Global Teaching InSights

Technical Report

Section I: Study background

2 Conceptualising teaching quality into six domains for the Study

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This chapter describes the process to understand, categorise and harmonise two sources of teaching quality definitions: countries'/economies' conceptualisations of quality teaching, and the global research literature. It also presents the final six-domain conceptualisation of teaching quality of the Study.

Introduction

This chapter describes the activities undertaken to bridge and harmonise two sources of varying definitions of teaching quality. These two sources are countries'/economies' own conceptualisations of quality teaching, and the global research literature. This effort nominated specific constructs, teaching practices, and learning outcomes that were important to participating countries/economies. As the chapter details, there were significant overlaps across country/economy conceptualisations as well as areas of divergence. Most relevant for the Global Teaching InSights (results from the TALIS Video Study project, and is hereafter cited in this chapter as "the Study" or "GTI") conceptualisation, the varied ways of parsing and naming teaching and learning had to be understood and reconciled prior to harmonising with the other OECD frameworks and the literature review.

The final section of the chapter presents the final conceptualisation of teaching quality of the Study. Teaching quality is broken down into six domains of practice. All study instruments have been aligned to this conceptualisation. The observation and artefact codes were developed directly from the six domain conceptualisation (Chapters 4 and 5 provide additional detail on these instruments' development). The teaching quality domains identified in the conceptualisation are generic dimensions of teaching quality that can be applied across subjects and subject matter. The domains provide the structure and general substance for the relevant aspects of teaching that are differentially operationalised, depending on measurement instrument.

Consideration of defining common conceptualisation of teaching

The common conceptualisation of teaching in the Study followed an approach to take into consideration several premises:

- **No single effective way of teaching**. The goal was not to identify the globally most effective way of teaching. The approach adopted was rather comprehensive, recognising that 1) teaching has multiple goals; 2) different practices and features of teaching are relevant for different goals; 3) practices are combined and used in different ways; and 4) these relationships as well as pedagogical norms may vary between cultures.
- **Focus on "how to teach".** Research on teaching can be categorised into two types, research focused on "what to teach" and research focused on "how to teach". The literature that was reviewed has been that of the "how to teach" strand, even if completely removing "what to teach" is impossible.
- **Teaching during classroom instruction**. The common conceptualisation of teaching quality focused on what occurs during classroom instruction. As a result, the following aspects of the school life were not included: a.) teacher characteristics; b) the surroundings (e.g. the school climate, cooperation with teachers or parents, system-level norms and values); c) reflections on teaching; and d) summative assessment/assessment of learning (as opposed to formative assessment which aims at adapting instruction to students and therefore was included).
- **Looking beyond what the teacher does**. While the Study is primarily focused on what the teacher does, to a large extent teaching is a combination of teacher and student actions around specific subject matter (sometimes referred to as the "instructional triangle"). Some classroom practices do focus solely on the content (e.g. ensuring correct and coherent treatment of content), but practices can also relate to the students (e.g. supporting social relationships among and between teacher and students), or be about the students in interaction with the content (e.g. encouraging cognitive student engagement). Therefore, the practices considered in the conceptualisation of teaching quality reflected actions taken by the teacher and by the students, avoiding a completely teacher-centred view of practice.

To develop a shared understanding of quality teaching, Global Teaching InSights (resulting from the TALIS Video Study project) built upon national standards and international research on teaching. The goal was to identify common aspects of teaching across the world through a collaborative process and to understand cross-cultural diversity in teaching practices. As Chapter 1 explained, the Study builds on relevant OECD conceptual frameworks such as PISA 2012 and TALIS 2018. The conceptualisation is also informed by participating countries' and economies' individual conceptualisations of teaching and a review of the research literature on teaching quality. This chapter describes each of these two sets of activities and then presents the six domains of teaching quality that are used in the Study.

The conceptualisations of teaching quality of participating countries/economies

To understand cross-cultural diversity in teaching practices, national experts from different fields (e.g. pedagogy, survey methods and video observation) in each participating school system were invited to provide five or fewer

- research reviews on quality teaching from their own country/economy (e.g. journal articles, book chapters, reports)
- empirical papers conceptualising quality teaching (if no research review was available)
- pedagogical materials
- reports published by education authorities, research institutes and governmental organisations

and to submit a summary of these documents in English.

In addition to the eight country-economies that participated in the Main Survey, the United States participated in this stage of the project. Each country/economy provided an overview of their own conceptualisation of quality teaching, teaching standards, and research on quality teaching and observation protocols, citing a wide range of national documents. In addition, four of the nine National Study Centres (NSCs) submitted original research papers in English.

The International Consortium carefully reviewed the submissions, combined information from all submitted documents, extracted lists of criteria and indicators of good teaching, and discussed them bilaterally with National Project Managers (NPMs) and National Study Centres (NSCs).

NPMs and national experts were asked to select a maximum of five or fewer elements of student-oriented teaching goals and a maximum of ten or fewer dimensions of teaching quality. In addition, NPMs were also invited for an in-person meeting, held in Washington, D.C. in May 2016. In smaller groups and in a plenary session, country representatives were asked 1.) to discuss each country's/economy's own conceptualisation of teaching quality; 2) to discuss similarities and differences in participating countries' and economies' own conceptualisation of teaching quality; 3) to identify common (or similar) student-oriented teaching goals and dimensions of teaching quality; and 4) to define common aspects of teaching goals and teaching quality across school systems.

As there were variations across participating countries/economies, for example, in country's/economy's national teaching evaluation systems for defining criteria for quality teaching, a cross-national common conceptualisation of quality teaching was identified by:

- collecting information on participating countries' and economies' own conceptualisations of quality teaching, as described above
- identifying similarities and differences in participating countries' and economies' own conceptualisation of quality teaching
- developing an overarching, well-structured set of constructs and sub-constructs of quality teaching across all participating countries and economies (Table 2.1)

- mapping each participating country'/economy's own concepts on this overarching set of constructs (see Annex 2.A for more information).

This combined conceptualisation did not restrict teaching quality to a set of "effective" teaching practices, or to a single paradigm such as "constructivist teaching" (the belief that learning occurs as learners are actively involved in a process of meaning and knowledge construction as opposed to passively receiving information) or "direct teaching" (a teacher-directed method, meaning that the teacher stands in front of a classroom and presents the information).

Based on the careful review of documents and in-person discussions, a rubric encompassed most of the dimensions of quality teaching. The rubric lists a larger number of classroom practices. The classroom practices were classified into seven quality teaching constructs. Consequently, the common conceptualisation of teaching across participating countries/economies contains seven constructs and several sub-constructs of quality teaching (Table 2.1):

- Content coverage aims ensuring correct and coherent treatment of content by aligning lessons and unit goals with curriculum.
- Content-related structure includes the implementation of transparent lesson and unit goals that connects prior and future content by structuring teaching and lessons around well-organised and well-arranged content.
- Cognitive demands describes how teachers encourage cognitive student engagement, and how teachers are preparing tasks and questions that promote deep thinking.
- Practice/proceduralisation covers the opportunities teachers provide for practicing the content in the classroom.
- Adaptiveness includes different practices teachers use for delivering customised resources and learning activities to address the unique needs of each student.
- Social and emotional support describes how teachers support social relatedness between teacher and students as well as among students.
- Classroom management refers to the wide variety of skills and techniques that teachers use to keep students organised, orderly, focused, attentive, on task, and academically productive during a class.

The first two columns of Table 2.1 list all the seven constructs and their corresponding sub-constructs.

Countries/economies were asked to rate the importance of the identified teaching quality constructs during classroom activities. The third column of Table 2.1 shows how participating countries/economies rated these sub-constructs. On average across the eight participating countries/economies, the importance ratings of each sub-constructs were high, between three and four score-points on a 4-point scale. Sub-constructs of content coverage and cognitive demands got the highest average rating, on average across participating countries/economies. "Aligning lesson and unit goals with curriculum"; "connecting prior and future content", "encouraging cognitive student engagement"; and "providing tasks and questions that promote deep thinking" are the four sub-constructs that got an average of four score-points across participating countries/economies. "Withitness" (being aware of all actions in the classroom) as a sub-construct of classroom management got the lowest average rating, around three score-points from all participating countries and economies.

As described earlier in this chapter, teachers may implement classroom practices differently. Some teachers mainly focus on the content, some on students, while others on students' content-specific interactions. As a result, each construct and sub-construct was further classified by the focus of classroom practices (whether the practice has a content or a student focus or rather a student-content focus). The fourth column of Table 2.1 shows the focus(es) of each classroom practice. For example, student focus characterised two sub-constructs of the social-emotional support classroom practice ("supporting

social relationships between and among teacher" and "supporting student experience of autonomy students"); while only content focus characterised one of the sub-constructs of cognitive demand, which is "providing tasks and questions that promote deep thinking". By contrast, all sub-constructs of adaptiveness, such as "monitoring adaptiveness" or "providing feedback" had a content-student focus.

A second activity was carried out in order to gather international research perspectives on teaching quality and how it might be operationalised variably across instruments in the Study. This review of international research is described in the next section.

Table 2.1. Participating countries'/economies' conceptualisation of quality teaching

Construct	Sub-construct	Importance rating	Focus
1. Content coverage	1.1 Ensuring correct and coherent treatment of content	3.71	Content
	1.2 Aligning lesson and unit goals with curriculum	4	Content
2. Content-related structure	2.1 Implementing transparent lesson and unit goals	3.86	Content
	2.2 Connecting prior and future content	4	Content-Student
	2.3 Structuring	3.86	Content-Student
3. Cognitive demand	3.1 Providing tasks and questions that promote deep thinking	4	Content
	3.2 Encouraging cognitive student engagement	4	Content-Student
4. Practice/Proceduralisation	4.1 Providing opportunities for practicing	3.57	Content-Student
5. Adaptiveness	5.1 Understand student characteristics	3.86	Content-Student
	5.2 Monitoring understanding	3.86	Content-Student
	5.3 Adjusting instruction to achievement level	3.86	Content-Student
	5.4 Providing feedback	3.71	Content-Student
	5.5 Addressing student errors	3.71	Content-Student
	5.6 Differentiating	3.43	Content-Student
	5.7 Responding flexibly to the students' contributions	3.43	Content-Student
6. Socio-emotional support	6.1 Supporting social relationships between and among teacher and students	3.43	Student
	6.2 Supporting student experience of autonomy	3.29	Student
	6.3 Using interesting tasks	3.29	Content-Student
7. Classroom management	7.1 Establish and maintain clear standards of student behaviour	3.43	Student
	7.2 Withitness (i.e. being aware of all actions in the classroom)	3.14	Student
	7.3 Avoid waste of time (three aspects: time management, organisation of material and space, smoothness)	3.71	Student

Source: OECD, Global Teaching InSights Database.

Systematic review of the global observation literature

To ensure the Study's observation and artefact tools reflected the current empirical understanding of teaching and how it might be measured through observations and artefacts, the observation code development team (hereafter the observation team) led a three-part global review of: 1) the global observation literature between 1970-2016 in peer-reviewed journals from pre-school to grade 12; 2) expert-nominated protocols and validity evidence; and 3) the primary grades observation literature focused on 1990-2014. The observation team entirely implemented the first and second parts of the review, while the third part built on work by scholars at the University of Twente, carried out the third part.

In Part 1, Educational Testing Service (ETS) and Michigan State University scholars conducted a systematic search around the research question "How are observation protocols used to understand the

relationships between teaching and student outcomes around the globe?". The search plan reflected the observation team's understanding of the types of literature in which observation protocols appear in empirical studies. These range from school effectiveness studies in which a brand-new protocol is used once for that study, to studies of professional development programmes, to validity studies that examine the extent to which an observation protocol has been validated for the purpose that the protocol claims to serve. Thus, Part 1 went beyond the measurement literature on observation protocols.

In Part 2, the observation team also sought out expert recommendations from three groups around the world: 1) National Study Centres (NSCs) in the eight participating countries/economies; 2) experts that have carried out observation studies within and across participating countries/economies; and 3) members of the Study's Technical Advisory Group (TAG). Each group was asked to nominate research about important observation protocols in their or other countries. Any protocols or studies gathered from this part were added to and treated in the same way as studies identified in Part 1.

Finally, for Part 3 of the global review, the observation team reviewed the database of observation protocols and validity evidence conducted by University of Twente scholars (Dobbelaer, 2019[1]). The 18-month systematic review of classroom observation systems worldwide identified articles and protocols that were not already found in the earlier parts of the review. These items were added to the large body of protocols and studies that were already collected.

Boundaries of the literature reviewed

For Part 1, the observation team defined the following set of explicit rules to guide decisions on what to include or exclude from the literature collected.

- Grade level. Each observation protocol must be developed to be applied in the context of primary and secondary education, the associated studies must also take place in these schools.
- Subject matter of the protocol. Each observation protocol must be developed to be used across all subjects (e.g. the protocol developers claim the protocol can be used in any school subject) or specifically for mathematics; protocols specifically developed for science, social studies and English/language arts were excluded.
- Year. Each observation protocol and the associated validity studies must have been published no earlier than 1970 and no later than 2016.
- Language. Each observation protocol and the associated studies were written in English.

Articles nominated by experts (in Part 2) only had to meet the subject matter and language conditions. For Part 3, the University of Twente scholars defined similar boundaries as above with the exceptions that they limited the publication date to after January 1, 1990, included results that were written in Dutch as well as English, and focused on only the primary grades (from age 5-6 to eighth grade).

Sources of the literature considered

Parts 1 and 2 drew from a few major sources: peer-reviewed journals, books, government and non-government websites, reports and dissertations. Part 3 sources exclude government and non-government websites.

Search and identification process – Parts 1 and 2. In the search process, a wide range of different strategies were used. First, through expert consultation, observation instruments were identified that have been reported extensively in academic journals, mostly from the United States, and the media in the last five to seven years. The observation team collected instruments as well as their associated validity studies. Examples of instruments identified through this search strategy include: Classroom Assessment Scoring System (CLASS), Mathematical Quality of Instruction (MQI), the Framework for Teaching (FFT) the Pythagoras observation tool and the International System for Teacher Observation and Feedback (ISTOF)

(Danielson, 2007[2]; Hamre and Pianta, 2007[3]; Hill et al., 2008[4]; Klieme, Pauli and Reusser, 2009[5]; Teddlie et al., 2006[6]).

Second, the observation team searched for instruments used in the U.S. context. Using resources gathered by the Center on Great Teachers and Leaders of American Institutes for Research (AIR), and reviewed the classroom observation instruments compiled in their report "Approaches to evaluating teacher effectiveness: A research synthesis" (Goe, Bell and Little, 2008[7]). The observation team identified instruments that met the search criteria and then collected the instruments and studies documenting each instrument's validity evidence.

Next, the observation team used a snowball strategy to search for instruments and validity studies that were mentioned in Steps 1-2 and seemed to be relevant based on pre-defined explicit search rules.

Another significant part of the search involved a broad systematic search for classroom observation protocols and associated validity evidence. Several steps were taken for this systematic search. First, the following key search terms were identified:

- classroom observation protocols and synonyms (e.g. classroom observation instruments, classroom assessment, observational research)
- quality teaching and synonyms (e.g. teaching effectiveness, instructional quality, effective teaching, teacher assessment)
- key terms on validity evidence (e.g. validity, reliability, outcome; generalisability theory; measurements).

The observation team then identified relevant databases, such as EBSCOhost, ERIC, Google Scholar, PsychINFO and the Michigan State University library system. After a preliminary search and review of results using various combinations of the search terms identified above, the observation team narrowed the scope with the following search terms for the systematic search: "classroom observation protocol" + validity; and "classroom observation instrument" + validity. The observation team searched the databases identified and found more than 2,000 documents; however, by eliminating duplicates and reading abstracts, only 107 documents were included in this stage of the literature review. Search results from this part of the formal search are summarised in Table 2.2.

Table 2.2. Summary of the Study's literature review search results

Total	Number of results
Total search results	2 137
Total without duplicates	1 312
Rejected in preliminary review	1 156
Rejected in further review	49
Total studies included	107

Source: OECD, Global Teaching InSights Database.

In addition, the observation team conducted a manual search through targeted journals, with a focus on international and comparative journals. First, journals that publish international and comparative studies in the field of teaching and learning were identified, and then hand-searched the journals for observation protocols and associated validity studies in non–English-speaking cultures, in case they were missed during the database search.

The University of Twente scholars used similar requirements and approaches in their search, except that they included two Dutch databases and a dissertation database.

Review of part 1 and 2 search results

The observation team members recorded and reviewed the search results from expert suggestions, the AIR review paper and the snowball search. For the systematic database search, one research team member reviewed the results, removed duplicates, hand-sorted the resulting abstracts, applied inclusion and exclusion rules, and categorised results that qualified for further review. The research team lead then reviewed the preliminary results and completed the final sorting. An EndNote library was created to record the search results and track the screening and reviewing process. These papers serve the background literature that undergirds the six domains of teaching quality used in the Study. How this broad body of literature was used to more directly guide the observation and artefact codes is described in Chapter 4 and 5. Chapter 9 describes how the six domains were operationalised in the Teacher and Student Questionnaires.

The final conceptualisation of quality teaching of the Study

The Study's conceptualisation of teaching quality resulted from the integration of the three bodies of knowledge described – country/economy conceptualisations, PISA 2012 and TALIS 2018 analytical frameworks, and the literature review activities. The integration effort involved reading the articles and frameworks, summarising key insights around the constructs, teaching practices, and student outcomes of relevance. At a high level, these multiple views of quality teaching were aligned; however, they regularly emphasised different practices and defined those practices somewhat differently. Further, there were aspects of teaching that were missing from one source or specified in a unique enough manner that they needed to be treated as a different aspect of teaching. In general, these nuances and discrepancies were discussed iteratively with participating countries/economies until a set of constructs that captured teaching in ways that aligned with all three bodies of knowledge was agreed upon.

The six domains of quality teaching measured in the observation codes are: 1) classroom management, 2) social-emotional support, 3) discourse, 4) quality of subject matter, 5) student cognitive engagement, and 6) assessment of and responses to student understanding. Each domain is further operationalised into indicators and components depending on whether and how the valued teaching practices can be seen and evaluated by a rater (Table 2.3). The codes capture behaviours that are observable during lessons and about which raters can make inferences without significant additional information from other sources (e.g. an interview with the teacher or the entire quadratic equations unit plan). The six domains of the Study in greater detail are described in the following sections (for the description of Indicator and component "codes", see Chapter 4 and Annexes A and B). It is worth noting that the observation system used in this technical report and its associated policy report (OECD, 2020[8])is not the same as the observation tool that accompanies the Global Teaching InSights initiative video library.

Box 2.1. Taking the tools of the Study to the classroom at scale

The OECD has developed the Global Teaching InSights platform to provide a resource for teachers, teacher educators and school leaders. The aim is to empower teachers to observe and reflect on teaching and to facilitate a global conversation around classroom pedagogy. The observation tool of the Study has been adapted for the teaching profession's use. It can be found on the platform, as well as some of the resources collected in the Study, including classroom videos and teaching materials.

Table 2.3. Study domains, components and holistic domain ratings, and indicators

Domain	Components	Indicators
Classroom management	Routines Monitoring Disruptions Classroom management (overall)	Time on task Activity structure and frequency Time of lesson (only after last segment)
Social-emotional support	Respect Encouragement and warmth Risk-taking Social-emotional support (overall)	Persistence Requests for public sharing
Discourse	Nature of discourse Questioning Explanations Discourse (overall)	Discussion opportunities
Quality of subject matter	Explicit connections Explicit patterns and generalisations Clarity Quality of subject matter (overall)	Explicit learning goals Accuracy Real-world connections Connecting mathematical topics Mathematical summary Types of representation Organisation of procedural instruction
Student cognitive engagement	Engagement in cognitively demanding subject matter Multiple approaches to/perspectives on reasoning Understanding of subject matter procedures and processes Student cognitive engagement (overall)	Metacognition Repetitive use opportunities Technology for understanding Classroom technology Student technology Software use for learning
Assessment of and responses to student understanding	Eliciting student thinking Teacher feedback Aligning instruction to present student thinking Assessment of and responses to student understanding (overall)	

Source: OECD, Global Teaching InSights Database.

Classroom management

Classroom management concerns the process of ensuring that lessons run smoothly and efficiently to maximise teachers' and students' time to focus on academic and social-emotional learning (van Tartwijk and Hammerness, 2011[9]).

A particularly important feature of effective classroom management involves establishing and executing routines for common managerial tasks that happen regularly in the classroom (e.g. passing out papers, getting into pairs, beginning the lesson and taking attendance). Good classroom routines are efficient and help the class to avoid wasting instructional time as much as possible (Anderson, Evertson and Emmer, 1980[10]; Anderson, L., Ryan and Shapiro, 1989[11]; Muijs and Reynolds, 2000[12]). Effective routines are well organised and carried out smoothly and consistently. They may also support students' time on task, thereby maximising their academic growth (Muijs and Reynolds, 2000[12]).

Classroom management also involves the teacher monitoring what is happening across the group of students and proactively addressing issues before they become disruptions. Monitoring can be done in various ways but often features actions such as the teacher maintaining physical proximity to students,

scanning the whole classroom from time to time, facing students, calling on a range of students, checking on individual student and group progress, and noticing whether students are on task. In efficient classrooms there is a high ratio of time on task to lesson duration (Prater, 1992[13]).

Classrooms disruptions are inevitable, of course. Effective routines and monitoring help reduce the impact of classroom disruptions such as student misbehaviour, external interruptions or failures of technology when they do occur. In a well-managed classroom, teachers quickly and effectively address disruptions, bringing the instructional activities back on track.

Learning takes place in activity structures or what are sometimes referred to as surface features of instruction – whole group, small group, pairs and individual. While the empirical evidence does not support claims about the general efficacy of certain structures, teachers constantly decide which structures to use to achieve learning goals. It is important, therefore, to understand classroom activity structures within and across countries/economies.

Social-emotional support

Group learning of the type students experience in classrooms requires students to grapple with uncertainty and social dynamics. Such processes require social-emotional support (Klieme, Pauli and Reusser, 2009[5]). A positive classroom climate is an essential element to foster a supportive learning environment. This is often characterised by the teacher and students demonstrating respect for one another and regular moments of encouragement and shared warmth in the classroom. In such an environment, teachers and students use respectful language, positive tones of voice and other culturally accepted manners when verbally communicating. Shared warmth such as smiling or laughter is likely to be observed in these classroom interactions.

Another indicator of social-emotional support involves the degree to which students are willing to take risks in the classroom. When students feel safe, they are more willing to ask questions of and seek guidance from the teacher or other students. They are also more likely to volunteer to share an idea, attempt to articulate an opinion about an issue or share their thoughts with the whole class (Pianta and Hamre, 2009[14]; Ryan, Gheen and Midgley, 1998[15]; Ryan and Patrick, 2001[16]). Teachers sometimes encourage this type of social-emotional risk-taking by requesting that students share their thoughts with the classroom.

Learning requires that students be intellectually and sometimes emotionally challenged (Ball and Bass, 2000[17]). Such challenge often manifests behaviourally as student errors, misconceptions or difficulties. It is critical for students to persist through these challenges in order for them to learn (Ball and Bass, 2000[17]; Linnenbrink and Pintrich, 2003[18]). Effective support is demonstrated by teachers and students being patient and encouraging. An acceptance-oriented environment built on trust should make students feel comfortable and secure, encouraging them to take risks when trying to overcome challenges of various types.

Discourse

Classroom discourse – the written and spoken word – is the medium through which teaching and learning takes place. It is important that there are opportunities for discourse, although there is cultural variation in how such discourse appears because communication is a cultural practice (Xu and Clarke, 2019[19]). Students need opportunities to engage in discourse that are clearly focused on a learning objective. It is valuable for students to take a role in such discourse and provide detailed explanations of their thinking so that becomes visible to peers and the teacher (Cazden and Beck, 2003[20]).

Discussion, a form of discourse, has been documented to be important to student learning (Murphy et al., 2009[21]; Nystrand, 2006[22])). Discussions are extended conversations between and among the teacher and students where students do a good deal of the talking. Although teachers may guide the discussion towards a learning goal, discussions are predominantly based on student ideas and characterised by

student-to-student interaction (Franke, Kazemi and Battey, 2007[23]). Discussion opportunities are a potentially important learning opportunity for students (Chapin, O'Connor and Anderson, 2009[24]; Kazemi and Franke, 2004[25]).

One major feature of classroom discourse is questioning. Teachers ask many questions in the course of a single lesson (Nystrand et al., 2003[26]). Questioning that facilitates learning requires students to engage in a range of levels of cognitive reasoning that privileges higher-order reasoning – reasoning that asks students to analyse, synthesise, justify, or conjecture (Henningsen and Stein, 1997[27]). Characteristics of such questioning are an appropriate mixture of varied discourse patterns, including IRE (initiate, respond, evaluate), and students speaking back and forth to one another or one after another without the teacher evaluating each student's response. Supportive questioning places the teacher in a facilitating role rather than directing or controlling the discourse without regard for students' contributions (Williams and Baxter, 1996[28]).

Another essential element of discourse is explanations (Lachner, Weinhuber and Nückles, 2019[29]). Explanations are descriptions of why ideas or processes are the way they are (Nunokawa, 2010[30]). They might be written or spoken. In mathematics classrooms, for example, detailed explanations of mathematical ideas or procedures either by the teacher or students support students' learning of mathematics. Well-developed and detailed explanations that focus on deeper features of the mathematics are evidence of thorough understanding of subject matter (Hill, Rowan and Ball, 2005[31]).

Quality of subject matter

While classroom management and social-emotional support will allow classroom interactions to proceed smoothly – with students being on task, engaged and motivated – another important goal of teaching is to promote student interest in and understanding of the subject matter. Classrooms that revolve around quality subject matter learning are first and foremost characterised by the clarity and accuracy of the ideas, concepts and tasks presented. In subject matter-rich classrooms, the content in which the teacher and students engage is correct as well as clearly represented so that students can focus on understanding the meaning of the concept or task.

Student cognition is affected by the explicitness of the learning goals set forth for each lesson (and the extent to which lesson activities are aligned with the learning goal). Student thinking is supported when the teacher clearly communicates the learning goal to students verbally, in written form, or both. Such explicitness supports students' thinking about what they will learn and where it fits with other topics they have learnt within that content area or how that idea might connect to their personal experiences or life outside of school (Rakoczy et al., 2007[32]).

In the case of mathematics, the types of representations are important markers of these subject matter practices. There is not a straightforward relationship that suggests, for example, that as more types of representations are used, students learn more. Quite the opposite might be true. But understanding what types of representations are being used and how they are being used may lead to new understandings of quality teaching and student learning. In mathematics, for example, multiple representations may be used to support students' understanding (Brenner et al., 1997[33]).

The types and quality of instructional connections can also indicate classrooms that exemplify high levels of subject matter quality. Classrooms are subject matter-rich when students and teachers make explicit connections among subject matter ideas, procedures, perspectives, representations or equations that are clear and appropriate. These connections may be experiential connections, where the content being learnt is connected to or applied to "real-world" contexts, or subject matter connections where the content being learnt is connected to other topics in the same subject matter or topics in other subject matters (Ball, 1988[34]; Henningsen and Stein, 1997[27]; Leinhardt and A. Smith, 1985[35]).

Explicit patterns and generalisations are important as well. The teacher and students in classrooms with high quality subject matter explicitly look for patterns and generalisations in their work together (Ball, 1988[34]). In addition, they generalise from the content students are working on to a foundational concept or definitions underlying the content (Henningsen and Stein, 1997[27]).

Quality of subject matter may also be evident in the organisation of procedures and content, within and across lessons. The extent to which procedural instructions are clear, correct and well-organised has an impact on whether students are able to make sense of the procedures being taught and apply them appropriately (Ball, 1988[34]). In addition, the quality of lessons is characterised by the presence, clarity and depth of frequent content summaries where teacher and students explicitly and clearly review and summarise what has been learnt (Hospel and Galand, 2016[36]; Kane and Cantrell, 2010[37]; Seidel, Rimmele and Prenzel, 2005[38]). Such summaries can provide students and teachers the opportunity to make sense of the lesson's work or consolidate the knowledge and competencies developed.

Student cognitive engagement

As described above, teachers must give students opportunities to engage subject matter practices. But having the opportunity to engage in subject matter practices does not necessarily mean that students actually have engaged in these practices. Sometimes the teacher engages in the practice, but students only watch. Other times, when students struggle, the teacher changes what they have asked the students to reduce the struggle. So in the end students do not fully engage in subject matter practices (Baumert et al., 2010[39]; Hiebert and Grouws, 2007[40]; Klieme, Pauli and Reusser, 2009[5]). Again, specific practices depend on the subject matter, but in mathematics classrooms, subject matter practices include engaging in analyses, and creation or evaluation work that is cognitively rich and requires thoughtfulness (Lipowsky et al., 2009[41]; Mishra and Koehler, 2006[42]; Nunokawa, 2010[30]). The longer and more often students engage in these practices, the more cognitively active they are likely to be.

When students are engaged in cognitively demanding subject matter – in particular, when they work on subject matter procedures and processes – it is important that they use available opportunities to understand why subject matter procedures and processes make sense. For example, students benefit from making sense of individual steps in a mathematical procedure or process; their understanding of the subject matter improves as they attend to the goals and properties of procedures and processes, or attend to why a procedure works or a solution is correct (Ball, 1988[34]; Mishra and Koehler, 2006[42]; Nunokawa, 2010[30]).

Students' cognitive engagement may be enhanced by using multiple approaches to and perspectives on reasoning. For example, in mathematics classrooms, the teacher and students might use two or more procedures or reasoning approaches to solve a problem or type of problem. The depth at which these approaches or perspectives are considered as well as the nature of the similarities and differences across approaches may shape what students learn (Baumert et al., 2013[43]).

Attention to metacognition is another critical factor for students' cognitive engagement. A teacher may model self-reflective thinking for students and ask students to reflect on their own thinking in order to develop deeper understandings of their own learning patterns as well as the content and practices being learnt (Putnam and Borko, 1997[44]; Schoenfeld, 2016[45]).

Learning not only takes place through teacher lecture and modelling, but also through practice opportunities. Practicing may be actions such as writing more than one introductory paragraph for an essay or completing a set of problems with the same underlying theme. Practice opportunities are critical for students to master particular skills through repetition (Ball and Bass, 2000[17]; Ericsson, Krampe and Tesch-Römer, 1993[46]).

In a world that is increasingly driven by technology, it is important to understand how it is used in a given discipline and its relation to students' conceptual understanding (Fishman and Dede, 2016[47]).

Some technology is used simply to communicate more effectively or efficiently (e.g. using an overhead projector that allows a teacher to highlight key content with coloured markers). Other technology, such as computer programmes or software, can be used to plot students' experimental data and quickly calculate equations that describe that data. All of which can provide students with more robust and data-based opportunities to learn. The type of technology used in the classroom may support students' cognitive engagement.

Assessment of and responses to student understanding

To support students' understanding, teachers elicit students' thinking, interpret it and adapt their instruction in response (Black and Wiliam, 2009[48]). Eliciting student thinking is the first step in this group of practices. In addition, teachers use appropriate questions, prompts or tasks so that students have opportunities to answer but also can explain their reasoning. A teacher is successful in eliciting student thinking when students' oral and written responses make evident their level of understanding about the process, practices and ideas pertinent to the subject matter.

Once student thinking is elicited, they receive teacher feedback on their thinking. There may be back-and-forth exchanges, or feedback loops, between the teacher and students that focus on why the students' understandings are correct or incorrect, and why the ideas and procedures are the way they are. Throughout these exchanges, the teacher uses student responses and actions as a basis for further questioning or other instructional practice (Dignath, Buettner and Langfeldt, 2008[49]; Hattie and Timperley, 2007[50]; Kyriakides and Creemers, 2008[51]; Muijs and Reynolds, 2010[52]; Scheerens, 2016[53]). Teachers' feedback may span multiple students' ideas and contributions, leading over time to an appropriate and responsive treatment of the ideas being learnt.

In addition to providing feedback to students, teachers use students' responses productively by aligning instruction to current student understanding. Teachers may align instruction in a variety of ways. For example, they might review homework problems and notice patterns in students' errors that shape the teachers' subsequent explanations or teachers may highlight to students the varied understandings in the classroom. There are diverse ways that teachers use students' contributions to support student understanding (Borko and Livingston, 1989[54]). For example, if students state an observation or ask a question, the teacher may use those responses to help improve students' understanding. The teacher may draw attention to the contribution, ask a question in response to a student's question, have students provide the next step in the procedure or acknowledge patterns in student contributions. Sometimes, teachers provide hints and cues when students struggle mathematically or make errors (Hayes, 2003[55]; Taylor, 2007[56]).

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Annex 2.A. Differences in the conceptualisations of quality teaching

Annex Table 2.A.1. The link between countries'/economies' own and the common conceptualisations of quality teaching

Combined constructs and sub-constructs		Country/economy concepts
1. Content coverage	1.1 Ensuring correct and coherent treatment of content	The teaching strategies are coherent (B-M-V [Chile]) The teacher provides correct and coherent content (Shanghai [China]) The teacher designs situations that allows a student to move himself from everyday language to mathematical language in order to communicate the results of an activity, argue and defend their ideas or use it to solve new problem situations (Mexico) The class contents are treated with conceptual accuracy (B-M-V [Chile})
	1.2 Aligning lesson and unit goals with curriculum	Organise the objectives and contents in coherence with the education plan (B-M-V [Chile]) Attain curriculum standards and expected outcomes (Mexico)
2. Content-related structure	2.1 Implementing transparent lesson and unit goals	Communicate learning objectives in a clear and precise way (B-M-V [Chile]) Know what students need to learn (Mexico) Clarify the views and thinking to be developed (K-S-T [Japan]) Plan coherent series of lessons that have clear objectives (England [United Kingdom])
	2.2 Connecting prior and future content	Relation between current and future content (B-M-V [Chile]) Focus the students on the substantial connections between new and relevant or prior knowledge (Shanghai [China]) Form connections with the body of knowledge already possessed by the student (K-S-T [Japan]
	2.3 Structuring	Use of structured teaching (England [United Kingdom]) Provide well-organised and well-arranged content (Shanghai [China]) Highlight key points/ Make knowledge points clear (Shanghai [China]) Lesson structure (K-S-T [Japan]) Plan and organise their lessons well (Germany*)
3. Cognitive demand	3.1 Providing tasks and questions that promote deep thinking	Integration of contents of different disciplines (B-M-V [Chile]) Depth of content knowledge imparted (B-M-V [Chile]) Inclusion of problem solving (B-M-V [Chile]) Consideration of different representations of mathematical content (B-M-V [Chile]) Contextualised problem solving (B-M-V [Chile]) Provide problem-based situations (Colombia) Challenging tasks (Germany*) Teach Mathematics as an ensemble (Madrid [Spain]) Use contextualised problem-solving (Mexico) Open ended approach (K-S-T [Japan]) Moderately difficult questions (K-S-T [Japan]) Interesting challenges (K-S-T [Japan]) Multiple solutions, method of applying oneself to the problem (K-S-T [Japan]) Consider a constructivist mathematic knowledge proposal (B-M-V [Chile])

Combined constructs and sub-constructs		Country/economy concepts
	3.2 Encouraging cognitive student engagement	Promote the development of different strategies to solve problems (Colombia) Promotes the development of independent thought (B-M-V [Chile]) Let students explain their thinking (Colombia) Activating prior knowledge (Germany*) Content-related discourse and participation practices (Germany*) Work with troubleshooting (Madrid [Spain]) Provide opportunities to make use of the language (Madrid [Spain]) Support reasoning (Madrid [Spain]) invites them to reflect, to find different ways to solve problems and formulate arguments that validate the results (Mexico) Promote independent thinking (Mexico) Making majority of students engaged in classroom learning activities (Shanghai [China]) Enhance quality of ideas through sharing (K-S-T [Japan]) Extend thinking by reflecting on what was previously expressed (K-S-T [Japan]) Have students present their explanations to one another through making connections with mathematical formulae and diagrams (K-S-T [Japan]) Encourage the students to have questions and have subjective learning (K-S-T [Japan]) Elicit questions (K-S-T [Japan]) Constantly on the alert for alternative solutions (K-S-T [Japan]) Constructively criticise the inadequacies of other people's ideas (K-S-T [Japan]) Guide students to structure their knowledge (Shanghai [China]) The teaching strategies are challenging (B-M-V [Chile]) Promote the development of different strategies to solve problems. (Colombia) Simulate a micro scientific society (Colombia) Allow different learning paths (Colombia) Work with troubleshooting (Madrid [Spain]) Provide students with and accept a diversity of approaches (Madrid [Spain])
4. Practice/Proceduralisation	4.1 Providing opportunities for practising	Planned reappearance and correction of error- prone and easily-confused problems (Shanghai [China]) Promote mathematic activity, "doing math" (Colombia) Reconsider thinking process and learn by analogy (Shanghai [China])
5. Adaptiveness	Organises the objectives and contents in coherence with the singularities of the students (B-M-V [Chile]) Understanding the nature and role of teaching in the learning process, in order to judge which teaching techniques are appropriate for the situation (England [United Kingdom]) Detailed instruction tailored to the individual (K-S-T [Japan])	
	5.1 Understand student characteristics	Know the characteristics, knowledge and experiences of their students (B-M-V [Chile]) The understanding teachers have about student's specific capabilities (B-M-V [Chile]) Understand the strategies students use to learn (B-M-V [Chile]) Teachers judge the individual learning prerequisites of their students (Germany*) Knowledge of individual students (England (United Kingdom)) Knowledge of the students (Mexico) Consider a child's prior knowledge (Mexico) Know how their students learn (Mexico)
	5.2 Monitoring understanding	Formative assessment (Colombia) Formative assessment (Mexico) Evaluates and monitors the understanding and learning of the contents by the students (B-M-V [Chile]) Monitoring students' understanding (England [United Kingdom])

Combined constructs and sub-constructs		Country/economy concepts
		Adopt the right remedial instruction through diagnosis (Shanghai [China])
	5.3 Adjusting instruction to achievement level	The class contents are understandable for the students (B-M-V [Chile]) Ensuring all students are challenged and stretched (England [United Kingdom]) Fit student's cognition and thinking levels (Shanghai [China])
	5.4 Providing feedback	Providing incisive feedback about what pupils can do to improve their knowledge, understanding, skills, and learning strategies (England [United Kingdom]) The use and development of feedback techniques and error correction B-M-V [Chile]) Positive and constructive teacher feedback (Germany*) Support students to reflect on their learning (Colombia) Teacher acts as a guide leading students to reflect (Mexico) Students are capable of questioning what they don't understand (K-S-T [Japan]) Acknowledgment and encouraging from teachers B-M-V [Chile]) Positive and constructive teacher feedback (Germany*) Individual learner support (Germany*) Attributing students' success to their efforts, rewarding effort rather than their innate ability (England [United Kingdom]) Having high expectations of all students (that they can master the material and show a positive attitude to learning (England [United Kingdom]) Manifests high expectations about the learning and development of all students (B-M-V [Chile])
	5.5 Addressing student errors	The use and development of error correction (B-M-V [Chile]) The disposition of strategies that students use to overcome difficulties and learn from mistakes (B-M-V [Chile]) A positive approach to student errors and misconceptions (Germany*) Error analysis (Madrid [Spain]) Guide students to become aware of their own errors (K-S-T [Japan]) Teachers give individual feedback (Germany*)
	5.6 Differentiating	The handling of student's diversity (B-M-V [Chile]) Take into account students' heterogeneity (Colombia) Teachers use differentiation in their instruction (Germany*) Promoting equality of opportunity and valuing diversity (England [United Kingdom]) Use differentiated practices (Mexico)
	5.7 Responding flexibly to the students' contributions	Use flexible teaching strategies (Mexico) Adjust teaching process promptly according to real classroom conditions (Shanghai [China])
6. Socio-emotional support	6.1 Supporting social relationships between and among teacher and students	Establishes an acceptance oriented environment, with equity, trust, solidarity and respect as goals (B-M-V [Chile]) Social interactions, e.g. co-construction and collaborative learning (Mexico) Supportive teacher-student relationships (Germany*) Caring teacher behaviour (Germany*) Gentle and humorous atmosphere (K-S-T [Japan]) Communicate one's own thinking and feelings (K-S-T [Japan]) Classroom cooperative work environments (Colombia) Team work (B-M-V [Chile]) Support constructive and social interaction processes (Colombia) Establishing an atmosphere of mutual respect in which all students can communicate and contribute (England [United Kingdom])

Combined constructs and sub-constructs		Country/economy concepts
	6.2 Supporting student experience of autonomy	The creation of a space that encourages the spontaneous participation of students (B-M-V [Chile]) The active participation of students inside and outside the classroom (B-M-V [Chile]) Encourage students to active participation (Madrid [Spain])
	6.3 Using interesting tasks	The teacher designs problematic situations that produce the interest of students (Mexico) Relationship between content and real life (B-M-V [Chile]) Provide connections to daily life (Colombia) Encourage students to pose and resolve problems related to their background (Madrid [Spain]) Build a numerical and operational sense by exploring real objects (Madrid [Spain]) Show students usefulness of knowledge (Colombia)
7. Classroom management	7.1 Establish and maintain clear standards of student behaviour	Establishes and keeps consistent house rules in the classroom (B-M-V [Chile]) Establish clear rules and procedures (Germany*) Setting clear rules for dealing with classroom disorder and enforcing them consistently (England [United Kingdom]) Manage minor disciplinary problems and disruptions (Germany*) Stop inappropriate behaviour (Germany*) Setting clear rules for dealing with classroom disorder and enforcing them consistently (England [United Kingdom])
	7.2 Withitness (i.e. being aware of all actions in the classroom)	Keep a whole-group focus (Germany*) Keep track of students' work (Germany*)
	7.3 Avoid waste of time (three aspects: time management, organisation of material and space, smoothness)	Optimise the time allotted to teaching (B-M-V [Chile]) Making efficient use of lesson time (England [United Kingdom]) Effective strategies for managing students' behaviour to ensure they are "on task" (England [United Kingdom]) Organise the spaces, materials, time management to get the expected learning (Mexico) Established an organised work environment, utilising the space and resources to facilitate learning (B-M-V [Chile]) Manage transitions between lesson segments smoothly (Germany*)

Notes: Bíobio, Metropolitana and Valparaíso (Chile) (hereafter "B-M-V [Chile]").
Kumagaya, Shizuoka and Toda (Japan) (hereafter "K-S-T [Japan]").
*Germany refers to a convenience sample of volunteer schools.
Source: OECD, Global Teaching InSights Database.