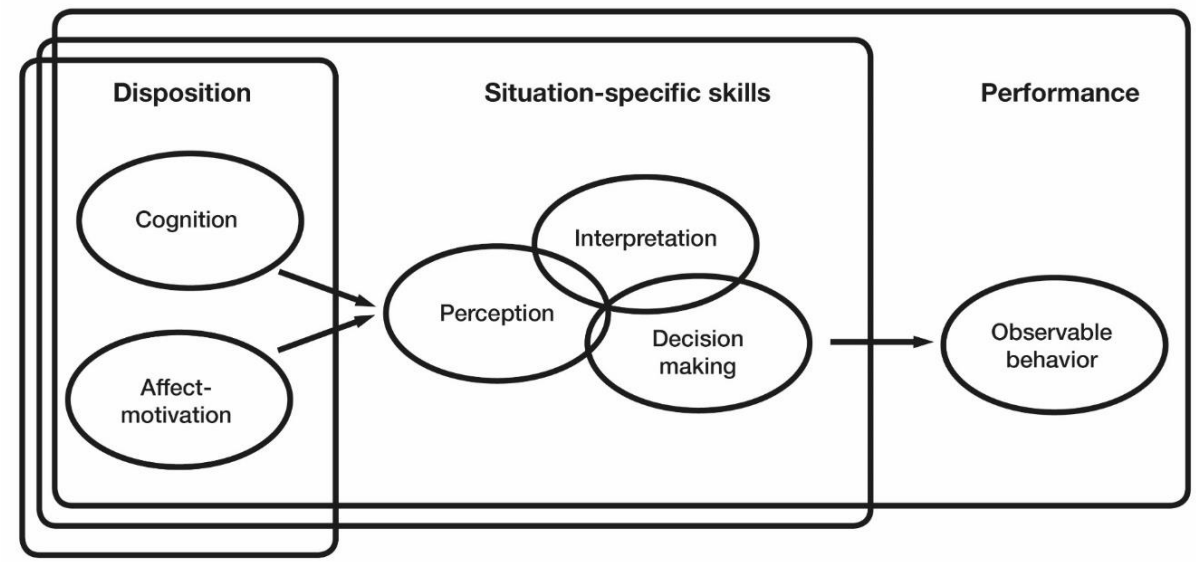
Departure point of theoretical framework:

- teachers' noticing as **situated** or **situation-specific** skills complementing the knowledge-based construct of teachers' competence (**cognitive aspect** of teachers' professional competence);
- the relationship between teachers' professional knowledge and instructional quality/teaching practice "is far from simple and straightforward" (Depaepe, Verschaffel, Star, 2020, p. 181);
- teachers' situation-specific skills as necessary **transformation** of the cognitive dimensions of competence (e.g., knowledge) into classroom performance (Blömeke and Kaiser, 2017).

Reference to the approach modeling competence as a continuum by Blömeke, Gustafsson, & Shavelson (2015)

Theoretical Framework of the Study

Teacher competence as continuum



(Blömeke, Gustafsson, & Shavelson, 2015)

Theoretical Framework of the Study

Theoretical Framework on Teachers' Noticing

Conceptualisation of noticing as: **Perception**, **Interpretation**, and **Decision-making (PID-model)** (Kaiser et al., 2015, 2017).

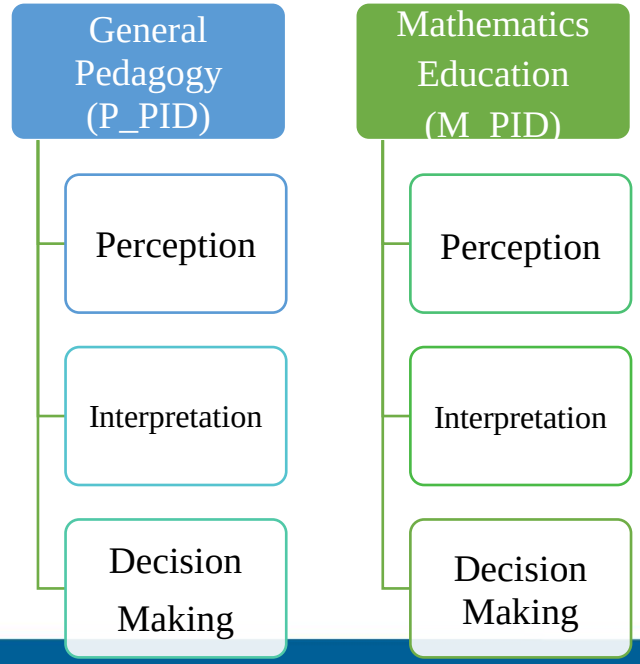
Three sub-facets of noticing:

- **Perceiving** particular events in an instructional setting;
- **Interpreting** the perceived activities in the instructional setting;
- **Decision-making**, either anticipating a response to students' activities or proposing alternative instructional strategies.

Theoretical Framework of the Study

Theoretical Framework on Teachers' Noticing

Conceptualisation of noticing as: Perception, Interpretation, and Decision-making (PID-model) (Kaiser et al., 2015, 2017).



Theoretical Framework of the Study

Similarity of PID-model to earlier approaches (such as Jacobs et al., 2010), but **going beyond** those approaches, which are mainly focusing on teachers' professional **noticing of students' mathematical thinking**.

Three sub-facets of PID model focus not only perception of noteworthy events and interpretation, but further decisions and reasonable responses.

Overall: PID model comprises a **broad understanding of teachers' noticing**, including many aspects important for **quality-oriented mathematics teaching**, such as design of mathematics teaching, potential for cognitive activation of students, and classroom management (Kaiser et al., 2015, 2017).

Design of the Study and Participants

Samples: 118 secondary mathematics teachers from Hamburg (second biggest German city) and 203 junior secondary mathematics teachers from Chongqing

Data collection: 2014-15 in Hamburg / October-December 2016 in Chongqing

Differences in **schooling culture**: junior secondary teachers in China only teach one subject to students in grades 7-9 (students' age 12-14) / secondary teachers in Germany teach two subjects to students from grade 5 to 10 or 12/13 (students' age 10-16 or 18/19)

Demographics: 42% of German teachers were female, 11 years of teaching experience on average/ 32% of Chinese teachers were female, 15 years of teaching experience on average.

Instruments and Data Collection

The original **Three video-vignettes** developed in TEDS-FU for **secondary** mathematics teachers:

- Video-vignettes cover a **range of mathematical topics** usually taught in Grades 8-10 (e.g., functions, volumes and surfaces), lasting 3.5 to 4 minutes
- **Scripted plots** with different teachers and different students from different types of German schools
- Providing **overview** about the **lesson**, but focus on different phases of teaching, e.g. introduction of a mathematical task followed by work on task, …
- Provision of **background information** such as information about the class and prior teaching

After watching each of the three videos, teachers had to answer **closed** and **constructed-response items** relating to scenes observed.

Instruments and Data Collection

Distinction between Perception, Interpretation, and Decision-making under:

- **Pedagogical perspective (P_PID),** e.g. lesson structure, adaptivity, motivation, classroom management, assessment
- **Mathematics pedagogical perspective (M_PID),** e.g. different explanations of mathematical concepts, analysis of mental processes, identification of task types, mathematical ideas

In total: **38 closed items** (22 P_PID and 16 M_PID) using Likert scales and **36 constructed-response items** (18 P_PID and 18 M_PID).

Validation of rating of closed items by expert rating (Hoth et al., 2017).

Development of **coding manual** through systematic analysis of relevant theories and wide discussions with teachers and researchers, extensive coding manuals with **correct**, **semi-correct** and **wrong answers** developed out of the material using verbatim answers by test persons.

Validating the German Instruments within Chinese context

Extensive studies on the question, whether the instruments developed in the frame of a German study can be adapted to China.

Translation of the video-based instruments from German into English and then into Chinese, several steps of checking accuracy and adequacy by German and Chinese scholars.

Deletion of a few items, e.g. referring to **German standards** in mathematics education, curricular aspects. Deletion of two parts of the video-vignettes, which were **cultural dependent**:

- check of attendance in German classroom, not necessary in China
- gender-related explanation of self-attribution of success, not adequate for China as female student asked question in working phase

Three Chinese junior secondary teachers and their students **retook the three video-vignettes** performing exactly as their German counterparts.

Details can be found in Yang et al. (2018).

Validating the German Instruments within Chinese context


1


2


3

Im Video wurden drei Paare in ihrem Arbeitsprozess genauer betrachtet. Diese Arbeitsprozesse sollen im Fol-

In the video-vignette the working processes of three cooperating pairs have been observed more closely. These working processes are to be examined from two perspectives: (a) mathematics education and (b) pedagogy.

(a) mathematics educational perspective
In each of the three approaches the task is represented and solved mathematica
way.
Please describe (in note form) the essential aspects of the approaches in a cont
from a mathematics education view.

Please name – if possible – the corresponding technical terms.

(b) pedagogical perspective
Please describe (in note form) for each of the three pairs in a contrasting mode t
aspects of the way the two students cooperated in their work.

在视频中展示了三组学生的学习过程。现在将从两个角度来分析这个过程：1）数学教育的角度； 2）一般教育学的角度。

1）数学教育的角度：

每个小组都以自己的独特的数学方式展现且并完成了该任务。请从数学教育的角度对比并简要描述这三种方式的关键不同之处（如果可能的话，请使用专业术语）。

2）一般教育学角度

这三组同学的小组活动方式各不一样，请对比且简要描述这三组学生课堂合作方式的关键不同之处（记录要点即可）。

Data analysis

Analysis of the data **quantitatively** and **qualitatively**.

Qualitative approach:

For the constructed-response items usage of **the translated, checked coding manual.**

Translation of 50 randomly selected Chinese teachers' answers into English, afterwards **coding training** by one of the experienced coders from TEDS-Instruct using answers of ten teachers, afterwards separate coding of 40 answers by both coders, **satisfactory values of Cohen's kappa** ($k>0.76$ and $K_{average}= 0.84$).

Differences in coding discussed to reach a **common understanding**; specific problems discussed with the main developer of the original German instrument.

Coding of missing answers as zero.

Data analysis

Quantitative approach:

Separate calculation of **relative item difficulties** from a one-parameter (Rasch model) item response theory (IRT) model for P_PID (professional pedagogical noticing) and M_PID (professional mathematics pedagogical noticing).

Estimation of **internal consistency** using the **Cronbach alpha reliability coefficient** in Germany and China separately; test shows sufficient reliabilities in both countries.

	N	P_PID	M_PID
		Cronbach's α	Cronbach's α
German in-service teachers	118	0.82	0.79
Chinese in-service teachers	203	0.84	0.76

Reliabilities (Cronbach's Alpha) of P_PID and M_PID

Data analysis

- Usage of **differential item functioning (DIF)** in order to identify items typically in favour of German or Chinese teachers.
- Originally **DIF** evaluated **whether items are functioning in the same manner in various groups of participants in achievement tests**. However, DIF can also be used for **identifying cross-country differences** in cultures (Mesic, 2012).
- Calculation of DIF here served the aim of identifying societal and cultural factors from the German and Chinese contexts allowing to reconstruct similarities and differences of teachers' professional noticing at item level.

Data analysis

In detail: **item with**

uniform DIF: teachers from Germany or China outperformed the counterparts from the other country systematically throughout all the ability levels, i.e. societal and cultural differences between these two countries may act as main factors that impact teachers' competence on the aspect the item investigated.

non-uniform DIF: societal and cultural impact on the response behaviour was varied across different across teachers' competence levels.

Overall Performance in Noticing of Chinese and German Teachers

Remarkable **differences** between Chinese and German teachers (after transformation to 500 as mean and 100 as standard deviation).

Pedagogical professional noticing (P_PID): German teachers showed significant higher mean score than the Chinese teachers.

Mathematics pedagogical noticing (M_PID): Chinese teachers showed significantly higher mean score than the German teachers.

	German Teachers (M±SD)	Chinese Teachers (M±SD)	T
P_PID	500±100	436.19±107.03	5.27***
M_PID	500±100	567.52±97.52	-5.93***

Mean Scores and Standard Deviations for P_PID and M_PID and Differences
Note. *** p<0.001

Strengths and Weaknesses in Pedagogical Noticing (P_PID)

Differential item function analysis (DIF): Class B (moderate DIF):

$0.035<\Delta R2\leq 0.07$, Class C (large DIF): $0.07<\Delta R2$

		Perception	Analyzing and Decision	In total
Favor Germany	Class B	3	1	4
	Class C	6	0	6
Favor China	Class B	1	1	2
	Class C	1	2	3

In total **double** as many items in **favour of German teachers**.

Most items favoring German mathematics teachers were "**Perception**" related items about students' behavior, explicitly shown in the video-clips.

More items on "**Analyzing and Decision-Making**" favored Chinese teachers, using their knowledge to reason about incidents not shown in video-clips.

Strengths and Weaknesses in Pedagogical Noticing (P_PID)

Content analysis of items reveals concerning '**Perception**':

- Items in favour of **German teachers**: related to:
  - **classroom management** (e.g., "It takes very long for the student to calm down and for the lesson to start")
  - **students' behaviour** (e.g., "Most of the students take an active part in the lesson")
  - **teachers' behaviour** (e.g., "The teacher presents the question visually and acoustically")
- Items in favour of **Chinese teachers**: related to
  - **students' learning motivation** (e.g., "Using the start of her lesson, the teacher tries to evoke an intrinsic motivation in the students")
  - **students' thinking** (e.g., "The teacher provides the students with the opportunity to individually think about the question")

Strengths and Weaknesses in Pedagogical Noticing (P_PID)

Content analysis of items reveals concerning '**Analyzing/Interpreting and Decision-making**':

- The only item in favour of **German teachers**: asked teachers to judge how **one specific student's statement is different** from the statements made by his classmates (correct answer: the student's statement refers to his classmates' statements).
- Items in favour of **Chinese teachers**: investigated **teachers' competencies to modify the seen lesson** and to identify the phase within the lesson and the activities, where changes would be needed to better meet the class's learning conditions or to describe aspects where the teacher's behavior was not adequate for supporting students' cognitive activities.

Overall these items favoring Chinese teachers required **solid knowledge** on cognitive development of students by teachers and in **developing lesson plans flexibly** in various ways to meet the needs of students with various backgrounds.

Strengths and Weaknesses in Mathematics Pedagogical Noticing (M_PID)

Differential item function analysis (DIF): Class B (moderate DIF): $0.035<\Delta R^2\leq 0.07$; Class C (large DIF): $0.07<\Delta R^2$.

		Perception	Analyzing and Decision	In Total
Favor Germany	Class B	4	3	7
	Class C	1	1	2
Favor China	Class B	2	3	5
	Class C	1	4	5

Different picture, more or less **same number of items** in favour of German and Chinese teachers, more items with large DIF favoring Chinese teachers.

German teachers' strength in **perception** items, concerning aspects like modelling and visual approaches of teaching.

Chinese teachers strength on **analyzing/interpreting** and **decision-making** with aspects like using knowledge to make relevant judgments on students' work and developing alternative ways of teaching.

Strengths and Weaknesses in Mathematics Pedagogical Noticing (M_PID)

Content analysis of items reveals concerning '**Perception**':

- Items in favour of **German** teachers: related to
  - **students' statements in the classroom** (e.g., "Jackie's statement is a helpful contribution to the lesson question")
  - **mathematical modeling** (e.g., "There are modelling competencies necessary to work on the central question")
  - **open-ended characteristics of the task** (e.g., "The task shows features of an open question").
- Items in favour of **Chinese** teachers:
  - required teachers to evaluate which **kind of knowledge** was **necessary to tackle the task successfully** (e.g., "The central mathematical idea or functional coherence comes into effect during teaching")
  - required teachers to use **relevant knowledge to evaluate students' work** (e.g., "When students calculate the volume of the solid, they use the correct measuring unit cm^3 to present their answers").

Strengths and Weaknesses in Mathematics Pedagogical Noticing (M_PID)

Content analysis of items reveals concerning 'Analyzing/Interpreting and Decision-making':

- Item in favour of German teachers: required teachers to modify the task to make it more realistic or foster modeling competence to solve the task or required teachers to identify whether a student preferred a formal approach other than a visual approach.
- Items in favour of Chinese teachers: required teachers to use adequate professional terminology, identify mistakes of a student and identify the difference of this statement from the classmates' statements from a mathematical point of view (i.e. teachers needed to notice that the student was deducing or making a linear assumption); required teachers to suggest possible ways to correct a wrong assumption by student (e.g. about a linear relation between a ball's diameter and its weight made by a student).

Differences on Pedagogical Professional Noticing (P_PID) - Summary

Summary

Better performance of **German mathematics teachers in pedagogical noticing** consistent with known insights from knowledge-based studies (such as TEDS-M) (König et al., 2011) amongst others due to **higher opportunities to learn** by German pre-service teachers in pedagogy compared to their Taiwanese counterparts (Wang & Tang, 2013).

Items favouring **German teachers mainly** from **perception** of issues on classroom management, students' behavior and teacher-student-interactions; of high importance in German classrooms, but not in Chinese, especially due to Confucian heritage culture (Cai & Wang, 2010).

In **China**, **growing importance** of **students' interests, motivation** and **confidence** in **most recent mathematics curriculum reform**: possible explanation of better performance of Chinese teachers in these items.

Items favouring **Chinese** teachers strongly relate to **analyzing/interpreting** and **decision-making**, e.g. judging inadequacy of teaching sequences and modifying it; high importance in mentoring phase of early career teachers mandatory in China (Lu et al., 2020).

Differences on Mathematics Pedagogical Professional Noticing (M_PID) - Summary

Summary

Better performance of Chinese teachers concerning mathematics pedagogical noticing, consistent with previous findings, e.g. from TEDS-M, where East Asian pre-service teachers outperformed Western counterparts on their **subject knowledge** (Blömeke et al., 2013; similarly Kleickmann et al., 2015), amongst others due to more opportunities to learn.

Items in favour of **German teachers** due to **differences** in **curriculum traditions**, e.g. high importance of mathematical modelling in German national standards in contrast to China or high importance of non-formal aspects and usage of a variety of representations in German mathematics teaching (Blum et al., 2005).

Items in favour of **Chinese teachers** refer to mathematical evaluation of students' answers, judging characteristics of teaching tasks, and developing teaching sequences to facilitate students' understanding. Explanations may refer to **higher mathematical knowledge** of Chinese teachers and the need to participate in **Chinese lesson study** with many opportunities to observe and evaluate lessons of other teachers.

Limitations and Outlook

Limitations of the studies:

only selection of **two countries,** mainly two regions, wider geographical range needed in further studies;

different ways of testing in the two countries, web-based testing in Germany, paper-and-pencil test in China due to practical difficulties.

Further studies needed, preferably with larger sample size, in order to improve trustworthiness of the findings and allow generalisations.

Thank You!