Anna-Katharina Praetorius
Charalambos Y. Charalambous *Editors*

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Current Status and Open Issues

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To David K. Cohen,
For all his work on understanding teaching
And for inspiring so many scholars through this work

Foreword

Editors: David K. Cohen had been originally scheduled to contribute a chapter to this volume. His death in September 2020 prevented his contribution. David was a prolific scholar of teaching, learning, and social policy; at the heart of his work was a focus on what happens within classrooms to produce students' learning opportunities and learning outcomes. In the following, Magdalene Lampert and Heather Hill consider what David might have thought about theories of teaching.

Heather: Had I ever approached David and told him I wanted to develop a theory of teaching, David would have raised an eyebrow, let out his raucous chuckle, and said "Heather, why on *earth* would you want to do such a thing?"

And that is exactly the question David would have asked about the endeavor that follows in this volume. Why *would* you want to develop a theory of teaching?

My own brief inventory of theories of teaching within contemporary social science suggests that authors have had different answers to this question over the years. Some theories seem simply to want to *describe* teaching, and in particular, aspects of teaching that the authors see as relevant to a particular way of thinking about the world. Many of these theories are generated through simple yet shrewd observation. Dan Lortie and Susan Moore Johnson, for instance, present sociologically-based analyses of teachers' motivations and social relationships, and describe the nature of teachers' work. Gloria Ladson Billings and Richard Milner have used critical race theory and examples of practice to examine and outline theories of teaching. Magdalene Lampert, Jean Lave, and others created theories of teaching based on views from disciplinary communities and communities of practice.

Other theories want to *prescribe* teaching explicitly, sometimes based on a theory of student learning (e.g., progressivism; constructivism), other times based on a view of desirable student outcomes (e.g., twenty-first-century learning), and still other times based on evidence about what boosts student achievement, typically on standardized tests (e.g., process-product studies, which compare observed teaching moves to student performance gains).

Still other theories embed these descriptions and prescriptions in a wider context, examining the resources—both those internal to teachers themselves and those that exist in the environment—that predict what teaching might look like. David himself, for instance, co-authored a classic piece describing resources for instruction, including teachers' own knowledge, incentives for learners, and the norms and instructional guidance present in environments (Cohen et al., 2003).

In many of these cases, theories of teaching prescribe "what" teachers should do. They detail instructional moves teachers should make, the types of decision-making teachers should deploy, or the ways in which teachers must meet students' need. Many of these theories also describe how good teaching can be encouraged, for instance by changing teachers' beliefs about content or students, or by boosting their content knowledge.

Magdalene: As an experienced teacher and teacher educator, I dove into the scholarship of teaching in the 1980s. I found it frustrating. Most of what I read considered only one facet of teaching or another. I knew that in the classroom, I needed to take everything into consideration all of the time. The solutions to teaching problems that were proposed by researchers seemed naïve—I wondered if they had ever faced a large group of children or adolescents in the confined space and limited time that schools offered for instruction. I challenged the scholarly perspective, asking "How do teachers manage to teach?" (Lampert, 1985). I answered the question by analyzing instances of teaching from my own classroom and others I had observed. Writing in the first person in a distinguished academic journal, I described the work of facing the problems of practice and examined what I did from several scholarly points of view. I created a theory of teaching as face-to-face dilemma management to contrast with the notion that the essential problems of teaching could be solved outside the classroom by researchers, or by teachers "thinking" before and after the fact about their interactions with students.

Over the next ten years, I decided to study teaching deliberately, spending an hour a day teaching mathematics in a fifth-grade multi-ethnic, multi-racial, untracked public school class that drew students from a variety of socio-economic backgrounds. I studied a particular kind of teaching, one that was of interest to researchers and reformers at the time, namely teaching by engaging all students in the class in learning by doing authentic intellectual work. The challenge that I set for myself was to inform those who argued that this is what should be happening in schools about what it would take to bring it about every day, all year, at the classroom level. From the inside of this experiment, I created the theory that teaching occurs across a set of simultaneously managed long-term relationships: between teacher and students—as individuals, subgroups, a whole class; between teacher and the content being taught—in the moment, in the lesson, in the unit, and across the year; and between teacher and contexts—personal, social, racial, ethnic, political, economic. I posited that it was not only these teacherly relationships, but also the relationships that students had with one another, with the content and with the context, that would produce learning (Lampert, 2001).

During this period of work, my husband David Cohen provided an immediate audience. When I came home from school every day, he challenged me not only to recount what had happened in my classroom, but to make sense of it in relation to what I was reading and what else was going on in the educational reform landscape. He was my primary inspiration for talking and writing about what I was trying to do with students in ways that people in the worlds of research and reform—including he, himself—could make use of. We developed a shared understanding of why I was doing what I was doing.

Heather: This knitting together of experiences from the classroom, the academy, and the world of educational reform was highly unusual, and likely shaped David's own thinking about theories of teaching, not just in the sense of the specifics of what he and Magdalene co-constructed over the dinner table, but also in his understanding of the purpose behind efforts to theorize the domain of teaching.

Returning to the theory-of-teaching literature that existed at the time Magdalene and David were talking and writing, my brief review suggests that many authors do not answer David's imagined question, explaining why we need a theory of teaching in general, and their own theory in particular. Most pieces decline to name exactly why they are being produced. Reading between the lines, many seem written as an exercise in organization and definition (and rather vigorous exercise at that; it is hard to craft a theory of teaching) rather than with a particular purpose in mind. On occasion, authors point vaguely to their goal—to more precisely define teaching, or to guide future empirical research. And often, authors conclude their theory of teaching by referencing the need to test the theory, to continue theory development, or to integrate one theory with another. Some imply a connection to practice, but do not specify much beyond that general implication. In this sense, David's imagined question to me—why invent a theory of teaching—is dead on.

Further, none of the theories I observed during my brief inventory get to the heart of *why* teaching looks the way it does. Most aspire to list a set of desirable traits in classrooms and teachers, a smaller number aspire to inspire teachers and policymakers to move toward that goal, but ultimately, most cannot *explain* why we have a system of teaching that, at least in the United States, resists so many efforts to move it toward more ambitious instruction. Missing this fundamental analysis, theories of teaching cannot get far.

As it turns out, David did develop a theory of teaching exactly around this point, although one that bears little resemblance to other theories. That theory is contained in his 2011 book, *Teaching and Its Predicaments*. I'll let Magdalene explain how that book came about.

Magdalene: When I first met David Cohen in 1978, he had just started to work on his theory of teaching, published in detail more than 30 years later. He carried around a typed manuscript that he (affectionately) called "Al"—short for albatross. And when he could, he also carried with him a small Olivetti portable typewriter in case a new idea came to him. His inescapable burden was to figure out why, with all of the policy interventions that had been initiated in the United States, teaching was so impervious to change.

At the time, he was also editing the page proofs for *Usable Knowledge*, which he coauthored with Charles Lindblom (Lindblom & Cohen, 1979), a distinguished political scientist known for creating the theory of "incrementalism." Lindblom characterized political efforts to bring about change as necessarily involving "muddling through." This was a radical alternative to the view that policymaking should follow the model of rational problem-solving using knowledge produced by research. David was also beginning to interview teachers for the *Study of High Schools* with Arthur Powell and Ted Sizer. He was rethinking the findings of the *Follow Through* experiment with planned variation in instructional design with colleagues Mary Kennedy and Richard Elmore at the Huron Institute.[1]

With a class at the Harvard Graduate School of Education, David and his colleague Sara Lawrence Lightfoot read the American academic literature on teaching: John Dewey's chapters in *Democracy and Education*, William James' *Talks to Teachers*, Willard Waller's *Sociology of Teaching*, and the more "contemporary" works of Israel Scheffler (*Reason and Teaching*), Michael Dunkin and Bruce Biddle (*The Study of Teaching*), Dan Lortie (*Schoolteacher: A Sociological Study*), and Phil Jackson (*Life in Classrooms*). I was a student in that class, and it was a veritable cornucopia of frustration from my point of view as a practitioner. As "theories of teaching" what I found in the latter two of these books made the most sense to me. These authors actually hung out in schools, spoke with teachers, and tried to make sense of their experience.

Why did David Cohen need a theory of teaching? In the 1970s and 1980s, he was in the midst of inventing the field of educational policy research, where his focus was often on trying to explain the inequalities in educational outcomes.[2] As he dug deeper and deeper into those explanations, he found his way into classrooms.[3] The question that drove David's thinking as a policy researcher was: why is teaching so hard to govern/change? What drove his choice of topics to write about came to be questions like: What did policymakers need to understand about *teaching in classrooms* if reforms were to succeed? What matters if you want to build an infrastructure around the interaction between teachers and students that will result in students' learning? And he came to realize that in building a theory of teaching, it mattered to specify, with regards to students: Learning what? Learning how?

Between the 1980s and the 2011 publication of *Predicaments*, David's scholarly work probed deeper and deeper into schools and classrooms. Beginning with "the California Study" (Cohen & Hill, 2001), to the study of systemic instructional improvement in high poverty schools (Cohen et al., 2013), to the examination of the

[1] *Follow Through* was the largest and most expensive experimental project in education funded by the US federal government that has ever been conducted.

[2] See, for example: Cohen, D.K. (1974). Segregation, desegregation, and Brown: A twenty-year retrospective. Society, 12, (1); Cohen, D.K. and Garet, M. (1975). Reforming educational policy with applied research. Harvard Educational Review, 45, (1); Cohen, D.K. (1982). Policy and organization: The impact of state and federal educational policy on school governance. Harvard Educational Review, Special Issue; Cohen, D.K. (1984). The American common school: A divided vision. Education and Urban Society 16, 253-261.

[3] See, for example, Cohen, D.K., Donald Peurach, Joshua Glazer, Simona Goldin and Karen Gates, (2013) Improvement By Design: Improving Education In High-Poverty Schools. Chicago, University of Chicago Press; Cohen, D.K. (1990). A revolution in one classroom: The case of Mrs. Oublier. In S. Fuhrman (Ed.), Educational Evaluation and Policy Analysis, 12, (3), AERA, San Francisco: Jossey-Bass Inc, Fall 1990.

implementation of the Common Core with his dear colleague Susan Moffitt (Moffitt et al., forthcoming), David collected evidence to answer these questions. David sometimes crouched in classrooms, sometimes talked to teachers, sometimes gathered evidence on teaching from other countries, sometimes read about other human improvement professions, and even sometimes returned to his roots as a historian, seeking to understand how classrooms in different eras influenced and were influenced by American political development and racial oppression. The result of these years of steeping and stewing—remember, by now Al had been in the works for three decades—was a theory of teaching suited to what he had both seen himself, created with me, and integrated with his wider sensibility about how humans operate.

Heather: The theory presented in *Teaching and Its Predicaments* is qualitatively different than most theories of teaching. To start, David's theory had a strong reason for being—to answer the question, "Why is good teaching such hard work?" Instead of prescribing instruction, it analyzes the conditions that bring about different kinds of instruction. Because of this, David's theory explains the variability that we observe in teaching elegantly and efficiently.

This theory begins by viewing teaching in the vein of other human improvement professions, including therapy and social work. Practitioners working in this sector can only achieve success if their clients do—symptoms abate, learning occurs—and importantly, those successes require cooperation and effort from the client. Further, practitioners must induce clients toward these gains absent a well-established recipe for success; there is no one way to help a child learn or to help lift a patient's depression. And both practitioners and clients faced mixed incentives for undertaking this work. The more ambitious the change the pair wishes to see, the harder the practitioner and client must work to achieve success and the greater the likelihood of failure. Less ambitious goals may be more reasonably achieved, but at the cost of real improvement and real learning. The result is a conundrum in which it seems difficult to imagine successful ambitious teaching, and in fact, David ends this analysis with a phrase that delights and befuddles my students every year: "human improvement professions are impossible" (p. 15).

David then extends this analysis to examine the act of teaching in particular. Teaching varies along several dimensions: on whether the teacher pays close attention to the learner's thinking, and then designs instruction responsive to it, or designs instruction without regard to learner thinking; the kind of knowledge that is extended to learners, whether inert and "finished" or constructed through the practice of inquiry; and the organization of discourse in the classroom, from structures that invite students to participate actively and exchange knowledge to those that leave the teacher as the sole dispenser of knowledge. Permuting these dimensions gives rise to distinct profiles of teaching, profiles that in some regards appear supported by recent evidence (Agathangelou et al., accepted).

The rest of David's book grows from these insights, outlining the resources—external and internal—teachers need to teach well. And in fact, to the original point of this forward, this is why David developed his theory of teaching at all. If teaching occurs without close attention to student thinking, extends “finished” knowledge to students, and allows little student input to their learning experience, what resources must we apply (and how) to ensure that teaching changes?

Thus David’s book, despite not ever being an entrant into the “theories of teaching” sweepstakes, holds a simple and elegant theory of teaching, and as Magdalene says above, does it for a purpose: with the thought that we can design resources that better enable good teaching if we take account of the work that is involved in teaching well. And David’s theory broadens our view of teaching beyond the immediacy of classrooms and schools. Good teaching derives in part from the social contract. Better teaching is possible when communities agree about the goals of teaching, take joint responsibility for results, and where teachers and students buy in to working together. I will let the reader imagine (or read David’s work) for some the policy downflow from this argument.

Ultimately, David’s book was both engaging and useful, speaking to practitioners like Magdalene and like my students, who (once they accustom themselves to David’s prose) are elated to find that his characterization of teaching captures well their own experiences, dilemmas, and worries. In explaining variability in teaching, David also avoided two of the perils associated with setting out more prescriptive theory. One is that any prescriptive theory ultimately rests on a subjective judgment or two—it depends, for instance, on whether you see value in standardized tests, whether you believe students learn by constructing knowledge in their own head, or even whether theory should be based on an understanding of student learning or observations of what teachers actually do in the classroom. Thus a prescriptive teaching theory is only a good theory if you agree with the assumptions within it. Another peril of prescriptive theory is that words on paper rarely have the power to change teaching itself; instead it takes careful thought—thought of the type David was engaged—in order to develop them into a living system intended to change practice.

Of course, David would be the first to point out that not every theory will take shape like his did. Theory development is governed by the reason for having that theory—whether implicitly or explicitly. But a better understanding of how teaching theory is shaped by those purposes would, we imagine, have been within David’s sights.

We don’t know what David would have said in his chapter, or how that work would have contributed to our understanding of classrooms and educators. Charalambos Charalambous kindly reminded us when writing this foreword that David was interested in “a question about the possible influence—on teaching and thus theories of teaching—of the organizations in which teaching occurs, and a question about the purposes of teaching.” This suggests that David would have continued the work he began in *Predicaments*, thinking about the broad social parameters that affect teaching, and what might be done given those constraints. But both Magdalene and I know well that where David started was not always where he ended, especially when it came to writing. For him, it was always a journey, one on which he generously invited so many others, and one from which we have learned so much.

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Preface

Everyone from students who have spent years in classrooms to academics whose life work is the study of teaching thinks that they understand what teaching is. But do we *really* understand teaching? In some ways we do. We can all remember the extraordinary lessons or the boring ones and can give examples of when teachers did something that made everything clear, or clear as mud. But teaching is such a complex phenomenon that we can get drawn into peculiarities if we do not have a system that allows us to view those individual experiences in relation to each other. This is where theories come into play because they are the basis for systematically understanding complex scientific phenomena. What are the important theories that enable the better understanding of teaching? During the course of our collaboration over the past years, we came to the realization that there is no clear answer to this question. This led us to consider how we could initiate a process that might eventually lead to an answer. But let us start from the beginning.

During a symposium in 2016, we were using different observation frameworks to analyze the same lesson and realized how important and useful it was to compare different approaches to studying teaching quality. We therefore continued this work, by inviting 11 groups of scholars to analyze the same three videotaped lessons using their own frameworks [published as special issue 50(3) in *ZDM Mathematics Education*]. One of the issues we struggled with when summarizing the different approaches was identifying their theoretical underpinnings. Different conceptualizations were often referred to without any explicit reference to a particular theory. At other times, theories were identified, but they mostly pertained to learning rather than teaching. We wondered why this was the case, which led us to pose two further questions: Are there any theories of teaching? If theories of teaching exist, what do they look like?

Attempting to resolve these issues, we resorted to the literature. We quickly realized that different terms—theories, conceptions, frameworks, and models—were often used interchangeably. As we continued reading, we came across contradictory statements. Some authors discussed the plethora of existing theories of teaching while others argued that there was no theory of teaching. Clearly, it was time for an overview of existing work on theorizing teaching.

Convinced that this was not something that the two of us could tackle on our own, we asked renowned scholars to contribute a chapter discussing their ideas on theorizing teaching. In order to be able to better compare the contributions, we asked all of them to respond to the same set of questions when writing their chapters. We also initiated an exchange between them, asking them to comment on their colleagues' ideas, to ensure that the book was not simply a collection of disparate ideas. To ensure that there would be at least some common ground necessary for productive exchanges, we purposefully limited the range of perspectives, inviting scholars researching teaching quality mainly in Western countries; we enriched this selection with other perspectives to safeguard against a rather monolithic consideration of the aforementioned questions.

In the introductory chapter of this book, we summarize what work has been undertaken to date and conclude with five questions reflecting open issues on theorizing teaching that the invited scholars were asked to consider in the eight chapters that follow. In addressing the five questions, James Hiebert and James Stigler emphasize the importance of collaborating with practitioners to theorize and improve teaching. Svenja Vieluf and Eckhard Klieme work at the intersection of educational effectiveness research and practice theory, whereas Jaap Scheerens as well as Leonidas Kyriakides and colleagues take an approach based primarily on educational effectiveness. Drawing on their work in mathematics education, Alan Schoenfeld as well as Patricio Herbst and Daniel Chazan adopt a more content-specific lens. Gert Biesta approaches the questions through an educational-theory lens whereas Jinfa Cai and colleagues add an Asian perspective on issues surrounding theorizing teaching. The tenth chapter, co-authored by all of the contributors, presents the results of a Delphi study designed to highlight areas of convergence in the ideas presented by the authors. The final chapter discusses the key issues raised by the Delphi study, highlights open issues, and proposes ways in which theorizing teaching can move forward in the years to come. We are indebted to all of the contributors, not only for their willingness to participate in this exercise, but also for their forbearance in light of the many constraints and demands we imposed on them in our attempts to ensure that they would "talk" to each other.

We dedicate this book to David K. Cohen, a scholar renowned for this deep thinking on issues surrounding the work of teaching and his remarkable contribution to research on teaching. David was the first to accept our invitation to contribute a chapter to this book. Unfortunately, as the project was unfolding, David passed away. Heather C. Hill and Magdalene Lampert, two scholars who collaborated closely with David, graciously accepted our invitation to write a foreword to the book where they reflect on how David might have approached the issue of theorizing teaching. We are indebted to them for their insights.

While writing this book we received support and comments from many colleagues, whom we would like to acknowledge and thank: Svenja Vieluf for thoughtful comments on the introductory chapter; Eckhard Klieme and Gary Fenstermacher for constructive and thought-provoking feedback on the concluding chapter; all the contributors for their comments and suggestions along the way; and Jana Helbling, Fabian Hug, Michelle Huber, and Ayse Yenal Vance for their support with editing and formatting.

When you read this book, either from beginning to end or by focusing on selected chapters, you will realize, much as we did during its production, that addressing the issues raised by theorizing teaching is a very complex task, but that the process of grappling with the subject is, of itself, rewarding. We hope that you agree with us that it is a task worth pursuing!

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Chapter 1
Where Are We on Theorizing Teaching? A Literature Overview

Anna-Katharina Praetorius and Charalambos Y. Charalambous

Abstract This chapter begins by outlining the key ideas and problems of the theorizing of teaching as discussed in selected English-language literature published over the past six decades. The focus is on the value of theories of teaching and the ways theories of teaching and related terms have been defined. After creating a synthesis of the various attributes which researchers have suggested can be used for assessing the quality of theories of teaching, we discuss the process and difficulties of generating theories, and present a summary of theories of teaching found in the literature. The second part of this chapter clarifies the aims of this book, describes the sampling criteria for the selection of contributors, provides an overview of the structure of the book, and lists the questions that the contributors were asked to address.

Keywords Theorizing teaching · Theory attributes · Theory definition · Theory generation · Theories of teaching

1 Introduction

Because teaching serves a vital function for societies, conveying knowledge and competences as well as cultural norms and values, researchers have been trying to identify the characteristics of high quality teaching for decades. Over this same period, there have been ongoing academic debates about whether there are theories of teaching and the extent to which the research into teaching quality needs to be approached from a theoretical perspective. Hyman in 1971 argued that although

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there is no “complete agreement about what a theory of teaching is or should be, educational writers all agree there is a need for it” (cited after Newsome, 1992). Some academics (e.g., Klauer, 1985; Openshaw & Clarke, 1970; Philips, 2003) assert that there are numerous theories of teaching, but there are others who have suggested that there have been few advances in the development of a theory of teaching (e.g., Berliner, 2009; Hill & Schrum, 2002; Rosenshine, 2009) and claimed theory of teaching is “a stepchild” of theoretical work on teaching and learning (Gage, 2009, p. 1).

This divergence of opinion might be because, although there have been multiple attempts to conceptualize teaching (e.g., Berliner, 2005; Fenstermacher & Richardson, 2005; Gage, 2009; Lampert, 2001), the field does not seem to have reached a consensus on what constitutes a theory of teaching and what such a theory should encompass. This is also evident in the way the distinction between the term *theory* and other related terms remains unclear (Praetorius et al., 2020), with theory being used interchangeably with more narrowly defined terms such as conception, framework, and model.

For this book we asked distinguished academics working on the theorizing of teaching to reflect on the existence, definition, and attributes of theories of teaching. The resulting chapters deliver an up-to-date overview of theorizing teaching which is important for future work on teaching and teaching quality. In order to provide a context for the rest of the book, this chapter defines terms and provides a general literature review of the subject.

We first describe how we selected the publications on which this chapter is based before discussing the importance of theories of teaching and exploring the various definitions of a theory and other related terms. We then synthesize a list of the attributes which researchers have suggested determine the quality of theories of teaching and discuss the process and inherent difficulties of generating such theories. Next, we review theories of teaching in the literature after which we discuss what we hoped to achieve by producing this book, outline the sampling criteria that informed the selection of authors, provide an overview of the structure of the book, and conclude by presenting the questions that guided the writing of the chapters to follow.

2 Identifying Publications on Theories of Teaching

To ensure that our review of theories of teaching was based on a sufficiently broad sample of the literature we used a three-pronged approach.

First, we screened the titles of all of the chapters in the five existing editions of the *Handbook of research on teaching* (1963, 1973, 1986, 2001, 2016) on the grounds that each edition would reveal the important issues in teaching at the time of publication. We sampled all chapters that included the term theory or a related term (conception, framework, model, paradigm) in the title. We also reviewed the titles of the rest of the chapters and, based on a consensual decision, included those we thought might be relevant (e.g., chapters synthesizing existing research on teaching were included as they referred to theory-related issues). We selected 15 chapters in total: one from 1963, two from 1973, four from 1986, six from 2001, and two from 2016.

Second, we conducted a literature search in the fall of 2019. As we were mostly interested in internationally recognized work where theories of teaching are the focus of the publication, we (a) limited our search to publications in which the terms listed below appear in the title, (b) used the education-focused Scopus database in Social Sciences and Psychology, and (c) focused on English-language publications. We used the search terms "theory of teaching" OR "theories of teaching" OR "teaching theory" OR "teaching theories". We initially identified 92 publications. Except for two publications that were not available on the literature databases to which we had access, 44 publications were excluded because a title-abstract screening revealed that their focus was on issues that differed from the ones in which we were interested (e.g., practical or teaching theories of teachers). Another 33 publications were excluded after an initial full-text screening because the term theory was either not defined or not explained in them. As a result, 13 publications were identified as suitable for a further full-text screening.

Third, we used the snowballing technique (i.e., reference list checking) to complement our literature search. Based on that, we added two books relevant to our topic (Schoenfeld, 2011; Gage, 2009) and one journal publication (Bikner-Ahsbahs & Prediger, 2010). In total, 31 publications have been used as the basis for this review (these are marked with an asterisk in the reference list).

We acknowledge that our selection criteria, especially the requirement that theories be explicitly mentioned, resulted in the exclusion of some work that directly focuses on unpacking teaching practice (e.g., Cohen, 2011; Lampert, 2001). For example, despite it providing a detailed account of the work of teaching, Lampert's *Teaching Problems and the Problems of Teaching* was not included because Lampert refers to her work as an elaborated model of teaching practice (see Chap. 14). We felt the restriction was necessary in order to have a manageable number of publications to process for this chapter.

3 The Importance of Theories of Teaching

Theories play a central role in all scientific research. Justifying their importance for research, Colquitt and Zapata-Phelan (2007) summarized scholarly opinion on the issue and concluded that theories allow for the *understanding* and *prediction of* outcomes of interest, *describe* and *explain* a process or sequence of events, *raise consciousness* about a specific set of concepts and *prevent* scholars from "being dazzled by the complexity of the empirical world by providing a linguistic tool for organizing it" (p. 1281). Hill and Smith (2005) expand on this by pointing out that a "good theory helps identify what factors should be studied and how and why they are related" (p. 2).

Scholars have argued that theories are important (Biddle & Anderson, 1986; Floden, 2001) because they are both the means for and an end goal of research on teaching (Bikner-Ahsbahs & Prediger, 2010; Gage, 1963a). They help us to better understand teaching (i.e., the goal) and serve as tools that facilitate research (i.e., the means). It has also been said that theories make the assumptions we have about teaching explicit, define the goals of our research, help us to discover, select, sharpen, and modify situations, research objectives and variables and any related research questions, bring order to variables, support selection methods, and synthesize, explain, and interpret the resulting data; theories of teaching may also enable researchers to predict future outcomes and contribute to making research more cumulative (Biddle & Anderson, 1986; Bikner-Ahsbahs & Prediger, 2010; Snow, 1973). Biddle and Anderson (1986) further suggested that a theory be a prerequisite for developing any policy recommendations.

Several publications discuss the relation between theories of teaching and theories of learning. Gage (1963a, b) noted the relative scarcity of theories of teaching compared to theories of learning and summarized the view of some scholars as follows:

> [I]f we have an adequate theory of learning, then the teacher must of necessity act upon that theory, without employing any separate theory of teaching. The teacher, if [s]he is to engender learning, must of necessity do what the theory of learning stipulates as necessary for learning to occur. Teaching must thus be a kind of 'mirror image' of learning. (p. 133)

Gage (1963a, b) himself did not support this line of thinking and instead used the analogy of a farmer to make a case for having theories of both teaching and learning: Farmers need to not only know how plants grow (theories of learning) but also how to farm (theories of teaching). Snow (1973) argued that the principle of parsimony dictated that theories of teaching need to build on theories of learning, although they have to be more complex (for a similar argument, see also Openshaw & Clarke, 1970). Fenstermacher (1986) reasoned that teaching and learning are not causally related since teaching can exist without learning.

It is thus clear that researchers in education agree on the importance of having theories in general and that many also recognize the particular value of having theories of teaching. Earlier editions of the *Handbook of research on teaching* (1960s to 1980s) discussed the need for theories of teaching more often than later ones, but the reason for the reduced emphasis in more recent editions is not clear. Do education researchers now feel that there is a consensus on the importance of theories on teaching and the degree to which such theories exist? This question will be explored in this book.

4 Theory: Definition and Related Concepts

Although theories play a pivotal role in scientific research, there is no single definition of what comprises a theory. In the field of teaching, Snow (1973) remarked that there "appear to be almost as many definitions of theory as there are people concerned with theory" (p. 78). Of the 31 publications reviewed for this chapter, only seven included explicit definitions of the term theory. These definitions are outlined in Table 1.1.

Table 1.1 Definitions of theories in sources reviewed

Biddle & Anderson (1986)	"By scientific theory we mean the system of concepts and propositions that is used to represent, think about, and predict observable events. Within a mature science that theory is also explanatory and formalized. It does not represent ultimate "truth," however; indeed, it will be superseded by other theories presently. Instead, it represents the best explanation we have, at present, for those events we have so far observed." (p. 241)
Bikner-Ahsbahs & Prediger (2010)	"'[T]heories' are constructions in a state of flux. They are more or less consistent systems of concepts and relationships, based on assumptions and norms. They consist of a core, of empirical components, and their application area. The core includes basic foundations, assumptions and norms which are taken for granted. The empirical components comprise additional concepts and relationships with paradigmatic examples; it determines the empirical content and usefulness through applicability." (p. 488) They also distinguished between two different understandings of theory, a static and a dynamic one. The static perspective focuses on "theory as a human construction to present, organize and systematize a set of results about a piece of the real world, which then becomes a tool to be used" (p. 485) whereas the dynamic one understands "theory as a tool in use rooted in some kind of philosophical background which has to be developed in a suitable way in order to answer a specific question about an object" (p. 485), thus emphasizing that theories are always under development
Gage (1963a, b)	"[W]e use the term *theory* in a modest sense to refer to any systematic ordering of ideas about phenomena of a field of inquiry." (p. 102) "Theories of teaching would make explicit how teachers behave, why they behave as they do, and with what effects." (p. 133)
Openshaw & Clarke (1970)	"A theory must define and delimit and make statements of relationship among variables." (p. 411) "Teaching theory must state relationships among the sets of variables involved so that (a) teacher behaviors that will achieve curricular objectives are specified, (b) teacher behaviors that will fail to achieve curricular objectives are specified, (c) teacher behaviors that will achieve other (unwanted) behaviors are specified." (p. 408) They also refer to Kerlinger's definition of theory (1964, p. 11): "A theory is a set of interrelated constructs (concepts), definitions and propositions which presents a systematic view of phenomena by specifying relations among variables, with the purpose of explaining and predicting phenomena" Moreover they use Smith's definition of theory of teaching: "A theory of teaching will consist of: (a) a statement of variables comprising teacher behaviour, (b) a formulation of the possible relations among these variables, and (c) hypotheses about the relations between the variables comprising teaching behaviour and the variables descriptive of the psychological and social conditions within which the teaching behaviour occurs."
Schoenfeld (2011)	"A framework tells you what to look at and what its impact might be. A theory tells you how things fit together. It says how and why things work the way they do, and it allows for explanations and even predictions of behaviour." (p. 4)
Snow (1973)	"A theory is a symbolic construction designed to bring generalizable facts (or laws) into systematic connection. It consists of a) a set of units (facts, concepts, variables) and b) a system of relationships among the units. These are defined and interpreted in statements that are understandable to others and make predictions about empirical events." (p. 78)
Sztajn et al. (2012)	The authors are following Schoenfeld's (Schoenfeld 2011) definition: "Theory brings the pieces together into an explanatory framework that allows for justifications and predictions." (p. 152)

The definitions all refer to a set of units (variously termed ideas, facts, concepts, variables, constructs, definitions, and propositions) and a system of how they are related. Some also explain that theories are based on assumptions and norms and that they can either be more stable or more dynamic. A few of the definitions include not only the components of the theories, but also the functions of those components such as that they can be used to describe, explain, and predict certain events, and that they should allow for the making of generalizations.

A survey of the handbook chapters and journal articles revealed that other terms are sometimes used interchangeably with theory. *Model* is one such often used equivalent. According to Snow (1973), theory and model "may be regarded as synonymous when used to label theoretical constructions expressed in formal postulational style" (p. 81). Oser and Baeriswyl (2001) characterize teaching models as "showpieces in educational theory" (p. 1039), while others evaluate models using criteria such as "theoretical beauty" (Nuthall & Snook, 1973, p. 48), and Shulman (1986) calls a model by Dunkin and Biddle a "theoretical matrix". Framework and conception are also used in this way in other publications we reviewed. For example, Sztajn et al. (2012), describe their theory as a theoretical framework (see also Klauer, 1985) and Ericson and Ellett (1987) use conception and theory as equivalent in several places.

Attempting to bring some clarity to the boundaries between these terms, we resorted to definitions provided by the Oxford English Dictionary (see Table 1.2).

We have ordered the terms hierarchically in the table, from simplest to most complex. We start with *conception* which has the fewest requirements in terms of structure and connections between ideas; it simply refers to an idea or view of something. We then move to *framework*, which unlike conception, implies a structure in which ideas are organized. In addition to having a structure, we define *model* as also including relations between ideas, which are key to supporting predictions. Similar to *model*, *theory* also includes the structures and relations among ideas, but the latter term is broader, since theories represent a system of ideas and underlying principles; models, by contrast, provide a simplified description of the ideas of interest and their interrelations. The term *theory* therefore has more presuppositions than the other terms. Thus, we can say that frameworks can evolve into models by including relations among constructs of interest; similarly, models can mature into theories (Leplin, 1980) by fulfilling certain criteria reflecting general underlying principles (see also Praetorius et al., 2020).

Table 1.2 Definitions of theory and related terms according to the Oxford English Dictionary

Term	Definition
Conception	An abstract idea, a concept The way in which something is perceived or regarded
Framework	A basic structure underlying a system, concept, or text
Model	A simplified description […] of a system or process, to assist […] predictions
Theory	A supposition or a system of ideas intended to explain something, especially one based on general principles independent of the thing to be explained

Applying this to research on teaching quality, one could argue that a compilation of aspects of teaching represents a conception of teaching quality. If these aspects are organized into categories (often called dimensions or domains, cf. Praetorius & Charalambous, 2018), then they can be considered to form a framework. Linking these categories to specific student learning activities and outcomes results in a model. If this model also fulfils a set of criteria (e.g., being based on logical, theoretically related and internally consistent statements that are empirically testable, while also sketching the boundaries of the applicability of these statements; see more in Praetorius et al., 2020), it can be considered a theory.

In summary, the sources we have reviewed provide no generally agreed definition of the term theory for the field of teaching. The existing definitions do have one area of overlap, however, in that they all refer to the systematic organization of different concepts. It is also evident that it is difficult to distinguish the term theory from other similar terms such as conception, framework, and model. Dictionary definitions of these terms (e.g., from the Oxford English Dictionary) can help, but it is unclear whether the boundaries between the definitions of the terms are sufficiently obvious or if scholars in the field of research on teaching would agree to make such distinctions.

5 Attributes of a Theory of Teaching

Although the definitions provided above also include attributes of theories, some authors in addition explicitly discuss specific attributes that can be used to evaluate the quality of a theory. Table 1.3 presents three lists of such attributes identified in our literature search. These lists were published between 1968 and 1980 and include between 10 and 14 attributes. Six of them are mentioned in all three lists, so it can be assumed that their importance is generally agreed. These attributes state that theories should consist of: (a) clearly defined terms and a set of postulates, (b) explicit boundaries, (c) internally consistent statements, while also being (d) consistent with empirical data, (e) capable of generating hypotheses, and (f) testable. Four attributes are shared by two of the three lists and might therefore be assumed to be at least partly accepted by the research community. According to these attributes, theories should (g) have predictive value, (h) be parsimonious, (i) include quantitative relations and (j) include qualitative relations.

There does not seem to be much consensus on the inclusion of some of the attributes as they were each only mentioned in one of the three lists: Theories need (k) to generalize beyond data as well as require (l) vigilance; to avoid (m) unnecessary symbolization, (n) unnecessary formalization, (o) oversimplification; to include (p) theoretically related statements, (q) a hierarchical or systematic order of statements, (r) higher level constructs integrate lower level constructs; and contain or clearly imply (s) prescriptive statements.

Not only can these attributes be very useful for evaluating the quality of a theory, but they can also be used when generating a theory. We need to consider, however,

Table 1.3 Lists of attributes of theories of teaching

Openshaw & Clarke (1970)	Snow (1973)	Kane & Marsh (1980)
A statement of instructional theory should include a set of postulates and definition of terms involved in these postulates	The statement of a theory should make explicit its postulates (axioms and theorems) and the definitions of terms involved in these postulates	Logical statements (axioms, corollaries, postulates) Clearly defined statements
The statement of an instructional theory or subtheory should make explicit the boundaries of its concern and the limitations under which it is proposed	The statement of a theory should make explicit the boundaries of its concern and the limitations under which it is proposed	The boundaries or limitations of concern of the theory should be stated, including such limitations as theories of learning and development subscribed to, philosophies adhered to, characteristics of the students and organizations deemed suitable. The most general theory will have as few such limitations as possible
A theoretical construction must have internal consistency – a logical set of relationships	A theory should have internal consistency as a logical system	Internally consistent statements
An instructional theory should be congruent with empirical data	A theory should be consistent with existing empirical data	The statements should have demonstrable empirical support However, at the present time it may be necessary to include as yet untested hypotheses to meet the completeness criteria
An instructional theory must be capable of generating hypotheses	A theory should be capable of generating specific hypotheses and predictions	Capable of being easily and clearly restated in the form of hypotheses
An instructional theory must be verifiable An instructional theory must be stated in such a way that it is possible to collect data to disprove it	A theory should be testable	Testability Hypotheses about which evidence can be collected to either verify or refute them
An instructional theory must not only explain past events but must also be capable of predicting future events		Statements should have predictive value in similar situations
At the present time, instructional theories may be expected to represent qualitative synthesis		Qualitatively related statements

(continued)

Table 1.3 (continued)

	A theory should be parsimonious	These statements should be as few as possible to cover all of the theories and findings relevant to the area specified
	A theory should be quantifiable	If possible, these statements should be quantitatively related
An instructional theory must contain generalizations which go beyond the data		
	Unnecessary symbolization should be avoided	
	Unnecessary formalization should be avoided	
	Oversimplification should be avoided	
	Theorizing by means of models requires vigilance	
		Theoretically related statements
		Hierarchical or systematic order of the statements
		The higher level constructs integrate the constructs below
		To be of practical use, a theory of instruction should contain or clearly imply a series of prescriptive statements, specifying how best to obtain given ends, if they are desired. Areas to be covered include strategies, sequencing, materials, reinforcements, motivation

whether these attributes could be more broadly accepted, given that they are based on a particular understanding of science (see Praetorius et al., 2020). It would also be useful to consider whether the attributes found on all three lists resemble those highlighted by scholars working on teaching nowadays.

6 The Process of and Difficulties in Generating Theories of Teaching

Interestingly, researchers often emphasize that the theory they are writing about is not yet fully developed, characterizing their work as being a step “toward a theory of teaching” (e.g., Durka, 1979; Gage 1963a, b; Langer & Applebee, 1986; Shuell, 1993; Stone, 2013 Sztajn et al., 2012; Zimmerman & Kleefeld, 1977). At the same time, the issues and challenges posed by the development of theories of teaching are not much discussed in the literature on teaching. The most detailed discussion we are aware of can be found in Snow (1973). Snow stated that metaphors (i.e., "basic heuristics for theoretical speculation in science", p. 81) and models (i.e., "projection of a possible system of relationships among phenomena, realized in verbal, material, graphic or symbolic terms", p. 81) are precursors to theory building, and that metaphors can be developed into models by codifying them into symbolic or representational form. Snow also highlighted the pivotal role played by metatheories in theory development (i.e., "a theory concerned with the development, investigation or description of theory itself", p. 79, "a kind of syntax or grammatical structure within which a particular theory can be developed and stated", p. 80).

Snow (1973) went on to describe the processes involved in developing theories. These are:

(a) Analyzing (i.e., defining the units to be used)
(b) Translating (i.e., adapting theories from one domain to serve another domain)
(c) Schematizing (i.e., using figures/representations to denote ideas/relations)
(d) Miniaturizing (i.e., working on a portion of the domain instead of trying to capture the entire domain)
(e) Taxonomizing (e.g., through taxonomies of learning outcomes; taxonomies of types of teaching activities; components of the learning process; and families of learning theories)

He further argued that miniaturizing could be used as the starting point for developing more general theories but noted that approaches such as miniaturizing have been infrequently used in the past. In a similar vein, he also mentioned the possibility of starting with existing theories of learning and adding propositions for describing and prescribing teaching, leading to what he called minimum theories (for such approaches, see Sect. 7). Snow went on to argue for the importance of explicitly taking into account different levels of theories, ordered alphabetically from the most (A) to the least developed (F). According to his suggestion, D(escriptive)-, E(lementisms)-, and F(ormative hypotheses)-Theories mainly consist of summarizing empirical relations; B(roken axiomatic)- and C(onceptual)-Theories focus on a back and forth between theoretical considerations and empirical data, whereas A(xiomatic)-Theories are the most formal and logically structured theories and include a research agenda to test the hypotheses based on theoretical ideas. According to Snow, A-Theories do not exist in Education and Psychology, therefore B-Theories are the highest level that might be achieved in the near future, including, for example, theories that have been proven to be insufficient but still useful.

Biddle and Anderson (1986) also discussed the process of developing theories of teaching, focusing on the close dependency between theories and events. Whereas Snow (1973) pointed to different processes involved in generating theories, Biddle and Anderson (1986) placed more emphasis on the fundamental building blocks of theories and how these get transformed in the process of generating theories. They suggested that the starting point for developing theories are concrete events. Based on the formal observations of these events, theories are developed, involving the creation of (a) elements, (b) postulates, (c) conceptual definitions, (d) empirical findings, and (e) empirical hypotheses (defined as “new, derived statements about relations among conceptual definitions” (p. 241). These theories are then applied to new events, through experimentation involving prediction and agreed-upon methods (operations). Theories might then be revised on the basis of these new observations.

Some publications describe the challenges posed by developing and applying theories. Biddle and Anderson (1986), for example, noted that theories of teaching need to be highly complex:

> Teaching consists of a set of observable practices that have causes and effects that can be measured. Complexity is generated because these practices, causes, and effects are multi-faceted, contextually bound, and difficult to conceptualize and study effectively. To gain understanding of these phenomena is the central purpose of research on teaching, but it is unreasonable to believe that our understanding will often be expressed as simple, universally applicable propositions. Instead, if teaching is complex, then our theories concerning it must be complex also. (p. 244–245)

In light of Sect. 4, this accords with the attribute of “avoiding oversimplification” (Snow, 1973), but also implies that the attribute of parsimony, suggested by Snow (1973) and Kane and Marsh (1980), may not be easily applicable.

Bikner-Ashbahs and Prediger (2010) identified two ways in which theories can develop. Empirically grounded theories “develop in a spiral process of empirical analysis and theory construction” (p. 500) and prescriptive theories develop by “argumentative connections to other theory elements and by a successive process of making explicit the philosophical base” (p. 501). Within each system, aspects of theories can also develop in different directions: explicitness (i.e., implicit suppositions and the underlying philosophical basis becoming more explicit in mature theories), empirical scope (i.e., developing from local and contextualized theories to formal theories), stability (i.e., increasing the stability of theories by increasing its applications), and connectivity (i.e., linking theories).

In conclusion, our review of the selected literature from the past six decades reveals that, while there have been some suggestions for how best to develop theories of teaching, not much effort has been expended on actually generating theories. The necessary complexity of any theory of teaching as well as how research can be cumulative across multiple theories is perhaps the biggest of the many challenges faced by researchers.

7 The (Non-)Existence of Theories of Teaching

7.1 Theory References in the Handbook Chapters

In some of the handbook chapters we reviewed it was argued that theories of teaching had not been the focus of research at the time they were written – it was even stated that such theories did not exist. Gage (1963a, b), for example, mentioned that theories of teaching had rarely been discussed until then and concluded that such a theory “almost may be said not even to exist thus far” (p. 133). Nuthall and Snook

(1973) concluded that “the guiding force of much of the research on teaching has not been the gradual refinement of seminal models and larger theoretical structures” (p. 48), while Snow (1973) did not mention theories directly but did highlight the existence of models. Years later, Floden (2001) bluntly, and rather pessimistically, commented: “A theory of teaching is a worthy goal; it is unlikely to be attained in the near future” (p. 14).

In other handbook chapters, there was an underlying assumption that theories existed without much evidence for them presented. For instance, Fenstermacher (1986) mentioned the existence of normative theories of teaching, without listing any concrete examples and referring only to an overview in a handbook chapter by Greene (1986). Fenstermacher (1986) defined normative theories of teaching as employing “philosophical inquiry and wisdom to stipulate what is in the educative interest of the learner and how, in general, teachers might act to insure the learner’s education” (p. 46).

Biddle and Anderson (1986) identified two different types of theories. According to them, some theories use common language explanations for events (type 1): “theory at this level provides us with a tentative ‘understanding’ for why things work the way they do and implies actions that we might take if we are to achieve specific effects”. They refer to Good’s (1982) thoughts about why a certain treatment program was effective (e.g., emphasizing the meaning of mathematical concepts) as an example of this type of theory. According to Biddle and Anderson, few theories of teaching are formally stated with propositions and definitions for the terms used (type 2). They used Nuthall (n.d.) as an example, in which he stated reasons why students should learn during question and answer cycles in the classroom (e.g., “All pupils in a class respond covertly to each question which a teacher asks during class discussion, unless the question fails to motivate the covert response process”, p. 13).

Oser and Baeriswyl (2001) referred to the Elaboration Theory formulated by Reigeluth and Stein (1983) as an example of a theory of teaching. This is a prescriptive theory from the area of instructional design. According to Oser and Baeriswyl, it focuses on the description of methods of instruction. It includes seven methods (Reigeluth & Stein, 1983, p. 345): (a) a simple-to-complex sequence (for the main structure of the course), (b) learning-prerequisite sequences (within individual lessons of the course), (c) summarizers, (d) synthesizers, (e) analogies, (f) cognitive-strategy activators, and (g) learner-control formats. For each of the methods, the expected result is described [e.g., for (a) the formation of more stable cognitive structures, causing better long-term retention and transfer] along with related hypotheses [e.g., for (a) the sequence is based on epitomizing instead of summarizing to make learning more meaningful and less rote]. Oser and Baeriswyl further argued that a theory of teaching cannot be equated with a theory of learning, but that some approaches such as Aebli’s didactical model aim to bring both together.

Unfortunately, there appears to be no consensus on whether theories of teaching exist. Some of the authors of the handbook chapters doubted the existence of genuine theories of teaching. Those who did write about them, listed as theories ideas which could be described as dynamic compared to the static understanding of theory; yet, these ideas mostly do not accord with the attributes for theories listed in Sect. 4.

7.2 *Theory References in Journal Articles*

Some of the journal articles reviewed contained references to a theory, but did not go into much detail. Sztajn et al. (2012), for example, essentially presented their learning trajectory based instruction theory by referring to the components it included (e.g., task demand, specialized content knowledge, and monitor), but did not give any consideration to the way the components fit into a structure.

Only two papers included detailed discussions of theories of teaching. The first is by Klauer (1985). He stressed that an "all-encompassing theory of teaching can be conceived only as a hierarchy of interrelated theories" (p. 5). Presenting an initial hierarchy (and mentioning that further work is needed for a complete understanding of the system), he distinguished six higher-order subtheories based on a 2 × 3 matrix, referring to the type of study (descriptive, prescriptive, and normative) and the type of question to be answered (what to teach, how to teach) (see Fig. 1.1).

Klauer then provided a detailed description of one of these subtheories (i.e., prescriptive, how to teach), based on information processing models. He identified six teaching functions ("should functions") that are necessary and sufficient for learning to occur. These are (a) motivation, (b) information, (c) information processing, (d) storing and retrieving, (e) transfer of information, and (f) monitoring and directing. He turned his idea into a teaching algorithm (see Fig. 1.2). His approach, coming up with teaching functions, was based on analyzing (a) the learning objectives, (b) the student processes necessary for achieving these objectives, and (c) the processes associated with different aspects of teaching that align teaching and learning. Klauer's theory is therefore another example of the close relation between theories of learning and theories of teaching and how the former can inform the latter.

		Type of Study			
		Descriptive	**Prescriptive**	**Normative**	
Type of Question	**What?**	**A** Objectives/ subject matter in classrooms	**B** Curriculum	**C** Ultimate ends	Theory of teaching objectives
	How?	**D** Teacher-student interactions	**E** Teaching methods	**F** Professional ethical standards	Theory of teaching methods
		Educational psychology (Teaching research)	Educational technology or science of teaching design	Philosophy of education	

Fig. 1.1 Higher-order subtheories of teaching as categorized by Klauer (1985, p. 7). Reprinted with permission

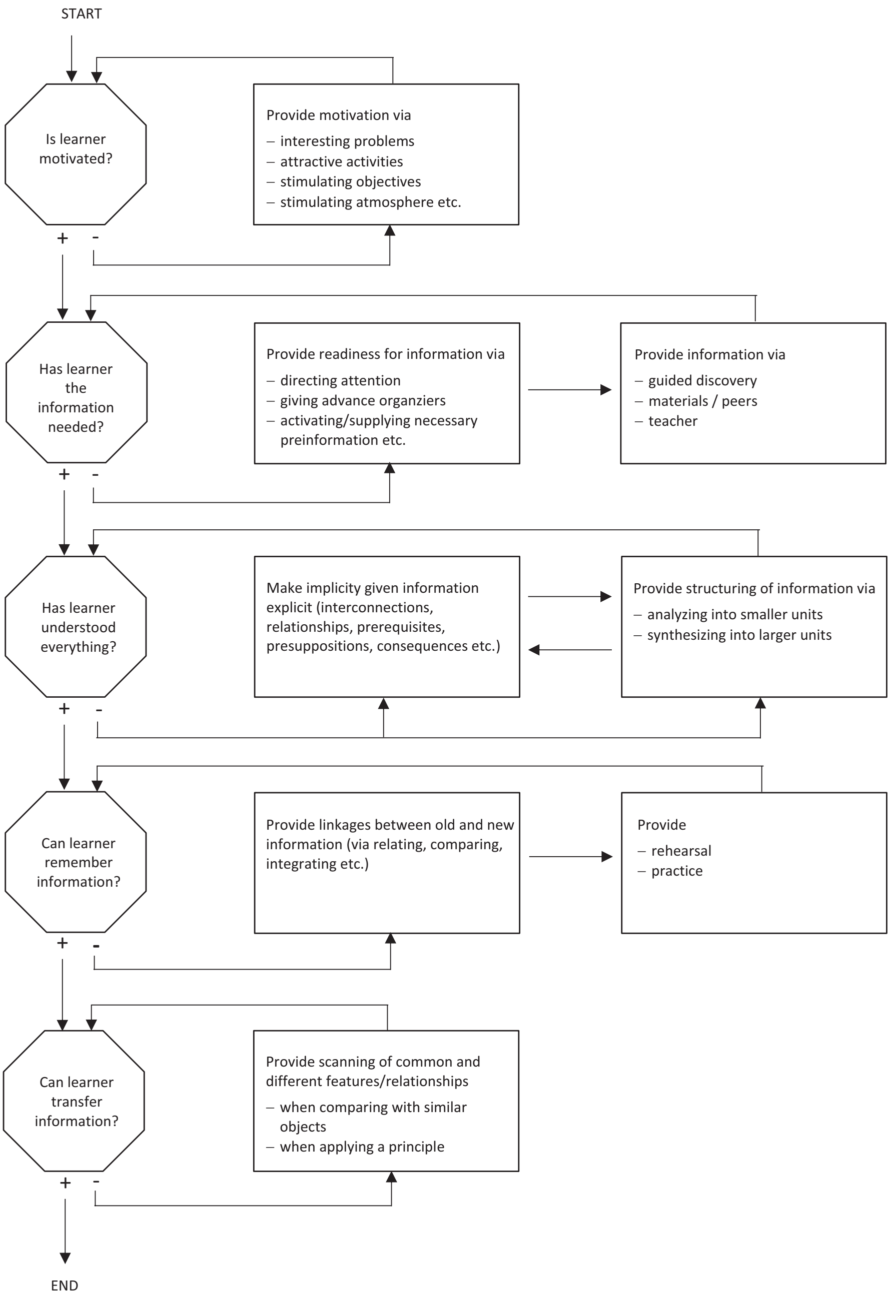

Fig. 1.2 Teaching algorithm proposed by Klauer (1985, p. 12). Reprinted with permission

Openshaw's and Clarke's (1970) paper is the second example of complex thinking about theories of teaching. The authors stated that having a learning theory is a necessary but not sufficient condition for developing a teaching theory and that theories of teaching can only be normative (see also Table 1.1). They distinguished three levels of teaching actions. Prescriptive statements were presented for each level (see examples below), which then had descriptive corollaries (what happens when) that enabled the generation of predictions about teaching (p. 409):

– Level 1: Teaching activities that set the stage for learning and are thus necessary conditions for teaching (e.g., develop teacher-student interpersonal relationships conducive to student learning)
– Level 2: Teaching activities that are at the core of learning and therefore are necessary and sufficient conditions for teaching (e.g., employ strategies that produce minimal interference with other objectives and that are appropriate to (a) the characteristics of the learner, (b) how students learn, and (c) the specific curricular objectives)
– Level 3: Teaching activities that appraise the process and the product and are described as necessary for the efficiency of teaching (e.g., appraise student progress toward curricular objectives with a view to reteaching, revising teaching strategies, revising curricular objectives, or a combination of these)

Like Klauer (1985), Openshaw and Clarke (1970) developed their theory around student learning. They specified, among others, the following relations among the different levels: (a) Level 1 outcomes are the basis for Level 2, (b) feedback from Level 3 supports the efficiency of Levels 1 and 2, and (c) efficiency is also increased if more Level 1 outcomes are indirectly realized through Level 2 activities.

We can conclude that although some authors claimed that no theories of teaching existed, others proposed them. The theories of teaching proposed varied considerably in their focus and sophistication as well as in the degree to and the manner in which their approaches were justified. Some of them had a static understanding of theories, others a dynamic one. Authors described their theories as descriptive, prescriptive, or normative. A few publications considered the relation between theories of teaching and learning. Others expanded these ideas, stating that theories of teaching needed to be more complex than theories of learning since learning must be a part of any theory of teaching (Gage 1963a, b; Snow, 1973). Some authors, however, argued that teaching cannot necessarily be seen as the cause of learning since students are responsible for their own learning (Biesta & Stengel, 2016).

Most of the selected literature on theories was written by scholars in the fields of educational science, educational psychology, philosophy of education, and research on teaching within disciplines. The literature is very broadly formulated and does not focus on specific subjects or student populations. Recently, however, there is an increased interest in how different student populations respond to teaching (e.g., Kennedy, 2010) and researchers are more systematically paying attention to differences in what counts as high-quality teaching in different subjects (e.g., Fogo, 2014; Kyriakides et al., 2018; Praetorius et al., 2020).

7.3 Dealing with the Existing Diversity

The theorizing of teaching is a very diverse subject. Not only do academics not agree on whether theories of teaching exist, but when they do believe that there are theories, they identify a variety of theories and assign different definitions and attributes to those theories, all with varying degrees of explicitness and sophistication.

The diversity need not be problematic. Bikner-Ahsbahs and Prediger (2010) state that one should consider "the diversity of theoretical approaches as a resource for grasping complexity that is scientifically necessary" (p. 489) while emphasizing that accepting "that the diversity of theories is a resource for scientific progress does not mean accepting the co-existence of isolated, arbitrary theoretical approaches which ignore others" (p. 489). This can lead to outsiders perceiving the research community as incoherent. It can also increase the likelihood of miscommunication, result in no integration of empirical results, and a consequent lack of scientific progress in the community. The authors therefore highlight that "[p]lurality can only become fruitful, when different approaches and traditions *come into interaction*" (p. 490), establishing a "culture of constructive debate", including the discussion of theory development, specific theories and their strengths and weaknesses, and metatheoretical and methodological issues. They identify different degrees of theory integration (see Fig. 1.3) with the aim of discussing the extent to which theories can be integrated to allow for better communication and understanding, better alignment of research results, and enhancing the coherence within a community, limiting the exponential inflation of the number of theories, and creating a more comprehensive network of theories to improve teaching and learning.

Bikner-Ahsbahs and Prediger (2010) consider *understanding the theories of others* and *making your own theory understandable* the fundamental steps in any inter-theory communication. The authors identify *contrasting* and *comparing* as the strategies most often used to find connections between theories. Contrasting is mainly about extracting big, distinctive differences between theories while comparing is about general similarities and differences. *Coordinating* and *combining* focuses on a deeper insight into empirical phenomena. Combining is possible with any selection of theories, even if the theories being combined have conflicting basic assumptions, but coordinating only works with theories which are highly compatible. *Synthesizing* and *integrating locally* is about working to form theories into one larger theory. Synthesizing means the connection of equally stable theories into a new theory. Integrating locally is applied if one of the theories is more complex and only selected aspects of another theory are included.

Unifying globally has as its goal creating one overarching theory. The extent to which this may be possible has been discussed in teaching research. Openshaw and Clarke (1970) argued that a single theory of teaching was unlikely to be developed since teaching encompasses several processes. Gage (1963a, b) identified two types of theories of teaching, those focusing on why teachers behave the way that they do and those aiming to elucidate how teacher behavior actually leads to student learning. Shulman (1986) also argued that a single theory of teaching is impossible as

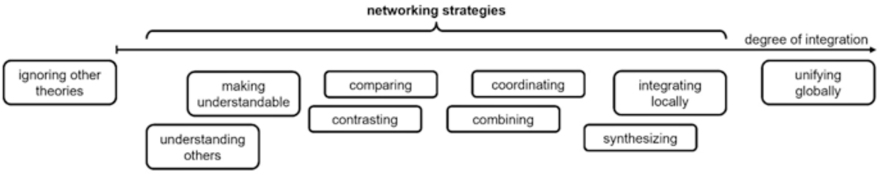

Fig. 1.3 Networking strategies for theoretical approaches proposed by Bikner-Ashbahs and Prediger (2010, p. 492). Reprinted with permission

there is no "real world" of teaching, because different models put the same people into different roles and are oriented for different purposes. Consequently, he argued that a "plurality of theories must not be regarded as a preliminary stage of knowledge which will at some time in the future be replaced by the One True Theory" (p. 14). In a similar vein, Nuthall and Snook (1973) questioned whether one of the ultimate goals of conducting research, being cumulative, is possible at all across multiple models (or theories) since different models address different aspects of teaching and are often based on different assumptions. This resonates well with the statement by Bikner-Ashbahs and Prediger (2010) that a research community should aim to integrate different theories "*as far as possible, but not further*" (p. 503), implying that very different assumptions cannot be integrated in a useful way.

Klauer (1985), however, suggested that it might be possible to develop an overarching theory:

> This situation could be perceived as discouraging if one looked for one theory of teaching that would be adequate for all instructional problems. Alternatively, it could be seen as reflecting the fact that these various attempts are more or less useful for different purposes so that each of them possibly has its appropriate place in a larger frame of reference. Such a frame of reference can be provided by an all-encompassing theory of teaching if it is conceived as a hierarchical theory. (p. 6)

Given the divide in opinions on whether an overarching theory can be developed, this is another open issue that needs to be explored.

8 Aims, Scope, and Structure of the Book

Because there is such a wide range of views on the theorizing of teaching, our goal in this book is to initiate an exchange between internationally recognized scholars towards what Bikner-Ashbahs and Prediger (2010) call a "culture of constructive debate".

As far as we know, structured exchanges on this topic do not exist, so we decided that it would be useful to focus large parts of the book (see Chaps. 2–9) on the first steps of the networking strategies suggested by Bikner-Ashbahs and Prediger (2010), "understanding others" and "making understandable". To do this, we asked all contributing authors to answer the same five questions in their chapters. We then went one step further by "comparing" and "contrasting" the different answers to these questions in the two last Chaps. (10 and 11) of the book. In order to include the most integrated point of the networking strategy, one of the five questions was about the possibility of "unifying globally". The five questions all of the contributors were asked to answer were formulated on the basis of the literature (see above) as highly diverse. We therefore phrased the first two questions in a very fundamental way:

– What is a theory (of teaching)?
– What should it contain and why?

When we realized that there was a gap between recent literature on teaching research, which has tended to focus on differences between subjects as well as student populations, and the literature on theories of teaching which has not, we added a question on this subject:

– Can such a theory accommodate differences across subjects and student populations? If so, how? If not, why?

Because there is very little overlap regarding theories of teaching named between articles published, we also asked our contributors directly:

– Do we already have a theory/theories of teaching? If so, what is/are they?

Finally, we wanted to know if the experts believed that achieving the highest level of networking identified by Bikner-Ahsbahs and Prediger (2010), "unifying globally", could ever be achieved:

– In the future, in what ways might it be possible, if at all, to create a (more comprehensive) theory of teaching?

Although the authors were free to reflect on these questions in any way they saw fit, they were explicitly asked to address these questions at some point in their contribution—something that most of them did toward the end of their chapters, after having presented and discussed their own work.

Selecting contributors for the book was a hard task since theorizing teaching can be approached from a number of different angles. In addition to teaching quality, considered in this book, other angles include critical (race) theory (e.g., Howard & Navarro, 2016; Ladson-Billings & Tate, 1995; Ledesma & Calderón, 2015), ecological theories (e.g., Bronfenbrenner, 1989), relational and affective teaching (e.g., Grossman et al., 2009; Lampert, 2001; Noddings, 2001), sociocultural (e.g., Banks & Banks, 2004; Gallego & Cole, 2001; Gay, 2018) and sociopolitical (e.g., Nasir et al., 2016; Nieto, 2005) contexts, historical perspectives (e.g., Kafka, 2016; Sweeting, 2005), and many more. Because networking between theories is most productive if there is sufficient overlap between the theories (Bikner-Ahsbahs & Prediger, 2010), we decided to minimize the diversity between chapters and focus on teaching quality by including several chapters on this subject and added a few contributors to give us a wider perspective. Several criteria were used to select the contributors. First, they had to have been recognized by the international community for their contribution to conceptualizing and investigating teaching. Second, the contributors to this book either research teaching in general and/or examine the particular demands that teaching mathematics imposes on teachers. Third, we wanted to bring together an international group of researchers, including scholars from the two continents where most of the empirical research on teaching has been published over the past decades, Europe and North America. Because we wanted to include an Asian perspective, we also invited a group led by a Chinese scholar to join this project (Chap. 8). Finally, we opted to enrich this selection with a perspective that specifically views teaching as an act of communication (Chap. 9). Although these criteria were deemed necessary for the purposes of this exercise, it is important that future networking exercises shift their focus to other geographical regions, traditions, paradigms, and school subjects.

9 Conclusion

We believed that by bringing together a group of internationally recognized scholars of teaching, advances could be made in defining theories of teaching, better understanding their constituent elements, and developing a sense of the ways in which such theories can be generated, presented, or further expanded. Given Kurt Lewin's well-known motto "nothing is as practical as a good theory," it was anticipated that these advances could have not only theoretical but also practical benefits for the deeper understanding and improvement of teaching. Biddle and Anderson (1986, p. 245) echo this, by passionately arguing for the careful study and understanding of teaching:

> [W]ho will save our threatened civilization if not its educated citizens? We all have a stake in education, then, and if teaching makes a difference in the lives of pupils, we clearly must learn more about teaching. The task may be a lot more complex than we thought it was, but we do not have viable alternatives to acquisition of the knowledge that research on teaching can provide.

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Chapter 2
Creating Practical Theories of Teaching

James Hiebert and James W. Stigler

Abstract In this chapter we propose a way to create theories of teaching that are useful for teachers as well as researchers. Key to our proposal is a new model of teaching that treats sustained learning opportunities (SLOs) as a mediating construct that lies between teaching, on the one hand, and learning, on the other. SLOs become the proximal goal of classroom teaching. Rather than making instructional decisions based on desired learning outcomes, teachers could focus on the kinds of SLOs students need. Because learning research has established reliable links between specific types of learning opportunities and specific learning outcomes, theories of teaching no longer must connect teaching directly with learning. Instead, theories of teaching can become theories of creating SLOs linked to the outcomes teachers want their students to achieve. After presenting our rationale for moving from theories of teaching to theories of creating SLOs, we describe the benefits of such theories for researchers *and* teachers, explain the work needed to build such theories, and describe the conditions under which this work could be conducted. We conclude by peering into the future and acknowledging the challenges researchers would face as they develop these theories.

Keywords Teaching mediator · Teaching theory · Useful theory · Learning opportunities · Teaching effects

1 Creating Practical Theories of Teaching

Imagine the challenges faced by Lucy Scott, a sixth-grade teacher planning a unit on equivalent fractions. She is deciding what tasks to use and how to discuss them with her students. Ms. Scott has taught these lessons before and knows she needs to make some changes. The last time she taught the lessons, the students seemed

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confused, leaving Ms. Scott unsure, at the end, whether or not her students really understood what it meant for fractions to be equivalent. How can Ms. Scott decide what changes to make? Are there theories that could help her predict, for example, what might happen if she chose one task over another? Do such theories even exist?

We begin this chapter with the unusual proposition that it is possible to build theories of teaching—*practical theories*—that are useful for teachers. At the heart of our argument is the concept of learning opportunities, specifically learning opportunities that can be sustained within and across daily classroom lessons. Rather than assuming that teaching behaviors have a predictable impact on student learning, we argue that it is the sustained learning opportunities (SLOs) created by these behaviors that predict student learning. In order to help students achieve particular learning goals, teachers need to create SLOs aligned with these goals. The creation of these opportunities provides a more proximal goal for teachers than the achievement of learning outcomes. Focusing on SLOs opens the possibility for teachers to reason in cause-effect terms because it is easier to anticipate the effects of teaching behaviors on SLOs than on learning outcomes.

We develop our argument by first discussing a simple model that has often guided research on teaching and its effects on learning. We then describe a more complex model, created to fix the simplistic assumptions of the simpler model. Although both of these models have generated a number of useful theories and programs of research, we claim that theories of teaching effectiveness based on these models have reached their limits for generating research that will take the field beyond where it is now. In addition, we do not believe these models can support theories that teachers can use to make instructional decisions. We argue that a different model is needed to further advance theories of teaching effectiveness and bring them closer to the work of teachers.

Our alternative model inserts a new, single, mediating construct—*sustained learning opportunities*, or SLOs—between teaching and learning. SLOs can be defined as the temporarily stable systems that emerge during classroom lessons from the interactions of multiple mediating variables to create the contexts in which learning occurs. A SLO is a unit of analysis that provides *the* pathway through which teaching leads to significant learning. We present our alternative model by elaborating the construct of SLOs, clarifying how the model differs from previous mediating variables models, and examining the essential role this new construct plays in mediating the connections between teaching and learning. Our aim is to present a convincing argument that a theory of teaching most useful for teachers will be a theory that guides the creation of SLOs.

We continue by explaining how our model drives the shift from theories of teaching to theories of creating SLOs, and we lay out the key ingredients of these theories. We present an example of a mini-theory that could be knit together with other mini-theories to create larger theories, and we step back to imagine ways in which teachers and researchers, as well as partnerships they might form, could use the construct of SLOs to build usable theories. We conclude our argument by acknowledging the challenges of developing theories of creating SLOs while still setting this goal as a worthy pursuit.

Kurt Lewin is credited with saying, “there is nothing as practical as a good theory” (Greenwood & Levin, 1998). Although theories of teaching effectiveness have usually been treated as guides for researchers, we interpret Lewin's phrase as a hypothesis that "good theories" could exist for practitioners as well as researchers. This is not to say that good theories for practitioners would not also be useful for researchers; quite the opposite. As we describe, developing theories of teaching for teachers opens new lines of investigations for researchers.

Throughout this chapter, we use the terms model and theory as proposed by Praetorius and Charalambous (this volume). Following the Oxford Dictionary, they defined models as simplified descriptions of systems for assisting researchers in making predictions and theories as elaborations of models that describe the systems themselves—interrelated sets of ideas—intended to explain something of interest. Or, to quote another idea that strikes us as useful: "good theory helps identify what factors should be studied and how and why they are related" (Hill & Smith, 2005, p. 2).

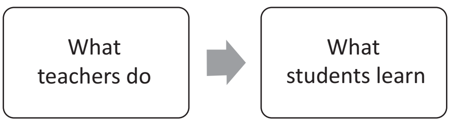
Our analysis is shaped by our interest in understanding how classroom teaching can support students' learning of valued content. We appreciate that the purposes of teaching include more than acquiring knowledge (Biesta, this volume) and that the theories of teaching can address more than its effectiveness (Herbst & Chazan, this volume). However, we believe there is value in theorizing about teaching effectiveness for learning content, especially in ways that are usable by teachers.

2 Moving Beyond a Simple Model of Teaching

Research on teaching has a long and illustrious history. It is fair to say that much of the work has treated as axiomatic the importance of investigating the effects of teaching on student learning outcomes (Floden, 2001). In fact, the credibility of theories of teaching is often based on whether the theory predicts learning outcomes (Farnham-Diggory, 1994; Herbst & Chazan, 2017). The basic model on which these theories are based looks roughly like the one pictured in Fig. 2.1. Teachers engage in teaching behaviors, and these behaviors impact what students learn. We know from value-added research that who students have as a teacher explains a good deal of the variance in how much they learn (Nye et al., 2004; Sanders & Rivers, 1996). It is reasonable to conclude that different teachers act differently, and that these differences help to explain what students learn.

The problem with this model is that it hasn't worked very well. Despite decades of research, and many innovations in how researchers describe the "what teachers do" part of the equation, they have generally found very low correlations between teacher actions, on one hand, and what students learn, on the other (Brophy & Good, 1986; Dunkin & Biddle, 1974; Hiebert & Grouws, 2007; Oser & Baeriswyl, 2001). One of the largest and most ambitious studies conducted based on this model—the

Fig. 2.1 A simple, common model for research on teaching



Bill & Melinda Gates Foundation *Measures of Effective Teaching* study—found few correlations between anything observable in teachers' actions and the learning outcomes of their students (Kane et al., 2013; Kane & Staiger, 2010). This leaves Lucy Scott and her colleagues without much guidance for planning instruction that could predictably help students learn, say, to understand equivalent fractions.

Beginning in the 1970s, researchers recognized that the simple model's lack of explanatory power could be attributed, at least in part, to the students' role in determining what they learned from instruction (Doyle, 1977; Rothkopf, 1976). Students do not simply stand between teaching and learning as passive recipients but actively process information and represent events that unfold during classroom lessons. Even simple cognitive tasks require students to actively process information and formulate a response (Shulman, 1986). The mediating role that students play could be pictured by inserting a box between what teachers do and what students learn, as shown in Fig. 2.2. This elaborated model was proposed as a way to move beyond the simpler process-product model (Gage, 1972; Rosenshine, 1976) to represent the more complex relationship between what teachers do and what students learn.

Researchers often inserted into the middle box one or more variables intended to capture how students process instruction. By 1986, Wittrock (1986a) could review numerous efforts to identify variables that mediated the relationship between teaching and learning. Variables he labeled "thinking processes" included attention, comprehension, motivation, interpretation of feedback, self-concept, cognitive strategies, and metacognitive strategies. Some researchers gathered multiple cognitive variables and organized them into a "cognitive mediational paradigm" (Winne, 1987). Other researchers introduced constructs, like "student work," to organize and interrelate the mediating effects of individual variables (Doyle, 1983, 1988). As Doyle argued, the work students do during instruction determines, to a large degree, what they will learn. Teaching that leads to one kind of work will yield a different outcome than teaching that prompts a different kind of work.

The idea of including mediating variables between what teachers do and what students learn has continued to influence the field today (Kyriakides et al., this volume; Scheerens, this volume). More complex models include different types of mediating cognitive variables (self-regulation, motivation, and engagement) as well as mediating social variables (teacher-student relationships, peer relationships, and family involvement (Cappella et al., 2016). These models, and the theories based on them, have generated numerous research programs providing important insights into teaching and learning (see Cappella et al., 2016).

Although we strongly endorse the insights that led to the creation of this mediation model (Fig. 2.2), we see two problems that have limited its success. First,

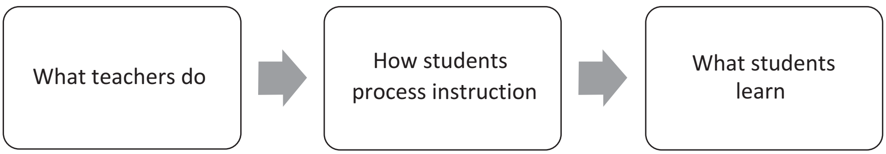


Fig. 2.2 An elaborated model for research on teaching

the number of variables that lie between teaching and learning is almost limitless. The more researchers learn, the larger the number becomes. Isolating the effects of individual variables is of limited use because a single variable accounts for too little variance. But, studying the effects of collections of variables quickly introduces overwhelming complexity. Cooley and Leinhardt (1975) anticipated this problem by noting that "the vast array of possible influencing variables" in studies of teaching results in "an unmanageable quantity of data that has produced no clear insight as to what practices make a difference in student learning" (p. 4). The problem is exacerbated by the fact that individual variables do not independently exert their influence on instructional effects. Researchers must consider their interactions.

When examining the progress of research programs on aptitude-treatment interactions (ATIs), Cronbach (1975) noted that, even with a small number of variables, the number of interactions would take researchers into "a hall of mirrors that extends to infinity" (p. 119). Theorizing about, and researching, the mediational effects of large collections of individual variables is simply untenable.

The second problem with the mediation model is that there are few constraints on the nature of the mediating variables, and different researchers describe mediating variables of different grain sizes and different types. This makes it difficult for theorists to piece together findings across empirical studies to build coherent theories. Cronbach (1975), for example, reviewed the moderating effects that macro-variables, such as student aptitudes, have on the relationship of instruction to learning, whereas Winne (1987) argued for the importance of micro-variables, such as "rehearse the defining attributes of the concept" (p. 343). A wide range of mediating variables along the continuum are found in Wittrock's (1986a) review, from motivation to students' perceptions of teacher expectations to reliable counting strategies for solving beginning arithmetic problems. And, the elaborated mediation model proposed by Cappella et al. (2016) identifies macro-variables and micro-variables, both cognitive and social. To reiterate, we believe the concept of mediating processes has merit but the way in which it has been operationalized does not lead toward the development of theories that teachers could use to make daily instructional decisions.

3 An Alternative Model of Teaching

The importance of recognizing the impact of mediating variables cannot be overstated. The model in Fig. 2.2 has resulted in a number of fruitful programs of research. Yet, the more that is learned, the more we believe there is something missing that could simplify the sets of mediating variables without losing the insights they have provided. The missing construct, in our view, stems from the realization that *what takes place in classrooms, as teaching unfolds, is not just the interplay of many variables but instead is the emergence of a stable system that defines the context in which learning takes place.* This system, which we call sustained learning opportunities (or SLOs), is not just a bunch of variables but is a new construct that we insert between teaching and learning (See Fig. 2.3).

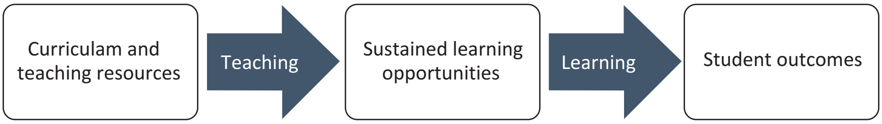


Fig. 2.3 An alternative model of teaching

Before we present a more detailed description of the model, it is worth making a few general points. First, the term "sustained learning opportunities" should not be confused with common uses of "learning opportunities," including its meaning of "curricular exposure" in international comparisons (McDonnell, 1995, p. 306). In addition, our use of "SLO" is very different than the acronym's association with "student learning objectives" (https://texasslo.org/Resources).

Second, although SLOs are created by classroom variables and their interactions, they cannot be described in terms of these variables. Instead, a SLO is a system that needs to be described and understood in its own right. Because SLOs represent the sustained episodes in classroom lessons designed to help students achieve challenging learning goals, teachers recognize them more easily than individual mediating variables.

Third, teachers don't single-handedly create SLOs. Instead, they orchestrate them, drawing on and coordinating all the resources they have to work with. These resources include curricula, but also include familiar cultural routines of teaching and learning and the beliefs that support these routines. Importantly, teachers do not create SLOs alone; students also play a role by participating in tasks and activities presented by the teacher (Schoenfeld, this volume; Vieluf & Klieme, this volume).

Fourth, we cannot overstate the importance of the word *sustained*. The learning opportunities that define students' experiences and thus shape their learning are not just occasional events that happen by chance. If learning opportunities are not deliberately created and sustained over time, they are unlikely to affect students' learning trajectories. Our interest is in understanding how students learn things that are hard to learn, that get mastered over long periods of time.

Finally, we want to highlight one of the most important features of the alternative model we are proposing. We have pointed out that SLOs themselves are a system, a construct worthy of a box. But we also see three more systems in Fig. 2.3 of which SLOs are only a part. All five components (three boxes and two arrows) comprise a system of teaching and learning. But the first three components (the first two boxes and the connecting arrow) comprise a system in its own right, as do the last three components (the second and third box and the arrow that connects them).

Along with the construct of SLOs, it is this nested set of systems shown in Fig. 2.4 that capture the model's most unique and significant contribution. In particular, our claim that the first and second box connected by the first arrow constitute a system of its own means that these components form a complete whole that can be analyzed and understood separately from the other systems. This, in turn, means that the quality of SLOs can be treated both as a dependent measure of one system—an outcome created by the curriculum and the teaching that brings the

Fig. 2.4 Two systems constitute the overall model

curriculum in touch with students—and as an independent measure of another system when used to predict learning.

The nested characteristic of the model helps to conceptualize the relationship between theories and research on teaching with theories and research on learning. In our model, one theory is not embedded in the other (Openshaw & Clarke, 1970; Snow, 1973); rather, the theories intersect around the middle box. In order to trace relationships between what teachers do and what students learn, our model suggests that theories of teaching must be aligned with theories of learning at this point of intersection. This intersection is precisely what enables theories of creating SLOs to be useful for teachers. From their point of view, the SLOs that provide the goal for instruction are those that theories and research on learning have linked to the learning outcomes teachers want their students to achieve.

We believe the alternative model clarifies for theorists and researchers the task of building practical theories that can guide teachers' day-to-day instructional decisions. Earlier, we pointed to the overwhelming number of individual variables in the mediation model that must be coordinated as a reason for searching for an alternative. With the diagram in Fig. 2.4, we can now see this problem from a new perspective. The traditional goal of connecting what teachers do with what students learn means documenting the connections across two distinct systems. On the other hand, building a theory of creating SLOs requires testing hypothesized connections within only the first system. Although it is true that traditional theories of teaching usually focus on the first arrow in Fig. 2.3, they often are required to explain the second arrow as well. We believe this poses a challenge that is too big for any theory that aims to support teachers' decision making (Vieluf & Klieme, this volume; cf. Kyriakides et al., this volume).

3.1 Unpacking the Model

We turn now to unpack the model presented in Figs. 2.3 and 2.4. The model consists of three boxes connected by two arrows. It is worth pointing out that the arrows in our diagram do more work than the arrows in most diagrams. Instead of representing only a flow from one box to the next, the arrows represent the processes that create the complex relationships between the three boxes. The arrows represent verbs, the boxes represent nouns. The boxes are things that change only when teaching or learning change them. The arrows represent the processes of teaching and learning that produce the changes.

The First Box The first box in our model consists of all the things teachers use to implement their lessons. These include written and supplementary materials (e.g., textbooks, pacing guides, concrete materials, lesson plans, etc.) designed by curriculum developers to create learning opportunities for students (Remillard et al., 2009), materials teachers create themselves, and materials they share locally and on the Internet. This is the raw material from which teachers draw as they select, adapt, coordinate, and implement sustained opportunities for student learning. In the previous models (Figs. 2.1 and 2.2) these things are left unspecified, though they clearly have a major impact on the kinds of SLOs teachers are able to create.

Also included in the first box are all of the teaching routines that are familiar to teachers, as well as all of the content, pedagogical, and cultural knowledge of teaching that teachers acquire while sitting in classrooms as students, engaged in teacher preparation, and working as teachers. Examples include the pedagogical content knowledge that assists teachers as they customize instructional activities for their students, and cultural knowledge that teachers use to create and sustain the daily classroom routines common within each culture.

The Second Box The second box in our model represents the learning opportunities that students actually participate in and experience over sustained and repeatable segments of time. Sustained learning opportunities are the relatively stable times within classroom lessons during which students engage with an instructional activity designed to help them achieve a learning goal. The fact that they are relatively stable, even if only for a few minutes, means they can be identified and studied. They are visible within the fast-moving and fleeting interplay of variables within classrooms.

A SLO emerges from the interaction of classroom variables as a signature characteristic of the lesson that matters most for students' learning. It derives its impact (and predictive power) from the way in which the variables interact to create its effect, not from its size or intensity. More is not necessarily better. The final quality of the SLO is determined by the interactions among the primary players—teacher, students, and content (Cohen et al., 2003; Lampert, 2001).

Indeed, a SLO could be thought of as a dramatic play. Putting on a play requires the coordination of many elements—sets, scripts, and actors, to name a few. The quality of the play cannot be judged by each of its elements evaluated individually but rather by the emergent qualities of the event that results from the interplay of these elements. Teachers and students are actors in a kind of play. They each must work to enact the play, to create a briefly-sustained temporary world in the classroom. In the case of a SLO, each actor learns from their experiences as they participate in the world they have created together.

We can clarify further the SLO construct by comparing it to related constructs. As noted earlier, we can distinguish SLOs from "opportunity to learn" (OTL). OTL represents content covered and/or the tasks presented to students (see McDonnell, 1995, for a history of OTL and Travers, 1993, for its use in SIMS). And, opportunities presented are different than opportunities experienced (Biesta, this volume; Praetorius et al., 2020; Vieluf & Klieme, this volume). A related distinction can be made between SLOs and the "enacted curriculum" (Remillard & Heck, 2014; Stein et al., 2007; Thompson & Usiskin, 2014). The emphasis in discussions of the enacted curriculum is often on the teaching moves and behaviors that transform the written curriculum into the learning opportunities that reach the students. SLOs emphasize the opportunities that emerge and are *experienced* by students as they participate in the enactment.

The construct we see as closest to SLOs is the construct of classroom tasks described by Tekkumru-Kisa et al. (2020). In their formulation, a classroom task "creates the context within which students think about the subject matter" (p. 607). Tasks move through four phases during a lesson (the *life* of a task). We connect the SLO construct to the third of their four phases: "the task as perceived by each student and as enacted by the teacher and the students is the *actual* intellectual work in which students engage (i.e., the level and kind of student thinking happening during the lesson)" (p. 607).

The Third Box The third box consists of student outcomes, the most prominent of which is student learning. In this chapter, we focus on learning outcomes aligned with academic or content goals. Changing the focus to other goals that societies, and teachers, often value might change what would fit into the components of our model but would not change the model itself (see Biesta, 2016, this volume, and Lampert, 2001, for examples of other important goals, such as students' forming identities as autonomous learners). It is also important to note that we include both immediate and long-term goals in this box.

The First Arrow The first arrow in our model includes much of what researchers and educators ordinarily think of as teaching. However, it includes more than the visible, public actions of teachers as they implement a lesson. It also includes planning for a lesson and reflecting on a lesson after it is taught. It represents all of the processes teachers use to turn the intended curriculum into the enacted curriculum—the curriculum that is presented to students. "The teacher is an active designer of curriculum rather than merely a transmitter or implementer" (Remillard, 2005, p. 214).

We focus on planning, implementing, and reflecting because we see them as the minimum processes needed to represent what the teacher does to create SLOs. We recognize that what is involved in these activities can be unpacked in different ways and at various levels of detail (Cai et al., this volume; Scheerens, this volume; Schoenfeld, this volume). In fact, any single chapter cannot do justice to all the ingredients that fit into this arrow (Ball & Forzani, 2009; Grossman, 2020; Lampert, 2001). Also, although the arrows in our model flow from left to right, we can imagine processes that flow in the opposite direction as well. What teachers and researchers learn from implementing curriculum and observing the sustained learning opportunities, for example, could have a “backward design” effect on the way in which the curriculum is revised and improved (Wiggins & McTighe, 2005).

The Second Arrow The second arrow represents the processes and cognitive mechanisms that transform learning opportunities as experienced by students into learning outcomes. Like the first arrow, it links two boxes to form a separable subsystem, this time consisting of interrelated elements that turn sustained learning opportunities into learning outcomes as assessed by a wide range of measures. The arrow establishes the types of SLOs that will become the targets teachers use to plan and implement instruction.

Establishing connections between particular types of SLOs and particular learning outcomes is usually the work of researchers. Researchers, however, are not the only ones who can contribute to educators’ understanding of the second arrow. Teachers learn about processes that produce student outcomes, for example, when they use formative assessment tools to get a sense of what their students are thinking and learning from the opportunities they experience (Silver & Mills, 2018; Wiliam, 2018), or when they review students’ work to get a more detailed look at students’ conceptions and misconceptions (Kazemi & Franke, 2004), or when they administer and grade quizzes and exams to find out what their students learned during the lesson(s). Unfortunately, the culture and practices of education research in the U.S. do not yet include a mechanism for routinely capturing this information.

Even though teachers do not usually contribute to more generalized knowledge connecting SLOs with learning outcomes, they frequently use what they learn from assessing outcomes to reflect on the effectiveness of their teaching. Although teachers’ reflections are part of the work of teaching, and so belong squarely inside the first arrow, they also could contribute to our understanding of the second arrow. This highlights the fact that the boundaries separating the two systems are not impermeable. There are places where work on teaching and work on learning can and should overlap (Romberg & Carpenter, 1986).

Connecting the Two Systems The ability of researchers to document links between SLOs and learning outcomes is crucial for the model shown in Figs. 2.3 and 2.4 to function as we propose. With these links established, the work of teaching represented by the first arrow could set a goal of creating SLOs that have been shown to align with desired learning outcomes. Teachers could focus on creating SLOs with specific features *if* they could assume that opportunities with these features led to the learning outcomes they intended.

It turns out that researchers have reported compelling evidence that links types of SLOs and particular learning outcomes (Bjork & Bjork, 2011; Cai et al., 2020; Hiebert & Grouws, 2007; Richland et al., 2012). Consider the case of mathematics. If we specify understanding of key concepts as an important mathematical proficiency and a desired learning outcome, we can identify two features of a SLO that enable this outcome. A first feature is often referred to as productive struggle (Hiebert & Grouws, 2007). Mounting evidence from the learning sciences indicates that deep and lasting learning results more often from periods of struggle and confusion than from smooth error-free learning or from the kind of Eureka! moments educators strive to create (Harackiewicz et al., 2008; Kapur & Bielaczyc, 2012). Robert and Elizabeth Bjork coined the term "desirable difficulties" to refer to a body of research showing that introducing difficulties into the learning process can produce deeper and longer-lasting learning, despite the fact that students often describe the experience as less enjoyable and believe that they have learned less (Bjork, 1994; Bjork & Bjork, 2011). If mathematics educators want students to understand a concept, they must find ways to engage students in struggling to make sense of the concept.

Of course, struggling by itself won't produce deep learning of significant mathematics. The struggle must be focused on the right things. This leads to a second feature of SLOs that predict conceptual learning outcomes: explicit connections (Hiebert & Grouws, 2007). To develop understanding, students must focus their efforts on making the connections that lend coherence to a domain and that result in knowledge that is both flexible and transferable. In particular, students must work to forge connections among core concepts, representations, and the world to which the concept applies (Fries et al., 2020; Hiebert & Carpenter, 1992; National Research Council, 1999, 2001; Roth & Garnier, 2006). These connections don't usually spring forth spontaneously. They must be made explicit, by students or the teacher, and they must be made at the right time, when students are prepared to recognize and construct these connections for themselves (Dewey, 1910). Explanations, comparisons, analogies, and visual representations are all tools that teachers can incorporate into SLOs that help students create connections and develop deeper understanding (Richland et al., 2004, 2012).

As we noted earlier, learning things that are hard to learn requires SLOs to be sustained over observable periods of time. To develop conceptual understanding, students must practice struggling productively with making important connections in the domain. Because this is not the usual form of practice, often called repetitive practice, it has been labeled deliberate practice, a term that comes from research on expertise (Ericsson, 2006). Deliberate practice involves a planned sequence of opportunities that stretch over more than one lesson, sometimes over many lessons. In fact, researchers have reported the kinds of sequential variation in mathematical problems that create these SLOs (Carpenter et al., 2017; Clements & Sarama, 2014; Fries et al., 2020; Huang & Li, 2017; Kullberg et al., 2017; Pang & Marton, 2009). Treating SLOs as the proximal goal for teaching depends on documenting more connections between features of SLOs and desired learning outcomes.

3.2 An Advantage of the Model for Teachers (and Researchers)

A driving motivation for writing this chapter was to explore whether reimagined theories of teaching could be more useful for teachers. By dividing the larger system of teaching and learning into two smaller systems, we have imagined a way for theorists and researchers to narrow their focus to one system or the other. This, we argue, can suggest new lines of research that previously might have been hidden by the expectation that researchers trace transformations from the written curriculum through the enacted curriculum, through the learning opportunities experienced by students and, finally, into learning outcomes. Research questions change if one works *within* a system (Fig. 2.4). As just noted, for example, research in System 2 can focus on connections between SLOs with particular features and desired learning outcomes. Lines of research in System 1 could focus on describing the classroom conditions that yield SLOs with particular features.

Theories of creating SLOs offer teachers a clear theory of what they need to create and what their creations should look like as they implement instruction. While teachers are implementing instruction, it is almost impossible to keep their eyes both on the instruction they are enacting and the evidence needed to judge whether students are achieving the learning goals of the lesson. Although still challenging, it is conceivable that teachers could monitor students' immediate responses to the learning opportunities being enacted because these are proximal to implementing the planned opportunities. Based on these responses and on theories of creating SLOs, teachers could adjust instruction to improve the quality of SLOs (see Biesta, this volume).

Walter Doyle previewed this idea more than four decades ago when assessing the usefulness of the process-product framework (similar to the simple model—in Fig. 2.1):

> In the event that the presentation did not accomplish its objective, the process-product formulations would offer no further guidance. Just knowing the relation of a technique to terminal performance fails to supply sufficient information about immediate contingencies in the classroom (Doyle, 1977, p. 126).

He then said that if teachers could focus on activating an intermediate response from students, they could "experiment" with instructional strategies to see which worked best. This, Doyle (1977) said, "enables a teacher to practice what Cronbach (1975) has called 'short-run empiricism,' in which one monitors responses to the treatment and adjusts it" (p. 126).

To reiterate, a theory of SLOs and how to create them could open new lines of research *and* could help teachers know what to look for when observing students' responses to instruction and what changes they might consider as they seek to improve the quality of the SLO they are creating. A theory of creating SLOs is our answer to the question posed in the first paragraph of this chapter: "Are there theories that could help Ms. Scott predict, for example, what might happen if she chooses one task vs. another?" We believe our alternative model of teaching could spawn theories of creating SLOs that are usable by Ms. Scott and her professional colleagues.

3.3 Limitations of the Model

Although we believe our model of teaching and learning captures meaningful aspects of teaching and provides teachers with a manageable system to which they can apply their efforts to improve, even this alternative model includes only a fraction of the *full* system of teaching. One only has to look through the extensive *Handbooks of Research on Teaching* (3rd edition, Wittrock, 1986b; 4th edition, Richardson, 2001; 5th edition, Gitomer & Bell, 2016) and the chapters in this volume to see the vast and rich legacy of relevant research and theory that address various aspects of the immensely complex system of teaching. Our model does not touch many factors, both outside and inside the classroom, that contribute to students' experiences in school (Cobb et al., 2018; Cohen, 2011; Creemers & Kyriakides, 2008; Kyriakides et al., this volume; Lampert, 1985, 2001).

We acknowledge that our model is located within a much larger multi-level system of schools, districts, and so on (Cobb et al., 2018; Scheerens, this volume; Scheerens et al., 2003; Strom et al., 2018), all of which impact teaching in some way. We attend to only a small portion of these factors and to only one level of the system of schooling. Because of the mind-bending complexity of teaching, everyone who wades into this domain must find ways to simplify the problem and put boundaries on their search for solutions, leaving large portions of the domain untouched. We are no exception.

One of the challenges facing those who presume to investigate teaching is how to simplify teaching to make it more tractable without, at the same time, losing its essential character. Grossman and McDonald (2008) express the challenge this way:

> A framework for teaching would require a careful parsing of the domain …. This effort to parse teaching would need to respect the difficulty of breaking apart such a complex system of activity and the dangers of doing irreparable harm to the integrity of the whole by making incisions at the wrong places (p. 186).

We sought to strike this balance between simplification and ecological validity in two ways. To simplify, we chose to focus on the major components of teaching that commonly fall under the control of educators whose work is purposefully directed toward improving teaching and learning. Classroom teachers, instructional leaders, curriculum developers, and education theorists and researchers, all fall into this group. To retain ecological validity, we preserved minimal elements of a *system* of teaching, as we understand it. Within this system, we focused on those factors that are of most concern to classroom teachers and over which they have some control. We wanted, in other words, to specify a model that could generate theories that would be useful for Lucy Scott and her fellow teachers.

4 Building and Using Theories of Creating Sustained Learning Opportunities

We turn now to discuss theories that could be built using the model shown in Figs. 2.3 and 2.4. We focus here on the first system in the model, the system that turns written curriculum and other teaching resources into specific types of SLOs linked with particular learning outcomes. We reflect on what this process might look like—what the main elements of such theories would be, and how the elements might be related. Our aim is to develop what Hill and Smith (2005, p. 2) called a "good theory": one that "helps identify what factors should be studied and how and why they are related." We start by presenting a sample hypothesis that illustrates the nature of these theories. We then imagine the kind of work researchers and teachers might do to build and use theories of creating SLOs.

4.1 A Sample Hypothesis in a Theory of Creating Sustained Learning Opportunities

Theories are built from a set of related hypotheses. One hypothesis that could be part of a theory of creating sustained learning opportunities is what we call the struggle-first hypothesis. Based on analyses of Japanese mathematics classrooms and on experimental research carried out in the United States, this hypothesis suggests that students will create connections among concepts more effectively if they engage in productive struggle *before* they are given direct instruction than they would if the direct instruction came first. When students are given direct instruction first, says the hypothesis, it removes the motivation to struggle because students already have the solution they need, thus short-circuiting the deeper learning that can occur during productive struggle.

It is worth noting how the struggle-first hypothesis differs from the mediating variables approach alluded to earlier. It we took the mediating variables approach, we might identify productive struggle as an important variable to measure. But simply measuring the amount of struggle in a lesson would not take into account the importance of how the struggle fits within a SLO. The same mediating variables can take on different meanings when they are part of different lessons (Janssen et al., 2015), a fact that becomes even more salient when comparing lessons across countries with different pedagogical traditions (Stigler et al., 1996; Stigler & Hiebert, 1999). Many variables, in addition to productive struggle, have been found to have different effects when embedded in different pedagogical systems (e.g. Kawanaka & Stigler, 1999).

The struggle-first hypothesis was initially formulated by researchers, and researchers have generated empirical evidence in support of the hypothesis. But to be useful for teachers, the hypothesis needs to be elaborated. Numerous secondary hypotheses need to be generated, tested and refined before the struggle-first hypothesis could guide teachers' actions across a wide variety of contexts and content. Because this variation in context occurs in classrooms, teachers must be part of the work that formulates, tests, and refines the hypotheses. As researchers and teachers flesh out the struggle-first hypotheses, they might ask questions such as, "What kinds of tasks work best for students who are encountering the topic for the first time?" or "What kinds of tasks work best for specific connections between core concepts of a specific content domain?"

It might be that beginning students struggle most productively to make connections when they are solving problems that have a particular level of cognitive demand (Stein & Lane, 1996; Tekkumru-Kisa et al., 2020), or with tasks that vary in particular ways from tasks students already have completed (Huang & Li, 2017; Marton, 2015; Pang & Marton, 2009). Teams of researchers and teachers might focus their classroom investigations on how the task is initially presented to students, often called the "launch" (Wieman, 2019); or on how subsequent class discussions should be orchestrated during and after the task is completed (Smith & Stein, 2018); or on the role of well-timed hints (Stigler & Hiebert, 1999); or on how best to sustain students' efforts to complete the task in the face of difficulties, and perhaps frustration (Mukhoiyaroh et al., 2017; Tulis & Fulmer, 2013).

These are just a few of the hypotheses that teams of teachers and researchers could generate and investigate. These secondary hypotheses get filled in and refined as teachers experiment with different strategies in their classrooms to shape the learning opportunity so students derive maximum benefit from productive struggle. Formulating, testing, and refining hypotheses is an iterative process that engages teachers and researchers in the kind of cause-effect reasoning that is essential for improving teaching. Notice also that these secondary hypotheses represent only a fraction of the work needed to elaborate and refine the main hypothesis; they focus only on the "struggle" part of the struggle-first hypothesis. Teacher-researcher teams must formulate and test additional hypotheses to explore the best ways to help students make explicit the connections that complete this sequence.

As teachers test secondary hypotheses in their own classrooms, researchers can gather the findings and look across classrooms for patterns in what teachers do and how students respond. Are there ways of implementing a task, for example, which leads to productive struggle for most students in most classrooms with specific characteristics? As researchers guide the refinement of secondary hypotheses by organizing the incoming results, sharing them with other researchers working on similar problems, and suggesting other forms of these secondary hypotheses for teachers to test, a mini-theory begins to take shape around how to create SLOs that support making key connections through productive struggle.

Other primary hypotheses, such as "understanding requires repeated struggle," trigger the development of other mini-theories that guide, for example, the sequencing of tasks and activities both within and across lessons. As mini-theories begin forming around hypotheses that fit together, the mini-theories expand in scope and incrementally move toward larger theories of creating SLOs. Although building these mini-theories takes considerable time (years rather than weeks or months), the work of teachers and researchers can be accumulated, coordinated, and aggregated to gradually but steadily move toward more useful theories of creating SLOs.

As a mini-theory is forming for how to create productive struggle with making key connections, one can imagine teachers drawing on the mini-theory as they plan a lesson. As teachers internalize the mini-theories, they will be able to represent them as mental models. Teachers can run these mental models during planning as a means of predicting what the consequences will be as they weigh various options for an upcoming lesson. As the mental models become richer and stronger, teachers will be able to run their mental models on the fly, as they teach, as a means of predicting how students with different characteristics will respond to different parts of a lesson. As teachers practice making and testing predictions of this sort, they are engaged in a high-quality professional learning process that some authors have referred to as deliberate performance (Fadde & Klein, 2010).

4.2 Imagining the Work of Building Theories of Creating Sustained Learning Opportunities

The problem of how best to build theories of teaching has received relatively little attention (Praetorius & Charalambous, this volume). There are no clear precedents to follow as we outline a possible path for building theories of creating SLOs. Nevertheless, we move beyond the example just presented and propose some general processes and guidelines that could help build these theories in order to provide a more complete picture of the theories we have in mind.

We begin by asking, "If theorists and researchers wish to create and test theories of SLOs, what might they encounter and how might their work lives change?" Although this kind of work has not been attempted in any kind of serious way, it might be useful to imagine what kind of work would be entailed in order to envision the kinds of changes researchers could expect. We can identify several changes that researchers, and teachers, might decide to make. But, we anticipate there are many more and each of the ones we identify would likely have ripple effects through the educational system.

Changing Roles for Teachers and Researchers Researchers and teachers have long worked toward different goals and have played different roles in the educational system. Our example of building even a mini-theory around the struggle-first hypothesis suggests that these groups might need to adopt shared goals and change their professional roles (and identities).

For some time, the field has recognized that it is ineffective for researchers to develop theories and then hand them to teachers. Researchers simply don't know enough about the processes and conditions that determine how teaching behaviors and routines work to create SLOs in classrooms. In a field such as education, where good practices can run ahead of good theories, "the experience and intuition of practitioners" becomes especially important (Lipsey, 1993, p. 12). If researchers want to be better positioned to engage seriously in solving problems of practice (Burkhardt & Schoenfeld, 2003; Cai et al., 2018; Cohen & Mehta, 2017) they will need to find ways to blur the boundaries between themselves and teachers (Akkerman & Bakker, 2011; Cai et al., 2018, this volume; Cohen-Vogel et al., 2015; Penuel et al., 2011). Perhaps researchers will find ways to work side-by-side with teachers to ensure they are addressing instructional problems that teachers actually face as they implement and evaluate learning opportunities.

We can envision three unique roles for researchers to play. First, they could suggest hypotheses for how SLOs with particular features might be created. "Struggle-first" was formulated by looking across multiple settings, even multiple cultures. Teachers are not usually in a position to do this work, but researchers are. They could look across classrooms and search for patterns in the effectiveness of various teaching behaviors for creating similar SLOs and, conversely, they could search for patterns across classrooms in the conditions that turn similar teaching behaviors and routines into different SLOs. Second, researchers could identify prior research that would provide a starting point for teachers' work on developing the types of mini-theories outlined above (see the citations in the earlier example of "struggle-first"). Third, researchers could interpret data on learning outcomes that emerge across classrooms in order to evaluate and refine the links between features of SLOs and learning outcomes (the second arrow in Figs. 2.3 and 2.4).

Teachers might want to expand their traditional roles as well. Teachers uniquely have intimate knowledge of their students, enabling them to both formulate predictions and test the predictions by observing students' responses to instruction. This is not new work for teachers. They constantly make predictions, often intuitively and tacitly, about how students are likely to respond to particular instructional activities. However, making these predictions purposefully and explicitly would be new for most teachers. Similarly, the observations needed to test predictions about SLOs are different than the kinds of observations teachers make every day. We could imagine that teachers who are involved in this work would gradually adopt an experimental orientation toward their work (Hiebert et al., 2003). By experimental orientation, we mean simply learning from "experience carefully planned in advance" (Fisher, 1953, p. 8) and bringing the power of causal thinking into their practice (Gallimore et al., 2009).

Imagine teachers and researchers developing teams, or partnerships, to meet the challenge of creating theories of SLOs. The promise of researcher-practitioner partnerships has been realized in professional fields outside of education (Bryk et al., 2015; Morris & Hiebert, 2009, 2011). From auto manufacturing to the repair of Xerox machines to clinical medicine to the wind turbine industry, this multiple expertise model has been used effectively to improve practices across a range of professions (Douthwaite, 2002; Gawande, 2007; Kenney, 2008; Langley et al., 2009; Rother, 2009). When teachers and researchers form partnerships around shared problems of practice, they can realize similar successes (Bicknell & Young-Loveridge, 2017; Coburn & Penuel, 2016; Donovan & Snow, 2018; Quartz et al., 2017).

The challenge for teacher-researcher partnerships would be to retain the richness and ecological validity of the information from individual teachers' classrooms while surmounting the contextual uniqueness of each classroom. Every teacher faces somewhat different challenges because there are many factors that influence how students take up the opportunities teachers intend (Biesta, this volume; Clarke et al., 2006; Nuthall, 2004; Stigler & Hiebert, 1999; Vieluf & Klieme, this volume). The same teaching moves that work in one classroom might not work in another classroom. And, somewhat different teaching moves might be needed in different classrooms for students to experience the same learning opportunities.

Researchers will need to find ways to aggregate what is learned by multiple teachers across many classrooms into more generalized hypotheses that can provide guidance to all the teachers trying to solve the same instructional problem. The concept of "networked improvement communities" (Bryk et al., 2015) will undoubtedly play an important role in gradually formulating generalized hypotheses that can guide teachers' predictions. Researchers will play an especially important role in looking across classrooms for patterns that link particular teaching moves with desired learning opportunities. However, it is too early to speculate how these approaches will play out and what additional, perhaps still unknown, approaches might be needed.

It goes without saying that changing roles in these or other ways is not trivial for either group (Cai et al., 2018; Yurkovsky et al., 2020). But, teachers and researchers might decide it is worth the effort if they see the payoff in sustainable improvements in teaching and richer learning for students.

Slowing Down the Cycle of Teaching In addition to changing the roles of teachers and researchers, building theories of creating SLOs will require slowing down, at least for some lessons, the common cycle of planning, implementing, and reflecting on classroom lessons. These activities are part of the work teachers do every day, but planning and reflecting are often done quickly, sometimes only as teachers enter and leave classrooms. This is not sufficient because building, using, and refining theories takes time—at the moment and over the long run. Teachers who invest in this work will need time to plan and reflect on specially targeted lessons each year.

Of course, teachers would not be able to make this happen on their own. Educators at various levels of the larger system (e.g., building and district administrators) would need to create the time and space for teachers to do this kind of work. Additional time would be needed even though it would not be necessary to slow down the cycle of teaching for more than a few lessons each year. The goal is not the creation of a full curriculum of lessons, but the development of theories that can be applied across multiple lessons. Over time teachers' work could be accumulated to yield gradually improving theories of creating SLOs.

Planning and Predicting Thoughtful planning of a lesson necessarily involves anticipating how students will respond to particular instructional tasks. A natural way for teachers to anticipate students' responses is to run the lesson in their heads, imagine how students will respond at key moments, and adjust their plans accordingly. Because teachers' knowledge is often implicit, they will need to work with researchers to make explicit the hypotheses that underlie their predictions.

A teacher might hypothesize, for example, that students' will engage more with an initially-challenging problem if they see how it relates to a similar problem they have recently learned to solve. A researcher could help to clarify the hypothesis and design an experiment that could lead to useful information related to the hypothesis. The teacher could then select or design specific tasks that would work within the research design. In this way, designing, implementing, and observing students' responses to a task is not only an act of teaching by teachers, but one of hypothesis testing by teachers and researchers.

Although anticipating how students will respond at key moments in a lesson is often something teachers do subconsciously, it is not always easy. Teachers, especially those with experience and especially as they get to know their students well, are likely to have good intuitions about how their students might respond to particular tasks. But, forming predictions about students' thinking during lessons across a range of topics will be difficult. Fortunately, teachers (with researchers' help) can draw ideas from the long and rich legacy of research on teaching and learning to formulate predictions about students' thinking in particular task situations.

In highly researched domains, such as mathematics, the predictions that teacher-researcher partnerships make can be informed by research findings that detail students' likely ways of thinking about problems of various types. For example, research on young children's arithmetic performance provides primary grade teachers with information on likely solution strategies children might propose to most arithmetic problems if teachers present them in certain sequences (Carpenter et al., 1996; 2014; Sarama & Clements, 2009). Teachers can use this information to do more than predict students' thinking; they can use it to select mathematical problems and implementation strategies that are likely to engage students in the intended SLOs (Carpenter et al., 2014; Clements et al., 2020). Promising work on learning trajectories provides increasingly fine-grained descriptions of children's thinking and could be used by teachers to plan instruction on some topics (Clements & Sarama, 2014; Clements et al., 2004; McGatha et al., 2002; Steffe, 2004).

Before moving to the second phase of the cycle, we should clarify the nature of the hypothesis testing process we are describing. We do not want to enter the continuing debate in education about the most useful methods for improving practice (Bulterman-Bos, 2008; Jacob & White, 2002; Moss et al., 2009) but rather want to alert the reader that we have in mind the kind of "short-run empiricism" (Cronbach, 1975) or "piecemeal tinkering" (Popper (1944/1985) that involves repeated small tests of small changes (Morris, 2012; Morris & Hiebert, 2011). In this approach, a hypothesis is formulated about the relationship between teachers' actions in the classroom and the SLO that is created, predictions are made about how students will respond, and just enough data are collected to assess the viability of the hypothesis. Proposed by Popper (1944/1985) as the best scientific method for improving socially-embedded professional practices, we see this kind ofsmall-scale hypothesis testing, with accumulation of results over multiple replications, as an appropriate method for teacher-researcher partnerships to employ.

Implementing and Observing The point of making predictions about the SLOs students will experience is to set up the next phase of the cycle—observing the impact of the implementation and assessing the accuracy of the prediction. Whether predictions are accurate is, of course, an empirical question. Predictions must be tested and then hypotheses refined. To build theories of creating SLOs, checking the predictions means observing the kinds of learning opportunities experienced by students.

Not just any observations will do. Needed are observations focused on whether the learning opportunities that were experienced by students possessed the desirable features identified during the planning phase, and whether changes in instructional choices (e.g., of the task presented) improved the quality of students' experience in the predicted ways. Because students' experience is mainly an internal affair, it is not easy to draw completely accurate conclusions. Observing the individual responses of 30 students and trying to accurately infer what they are thinking is unrealistic. Teachers' judgments will be estimates, without the psychometric properties of systematic and formal assessments. Over time, however, repeated judgments by skilled teachers will lead toward accurate-enough inferences. It is useful to remember that researchers have long called for teachers to make instructional decisions based on inferences about students' thinking (Carpenter et al., 2014; Dewey, 1929; Lampert et al., 2010; Nuthall, 2004; Wittrock, 1986a). We are simply suggesting that these inferences be made based on planning and thoughtfully considered purposes.

Imagine Lucy Scott presenting a cognitively demanding task on equivalent fractions and observing whether her students are engaged in productive struggle to connect the concept of equivalence with the numerical patterns in the written fractions. What might she look for? It is first important to recognize that, if it is possible to make accurate-enough observations, Lucy Scott is the person who could make them. Observing and interpreting students' behavior with reasonable accuracy requires extensive knowledge of students' past performance, their tendencies to respond to new challenges in particular ways, what their outward behaviors indicate about their internal struggles, and so on. Ms. Scott is the only person with this kind of intimate knowledge of her students.

Because productive struggle involves particular kinds of work, there are guidelines that Ms. Scott could use when observing her students. She could look for whether her students were wrestling with the task—(not immediately finding the answer but continuing to try), whether they were asking questions that were relevant to the key ideas of equivalent fractions, whether they were experiencing moments of confusion but sustaining their efforts, whether they were developing partial solutions that were on the right track (Brown, 1993; Ermeling et al., 2015; Hiebert et al., 1996; SanGiovanni et al., 2020).

In addition, teachers like Ms. Scott are likely to find that their observations of students' responses are enabled by the planning they did during the first phase of the cycle. Along with planning instruction, teachers can plan what kinds of observations they need to test their predictions. In some cases, what teachers look for will be visible (for example, in students' written work, or in their behavior while solving a problem); in other cases, teachers will need to elicit student thinking (for example, by asking pointed questions and asking students to share their thinking). The more that teacher-researcher partnerships learn, specifically, about the manifestations of productive struggle with equivalent fractions and with other topics, the more informed will be the guidelines for observing student responses.

Reflecting and Refining The third phase in the cycle of teaching is reflecting on the observations made during instruction in light of the predictions that were posed. Teachers frequently reflect on the success of a lesson but often do so quickly and without much thought. Participating in a teacher-researcher partnership and using a theory to guide reflection encourages teachers to slow down the process and make it explicit and systematic. As with planning and observing, theories play an important role in the reflecting phase of the teaching cycle. In the reflecting phase, teachers and researchers can work together to figure out how the results of a lesson can be used to revise a particular hypothesis or to suggest the creation of new hypotheses.

Looking back to see links between teaching strategies used during the lesson and learning opportunities experienced by students would enable researchers and teachers to examine the accuracy of their predictions, to learn from "experience carefully planned in advance" (Fisher, 1953, p. 8). It would reinforce for everyone the realization that the lessons for which they choose to slow down the teaching cycle are carefully planned experiments that can be seen through a cause-effect lens (Gallimore et al., 2009).

Because predictions are based on unproven hypotheses, many of the initial versions will not be very accurate. However, over the years, as researchers and teachers become more explicit about their predictions, gather more information, and reflect on this information to propose revisions, the soundness of the hypotheses and the accuracy of the predictions will gradually improve. As researchers gather information provided by individual teachers, examine emerging patterns, share these with other partnerships and suggest additional tests of best predictions, the robustness of hypotheses will grow and theories could be gradually built and refined.

To reap the benefits of many teachers individually testing and refining hypotheses, and many researchers assisting with gathering, organizing, and analyzing incoming data, there must be ways to record, store, and share the ongoing findings and the best current practices. This brings us to our third big change that teachers and researchers might make if they become invested in building theories of creating SLOs.

Creating Artifacts Long ago, Dewey (1929) observed that one of the saddest things about American education is that teachers take their best ideas with them when they retire. Educators have no good way to preserve what individual teachers learn from their experience. Thousands of teachers like Lucy Scott drive to school every day ready to tackle similar instructional problems (e.g., how to help students understand equivalent fractions), but the current education system in the U.S. provides no way to record and share their hypotheses, predictions, and observations so as to benefit other teachers and their students (Rothkopf, 2009).

A promising approach to recording, preserving, and sharing information across classrooms is to agree on an artifact into which teacher-researcher partnerships could record what they learn from the process we have described. A variety of artifacts are possible, including a record of the presentation of a particular task plus the ways in which students work on the task. Tekkumru-Kisa et al. (2020) argue that examining "the enactment of a particular task, from beginning to end … allows researchers to see, organize, and analyze students' opportunities to learn in meaningful ways" (p. 607). For us, however, lesson plans have a special appeal (Morris & Hiebert, 2011, 2015; Stigler & Hiebert, 1999). Cai et al. (this volume) recommend a similar artefact using a different name, "teaching cases"). For one thing, lesson plans are written at a grain size that is recognized across countries and cultures. Based on our analyses of the TIMSS Video Study lessons, we believe it is the smallest unit of instruction that preserves the system of creating SLOs (the system of teaching in Fig. 2.4) (Stigler & Hiebert, 1999). Although a single lesson usually does not develop a mathematical topic fully, it can be analyzed as a unit that stands on its own.

Teachers might find that written lesson plans have several advantages as a shared artifact (Morris & Hiebert, 2011). Because almost all teachers use lesson plans in some form, they are a familiar instructional tool indexed to content topics. By annotating lesson plans with the current and best teaching strategies for that lesson, teachers have access to this knowledge just when they need it. This knowledge consists of the most refined predictions at the time for how to create SLOs that have been found to help students achieve the lesson learning goals(s) along with the hypotheses that provide the rationale for these predictions. Accessible rationales increase the likelihood that the strategies will be implemented as intended and decrease the likelihood that future predictions will repeat the same mistakes as previous predictions.

Lesson plans also provide a natural receptacle for what partnerships learn as teachers enact the plans. And, because annotated lesson plans provide a storage place for knowledge, they can carry the profession's memory, providing a way for new teachers to pick up where the previous generation left off. Shared, updated lesson plans can prevent the profession from suffering "collective amnesia" (Shulman, 1987, p. 11), forcing every new teacher to start over. John Dewey would be pleased.

Finally, lesson plans provide a type of an instructional artifact around which teachers, researchers, and others with relevant expertise can collaborate to solve common instructional problems (Morris & Hiebert, 2011). Modifiable, shareable artifacts uniquely enable collaborative learning by becoming the public focal point for the exchange of information and ideas (Bereiter, 2005). A consequence of this collaborative activity is that teachers could experience a cultural shift from treating teaching as an individual private enterprise to treating it as a collaborative, public, and reflective activity. This would be a significant change, in part because it can encourage teachers to recognize they are capable of sustained growth as true professionals (Franke et al., 1998).

5 Conclusions

We have proposed a new conceptual model to guide research on teaching and learning. Although we built on the groundbreaking work of others who explored the idea of mediating variables between teaching and learning, our conceptualization is not common. Many researchers and practitioners still imagine that researchers will discover links between what teachers do and what students learn, with perhaps some mediating variables in between. Given the historical challenges of applying this traditional model to the day-to-day problems of classroom practice, we proposed an alternative model as a way to move theories of teaching closer to the work of Lucy Scott and her colleagues. Rather than trying to extract more from the traditional models, we believe efforts would be better spent fleshing out the alternative model that sets SLOs as the proximal goal of teaching.

The brief descriptions we have provided of the model, of the theories that could be built from the model, and of the processes that might be used to build the theories are intended to provide a glimpse into the possibilities. But the descriptions do not resolve many issues of which we are aware and even more issues that are sure to arise. It is clear that, in addition to the massive work that will be required to build out theories of creating SLOs, more work will be needed within the second system in the model (Fig. 2.4)—the transformation of SLOs into learning outcomes. More complete and better specified theories of learning are needed to tie SLOs to learning outcomes. These theories will require more sophisticated ways of defining and assessing what SLOs could look like in classrooms. Because theories of creating SLOs are dependent on specifying their features and linking them to well-defined learning outcomes, work within both systems must proceed together.

If the model we have proposed is taken seriously, researchers and teachers will need to work together to explore its ramifications and to build useful theories of creating SLOs. We have described some possibilities of the form this work might take, but we are curious to see what conditions teachers and researchers decide are critical for doing this work *and* for sustaining it over the time.

It is too early to make claims about the ultimate impact of this work, but we believe it is sufficiently promising to warrant serious attention. We recognize this is not a quick fix for putting useful theories into the hands of teachers. It will take years to see the payoffs in terms of student learning gains. As one anonymous reviewer of this chapter phrased it, “the promise of this work will depend on how it gets taken up, developed and elaborated.” This can be, by itself, a reason to *not* take the model seriously.

Following the TIMSS-R Video Study of Mathematics and Science Teaching, the first author testified before a U. S. congressional committee on education. The testimony did not describe theories of creating SLOs, but it did outline the work we have described that lies behind the creation of these theories. The next day the first author received a call from a U.S. senator’s office asking for more details about such a plan for American schools. The senator’s assistant asked how long this would take. When the assistant was told 15 years, maybe 10 at best, he laughed and asked what a 1–2 year plan would look like. When he was told there was no such plan, he hung up the phone and was not heard from again. Educational theorists and researchers face major challenges in convincing themselves and others of the benefits of long-term research agendas.

6 Our Answers to the Editors' Questions for the Authors

The editors of this book asked all authors to address the following questions, either in the context of their presentation or as an additional section at the end of their chapter. We have addressed most of the questions but our answers might be somewhat hidden and implicit. So, we will address all four questions here. If the earlier sections contained relevant responses, our answers will be brief.

6.1 What Is a Theory (of Teaching)?

We can begin with the definition of theory that we presented and that is consistent with the definition presented in the introductory chapter by the editors of this volume (Praetorius & Charalambous, this volume): an interrelated set of ideas intended to explain something. The statement we borrowed from Hill and Smith (2005)—"theory helps identify what factors should be studied and how and why they are related"—helps to clarify our focus. Because we are interested in theories of teaching that teachers actually can use, our theories of teaching attended to "factors" of the classroom environment that teachers normally use to make instructional decisions.

This bias toward theories that are usable by teachers leads us to the following answer to this first question. In a general sense, theories of teaching must account for how the intended curriculum, broadly defined, is transformed into learning opportunities that are experienced by students. This means that, in our view, theories of teaching consist of connected sets of hypotheses that predict how specific instructional activities and tasks will produce learning opportunities experienced by students in particular ways. That is, theories of teaching are capable of guiding the cause-effect reasoning that lies at the core of making instructional decisions about what kinds of tasks and activities will yield what kinds of sustained learning opportunities, and they do so with an eye toward studying and improving these decisions.

6.2 Can Such a Theory Accommodate Differences Across Subject Matters and Student Populations Taught? If So, How? If Not, Why?

Our response is “yes,” and “no.” Theories of teaching can be developed in general ways that allow researchers and educators to swap out subject matter, student populations, and other contextual variables without changing the theory. Returning to our interest in theories that are useful for teachers, such theories could help teachers make and test instructional decisions but mostly in general and vague ways. More helpful theories would be those developed with more specificity, and more specificity requires building into the theories information about contextual variables.

For example, when Lucy Scott, our sixth-grade teacher, makes decisions about what tasks could help her students understand equivalent fractions and how to implement these tasks, a useful theory would contain informed hypotheses about the kinds of experiences students need to develop conceptual understanding of key mathematical concepts and how to create them. The more specific the hypotheses are about developing understanding of equivalent fractions, the more useful the theory. The hypotheses would specify features of these experiences, like struggle-first, that would, in turn, suggest selecting equivalent fraction tasks with considerable cognitive demand and situating them deliberately in lessons so as to increase her students’ chances of experiencing productive struggle with equivalent fractions. Theories would become increasingly useful as other teachers experimented with similar tasks and researchers accumulated information over multiple trials.

This leads to another element of theories of teaching that makes them useful for teachers: hypotheses are specific enough to be indexed according to the learning goals or outcomes students are asked to achieve. Because different classroom experiences are related to different learning outcomes, teachers will want to access hypotheses about the kinds of teaching actions that will lead to experiences aligned with the learning goals they want their students to achieve. If the hypotheses are too general, they cannot help teachers like Ms. Scott make instructional decisions for *this* lesson with *this* learning goal.

6.3 Do We Already Have a Theory/Theories on Teaching? If So, Which Are They?

This question is difficult to answer because, in our view, theories of teaching are necessarily so complex that they are only in progress; they are never complete. In our view, not shared fully with some authors in this volume, the status of a theory can be measured by the number of hypotheses that have been formulated, the range of classroom learning events they can predict, and the state of empirical confirmation of these predictions. Using these criteria, we would say the field has theories at the very beginning stages of development. Often, the “theories” are more like small collections of hypotheses that still need to be fully tested.

One of the huge challenges facing theorists of teaching became clear for us while working on the TIMSS video studies. We learned that, although it is possible within a single culture to maintain the view that teachers' particular actions are the causes of particular learning outcomes, this view is hard to sustain in the context of cross-cultural comparisons. We found that many of the variables educators have believed are important—whether teachers lecture to the whole class or divide the class into student work groups, whether teachers use concrete or abstract representations, whether teachers use technological tools or just write on the chalkboard—turn out to vary among these countries. These do not appear to warrant theorists' attention as individual variables. It was not the teachers' actions, or even the problems presented to students, that higher-achieving countries shared. Rather, it was how the elements of a lesson were configured and the way in which students engaged with the learning opportunities.

To make things even more challenging, we found that different kinds of teacher actions could produce similar kinds of learning opportunities and similar kinds of teacher actions could produce different learning opportunities. What mattered was the way in which students took up the opportunities. Across the higher achieving countries, we saw many different instructional strategies and teachers' actions that resulted in the richest kinds of learning opportunities—repeated opportunities for students to engage in productive struggle to make connections among important mathematical concepts, facts, and procedures. These findings help to explain why the field is struggling to build theories of teaching that teachers can use.

6.4 In the Future, in What Ways Might It Be Possible, If at All, to Create a (More Comprehensive) Theory of Teaching?

Our first response to this question is that we have described what Lipsey (1993) calls "small theories attempting to explain treatment processes, not a large theory of general … phenomena" (p. 11). In this sense, we have shown, at least implicitly, our bias against "comprehensive" theories of teaching. This is due partly to our belief that "small theories," focused on teaching processes that lead to particular learning opportunities for students, are the kinds of theories that will be useful for teachers. Our interest in "small theories" also is due to our skepticism that, at this point in the history of theory development and research on teaching, developing a comprehensive theory of teaching is likely, or is even the next best step.

However, we certainly endorse the goal of creating more comprehensive "small theories." Our answer to the question of creating gradually more comprehensive (small) theories is contained in our descriptions of building theories of creating sustained learning opportunities. We can pull out a few features of this work that seem especially important: begin with documented connections between the kinds of sustained learning opportunities that yield specifiable learning outcomes; develop hypotheses about how teachers can create sustained learning opportunities of the targeted kinds; continuously test and revise predictions suggested by the hypotheses; coordinate the work of teachers and researchers to test predictions and revise hypotheses; aggregate findings across classrooms and search for patterns that rise above specific contexts; and, find ways to create sustainable partnerships between teachers and researchers, and build networks of partnerships. As learning theorists and researchers continue to identify the features of sustained learning opportunities that yield particular learning outcomes, researchers and teachers can continue to expand the scope of their theories of teaching.

We want to repeat that the processes we have identified for building more comprehensive theories are tailored to the values we expressed at the beginning of the chapter and to the kind of theories in which we are most interested. Stepping back, we recognize that the processes for building theories of teaching will result, in large part, from the kinds of theories the community wishes to build. Authors of other chapters in this volume outline different theory-building agendas.

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Chapter 3
Teaching Effectiveness Revisited Through the Lens of Practice Theories

Svenja Vieluf and Eckhard Klieme

Abstract In research on teaching, there is a tension between the intention to provide educational practice with clear and convertible recommendations and the wish to do justice to the whole complexity, contingency, uncertainty and ambiguity of social interactions. Multiple research paradigms address this tension in different ways. The chapter brings together two such contrasting paradigms: *Teaching Effectiveness Research* (TER), which uses quantitative methods for explaining and predicting criteria of "teaching success" with characteristics of teaching, and *practice theories*, which aim at reconstructing classroom practice to gain an understanding of the social order in the classroom without a priori assumptions regarding their desirability.

Presenting a specific instantiation of TER, the Theory of Basic Dimensions of Teaching Quality (TBD), the chapter elaborates on two major limitations of TER in general, and TBD in particular: a simplistic concept of relations between teaching and learning and a lack of understanding of the dynamics of classroom interaction. To better understand, and to some extent overcome these limitations, the chapter critically reflects on TER/TBD by contrasting it with a practice theoretical perspective. Using these two paradigms, the paper advances the idea that the dialogue between paradigms can be inspiring for empirical research and theory-building.

Keywords Teaching effectiveness research · Teaching quality · Opportunity-use models · Teaching practices · Practice theories

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1 Introduction

Teaching is attributed key importance for society: It is supposed to support the young generations with personal growth and autonomy (“Bildung”), help qualifying a workforce, socializing citizens and integrating them into society, and, thereby, both reproducing and stabilizing society as well as building human powers to develop and change it. Teaching also plays a role in the context of allocating students to different career paths (Fend, 2008, p. 53, see also Biesta, this volume).[1] Thus, one aim of research on teaching is finding out, how teaching can best fulfil one or several of these functions. However, the functions are controversial and some of them difficult to reconcile with each other. Teaching is set within fields of tension between different aims and expectations; for example, between the aims of fostering student autonomy versus ensuring that students achieve specific predefined educational goals and between treating all students equal versus compensating social disadvantage (Helsper et al., 2001; see also Biesta, this volume). Moreover, teaching is a social activity and, as such, intricate, not fully controllable and ambiguous (e.g., Cohen, 1989; Luhmann, 2002; Ricken, 2009). This makes it difficult to find answers to the question what constitutes good and successful teaching. Consequently, not only teachers, but also educational researchers, operate within a field of tension: The expectation that educational research should produce implementable advice for practice and the demand that educational research should give account of the whole complexity and ambiguity of the research topic can be considered difficult to reconcile.

Different research paradigms address this field of tension in fundamentally different ways. According to Kuhn (1962) a paradigm refers to a unique combination of ontology, epistemology, and methodology or to “a whole way of doing science, in some particular field” (Godfrey-Smith, 2003, p. 76).[2] Any paradigm may include a variety of theories which cover that field in general, or some part of it. The field of research on teaching is heterogeneous at the beginning of the twenty-first century, with several paradigms and many theories being concurrently relevant.[3] Some paradigms of research on teaching explicitly aim at answering the question, how teaching can best achieve its functions and aims. This is often framed as the quest

[1] Please note that this is a descriptive, not a normative statement, i.e., the observation that schools in the twenty-first century fulfil these functions does not imply that this ought to be so.

[2] This is not the only meaning of the term “paradigm”, not even the only meaning that Kuhn discusses, but for simplicity we refer only to this meaning in the present chapter.

[3] In contrast to Kuhn, but in line with e.g. Lakatos (1970) and Laudan (1977), we assume that different paradigms can co-exist over long periods of time within fields of the social sciences. Zima (2017) questions even more fundamentally whether Kuhn’s notions of paradigm can be applied to the social sciences at all. He suggests the idea of different “sociolects” instead. In his terms, the present paper promotes the vision of “dialogical theory” in the field of teaching, based on the “interaction of rival sociolects” (Zima, 2017, p. 116). Yet, the alterative terms like “research programmes” or “sociolects” also have disadvantages. Thus, we use Kuhn’s term “paradigm” in the present chapter even though we do not fully agree with his conceptions.

for teaching quality. Acknowledging that quality is both a normative and an empirical concept, answers are given in reference to conceptualizations of "good teaching" and/or "successful teaching" (Fenstermacher & Richardson, 2005). Paradigms in traditional pedagogy and didactics aim at specifying "good teaching" and providing guidance for reflective practitioners, combining philosophical and scientific concepts, professional wisdom, norms and rules for manoeuvring the complex space of teaching and supporting the process of "Bildung" (Prange, 2012; Terhart, 2016; Westbury et al., 2000). The concept of "successful teaching", in contrast, requires empirical analysis of "what works". It is the focus of teaching effectiveness research (TER; Kyriakides et al., this volume; Muijs et al., 2014; Scheerens, this volume; Seidel & Shavelson, 2007), which can be understood as a research paradigm that uses quantitative methods for explaining and predicting criteria for "teaching success" with characteristics of teaching. This paradigm is based on an instrumental understanding of teaching (see Chazan et al., 2016). Other paradigms present in the field of research on teaching explicitly refrain from defining and analysing "teaching quality" and ask more fundamental questions, such as "What is teaching?" "What distinguishes teaching from other forms of social practice?" (e.g., Breidenstein, 2006; Kolbe et al., 2008). They emphasize more the complexity, context-specificity, and ambiguity of teaching. The underlying understanding of teaching has been called "fundamental" by Chazan et al. (2016; see also Herbst & Chazan, this volume). The practice theoretical paradigm is one example. It aims at reconstructing practices to gain an understanding of the social order in the classroom without a priori assumptions regarding their desirability.

In the present paper we bring together two of these contrasting paradigms: We present a specific instantiation of TER, the Theory of Basic Dimensions of Teaching Quality (TBD), identifying major limitations and unresolved issues. We argue that major limitations of TER are a too simplistic concept of relations between teaching and learning and a neglect of the sequencing of interactions in the classroom and, thus, a lack of understanding of classroom dynamics.[4] In the attempt to better understand, and to some extent overcome these limitations, the chapter refers to a fundamentally different combination of ontology, epistemology, and methodology: the paradigm of practice theories. The chapter aims at critically reflecting TER, and in particular TBD, by contrasting it with a practice theoretical perspective and, based on this reflection, it also aims at developing first ideas for a reconceptualization of theoretical foundations of TBD and research methods used in the field. Building bridges between disparate paradigms is a risky project—yet it may help strengthen the theoretical foundations of research on teaching. Among other things such a venture creates awareness for the particular sets of assumptions, values, and beliefs

[4] These two criticisms against TER are shared by Hibert and Stigler (this volume). However, their response is substantially different from ours. Hiebert's and Stigler's theory is based on cognitive learning theories, while we refer to a social-constructivist understanding of teaching and learning.

about the social, about knowledge and about research itself, that characterize a research paradigm and may appear self-evident, almost "natural" from within.[5]

Consequently, the paper deviates from the pattern of other chapters in this volume. From an epistemological point of view, our aim is "doing theory": we explore and outline a specific theory of teaching quality as an example of TER theories (TBD), but we move on to revisit, re-conceptualize this theory and its measurement approach by discussing it from the perspective of a fundamentally different paradigm of social science (practice theories).

The structure of the chapter is the following: In Sect. 2 foundations and limitations of general TER are discussed as well as some recent developments in this field of research. TBD—as one specific theory within TER – is introduced in Sect. 3 and specific voids concerning this theory are identified. Section 4 introduces "opportunity-use-models of the effects of teaching", a further development of TER, which integrates mediated process-product research with constructivist systems theory. In Sect. 5 the practice theoretical perspective is introduced, and in Sect. 6 its potential for reconceptualising classroom dynamics in TER is mapped out. Ultimately, in Sect. 7, we will answer the questions put forward by the editors of this volume.

2 Foundations and Limitations of TER

TER (Scheerens, this volume; Seidel & Shavelson, 2007) responds to the quest for teaching quality through empirical and quantitative studies of "successful" teaching. The paradigm is part of the Educational Effectiveness branch of Educational Research which has developed over several decades (Hall et al., 2020; Kyriakides et al., this volume; Reynolds et al., 2014). Its approach to researching teaching is rooted in the epistemological perspective of "critical rationalism" (Popper, 1959). Its core is the search for teaching characteristics, patterns, or types of teaching which statistically predict so-called "student outcomes"—mostly learning gains in different subjects. TER, thus, aims at offering comparatively straightforward answers to the question, how classroom teaching and learning can be improved.[6] Since its invention more than half a century ago, TER has mostly been based on the

[5] Our approach differs from how Scheerens (this volume) compares TER with yet another paradigm, critical theory of education. Scheerens is basically confronting the two paradimgs, which he believes to be incommensurable, in order to sharpen his explication of TER. He does not seek building any bridges, and his comparison does not lead to any change in conceptualizing TER.

[6] The acronym TER is also often used for Teacher Effectiveness Research (e.g., Creemers & Kyriakides, 2015; Muijs et al., 2014). Similar to the distinction between "Teaching Quality" and "Teacher Quality" (Gitomer, 2008), identifying "teaching" as the research topic indicates a restriction (talking about professional activities, or more specific classroom activities, rather than all sorts of teacher characteristics), and oftentimes a confession that those activities need to be conceptualized as interaction of teachers and learners rather than teacher behavior. In the present chapter, we are talking about "Teaching Effectiveness"/"Teaching Quality" in that sense, while including relevant research that has been published under the label "Teacher effectiveness".

observation of classroom processes, combined with the measurement of so-called „student outcomes“ (Creemers & Kyriakides, 2015). In its beginning, it aimed at „determining how more and less effective teachers act and then trying to get teachers to act in the ways that distinguish the more effective ones” (Gage & Needels, 1989, p. 253) by examining direct effects of processes (mostly teacher behaviour, sometimes student behaviour, and teacher-student interactions) on outcomes (mostly student achievement). Later it was merged with the paradigm of cognitivism, and student cognitions were included as mediators between process and product in the so-called “mediated process-product approach” (e.g., Borich, 1986; Creemers & Kyriakides, 2015; Doyle, 1977; Rothkopf, 1976; Winne, 1987; see also Hiebert & Stigler, this volume). Meanwhile, TER has grown into a wide range of research activities which receive much attention within different research communities (educational psychology, organization research, Large Scale Assessment) as well as communities of professionals and policy makers.

2.1 Criticisms Against TER

TER has been harshly criticized ever since its emergence (Scheerens, this volume). Various points of criticism have been summarized, reviewed and evaluated by Gage and Needels (1989) already in the 1980ies—yet their paper is in many regards still relevant. They distinguished between conceptual criticism, methodological criticism, criticism of productivity, and criticisms of interpretation-evaluation. Conceptual criticism includes a neglect of teachers’ intentions (i.e., the teachers’ own conceptions of the purposes of their behaviour in the classroom), a neglect of contextual conditions influencing teaching (e.g., subject matter, grade level, student characteristics), and a neglect of the sequential nature of classroom interactions (i.e., that teaching a topic requires an introduction into the topic, consolidation of new knowledge, reasoning about the topic as well as transfer and that teaching effectiveness might depend on the concrete positioning of a teacher behaviour within such a sequence). Another conceptual criticism is that “the goal directed, normative nature of teaching makes it not amenable to empirical investigation” (ibid., p. 258). Teaching aims at achieving purposes which have been defined by humans and, thus, are subject to constant change. This variability, the critique argues, precludes the development of nomological laws and, thus, the use of scientific methods.[7] Criticism further concerns the assumption that teaching is directly related to learning. This has been dismissed as being too simplistic and mechanical, as reflecting “an overly simplified notion of causality” (Tom, 1984, p. 70). Even more fundamentally, process-product research has been criticized as being “atheoretical” (see Gage & Needels, 1989). Criticisms of methodology encompass that

[7] This criticism, however, reflects a very restricted view of science, and it has also been strongly rebutted by Gage and Needels.

process-product research has searched for "implausible relationships between teaching behaviour occurring at one point in time and student achievement in another subject-matter at a relatively distant other point in time" (ibid., p. 265) and, related to this, that it has treated teacher behaviours as generalizable across time and subject-matters, that it has used predetermined coding categories based on common sense and prior unstructured observations instead of systematic ethnography, that content is often ignored, that cognitive, emotional and motivational processes are neglected, that experiments are not used enough, and that inadequate achievement tests are used (ibid.). Further, process-product research has been criticised for being not sufficiently productive in terms of solving practical problems related to teaching—in particular, answering the question, how to best support student learning. Criticism of interpretation and application concerned the use of meta-analysis, difficulties with implementation in experimental studies, and that universal rules for teachers have been derived from correlational findings, which gives teachers mistaken confidence in the certainty of scientific results (ibid.).

Gage and Needels (1989) rebutted most of this criticism, even though they agreed that investigating longer sequences of teaching and learning activities and including content would be enlightening. Since they wrote their paper, additional progress in addressing the aforementioned points of criticism has been achieved (see Kyriakides et al., this volume, for an overview on phases of TER). The productivity of process-product research can no longer be called into question in terms of quantity and impact, e.g., on teacher education and educational policy. Moreover, several experiments suggest that inducing teachers to use teaching strategies and methods found to be correlated with achievement gains in other classes can actually help them increase the effectiveness of teaching (e.g., Good & Grouws, 1979; Griffin & Barnes, 1986). Further, as outlined above, process-product research has become more complex in the past decades, e.g., by moving from behaviouristic to cognitive approaches. The role of context (e.g., Creemers & Scheerens, 1994; Dunkin & Biddle, 1974) and content matter (Scheerens, 2017; Schmidt & Maier, 2009) further received increasing attention as well as teacher cognitions (Bardach & Klassen, 2020; Clark & Yinger, 1979; Hill et al., 2005, 2019; Kunter et al., 2013; Shavelson, 1983; Shulman, 1986). In addition to achievement, motivation (e.g., Pintrich, 2003) and emotions (e.g., Mayring & Rhoeneck, 2003) were examined as so-called "student outcomes". Plain taxonomies of effectiveness factors have been converted into theoretical models and even theories, such as the integrative process-mediation-product model based on developmental and educational theories which Cappella et al. (2016) presented in the latest edition of the Handbook of research on teaching, the comprehensive dynamic model of educational effectiveness (Kyriakides et al., this volume), or more focused approaches such as the TBD outlined in the present chapter (see Sect. 3). In terms of methodology, some recent coding protocols have been more strongly anchored in theoretical foundations than their predecessors (in particular those developed by Bell et al., 2012 and Hamre et al., 2013). Moreover, the rating process has been better understood and geared to support validity arguments (ibid). Content-focused longitudinal designs (e.g., Klieme et al., 2009; Wright & Nuthall, 1970), including experimental designs (Decristan et al., 2015), allow for studying proximal relationships between teaching and learning, as pre-post-measures and observations are both focused on a single specific unit of instruction. Recently such a design has even been combined with a study examining generalizability of effects across systemic contexts (Opfer et al., 2020). Many of these newer studies also acknowledge the normative nature of teaching by measuring multiple "products" (so-called "student outcomes") in parallel.

To sum up, on an international scale, there is a large body of empirical investigations of teaching within TER, more specifically within the enhanced mediated process-product-approach and many of the critical issues listed by Gage and Needels (1989) have been addressed. However, we argue in the following that past attempts of addressing the criticisms concerning conceptions of causality as well as concerning the neglect of the sequentiality of teaching interactions are still unsatisfactory. Even with mediating and moderating factors included, most TER still assumes a unidirectional, causal chain connecting teacher behaviour ultimately with student learning. As a consequence, the complexity of the moment-to-moment flow of classroom interactions, with teachers and students sometimes initiating an exchange, sometimes responding to each other (as shown, e.g., by classroom ethnography), as well as the contingencies and ambiguities involved in social interactions are not well understood in the teaching effectiveness paradigm. Before we discuss these issues, we will present TBD as one specific instantiation of TER, since the arguments become more vivid when they are illustrated with a specific theory.

3 The Theory of Three Basic Dimensions of Teaching Quality

The theory of basic dimensions of teaching quality (TBD) intends to give an account of results of TER in a systematic and parsimonious way, building upon findings of process-product- as well as mediated process-product-research (Seidel & Shavelson, 2007; Wang et al., 1993). Yet, it adds conceptions of human learning rooted in the paradigm of cognitive constructivism (Aebli, 1963; DeCorte, 2000; Piaget, 1955; Posner et al., 1982). TBD has grown out of an attempt (a) to identify basic dimensions among the many constructs used in TER, and (b) to explain how teaching quality, as covered by these basic dimensions, drives student learning and educational outcomes. Therefore, as Praetorius et al. (2020) pointed out, the theory has two main parts: (a) a structural part, specifying three dimensions which span the space of teaching quality, and (b) an explanatory part, showing how teaching quality explains and predicts student learning. In the Sects. 3.1 and 3.2, both parts of the theory will be outlined together with related research findings. In both cases, empirical findings are mixed—sometimes confirming the theory, sometimes rebutting it, sometimes suggesting a revision, e.g., the introduction of additional dimensions.

While conceptual foundations for TBD have been established by Klieme et al. as early as 2001, the model had not been evaluated in a comprehensive way until recently. Praetorius et al. (2018) reviewed more than 20 research projects guided by TBD, finding partial empirical support for the model. Applying criteria from the logical empiricism tradition in philosophy of science, Praetorius et al. (2020) stopped short of calling TBD a "theory", as they deplored a lack in clarity, coherence and comprehensiveness. Yet, they acknowledged that TBD is a parsimonious set of theoretical statements linking teaching to learning, related (although not always in a clear way) to well established theories, providing testable hypotheses and some guidance for professional practice. The present chapter, using a wider notion of "theory" (see Sect. 6), does call TBD a theory. However, we agree that TBD needs further theory development, including "elaborating on the underlying socio-cultural assumptions more explicitly" (Praetorius et al., 2020, p. 28). This chapter intends to respond to that request.

3.1 The Structural Part of TBD: Identifying Basic Dimensions of Teaching Quality

Clausen (2002) developed a broad set of high-inference video ratings based partly on pedagogical traditions (didactics, reform pedagogy), partly on empirical research in teaching effectiveness and classroom climate, and applied them to the German sample of the TIMSS 1995 Video Study. Through factor analysis of these ratings, Klieme et al. (2001) identified three "basic dimensions" labelled (1) Classroom management, (2) Cognitive activation, and (3) Student support (see also Klieme, 2019; Klieme & Rakoczy, 2003; Kunter & Trautwein, 2013, who provide detailed references to the research literature). Following Praetorius et al. (2018), these dimensions may be characterized as follows.

– Classroom management covers two key principles of teaching: identifying and strengthening desirable student behaviours (e.g., through communicating clear rules and establishing stable routines) and preventing undesirable ones (e.g., through monitoring and intervening immediately if necessary).
– Cognitive activation includes exploring and building on students' prior knowledge and ways of thinking, assigning challenging problems, engaging students in higher-level thinking processes and metacognition—as suggested by constructivist concepts of teaching for understanding.
– Student support is indicated by warmth and respect in classroom interactions, good social relationships, and teachers' helping with student learning.

Several empirical studies supported the three-dimensional structure, using high-inference observations of classroom practice (Klieme et al., 2001; Rakoczy, 2008), student questionnaires (e.g., Fauth et al., 2014) or questionnaires combined with an assessment of teaching materials (Baumert et al., 2010; Kunter & Voss, 2011); (for an overview of related research see Praetorius et al., 2018). Similar dimensioning has further been suggested by other researchers. In particular, the "Teaching Through Interactions (TTI)" framework, operationalized by the CLASS observation instrument (Hamre et al., 2013; Pianta & Hamre, 2009), includes classroom organization, instructional support, and emotional support, which has some resemblance to TBD—even though specific definitions and operationalisations are not the same (Praetorius et al., 2018; Praetorius & Charalambous, 2018; see also Bell, 2020). Moreover, Diederich and Tenorth (1997) argued that classroom teaching requires a certain level of student attentiveness, student understanding, and student motivation—conditions which Klieme et al. (2001) related to the basic dimensions of their model.

However, it should be noted that within the TBD approach (in contrast to TTI and CLASS), there is no canonical operationalization. Consequently, findings regarding the dimensional structure of teaching measures vary sometimes by mode (questionnaires vs. observations) or by perspective (teachers vs. students); also by grade level and subject taught. Some studies have suggested a need for additional dimensions such as clarity (Nilsen & Gustafsson, 2016), subject matter quality (Lipowsky et al., 2018), and cognitive support (Kleickmann et al., 2020).

It should further be noted that the dimensions of teaching quality are not independent from each other. Lack of understanding for their relationships has been a major criticism when Praetorius et al. (2020) evaluated the state of the art in TBD. Conceptually, teaching subject matter for student understanding and helping students to feel competent (a major aspect of student support) do overlap. Alternative modelling approaches developed outside of TBD suggest a hierarchy with classroom management as the foundational or "easiest" and cognitive activation as the most demanding area (Pietsch, 2010).

3.2 The Process Part of TBD: Explaining So-Called "Student Outcomes"

The theory developed by Diederich and Tenorth (1997) served as a starting point for outlining potential effects of the three basic dimensions on students, more specifically on their attentiveness, achievement and motivation. In order to provide more detailed arguments, the explanatory part of the TBD theory additionally refers to different paradigms of classroom research and learning theory:

- Classroom management lays the foundation for learning by preventing disruptions, noise and disorder, e.g. through continuous monitoring of student behaviour (Kounin, 1970). A certain level of quietness and orderliness is a precondition for "time on task", for attentively engaging with the learning content, which should have a positive effect on achievement (Evertson & Weinstein, 2013). If characterized by "informational behavioural regulation" rather than strict teacher control, classroom management may also foster students' experience of autonomy and competence (Kunter et al., 2007).
- Students' achievement and depth of understanding will further depend on the way the learning content is framed and presented. Based on cognitive constructivist learning theories (Aebli, 1963; DeCorte, 2000; Piaget, 1955; Posner et al.,

1982) it can be assumed that knowledge and understanding will be fostered if, among others, students' pre-knowledge is activated, new content is challenging pre- or misconceptions, and students are required to provide arguments and negotiate meaning. TBD assumes that "Cognitive activation", comprising those features, makes deep processing of the learning content more likely.
– Finally, TBD assumes "Student support"—including, among others, providing opportunities for students to present their thinking, informative feedback, and respectful and warm relationships between teachers and students—to foster the experience of autonomy, competence and relatedness which, according to the self-determination theory of motivation (Ryan & Deci, 2000), will deepen students' learning motivation and interest in the subject matter.

Figure 3.1 summarizes the hypothesized paths in a mediated process-product type of model. However, empirical research based on pre-post-designs and carried out mainly in Germany and Switzerland mostly addressed direct effects of teaching quality on student learning.

According to the review by Praetorius et al. (2018), the relationship between classroom management and achievement growth has been supported by the majority of studies—e.g. in secondary mathematics classes (Kuger et al., 2017; Lipowsky et al., 2009), primary science classes (Decristan et al., 2015), secondary German (reading) classes (Klieme et al., 2008) and English as a foreign language classes (Helmke et al., 2008). Some studies report classroom management to be additionally related to growth in student motivation (Doan et al., 2020; Kunter & Voss, 2011; Rakoczy, 2008). The effects hypothesized for cognitive activation and student support have found weaker empirical support. Cognitive activation was associated with achievement growth, e.g., for secondary mathematics (Dubberke et al., 2008; Kunter & Voss, 2011; Lipowsky et al., 2009), secondary German (reading) classes

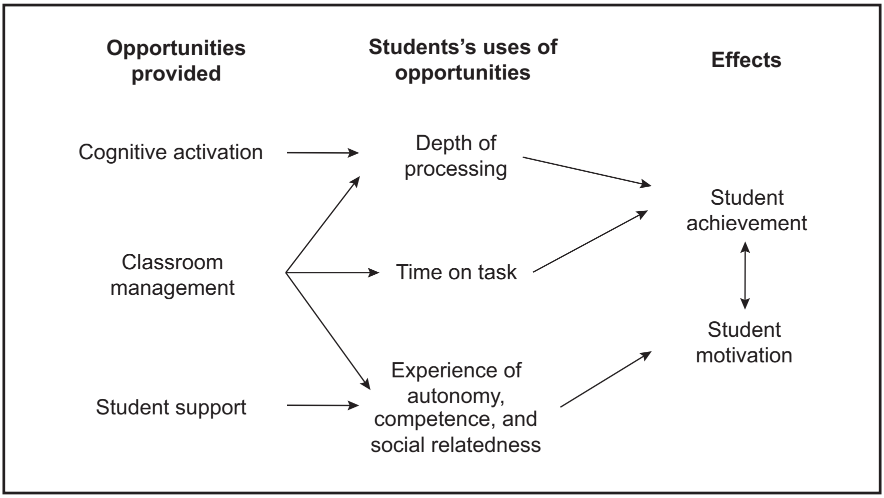

Fig. 3.1 Process part of TBD. (Praetorius et al., 2020, p. 20. Adapted and translated from Klieme et al., 2006)

(Klieme et al., 2010), and primary science education (Decristan et al., 2015). Student support was associated with growth in students' interest in primary (Fauth et al., 2019) and secondary schools (Klieme et al., 2008; Kunter, 2005). Yet, when restricting the review to the most powerful empirical design, multi-level longitudinal analyses modelling all three dimensions at once, less than half of the expected effects for cognitive activation and support were confirmed (Praetorius et al., 2018).

Although not explicated in TBD, student support further sometimes also correlates with achievement growth (e.g., Decristan et al., 2015, for science education in German primary schools), and cognitive activation correlates with change in student motivation (as, e.g., shown for mathematics classrooms in Shanghai in the TALIS Video Study; see Doan et al., 2020). One study even found cognitive activation to mediate effects of student support and classroom management on student interest in biology (Dorfner et al., 2018). Thus, functional consequences of teaching quality dimensions are not as clear-cut as expected. This may be due to the interrelation between the three dimensions discussed before. When two or all three (partially confounded) dimensions are included at once in predicting so-called „student outcomes", oftentimes just one dimension prevails. So far, little is known on how the three dimensions of teaching quality interact and complement each other.

Likewise, there has been little research testing the mediation part of the model, i.e. the hypothesis that teaching quality has an effect on so-called „student outcomes" through students' attentiveness, cognitive activity, and feeling of self-determination. Some empirical findings supported parts of this mediation model (Rakoczy, 2008). Recently, a German enhancement to the TALIS Video Study, applying a post-hoc student questionnaire to measure individual mediators or "the individual use of learning opportunities", confirmed effects of use on achievement and interest, but failed to establish mediation (Praetorius et al., 2020). To account for the interplay between the individual "use" and the "opportunities" provided by teaching, some researchers (e.g., Seidel, 2020) suggested moderation instead of mediation models, allowing for direct effects of either variable on "outcomes" plus an interaction term. However, as we argue in the following section, it is questionable whether „use" can in fact be disentangled from "opportunities" and measured through standardized student questionnaires.

4 Teaching Effectiveness Beyond Claims of Unidirectional Causal Impact: The Concept of Opportunity and Use

The idea that teachers can directly cause student learning has long been questioned (see Biesta as well as Hiebert & Stigler, this volume). The criticism of mechanistic linear conceptions of causality in TER has been addressed with the concept of "opportunity and use". This approach, which—as we argue—transcends mediated process-product models, is popular in the German speaking quantitative research on teaching effectiveness (Vieluf et al., 2020). A few authors (most from German-speaking countries) have also published research in English-speaking journals citing an opportunity-use-model (e.g., Brühwiler & Blatchford, 2011; Göbel & Helmke, 2010; Lipowsky et al., 2009). Yet, there is no publication in English language which provides a detailed description of the theoretical concept and its background.

Fend (1981, 1982) and Helmke (2003), who developed the first opportunity-use models (meanwhile other authors have formulated additional variations of these models), built upon international mediated process-product research as well as discussions about "opportunity to learn" (McDonnell, 1995). The "opportunity" in their models refers to teaching processes and the "use" to individual cognitive, motivational and emotional processes, i.e. the mediators in mediated process-product research. Learning, according to opportunity-use-models, only takes place when the learning opportunities emerging during the lesson are used by the students. Additionally, the roles of the context at different levels of the educational system and that of the individual characteristics of students and teachers are recognised. These are conceptualized as independent variables affecting opportunities and/or use, but sometimes also as moderator variables that moderate the associations between opportunity and use.

As shown in Fig. 3.1, the process part of TBD has also been framed as an opportunity-use-model (Klieme et al., 2006; Kunter & Trautwein, 2013; Praetorius et al., 2020). The three dimensions—classroom management, cognitive activation, and student support—are thought to describe patterns of classroom interaction indicating a specific quality of learning opportunities. Their effects on student achievement and student motivation are conceptualized to be mediated by students' use of the learning opportunities. Students are more motivated to learn and learn more, the more they get involved with the lesson content ("time on task"), the deeper they process this content, and the more they experience autonomy, competence, and relatedness during the lesson. Effective classroom management, cognitive activation and student support make this more likely.

Some parallels to Hiebert and Stigler's (in this book) concept of "sustained learning opportunities (SLOs)" become apparent. In particular, the three dimensions refer to patterns of interaction "that emerge during classroom lessons from the interactions of multiple mediating variables to create the contexts in which learning occurs" (ibid, p. 62) and it is assumed that teachers contribute to their interactive emergence, but cannot directly cause student learning. However, Fend went further than that. He also drew on systems theory (Luhmann, 2002; Luhmann & Schorr, 1979) to map out the relation between teaching and learning. He argued that the same opportunities are not always used by all students and that they are more likely to be used by students with whose psychic structures (e.g., pre-knowledge) they are compatible. Hence, teaching has no universal quality, but needs to be adaptive to the particular needs of each individual student. This idea could be understood as implying the existence of multiple moderation effects, i.e., systematic variation in the strength of the relations between opportunities and use depending on different student and context characteristics. The context at different levels of the educational system as well as individual characteristics of students and teachers are assumed not only to affect the qualities of teaching and learning themselves, but also the relation between both.

Yet, Fend also argued that the potential influence of teachers on students is—even more fundamentally—limited by the psychic systems' momentum of its own (in the sense of the German term "Eigendynamik") or by the "autonomous intentionality" (Fend, 2008, p. 130) of students. Use is then to a certain extent uncertain.

To understand this argument, it appears helpful to include a short summary of some aspects of Luhmann's complex constructivist systems theory, because Fend (in later publications of his opportunity-use-model) explicitly referred to this theory. Luhmann (1986) conceptualized systems as self-organized and autopoetic.[8] They need to ensure their continued existence and, to this end, they only take up information that is relevant for their survival and development. In the process, systems develop immanent structures and stabilize themselves implying that the elements of the system are continuously reproduced by the elements of the system. For social systems (e.g., school classes) and psychic systems (e.g., students and teachers) the elements are not substance but meanings. Social systems reproduce themselves on the basis of communication, while psychic systems reproduce themselves on the basis of thoughts. Different systems are operatively closed against each other: no system can contribute elements to the respective other system. Hence, no teacher can instil knowledge into students or change their thoughts nor can the social system of the classroom directly produce changes in a student. However, different systems can be structurally coupled: A personal or social system can observe other systems, learn how they function, and start adjusting their structures accordingly. Systems further can be self-reflective; they can notice "before-after differences". Learning, in this perspective, means that structural changes in the psychic systems of students take place with the aim of adapting to an environment. Such changes are self-induced and need to build upon the existing structures. Teachers can only try to trigger and support them, but not directly intervene into the psychic structures of students. Thus, there is a "technology deficit" inherent to education, i.e., a lack of a linear causal relation between teaching and learning (Luhmann & Schorr, 1979).

Fend's (1982, 2008) concept of opportunity-use refers to Luhmann's notion of a "technology deficit" when arguing that teaching cannot directly cause student learning, but only open up or limit opportunities for individual and autonomous forms of accommodation, i.e., for cognitive processes of revising existing cognitive schemas, perceptions, and understandings so that new information can be incorporated.

Similar to many other theorists of teaching (e.g., Cohen, 1989 or Biesta, this volume), Fend (1981, 1982) also emphasized that teaching is a social interaction, which is inherently uncertain. In social situations it is impossible to know exactly how others think and feel and what they mean when they say or do something. The behaviours of all others are to a certain extent unpredictable. Each individual decides what to do and how to behave under considerable uncertainty (this is called

[8] Note that Luhmann's abstract, philosophical/sociological notion of systems should not be mixed up with the (socio-)technological notion of systems as used, e.g., by Scheerens (this volume).

"double contingency" by Luhmann (1986)). Therefore, teachers can contribute to the interactive emergence of learning opportunities, but they cannot determine them. How their doings and sayings are understood by students might differ from how they were intended, and reactions of students—which are to a certain extent unpredictable—also fundamentally shape the interactions. Hiebert and Stigler (this volume) also write that teachers cannot create SLOs on their own, but only together with the students. Yet, Fend made this argument more explicit by representing the relations between opportunity and use as reciprocal and moderated, and as affected by a certain "Eigendynamik" of the different systems involved.

The following example aims at illustrating all three arguments[9]: One strategy for stimulating a cognitively activating dialogue is asking questions like: "Well, could you please explain why you think so?"[10] Yet, such questions cannot directly change students' thinking. The opportunity for cognitive activation inherent in such questions only unfolds when the student addressed by the question—or at least classmates—understand the question as invitation to reflect the own preconceptions (some might, for example, understand it as an implicit negative feedback revealing that what they had said was wrong and, consequently, pull out of the dialogue). When students understand the question as invitation to reflect, then they also must be motivated and able to cooperate and contribute to the dialogue by giving responses that offer insight into the way they construct the subject matter. Whether students are able and motivated is likely to depend on individual characteristics (their general learning motivation (trait), for example) as well as characteristics of the situation and momentary emotional states. Yet, it is, probably, also to a certain extent spontaneous and incidental how the student reacts; result of the students' autonomous intentionality (sometimes even largely unmotivated students participate). So, how the student reacts to the teacher question depends on many things and is quite uncertain. Yet, this reaction fundamentally shapes the subsequent course of classroom interaction and, thus, also the emergence of further learning opportunities. For example, when the student who was asked to explain her thoughts answers: "no idea", the teacher might insist or ask others. But when nobody replies, ultimately, the teacher cannot force students to think about the question, and will probably drop the topic. If students are often unwilling to get involved in such debates, then the teacher might give up and generally stop asking questions of this kind. If, however, the student participates and explains the reasons for her assumption, then the teacher gets a chance to inquire further about her ideas, ask why- and how-questions, and support the student with explaining her thoughts.[11] Then additional opportunities for reflecting preconceptions emerge in the interaction for the student herself, but also for her classmates. Hence, from this point of view, learning is not a consequence or "outcome" of classroom interactions, but rather it is part thereof,

[9] For a qualitative empirical approach to understanding how cognitive activation emerges in classroom interaction see also Schreyer et al. (in press).

[10] This question has been used as an indicator of "cognitive activation" in the Pythagoras study (see Rakoczy & Pauli, 2006, p. 226).

[11] And these are other indicators of "cognitive activation" in the Pythagoras study.

since students' use (and non-use) of learning opportunities shapes the course of the classroom interaction and consequently also the emergence of further learning opportunities.

Modelling a causal chain of variables—such as "inquiring into students thoughts causes student to reflect their ideas which causes students to learn"—does not live up to the complexity of classroom interactions, where inquiring into students' thoughts requires participation of students who might decide not to, and where the use of learning opportunities and the moment-to-moment changes in students' concepts and ideas are not only shaped by the opportunities but also shaping the opportunities. Hence, an opportunity-use approach fundamentally differs from a mediation and even goes beyond a moderation approach. The reason is the highly interactive nature of classroom activities: opportunity and use, teaching and learning can hardly be separated. As a consequence, conceptualizing the interplay of teacher and student behaviours as well as their cognitions, emotions, and motivational states in the classroom is quite difficult in a quantitative research paradigm that assumes linear causality between separable elements (see also Fauth et al., 2020).

Taking the opportunity-use-idea serious, we now conclude that Fig. 3.1 does not reflect this idea properly. So far, TBD has mostly been presented as a classical mediated process-product theory, i.e., a typical example of TER assuming linear causal relationships. This view is now challenged from a true opportunity-use perspective. The complexity of reciprocal interrelations between opportunities and use, teaching and learning, and teacher and student behaviour in the classroom is also reflected in an inconsistency in operationalisations of TBD, which has been pointed out by Fauth et al. (2020): Items meant to assess TBD dimensions sometimes refer to student behaviours, sometimes to teacher behaviours, and some leave open whose behaviours exactly they are referring to. More specifically, "classroom management" sometimes refers to teacher actions aimed at preventing disruptions and sometimes to the occurrence of disruptions, i.e. student behaviour. "Student support" sometimes refers to teacher behaviours, e.g., the type of feedback they give, and sometimes it refers to the quality of relationships between students and teachers which is inherently reciprocal. "Cognitive activation" is predominantly used as a label for specific teacher behaviours, such as inducing cognitive conflict, but sometimes it also refers to students' contributions to the classroom discourse, such as providing reasons for their answers to teacher questions (see also Praetorius et al., 2018). In a traditional mediation model, teacher and student behaviours have different positions within one causal chain and are, thus, not interchangeable. From an opportunity-use perspective it could be argued that opportunity and use are separable only at the level of concrete doings and sayings, i.e. single utterances or single gestures, because they stand in a complex non-causal but reciprocal relation. What we see when we observe learning opportunities is often the result of a complex process of situational adaptations of what teachers had planned and developed beforehand to their perception of students' needs in any concrete situation (and sometimes also to their own situational needs) and students' contributions to the interaction. Thus, the teacher and student behaviours observed in the context of

TBD research might be considered to be different sides of the same pattern of interaction.[12]

In conclusion, opportunity-use-models suggest a reconceptualization of the relation between teaching and learning that better takes the interactive, and therefore uncertain, nature of teaching and the "technology deficit" into account and conceptualizes learning as an autonomous process that cannot be enforced from the outside. What the opportunity-use model does not explain well is why specific sequences of interaction frequently emerge during lessons even though teacher behaviour cannot cause student behaviour and vice versa. Why do, for example, many (but not all!) students stop chatting with the neighbour when the teacher gazes at them? The gaze is rather not likely to have a causal effect. It does not physically prevent chatting. Yet, framing the gaze as an "opportunity" for stopping to chat is also not fully convincing. In the following we argue that perspectives from practice theories can make a significant contribution to answering this question.

5 Perspectives from the Paradigm of "Practice Theories"

The notion of "teaching practices" or "classroom practices" is oftentimes used when getting into details of classroom interaction and measurement thereof (e.g., Bell et al., 2020a). Creemers and Kyriakides (2015, p. 108) consider "understanding effective teaching practices" to be the main goal of process-product-studies on teacher (!) effectiveness, but they do not provide any definition of "practices". Rather, they move on listing strands of "teacher behaviour", ultimately elaborating eight "teacher factors that attempt to measure teacher behaviour in the classroom" within their dynamic model (ibid, p. 116). Likewise, Ball refers to teachers' classroom activities such as explaining, eliciting, diagnosing, and providing feedback as "high leverage teaching practices" (Ball & Forzani, 2009). Balls' conception of "practices", which is very influential in the US, also includes generic aspects of teaching such as "implementing organizational routines", "coordinating and adjusting instruction during a lesson", "building respectful relationships with students", and professional activities outside of classrooms (e.g. "talking about a student with parents or other caregivers"). As in Ball's list, descriptions of "practices" are often focused on the teacher, although in observation and measurement it is acknowledged that the enactment of practices is a co-construction by teachers and students (Bell et al., 2012). All in all, for at least 20 years (see Walberg & Paik, 2000), the term "teaching practices" has been used in a pragmatic way, without clear

[12] Some researchers (e.g., Kunter & Voss, 2013) suggested replacing the term "cognitive activation" by "potential for cognitive activation" in order to discriminate teacher behavior or classroom environment providing such potential from students' actual cognitive activity. The present chapter argues for a different view: Instead of trying to disentangle opportunity from use, which is basically not possible according to Luhmann and Fend, we are searching for ways to talk about them in combination. Practice theories offer such ways.

definition, when describing, classifying, or measuring activities inside or even outside the classroom (see Grossman et al., 2009; Lampert, 2010).

In contrast to this pragmatic and rather fuzzy talk of "teaching practices", there is a deeper theoretical tradition of "practice theories", based in sociology.

In Germany there is already a large body of research on teaching based on practice theories (e.g., Breidenstein, 2006; Idel & Rabenstein, 2013; Kolbe et al., 2008; Reh & Rabenstein, 2013; Reh et al., 2011). Also in the English-speaking discourse this perspective has gained significance (e.g., Edwards-Groves, 2017; Grootenboer & Edwards-Groves, 2019; Herbst & Chazan, 2003).

Sociological "practice theories" are heterogeneous in many regards, but commonly refer to an understanding of practices influenced by the American pragmatism (Pierce, Dewey, and James) and by Wittgenstein. Fundamental for the development of practice theories are the works of Bourdieu and Giddens, as well as the late work of Foucault. Also Butler, Latour, Garfinkel and Taylor are often referenced in this context. Schatzki (1996) as well as Reckwitz (2002, 2003) have worked out the commonalities of these theories to further develop the foundations of a practice theory.[13] Similar to Luhmann's (1984) constructivist theory of social systems, practice theories can be considered a sub-type of "cultural theories", i.e., of theories "which explain or understand action and social order by referring to symbolic and cognitive structures and their 'social construction of reality'" (Reckwitz, 2002, p. 246). However, while Luhmann described the social as systems that self-reproduce through communication, practice theories argue that the social consists of practices which include more than communication.

A practice[14] has been defined as a nexus or "set of hierarchically organized doings/sayings, tasks and projects" (Schatzki, 2002, p. 73). And as a "routinized way in which bodies are moved, objects are handled, subjects are treated, things are described and the world is understood" (Reckwitz, 2002, p. 250). Practices also encompass know-how as well as affects, ends, and purposes (which are not considered to belong to an individual but to be part of the practice) as well as artefacts. All the elements connected within a practice routinely occur together in a specific way and form a block of meaning that is intersubjectively understood (Reckwitz, 2002, p. 249). Yet, this meaning is largely tacit.[15]

This definition is in accordance with a common understanding of practice as "a habitual way or mode of acting" (e.g. Lampert, 2010). Yet, practice theories go beyond this and they understand practices not as an individual habit but as collectively shared. Practices do not serve the purpose of an individual, they include a

[13] "Practice theory" is however, understood as a way of seeig the social and, thus, might rather be called "paradigm" than "theory" in the terminology we adopt for this chapter.

[14] In the German language there is a distinction between *Praxis* and *Praktiken*. According to Reckwitz (2002) "practice" (*Praxis*) in the singular "represents merely an emphatic term to describe the whole of human action". In contrast, "a practice" (*Praktik*) or different "practices" are the focus of practice theories (p. 249).

[15] Bourdieu (1990, p. 69) argues: "It is because agents never know completely what they are doing that what they do has more sense than they know".

shared purpose in themselves. They also include mental doings and sayings and affects as well as artefacts, not only physical doings or sayings. Moreover, practices are not a concrete combination of elements. In carrying out practices there is always the possibility of small changes in interpretations and patterns of action, so there are always nuances which do not necessarily change the intersubjective meaning of the practice (Reckwitz, 2003; Reh et al., 2011; Schatzki, 1996). The practice theoretical perspective further has a "flat ontology" and does not distinguish between macro and micro levels (Schatzki, 2016). This means that the term "practice" can refer to events of differing complexity.

Teaching itself can be understood as a complex social practice, but it is also the interconnection ("bundle" or "complex") of a multiplicity of more basic practices (e.g. putting one's hand up, picking somebody, answering, looking for help, helping, reading, calculating, see e.g. Reh et al., 2011, p. 214). German research on teaching rooted in a practice theoretical perspective has often focused on two practices: pedagogical pointing and addressing (Idel & Rabenstein, 2013; Reh et al., 2011; Ricken, 2009).[16] These practices and many (maybe even all) other basic practices, included in the practice of teaching, can be found in other social contexts as well. Yet, the way they hang together within the practice of teaching is specific. Thus, in the practice theoretical perspective—instead of social norms or accumulated individual rational choices or autopoeisis of systems—practices are the fundament of the social order in the classroom, i.e. the reason for the constancy and continuity of patterns of doings and sayings in the classroom. To go back to our example in Sect. 4: From a practice theoretical perspective, students stop chatting with the neighbour when the teacher gazes at them, because they have come to participate in a practice of "studenting".

Learning can be considered part of every practice inside and outside of schools, including teaching (Lave, 1993; Lave & Wenger, 1991). Learning is existential to social practices as such, because "practices exist only if learned" (Schatzki, 2017, p. 34). Performing social practices always requires „knowing how to x, knowing how to identify x-ings, and knowing how to prompt as well as to respond to x-ings" (Schatzki, 2002, p. 77). Hence, coming to participate in a practice involves learning or coming to know what is needed to participate in it. It is coming to be able to carry out the sayings, doings, tasks, and projects that compose a practice, attaining increasingly greater facility with the performance, performing a wider variety of actions that make up the practice, using the artefacts, organisms, and things and arrangements in the settings where practices are carried out more flexibly and skilfully, choosing better what to do in a practice, coping better with relevant rules and starting to contribute to the determination of normativity related to the practice (Schatzki, 2017, pp. 31–34). This requires propositional knowledge, but—in particular—practical understandings or "know-how" (ibid, p. 24) as well as routinized

[16] Similar to Biesta (in this volume) they refer to Prange (2012) when arguing that "pointing" as a form of creating shared attention on an object is constitutive for teaching. However, they connect this argument to a practice theoretical perspective in general and, in particular, to Butler's concept of subjectivation.

modes of intentionality, i.e. of wanting or desiring certain things and avoiding others, and also a certain emotionality (Reckwitz, 2002, p. 254). Hence, learning—from a practice theoretical perspective—is that transformation of a subject, which is necessary for participation in the social practices a learner encounters (Lave & Wenger, 1991; Schatzki, 2017).

6 Reflecting TBD from the Background of Practice Theories

In the previous Sects. 2, 3, 4 and 5, TER, TBD, opportunity-use-theories, and practice theories were introduced and discussed separately. In this section we aim at bringing those perspectives together. Practice theories and TER, including TBD, appear to have little in common at first sight. TER assumes that the mind is the place of knowledge and meaning structures. TER even aims at finding out how the minds of students can be changed purposefully in a specific way. Practice theories, in contrast, locate know-how and meaning within practices. Similar to systems theory and the opportunity-use model of Fend (1981, 1982), practice theories further advocate an understanding of learning as situated (Ricken, 2009) and reject the idea that teaching processes can purposefully "produce" changes in students' minds. Another fundamental difference between TER and practice theories concerns normativity[17]: TER implicitly presumes that a high score in an achievement test (or a motivation questionnaire) is a desirable goal and central aim of schooling—which is an a priori normative decision (e.g. Sauerwein & Klieme, 2016). Practice theoretical research rather aims at understanding the inner logic of teaching (e.g., Fritzsche et al., 2010, p. 97). Its stance has often been described as one of "normative abstinence". Practice theoretical research on teaching reconstructs implicit ends and shared (often implicit) understandings of what is appropriate and not appropriate as part of practices. But it mostly refrains from determining which ends teaching <u>should</u> have, and from evaluating practices as good or bad, effective or ineffective, from the normative perspective of the researcher. Of course, education is always normatively charged and practices reconstructed may well bear normative consequences. However, the normative evaluation is ultimately left to the reader. Thus, there is more room for ambiguity, ambivalence and contradictions in this paradigm than in TER.[18] Accordingly, research on teaching that uses practice theories as theoretical foundation uses mainly qualitative methods, TER mainly quantitative methods. Yet, it is precisely these fundamental differences between the two paradigms which make it interesting to bring them together. Referring to Mannheim's (1931/1995)

[17] For a discussion of normativity in quantitative vs. qualitative research more generally, see also Praetorius et al. (2021).

[18] However, normative abstinence may not be necessarily connected with practice theories. Reckwitz (2002), in fact, suggested that practice theories might encourage "to regard the ethical problem as the question of creating and taking care of social routines, not as a question of the just, but of the 'good' life as it is expressed in certain body/understanding/things complexes" (p. 259).

theory of perspectivism (“Standortgebundenheit”) and inspired by the ethnographic strategy of “alienation” (“Befremdung”; Hirschauer & Amann, 1997) we argue that a deeper understanding of the familiar can be achieved when it is moved into distance, when it is irritated by taking a different perspective. More specifically, we argue that practice theories can help developing a conception of the relation between teaching and learning beyond the assumption of a linear causation and that it can contribute ideas how to better take the interactive nature of classroom teaching into account in TER.[19]

6.1 Associations Between Teaching Dimensions and So-Called “Student Outcomes” Reinterpreted from a Practice-Theoretical Perspective

From the practice theoretical perspective, the observed correlations between teaching dimensions and so-called “student outcomes” (e.g., changes in achievement test results or in measures of learning motivation, etc.) can be seen in a different light. A practice theoretical perspective suggests understanding teaching as well as test-taking and questionnaire-responding each as specific bundles of practices:

Test-taking describes a practice of producing written (or sometimes oral) responses to questions or assignments, which fulfil certain criteria like being presented with a characteristic expressive style, having a certain structure, being focused, etc. The practice of test-taking might further be interpreted as one variation of the practice of pointing, more specifically, a form of “re-pointing”, i.e., of showing and explaining to the teacher something that he*she had showed and explained before. Often, test-taking also involves general academic practices (e.g., argumentation), and subject-specific academic practices (e.g., mathematical reasoning or solving quadratic equations). Hence, the results of a specific test can be seen as indicative of students’ participation in a specific nexus of practices at a certain point in time; a nexus of practices that has a priori been defined as “good” within research practice (or professional practice or policy guidelines).

Scores in questionnaires aimed at measuring so-called “student outcomes” alternative to achievement (e.g., learning motivation) can also be considered the result of

[19] The conception of “sustained learning opportunities” (SLOs), as proposed by Hiebert and Stigler in this volume, also intends to reflect the interactive nature of teaching. SLOs are described as mixtures of teacher and student activities, a kind of dramatic play, or a complex task enacted by teacher and students. On first sight, the notion of SLO seems to be similar to the notion of practice. Yet, Hiebert and Stigler stick to the process-mediation-product paradigm, replacing traditional mediators by SLOs. They also keep thinking in terms of variables, ultimately defining SLOs as “the interactions of multiple mediating variables to create the contexts in which learning occurs”. And they keep setting teaching (the process that creates SLOs) apart from learning (the processes “that transform learning opportunities as experienced by students into learning outcomes”), while practices are combinations of teaching and learning activities.

a specific practice of filling out questionnaires. They are further self-reports of individual prior participation in the practices the questionnaire asks about, e.g. active learning. Sometimes they only focus on the affective component of these practices, e.g. experiencing enjoyment during learning.

Test scores and questionnaire responses might thus be seen to reveal whether students have come to participate in a priori defined and normatively charged practices. However, they can inform only *whether* students have come to participate in these practices, but not *where* (inside or outside school). In contrast, indicators of teaching dimensions (codings and ratings done by external observers or by participants themselves) inform about the presence or absence of specific a priori selected practices or bundles of practices *during* lessons. For example, a high score on the rating dimension "disciplinary climate" for a lesson indicates the absence of practices of disruption and the presence of the practice of collectively focusing attention on a defined learning content. A high score on the scale "cognitive activation" for a lesson indicates that practices such as irritating preconceptions or arguing have been present during that lesson (Klieme, 2019; Rakoczy & Pauli, 2006; Reusser, 2006; Schreyer et al., in press). Practices of using "errors" as learning opportunities or the absence of practices of social devaluation are, for example, observed in classrooms with a high score for "student support" (Rakoczy & Klieme, 2016).

When test-taking, questionnaire responding and teaching are all understood as complex bundles of practices, then correlations between so-called "student outcomes" and teaching dimensions can come about for three reasons:

First, the teaching dimensions refer to practices that are also part of test-taking. When a large part of the lesson time is spent on practicing these practices and many students participate, then it is likely that students will also participate skilfully in these practices when taking the test. Solving mathematical equations is one example for such practices that might be practiced during a lesson and later be part of an achievement test. Other examples include "comparing and evaluating different task solutions" or "providing reasons for answers to a question", which are both part of instruments aimed at measuring the dimension "cognitive activation" (see Praetorius et al., 2018). Hence, it appears that "cognitive activation" during the lesson should be particularly closely associated with test results. Empirical evidence for this is mixed (ibid.). One reason might be that in many studies measures of "cognitive activation" and achievement tests are not systematically aligned in terms of including similar practices.

Second, correlations between ratings/codes and test-scores can also come about when practices, which are observed to be frequent during a lesson, preclude participation in practices that are part of test-taking. This concerns, in particular, practices of disturbing a lesson which are sometimes observed as indicators for the dimension "classroom management". When students participate a lot in these practices, then they have less opportunity to come to participate in practices that will be part of the test, such as argumentation, solving mathematical equations, etc. In fact, many (but also not all) studies examining effects of TBD on so-called "student outcomes" reviewed by Praetorius et al. (2018) found negative correlations between the presence of disruptions and discipline problems in the classroom and outcomes. One reason for the inconsistent results could be that students also practice the practices relevant for the test at home when it is too noisy in the classroom.

Third, correlations can also be observed when practices involved in taking a test form a nexus with practices assessed by an observation instrument to measure teaching dimensions. For example, specific teacher practices of asking "why and how questions" can be associated with specific types of student argumentation, but not in a sense that "why and how questions" cause student argumentation. Rather, students may have come to participate in the practice of answering "why and how questions" with a specific type of argumentation. In this case, a correlation between the teacher practice of asking "why and how questions" and student test-scores would be observed if taking the test required argumentation practices, because the former would imply that students have often practiced argumentation in the classroom.

This interpretation of the teaching dimensions and their associations with so-called "student outcomes" has some parallels with the concept of "opportunity to learn" (McDonnell, 1995), only that it is not exclusively focused on content but on practices more generally. And it can better explain the empirical observation that correlations between teaching dimensions and so-called "student outcomes" are often only weak or moderate and sometimes expected effects are even absent (see e.g., Seidel & Shavelson, 2007 for TER in general and Praetorius et al., 2018 for research on TBD) than the idea of a linear causal effect between teaching and student learning. More specifically, one reason could be that practices, for example the practice of answering "why and how questions" by providing a certain type of arguments, exist in some classes only and not in others (because here students and teachers have not come to participate in it) or even only for some students, but not for others (because some have come to participate in the practices, others not). Then a correlation cannot be observed universally. Another possible reason for weak correlations is that the two types of research instruments (classroom observations vs. tests or other "outcome"-measures) provide information about the prevalence of practices in the classroom from different angles and with different blind spots: Classroom observations allow for exploring in much detail what happens in the classroom and who participates in which practices, which artefacts are used, etc. during one or several specific lessons. However, accessing mental doings and sayings is difficult through classroom observation. It is, for example, difficult to observe whether students in the classroom, who are not actively participating in a classroom debate, nevertheless formulate answers to the teacher questions "in their heads" or whether they drift off to think about something else. A test can help answering the latter question to a certain extent. However, with test results it can never be excluded that high test scores only reflect that students have participated in relevant practices at home with parents or friends. This is a particular weakness of using achievement tests in research on teaching. Hence, even when tests and observations are well-aligned and really provide different proxies for the presence of the same practices, they are still likely to differ in their results to a certain extent. The practice theoretical perspective can create a particular awareness of this difficulty in research on teaching, because it emphasizes that both types of instruments ultimately aim at assessing similar practices.

Giving up the idea of causality in TER is radical and we don't argue that all TER should do this. However, we think that going along with one alternative argumentation can be instructive and a good complement. In particular, it might be insightful to examine associations between teacher and student practices not only under the assumption that they cause each other, but also under the assumption that they may be associated through reiteration of the association, and, consequently, solely in some classrooms but not in others. This implies that research on teaching quality should reflect more systematically similarities of practices needed for taking achievement tests and the practices enacted in classrooms in the future (research on instructional sensitivity already moves in this direction, see e.g., Naumann et al., 2019). Moreover, it suggests that research on teaching quality should not only search for strong correlations, but also systematically examine differences between classrooms regarding the size of correlations between teacher and student practices, regarding patterns of behaviour-response. A practice theoretical perspective further raises awareness that, in schools, students learn constantly and not only subject-specific academic content—they also come to participate in many other social practices. This points to a need for identifying practices that students should not come to participate in schools. High quality teaching might not only imply that students learn normatively desirable practices such as argumentation, solving mathematical problems, interpreting poems and the like, but it might additionally imply that students do not come to participate in practices that can be considered undesirable, such as devaluing others to secure one's position of power or denying oneself in order to be accepted. Of crucial interest might further become the process of initiation into "high-quality" classroom practices as well as that into practices considered "low quality" (for an example of research examining the process pf initiation see Kemmis et al., 2014). The latter type of research might also focus on the question, why some students in some classrooms do not come to participate in "high-quality" practices while others in the same classroom do. Consequently, an important approach to researching teaching effectiveness might become the detailed reconstruction of the interactive emergence of "high-quality" as well as "low-quality" practices (for an example of a reconstruction of the interactive emergence of cognitive activation see Schreyer et al., in press) as well as the reconstruction of shared meanings or "practical rationality" (for an example see Herbst & Chazan, 2003)—in combination with the common quantitative analysis of correlations.

6.2 The Sequentiality of Classroom Interactions and Implications for the Observation of Teaching Dimensions

The extension of perspective inspired by practice theories, mapped out in this chapter, might also be instructive for a further development of instruments for classroom observation with the aim of better taking the sequentiality of classroom interactions into account. Quantitative observation-based analysis of teaching can take the form of low-inference scoring or high-inference rating. For low inference scoring the occurrence of observable, separate events, types of utterances or types of questions during the lesson is counted or classified. Examples are Bales' *Interaction Process Analysis* (Bales, 1976) and measures of teacher clarity (e.g., Rosenshine & Fürst, 1971). In contrast, high-inference rating requires more interpretation. The observers assess the degree or intensity—but sometimes also the frequency or a combination between frequency and intensity—of more complex patterns of teacher-student interactions. Gage and Needels (1989) argued that even low inference coding requires that preceding and subsequent events to the behaviour of interest are used as contextual information to infer meaning. Nevertheless, many of the earlier instruments coded rather isolated behaviours of teachers or students and used precedent and subsequent events in a rather indirect way as background information to choose the correct code only.

In contrast, recent high-inference observation protocols explicitly acknowledge the complexity of social interactions in the classroom. Two examples are the CLASS system (Hamre et al., 2013) and the observation system recently developed for use in different education systems in the TALIS Video Study (Bell et al., 2020b). For many codes included in these instruments, raters are instructed to use evidence from both teacher and student behaviour. Some codes even explicitly refer to the dynamics of teacher-student interaction, reflecting the foundational assumption that "teaching is intertwined with learning" (Bell, 2020, p. 57). This is true, e.g., for "Aligning instruction to student thinking". The observation manual for this component (Bell et al., 2020b, p. 75) actually refers to two types of interactions:

– "The teacher uses students' contributions." The manual identifies "four types of evidence that count as using student contributions", e.g. "asking a question in response" or "having students provide the next step", and provides several examples, e.g.: "A student gives an answer and the teacher says to another student 'Is that correct?'"; "Students are working in groups and the teacher selects groups to present their work in front of the whole class".
– "If students make errors or struggle mathematically, the teacher provides cues or hints to support student understanding". Again, the manual provides a definition of "cues and hints" and several examples, e.g.: "Look at it again, here, look at this side."; "Anything else?"

The manual further specifies grading schemes for the two types of interactions, discriminating by frequency ("not at all—rarely—sometimes—frequently"), which raters shall apply to segments of 15 min. In addition to the written manual, the observation system is comprised of training procedures, including master-rated training videos to be discussed between master raters and trainees. Thus, Bell et al. (2020b) conceptualize rating as socially co-constructed: a professional practice sui generis.

Yet, a suggestion made by Reh and Rabenstein (2013) goes even beyond this. They proposed making more use of the respective interaction partner's reactions for interpreting a doing or saying in the classroom and inferring the meaning of the situation. They illustrated this with the example of a teacher saying to a student: "you did this well", which can be praise but also sarcasm. Relevant for the further course of the interaction is not the interpretation of this event by external observers, not even what the teacher intended to communicate, but first and foremost the interpretation of the addressee as well as that of the by-standing students. Another example illustrating this suggestion actually comes from the TALIS Video Study. The observation protocol developed in this study was used in different education systems. To address potential "cultural" differences it states: "To understand whether a disruption is occurring in a specific culture, the raters must attend to how the other students and teacher react to the behaviour. A student eating food in class might not be a disruption in a classroom in one country's context but in another, it is a disruption." (Bell et al., 2020b, p. 28). Arguably, differences in interpretation of eating in class might not only be related to different traditions in different regions of the world, but they might also differ between schools—depending on school cultures—and even between individuals within schools. Hence, the Bell et al.'s argument might be put in more general terms: Eating in the classroom has very likely no universal meaning. Relevant for the further course in the classroom interaction is, therefore, not the objective event as such, but the meaning attributed to the event by those present in the situation.

The crucial point for operationalisations of TBD and similar dimensional frameworks is the following: In order to come up with *quantitative* measures, certain episodes of teacher-student-interaction need to be *qualitatively* understood. Ratings of teaching quality may require raters to identify instances of certain teaching practices, reconstructing episodes (e.g., does a student "struggle"? Does the teacher react to this "struggle"? Is this reaction meant and/or perceived as supporting student understanding?), and judging qualities of their enactment (e.g., does some teacher utterance qualify as a hint? Does some student behaviour qualify as a disruption?). As teacher and student behaviour, opportunity and use, are inextricably connected within such episodes, raters need to develop a holistic understanding of classroom activity, its co-construction by all participants and the socio-cultural fibres woven into it. Hence, it might be helpful to expand the use of the larger situational context and, in particular, of the reactions of interaction partners to an event of interest to infer meaning of that event in the process of coding/ rating. Methods developed within a qualitative research paradigm, in particular in the context of research examining practices, might be a useful basis.

The suggestion made by Reh and Rabenstein further raises awareness that for understanding teaching and learning in the classroom it may not only be important whether teachers do something during a lesson, but also how they do it. Going back to the example "aligning instruction to student thinking" presented above, the manual states: "The teacher uses students' contributions" and provides an example: "A student gives an answer and the teacher says to another student 'Is that correct?'". In this example, the question "Is that correct?" can be understood in different ways: Some students might think that the teacher implies that the first answer was definitively not correct and that they should present the correct response instead. Other students might feel invited to think about the first students' answer. In both cases the teacher has used students' contributions. However, in order to understand classroom routines relevant in the context of "cognitive activation" or a deep processing of the learning content it additionally appears relevant how the teacher used the student contribution and, in particular, how the students perceived and interpreted this use.

Another issue is the choice of the coding unit: Observation systems often focus on specific and concrete behaviours (low-inference systems) while systems previously used in the context of TBD mostly used broad characteristics of the whole lesson (high-inference systems). High inference ratings often create an ideal picture of teaching without informing how exactly this ideal, e.g., a quiet and engaged or supportive climate, emerges in interactions. Low-inference ratings, on the other hand, often inform whether and how often specific behaviours occur during the lesson but not why. Another alternative may be identifying blocks of meaning inspired by the idea of practices as interconnected elements—forms of bodily activities, forms of mental activities, 'things' and their use, understandings, states of emotion and motivational knowledge. Specific behaviours within such units of meaning would be considered interchangeable; a practice can involve different behaviours and still be the same practice (Reckwitz, 2003; Reh et al., 2011; Schatzki, 1996). Sophisticated protocols such as TALIS-Video are in fact referring to such complex units of meaning, as shown above. It should be noted that the rating ultimately aims at grading some "quality component", such as the degree of alignment between instruction and student thinking, cutting across various practices. The degree of alignment between instruction and student thinking, as rated in the TALIS-Video protocol, does not indicate a certain practice in the sense of practice theories. It is a more abstract measurement of a feature that cuts across various practices. As shown above, implementing the protocol requires raters to understand the type and quality of practice they observe, but the rating as such refers to the abstract feature rather than the practice as a unit of meaning. Yet, to make this inference it is important to understand the different practices, during which this abstract feature shows itself, as good as possible.

Helpful for realizing this might also be considering the importance of bodies (e.g. pointing with a finger, smiling) and artefacts (e.g. the blackboard, a pen for writing or an experimental kit) more systematically. For example, facial expressions and gestures of teachers and students indicating excitement might indicate that the teacher question "Is that correct?" is, in this class, routinely a start into a lively debate about solutions to math tasks that the teacher and (at least some) students usually enjoy. A sceptical facial expression of the teacher asking this question might, in contrast, indicate that the teacher is not content with the prior answer given by the student and wants other students to correct it. Yet, another teacher might ask this question and, in the same moment, take a piece of chalk and turn her back to the class. This probably indicates that the question "Is that correct?" is meant as invitation to demonstrate the solution step by step while the teacher notes it on the chalkboard. Explicitly including descriptions of bodies and artefacts in coding manuals could be helpful to increase the reliability and validity of coding and ratings of teaching dimensions.

Another difficult question is the choice of level for analysing teaching effects. Ethnographic analysis of teaching rooted in practice theories usually identifies specific and characteristic situations which often involve only a few students, not necessarily the whole class. TER often uses multilevel models and focuses on the class-level. It could be argued that within-class differences should receive more attention in this latter strand of research. A large body of research shows that teachers interact differently with different students in the classroom and that students participate in very different ways in classroom practices. For example, students perceived as struggling more with learning often get more learning support and less pressure, but teachers often give high achievers more warmth and emotional support (Babad, 1993). High-achievers are further often more involved in whole class interactions than low achievers and, consequently, get more opportunities for "practicing" several practices such as argumentation (Brophy, 1983). Even the same classroom situation provides different opportunities for different students. Schatzki (2017) pointed out: "Learning also takes a course in the literal sense that its occurrences form a broken space-time path through bundles of practices and arrangements (cf. Dreier's notion of personal trajectories). The shape taken by any such path typically reflects opportunities to learn that are afforded at particular space-time locations in bundles: at or in particular workstations, stoves, classrooms, training fields, meeting rooms, and the like" (p. 30). Whether and how students can participate in classroom practices also depends on their prior participation in related practices, both inside and outside school. Hence, it appears most realistic to judge the quality of the lesson for each individual student separately. At least, the evaluation of teaching quality should take intraclass differences into account in some way, e.g., by using variances and extreme values in addition to mean scores or by including information on how many of the students are participating in which practices during lessons (see also Vieluf et al., 2020; either type of score specification has also been used for some codes in Bell et al., 2020b).

7 Conclusion—With a Response to the Questions Guiding This Book

- Do we already have a theory/ theories on teaching? If so, which are they?
- In the future, in what ways might it be possible, if at all, to create a (more comprehensive) theory of teaching?

The present chapter answers the first question with a clear "yes": There is a multitude of theories of teaching (for the German speaking context see e.g., Lüders, 2014). The aim of the present chapter, however, is not providing an overview. Rather, it brings together two disparate paradigms—TER and practice theories—with the aim of refining one specific theory, TBD, by reflecting and scrutinizing it from the perspective of practice theories.

At the same time, we are reluctant to answer the second question in an affirmative way. From our perspective, creating "A" comprehensive theory of teaching does not seem to be a reasonable goal of scientific discourse. The reasons for this position are discussed in combination with a response to the third, meta-theoretical, and the fourth, more substantive question:

– What is a theory (of teaching)?
– What should it contain and why?

"Theory" is a fuzzy concept (see also Praetorius & Charalambous, this volume). Definitions of "theory" differ considerably between research paradigms, depending on epistemological and ontological perspectives (see e.g., Abend, 2008; Zima, 2017). The goal of creating "A" comprehensive theory of teaching, only makes sense within the traditional "statement view" of theory from critical rationalism (Popper, 1965/2005), which assumes a theory to be a coherent set of definitions, axioms, derived hypotheses, and empirical statements testing (i.e. potentially falsifying) these hypotheses. Within this perspective various criteria for the quality of theories have been formulated, such as consistency of statements, parsimony and inclusion of definitions of all terms, but also testability and empirical support (e.g., Kane & Marsh, 1980; see also Peratorius & Charalambous, this volume). TER is associated with this epistemological perspective (Scheerens, this volume). "Theory" here usually consists of constructs covering various elements and features of classroom teaching, procedures operationalizing those constructs, and models linking them with student learning and other constructs which have been a priori defined as desirable outcomes of schooling. Teaching effectiveness theories attempt to explain and predict so-called "student outcomes", explicitly modelled as effects of the learning environment. Earlier work within this paradigm was often just listing or grouping variables that had been identified as correlates of student achievement. Current work in TER, such as the TBD, includes more complex sets of statements, including theoretical postulates about why specific teaching dimensions have effects on student learning and other so-called "student outcomes". These theories may still not live up to the quality criteria formulated by Kane and Marsh (1980, for a specific discussion of TBD in light of these criteria see Praetorius et al., 2020b), but they are closer to this postulated ideal as compared to earlier approaches in TER.

Alternative epistemological perspectives, however, challenge fundamental assumptions of critical rationalism, in particular, the idea that an objective truth can be discovered using scientific methods. These alternative perspectives also have a long history, i.e., approaches emphasizing the "site-dependency" (Mannheim, 1931/1995) and social constructedness of knowledge (e.g., Fleck, 1935/1980) or those addressing the development, rise and fall of theories (Kuhn, 1962) as well as the so-called “Non-statement view” (Sneed, 1979). According to Kuhn, general principles such as, in the field of education, (a) the idea of the learning environment having causal impact on students’ information processing vs. (b) the idea that the classroom is a social sphere consisting of practices, can hardly be contested empirically, although they have inspired much sound empirical work—mostly quantitative in the first case, qualitative in the second case. These general principles belong to the core assumptions of separate paradigms which are basically incommensurable, since they are framing, if not constituting the field of classroom teaching and learning in different ways.

Separate paradigms include not only different basic assumptions about the social, about teaching and learning, but also differ with regard to their understandings of “theory” (Kuhn, 1962, p. 94). For example, Reckwitz (2002), one exponent of practice theories, understands social theories as vocabularies which offer “contingent systems of interpretation which enable us to make certain empirical statements (and exclude other forms of empirical statements)” and “a heuristic device, a sensitizing ‘framework’ for empirical research in the social sciences” which “opens up a certain way of seeing and analysing social phenomena” (p. 257). The core concepts and principles provide a framework for the development of theories of specific practices (Hirschauer, 2015, p. 172). Yet, a priori normative assumptions about how these theories should look like are often avoided within the practice theoretical paradigm (“normative abstinence”, see Sect. 4.). Instead, practice theories provide a theoretical framework for analysing research practices themselves, i.e., processes of “doing theory”, “doing empirical studies”, and “doing publications” (e.g., Bourdieu, 2015).

Hence, answers to the questions what constitutes a theory and what it should contain depend on the perspective.[20] The epistemological perspective of critical rationalism has been the key reference for TER and TBD. In this paper we argue in favour of recognizing diversity of perspectives—also with reference to epistemology—instead of opting for a single set of criteria for a “good theory”, because different perspectives always have different blind spots and can complement each other. In particular, since TBD integrates constructivist learning theories with TER to explain why certain types of classroom interaction are more effective than others for co-constructing knowledge in the classroom, it seems prudent to also draw on a constructivist understanding of the co-construction of knowledge within the social sciences. From our excursion into practice theories (in particular the reading of Bourdieu, 2015) we further take along for future research the idea to involve more in critical reflection of research practices—including the micro-politics and

[20] It has been argued by an anonymous reviewer that the choice among epistemological and other fundamental (theoretical and meta-theoretical) assumptions is driven by each researcher’s values. We believe this position to misunderstand the nature of scientific practice, which is largely shaped by traditions or paradigms researchers are socialized into, rather than individual value-driven choices. Of course, the fundamental core of a paradigm incorporates normative settings. Thus, starting an exchange between paradigms such as TER and PT may also lead to changes in normative assumptions, beliefs, and values

struggles for positions—in the field of quantitative empirical educational research and in critical reflection of the researchers' role in the process of knowledge construction.

Considering the incommensurability of paradigms, we think that it is desirable that TBD, TER in general, and practice theories alike will grow and become more and more sophisticated, and, instead of converging into one grand theory of teaching, even diversify into separate (sub-)theories. New paradigms, such as neuroscience, may further start to compete with existing strands of social science and the humanities. Nevertheless, we argue (in opposition to Kuhn) that fruitful exchange between paradigms is possible and we attempted to involve in just that in the present chapter, which has the aim of using practice theories for refining TBD in a process inspired by the idea of "alienation".[21]

– Can such a theory accommodate differences across subject matters and student populations taught? If so, how? If not, why?

This question points to what is probably the most striking difference between TER/ TBD and practice theories. Bell (2020, p. 57) claims that "teaching is definitionally situated in social-historical contexts". Yet, educational effectiveness research traditionally assumes that constructs and measures apply across contexts, and that relationships between teaching and learning are universal. Without this assumption (mostly left implicit), researchers would not be able to refer to studies from all kinds of contexts (countries, language areas, social groups, school types, age and grade levels, with different learning trajectories and classroom experiences) when deriving and discussing their own research question, and to merge all kinds of studies in meta-analyses. At the same time, using seemingly "identical" constructs and measures across contexts allows EER/TER to identify differences across subject matters and student populations taught. First, teaching variables have been compared, and it has been claimed that *mean levels* differ between groups of students, institutions, subjects or even education systems (e.g., more demanding mathematical tasks were observed in Japanese classrooms compared to German classrooms; Bell et al. 2020c; Stigler & Hiebert, 1999). Second, the size and orientation of *relationships* between teaching and learning outcomes have been compared and claimed to differ between groups of students (e.g., classroom management having a stronger effect on student achievement for low achieving students; Seiz et al., 2016), institutions (e.g., student-oriented teaching being correlated with achievement in comprehensive schools only; Bayer, 2020) or between different education systems (Doan et al., 2020). Thus, the assumption that educational processes are universal has been questioned from within the EER/TER paradigm.

Accommodating differences by explicitly comparing contexts or groups, however, has been challenged on three levels: (1) Adopting methods from cross-cultural psychology (e.g., van de Vijver & Tanzer, 1997), the equivalence of measures has

[21] In Zima's (2017) terms, the present chapter promotes the vision of "dialogical theory" in the field of teaching, based on the "interaction of rival sociolects".

been questioned. (2) Even when differences are measured in a valid, methodologically sound way, this does not mean they are understood *on a theoretical level*. (3) More fundamentally, any comparison requires a priori categorization and often uses binaries (e.g. male-female, low achievers vs. high achievers). Often, the complexity, situatedness, social constructedness and dynamic nature of such categories as well as their embeddedness in societal power structures are neglected (e.g., Phillips, 2010).

Practice theories, in contrast, refrain from any claims about "universal" relationships. A practice, understood as a nexus of doings, sayings, teleoaffective structures (affects, aims and purposes which are part of the practices) and artefacts, exists only when it is reiterated. Thus, relations between the doings and sayings included can be found across time and space. Yet, because the relations are not assumed to be causal, they exist only within the practice. They are not singular, but also never universal. They exist in their specific form only for those who have come to participate in them (Schäfer, 2016). Consequently, classroom ethnography (Breidenstein, 2012) attempts to reconstruct practices in a given social context. Understanding the role of the context (and the school subject) is part of understanding practices. General ideas (such as "practice", "shared meaning", and "pedagogical pointing") are used across studies and cases. Yet, they are supplying language to talk about teaching, while full, theory-driven, empirically saturated understanding is achieved on the basis of individual cases or groups of cases. Thus, PT also "accommodates" differences across subject matters and student populations taught, but conceptualizes these as socially constructed (see also Rabenstein et al., 2013).

8 Final Note

In the introduction we argued that not only teaching, but also educational research itself, is situated in fields of tension. One such field of tension is between the intention to provide educational practice with clear and convertible recommendations and the wish to do justice to the whole complexity, contingency, uncertainty and ambiguity of social interactions. Multiple research paradigms address this tension in different ways. By themselves they are necessarily limited and "under-determined by empirical 'facts'" (Reckwitz, 2002, p. 257). Yet, they all contribute substantially to our understanding of the social world. Mannheim (1931/1995) argued that a "true" picture can emerge from integrating different perspectives. Our aim was not finding such a synthesized truth in the middle. We argue more cautiously that dialogue between paradigms helps reflecting the own paradigmatic perspectives and research practices as well as underlying values and that it can inspire new research ideas. Accordingly, our paper is the result of an open process of bringing perspectives together and reflecting on irreconcilabilities with the purpose of "doing theory".

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Chapter 4
Theory on Teaching Effectiveness at Meta, General and Partial Level

Jaap Scheerens

Abstract This chapter focuses on theories in the context of educational effectiveness research. Three levels of theory are distinguished: (1) The meta-theoretical level uses a multi-level framework of measurable facets of educational quality to provide a structure into studying teaching and its effects on student learning. (2) The general theory of teaching effectiveness focuses on major substantive dimensions of pro-active, interactive, and retro-active strategies as well as "structured independence". (3) Partial theories are more specific in being closely tied to empirical outcomes, with "direct teaching" and tentative explanatory mechanisms in the realm of providing emotional support in classroom teaching being two examples. The three levels are considered to discuss the value of theories for research on teaching and its effects on student learning.

Keywords Educational effectiveness research · CIPO-model · Meta-theory · Core teaching dimensions · Direct teaching

1 Introduction

In this chapter I would like to reflect on the role of theory for research on teaching effectiveness. The focus on effectiveness reflects the preference to address teaching as instrumental to learning and student outcomes. Not only is this more interesting from a scientific perspective than focusing on teaching in general, as it sets the stage for causal theories about "what works, but it also has a natural connection with the "applied" question of educational quality. The structure of the paper is based on a sequence of three ways of theorizing about teaching effectiveness. A first contribution of "theory" to teaching effectiveness is the presentation of an underlying structure for empirical research and educational discourse. This is done by positioning teaching effectiveness in a multi-level framework of educational effectiveness and measurable

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facets of educational quality (Sect. 3). In a second step, major substantive dimensions of the basic framework are discussed: the elementary parts of teaching, pro-active and retro-active regulation in teaching, "structured independence", and classroom management, which includes classroom ecology and climate. These substantive dimensions are considered as building blocks for a general theory of teaching effectiveness (Sect. 4). Next, in a third step, more specific partial theories, closely tied to empirical outcomes, will be addressed by providing two illustrative examples: the theoretical underpinnings of "direct teaching" and tentative explanatory mechanisms in the realm of providing emotional support in classroom teaching (Sect. 5).

In the discussion section the status and usefulness of theory in an empiricist field like teaching effectiveness research will be assessed (Sect. 6).

2 Terminology

I will discuss theory about teaching, as an empiricist theory framed as teaching effectiveness. An empiricist theory, according to Chambers (1992), is one in which generalizations about observable variables are related to one another in ways that accord with observation (cited by Gage, 2009 p. 22). According to Snow (1973, p. 78) "its simplest form, a theory is a symbolic construction designed to bring generalizable facts (or laws) into systematic connection". The latter element, "systematic connection" reflects the aspiration that generalizations are connected to conjectures that explain the "how" and why" of the empirical findings. The logical structure of scientific explanations is the so called "covering law model", which means that research-based, empirical generalizations can be subsumed under a more general law or principle, which could be part of a broader and already established theory (Hempel & Oppenheim, 1948; Von Wright, 1971).

In the rational empiricist research tradition theoretical conjectures and empirical findings are intertwined in a cyclic process of inductive and deductive phases (de Groot, 1961). In the case of teaching effectiveness this process is still largely dominated by inductive interpretations based on empirical generalizations. So, when discussing theory in the field of teaching effectiveness there is likely to be more emphasis on "bottom up" theory formation, than on research that is guided "from above" and driven by existing theory.

Meta-theory is defined by Snow (1973, 79) as "a theory concerned with the development, investigation or description of theory itself". As a first example he mentions the Stimulus-Response versus the Stimulus-Organism-Response model in psychology, also indicated with the term "paradigm". Other examples of meta-theories are methodologies and epistemological positions, like the distinction between nomothetic and ideographic approaches. In this chapter I will use three distinct interpretations of meta- theory with respect to teaching effectiveness:

In the sense of a *logical structure of causal conditions to realize intended educational outcomes*, based on a model from systems theory, which distinguishes context, input, process, and outcome indicators (CIPO). I will usually refer to the distinction of educational effectiveness within this framework with the term "educational effectiveness research paradigm" (Sect. 3).

In the sense of the *epistemological premises of the scientific method* on which educational effectiveness research depends.

In the sense of *the nature of substantive theory (ontology*). In normal science is has an interpretation in the sense of defining characteristics of a substantive theory.

Substantive theories on teaching effectiveness are to be defined in close connection to the state of the art of empirical research, as manifest, for example, from meta-analyses of research studies. Substantive theory will be discussed at two levels of abstraction and empirical specificity:

– As contribution to *a general theory of teaching,* in the sense of a "*conceptual map*" which distinguishes a limited set of substantive dimensions through which teaching affects student learning and student outcomes; (Sect. 4). These substantive dimensions correspond to the level of abstraction in what Gage (2009, p. 123) refers to as "sub-theories" defined for main components of teaching and Praetorius et al. (2020) describe as basic dimensions of teaching in their TBD (Three Basic Dimensions) model.
– As p*artial theories of teaching*, to be defined in close connection to the state of the art of empirical research. Partial theories have a place in the main dimensions of the conceptual map, described in Sect. 4. Of these I will give just two illustrations: theoretical conjectures with respect to "direct teaching" and "social emotional support in teaching" (Sect. 5).

In the sequel basic terms like theory, model, paradigm, (conceptual) framework and conception will be used in accordance with the Introduction chapter of this volume (Praetorius & Charalambous, 2023, Table 2, p. 10/11). The distinctions between these terms are somewhat fuzzy, for example when it comes to distinguishing models and theories. Still there is an ascending order in grades of formal development and sophistication when going from conception, via framework and model, to theory. This would imply that the more ambitious concepts include less ambitious ones, in the sense that, for example, all frameworks are also conceptions, but that not all conceptions are frameworks. Given this global understanding I have applied these terms in a liberal way, where I would sometimes indicate a certain configuration as a conception, a framework, or a model.

3 Meta-Theory. A Systems Model on the Functioning of Education as the Underlying Structure of an Educational Effectiveness Research Paradigm and Its Practical Implications

In this section an underlying structure for empirical research and educational discourse is presented. This is done by positioning teaching effectiveness in a multilevel framework of educational effectiveness and measurable facets of educational quality. As indicated in Sect. 2, such a general underlying structure is seen as a meta-theory.

3.1 A Model Representing the Educational Effectiveness Research Paradigm

The elementary design of educational effectiveness research is the association of hypothetical effectiveness enhancing conditions and output measures, mostly student achievement. The basic model from systems theory, shown in Fig. 4.1, is helpful in clarifying this design. The major task of educational effectiveness research is to reveal the impact of relevant input characteristics on output and to "break open" the black box in order to show which process or throughput factors "work", next to the impact of contextual conditions.

The model, shown in Fig. 4.1, sometimes indicated with the acronym CIPO (which stands for Context, Input, Process, Output) can be used at different levels of aggregation, the level of a national educational system, the school level, the level of the instructional setting, often indicated as the classroom level and the individual student level. The levels are nested, in the sense that schools function within an educational system at national level, classrooms function within schools and students within classrooms. This is illustrated in Fig. 4.2.

Measured outputs, like (aggregated) achievement test data, make up the effect side of the model. Next, malleable or "managed conditions" (inputs and processes) hypothetically associated with outcomes form the core in the multi-level representation. The term "antecedents" is used to indicate previously given contextual conditions. These antecedents may represent the larger environment and culture, higher level policies as well as existing characteristics of teachers and students. At school and classroom level, the term ecology refers to partly controllable composition effects and their interaction with malleable variables (e.g. the interaction between classroom SES composition and a "good" relational climate at school (Luyten et al., 2005). A more detailed description of the model is given in Scheerens (2016).

Given the multi-level framework a bottom-up logic could be used for designing an overall structure where lower-level processes (starting from student learning) are "boosted" by higher level conditions. For example, when it is established that

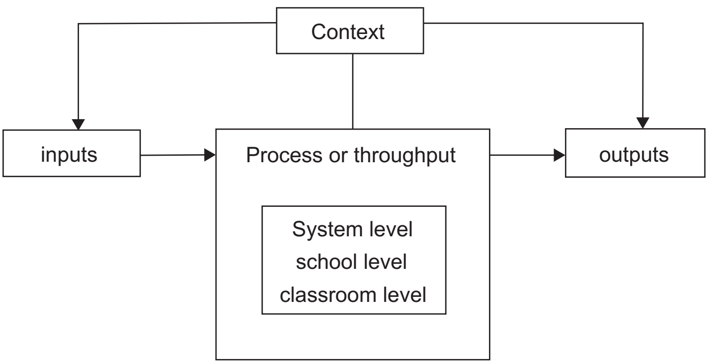

Fig. 4.1 A basic systems model on the functioning of education

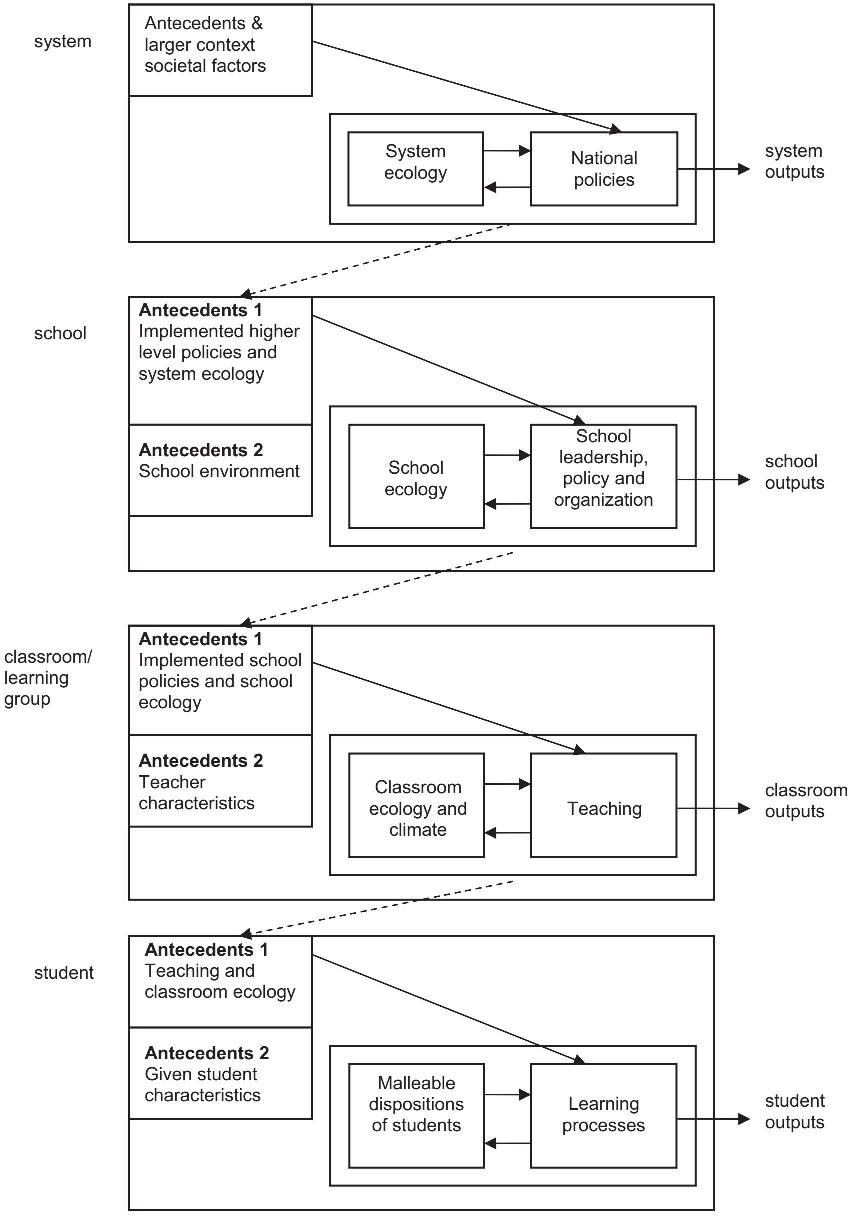

Fig. 4.2 Integrated multi-level model of education; solid arrows represent managed control actions, the dotted arrows from one system level to the next represent across level influences; feedback-loops (not shown in the diagram) are assumed to run from outcomes at each level to the box containing ecology and active policies at each object level and from lower to higher levels

"control strategies" in students' learning are effective (Artelt et al., 2003), structured teaching could be seen as a strategy that particularly supports weaker students.

The degree of higher- level control versus lower-level autonomy is an issue of central importance at all levels. At system level it is about effective patterns of functional decentralization, which means that, perhaps dependent on the larger context, certain patterns of centralization in some functional domain (e.g., the curriculum) and decentralization in another domain (e.g., financial management) work best. At school level it is about the degree of participative decision making, or "distributed leadership", and at classroom level it refers to the balance between strongly structured didactic approaches and more open teaching and learning situations that are expected to invite self-regulated learning. Structure versus independence is a red line that dominates policy and research agendas in education. Critics of educational effectiveness thinking sometimes have a tendency to depict it as a "closed" mechanistic perspective, neglecting, for example the professional autonomy of teachers. Here, on the contrary, autonomy is built into the system.

Further elaboration of the framework is provided in Scheerens et al. (2011, 2016). Multi-disciplinary applications from economics, sociology and psychology are discussed in Scheerens and Bosker (1997). The framework can be seen as a structure for multi-disciplinary educational research.

3.2 Scientific and Applied Use of the Framework

Although research on teaching is likely to take place in field settings, and in this sense applied, there are differences in degree to which the overriding interest is scientific as compared to supportive of practical or political decision-making. Making this difference more explicit is another example of meta-theoretical reflection, in line with Snow's definition, cited in Sect. 2.

The context- input-process- outcome framework can accommodate in-depth description of teaching, as well as associations of teaching processes with all other components in the framework, like for example the influences of school level policies on teaching strategies. From a scientific perspective the causal association of characteristics of teaching processes with outcome measures is of interest in assessing the predictive validity of measures of teaching processes (like direct observation schedules) and to test theories about the way specific teaching approaches affect learning and learning outcomes. Measurement issues concerning various components of the framework and questions of causal attribution, like for example the issue of "value-added" outcome indicators, are part and parcel of both a scientific and applied use.

Turning to the applied use of the framework, the structure is fit to define core policy issues in education, which can be seen as measurable facets of educational *quality* (Scheerens, 2016; the C., I., P., and O associations refer to the components of Fig. 4.1):

– *educational productivity* can be highlighted by focusing on output variables at different aggregation levels, the well-known comparisons between mean performance levels in educational assessments studies between countries, such as TIMSS and PISA, are examples of comparisons of national systems on educational productivity (O-quality)
– *educational effectiveness* would seek to determine the “net” effect of malleable educational conditions, defined at different levels, on outputs, while controlling for relevant antecedent conditions at the level of individual participants (IxPxO-quality)
– *educational equity* is captured by examining disparities between resources and processes as well as the variation between students and schools in educational outputs; and the degree to which achievement levels and disparities hang together with specific antecedents of students, schools and school contexts, e.g. the reading performance of girls from cultural minority background and the average achievement levels of schools in rural areas; (IxPxO-quality|sub-populations)
– *educational efficiency* would address questions of input provision and effectiveness at the lowest possible costs (IxPxO-quality|costs)
– *educational responsiveness* represents adaptive or proactive outreach of the educational system towards the relevant environment to shape intended outcomes (e.g. by means of a representative survey of support for a revision of educational goals and curricula) (CxO)

It is important to note that the responsiveness perspective ‘transcends’ the instrumental effectiveness perspective by not only looking at the question of how to do thing right, but first considering the question of how to do the right things. In other words, the responsiveness perspective leads to a critical analysis of educational goals. Adaptation to contextual demands can be situated at system, school and classroom level. For example, defining the school curriculum as a means to adapt to national standards, as well as to the specific environmental local context.

4 Substantive Building Blocks for a General Theory on Teaching Effectiveness

In this section we are leaving the realm of meta-theory to which the conceptual framework or paradigm of teaching effectiveness belongs, and address building blocks of a general substantive theory on teaching effectiveness. Substantive theories on teaching effectiveness are to reflect the state of the art of empirical research, as manifest, for example, from meta-analyses of research studies. After the introduction Sect. (4.1) I will present a summary of indicators, supported by empirical research, and categorized by the section on the classroom level in Fig. 4.2. Next, in Sect. 4.3 I will explore the possibility to describe a general theory of teaching effectiveness as a “conceptual map”, which distinguishes a limited set of dimensions through which teaching affects student learning and student outcomes and explain in what way such dimensions could become “building blocks” for a general theory on teaching.

4.1 Introduction

Snow's (1973, 87) work on distinguishing "grades of theory" and steps in the process of progressively developing higher levels of theory, provides a basis for speculating about the level of development of proclaimed theories of teaching, including dimensional models as indicated in the above. Starting out from "relatively simple summarization of empirical relationships without substantial inferences or deductive logic", which characterize lower level theories, he sketches the trajectory to further developed higher levels of theory. Conceptions that credibly simplify the description and explanation of relationships among observed variables have higher theoretical status than categories that are just summary labels. Other criteria that should be met are that conceptions represent meaningful dimensions, manifest parsimony, and have explanatory potential (e.g. when linked to more established theory). As such conditions are met, lower-level theories evolve to middle level theories, characterized by "continuing interaction" between provisional theoretical concepts and data (Reezigt et al., 1999). (ibid, 87). Higher level theory is characterized by a formal logico-deductive structure, with derived hypotheses guiding empirical testing. As to the standing of theory formation on teaching effectiveness, earlier analyses pointed out that it is predominantly at the lower end of the continuum presented by Snow; with "formative hypotheses", "elementism" (development of key-concepts and instruments), and "descriptive theories and taxonomies" as its major accomplishments and "eclecticism", or connecting with eclectic fields of developed theories, as rare exceptions (Scheerens, 2016, 260/261). Gage's attempts to connect "structuring" as one of his "sub-theories of teaching" to "covering laws" is such an exception (Gage, 2009). The theoretical support for the effectiveness of explicit direct instruction on the basis of cognitive information processing theory, to be discussed in Sect. 5, is another (Kirschner et al., 2006).

For the current presentation this state of affairs, with theory development progressing from lower to middle level of theory formation, is taken as an encouragement to working towards a parsimonious set of key dimensions, considered as building blocks for a general theory of teaching.

In summaries of the research literature on educational and teaching effectiveness authors have frequently subsumed operational variables that had received empirical support under a limited number of categories (Anderson, 1991; Creemers & Kyriakides, 2008; Klieme, 2012; Praetorius et al., 2020; Reezigt et al., 1999; Seidel & Steen, 2005; Scheerens, 2016; Stringfield & Slavin, 1992). Creemers and Kyriakides for example, distinguish the following "factors operating at student and classroom level": orientation, structuring, modelling, application, questioning, assessment, management of time and the classroom as a learning environment. Klieme (2012) mentions "content exposure and structure", "classroom management", supportive classroom climate", and "cognitive activation" as major rubrics under which 20 more specific variables are categorized. Gage (2009), distinguishes four "sub-theories of teaching": a conception of the process of teaching (in which he basically contrasts traditional and constructivist-oriented teaching), a conception of the content of teaching (with curriculum and instructional alignment as the key factor), a conception of students' capabilities and motivation, and a conception of classroom management. Chapters 4 and 6 of this volume show further developments in the dimensional models by Klieme and co-authors and Kyriakides and co-authors, respectively. My particular take on the tentative improvement of the current dimensional models is driven by (a) the interest in exploring to what extent dimensions could be conceptualized as continua, over and above colligations of discrete variables and (b) the challenge to find a parsimonious synthese of empirical variables from earlier work (Scheerens, 2016, p. 46). As a first step in trying to meet this latter challenge, I will start this section with a paragraph that present empirical indicators, embedded in one intersection of the model depicted in Fig. 4.2.

4.2 A Closer Look at Classroom Level Teaching

In my book "Educational effectiveness and ineffectiveness" (Scheerens, 2016) I used the model, illustrated in Fig. 4.2 to summarize research results. Apart from discussing the overall systemic properties of bringing together these levels in educational effectiveness, I summarized major outcomes in models of "learning", "teaching", effective "schooling" and "system level levers of educational effectiveness". Summary results based on empirical research at each level were formulated as indicators of major input, contextual/ecological and malleable process conditions. I will use the summary results on teaching effectiveness as a starting point for the development of substantive building blocks for a general theory of teaching. The overview of teaching variables is shown in Fig. 4.3.

The three columns in Fig. 4.3 show teacher characteristics, as a particular category of input indicators, indicators on classroom ecology and climate (seen as partly given and partly malleable) and teaching processes. In this chapter no further attention will be given to teacher characteristics, as the emphasis is on teaching processes and creating productive learning environments (the second and third column). The sub-categorization in the third column distinguishes pro-active, interactive and retro-active facets of teaching. I was prompted to use this particular categorization on the basis of contributions in the area of variations of the rational planning model (Scheerens et al., 2003). For completeness's sake I would like to mention that in the overall multi-level structure (Fig. 4.2) teaching effectiveness is seen as embedded in school and system level influences; a perspective that will not be elaborated on in this chapter.

Further reflection on the underlying structure of the overview of indicators, in the sense of a limited set of meaningful dimensions, is the next step in discussing "building blocks" for a general theory on teaching. How exactly such dimensions are considered as a step in theory formation is indicated in the next sub-section.

Teacher background characteristics	Classroom ecology and climate	Teaching processes
Professional knowledge - content knowledge - pedagogical knowledge - insight in student learning - pedagogical content knowledge *Professional motivation* - work satisfaction - locus of control *Preferred teaching strategies* - direct teaching - "constructivist" teaching	- class-size - classroom composition (average and heterogeneity) - match of teachers and classes - aspects of classroom climate, achievement orientation, discipline, support, ethos - teacher expectations on students' achievement	*Pro-active strategies* - opportunity to learn - selection and design of adequate learning tasks - technology enriched learning environments *Interactive strategies* - classroom management aimed at optimizing active learning time and opportunity to learn - optimizing structure and independence in teaching - learning to use learning strategies - allowing for manageable adaptivity in teaching - active teaching, diversity in presentation formats - a challenging presentation - cognitive activation - providing emotional support - enacting high expectations *Retroactive strategies* - setting realistic motivating standards - progress monitoring and assessment - adaptive testing - instrumental feedback

Fig. 4.3 Overview of indicators of effective teaching

4.3 Can Summary Categories of Variables Be Interpreted as Meaningful Dimensions for a General Theory on Teaching?

As it comes to the identification of core dimensions of teaching there is no need to reinvent the wheel. We can remain close to the contributions that are made in the literature, cited in the introductory part of this section. The main dimensions distinguished by Klieme and Gage are appealing in their coverage and parsimony. Klieme (2012) mentions "content exposure and structure", "classroom management", supportive classroom climate", and "cognitive activation" as major rubrics under which

20 more specific variables are categorized. Gage (2009), distinguishes four "sub-theories of teaching": a conception of the process of teaching (in which he basically contrasts, traditional and constructivist oriented teaching), a conception of the content of teaching (with curriculum and instructional alignment as the key factor), a conception of students' capabilities and motivation, and a conception of classroom management. Closely following Gage (2009), and building on the structure of the indicators summarized in Fig. 4.3. I would opt for the following dimensions:

– pro-active and retro-active regulation in teaching (as a content oriented dimension)
– structure and independence in teaching (as a central process dimension)
– classroom management (as a comprehensive summary dimension of effective teaching interventions).

The work on pro-active and retro-active regulation in teaching, in relation to curriculum and instructional alignment prompted me to distinguish a fourth dimension, indicated as "the elementary parts of teaching".

The overview presented below provides an advance organizer of the structure and content of the ensuing sub-sections, in which the building blocks will be described in more detail.

On Content

On content two related dimensions are considered, "the elementary parts of teaching" and pro-active and retro-active regulation in teaching.

The first considers *the matching of content elements, psychological operations, and didactic considerations* as the elementary parts of teaching. Distinguishing these "elementary components" of teaching, is in fact a general analytic definition of what teaching is. The theoretical potential of this dimension is that it provides a decisive distinction for the debate on subject matter-based objectives and "subject matter free" skills. In addition, it provides a basic "grammar" for defining curriculum alignment, not solely a matching of content but also of psychological operations.

The second dimension associated with content is labeled *pro-active and retro-active regulation in teaching* and deals with instructional alignment and learning from feedback. Here the eye-opener is the potential of retro-active regulation as an efficient lever of student achievement, particularly in settings where pro-active approaches are constrained because of vague objectives, lack of standardized methods and pedagogical principles ("open" education).

On Process

The third dimension, "*structure and independence in teaching*" sees this distinction as a continuum which might serve in overcoming entrenched positions between behavioristic and "constructivist" teaching strategies. The process of "fading", in the sense of gradually diminishing structure in a course or teaching sequence is seen as a bridging principle. Optimization in the degree of structure could be considered from the perspective of contingency theory, where effectiveness depends on student and situational characteristics.

On Classroom Management

The fourth building block refers to *classroom management,* with managing learning opportunities, classroom ecology and climate, and cognitive and emotional support as sub-categories. Unlike the three other dimensions, described in the above, "classroom management" is just an overarching label. The common element is that all sub-categories are malleable and, in principle, controllable by teachers. An alternative might be to consider the three sub-categories as dimensions in their own right. It is also debatable to put cognitive and emotional support together in one subcategory. Classroom management in the sense of a general collective concept could be analyzed from the perspective of control theory, and organization theory. Optimization is best perceived at the level of the sub-categories separately.

4.3.1 The Elementary Parts of Teaching: Matching of Content Elements, Psychological Operations, and Didactic Considerations

In prescriptive formulations, which concern for example the structure of educational objectives, two dimensional classifications are usually proposed (e.g. De Corte et al., 1976; Bloom et al., 1971). Subject matter content and psychological operations are the two basic dimensions. This perspective entails breaking down the contents, of e.g. a geography lesson in smaller units, and, for each content unit specifying the cognitive, or affective behavior/dispositions that should be acquired. Taxonomies of educational objectives have specified continua of operations that ascend in complexity. For example, in the cognitive domain: perception of information, recognition of information, reproduction of information, interpretative production of information, convergent production of information, evaluative production of information and divergent production of information.

Elements defined by the two basic dimensions (content and psychological operations) are used to indicate and specify learning tasks and achievement test items.

In the act of teaching, specific presentation forms and media should be applied when introducing the prime didactic elements as described in the above. The quality of teaching would thus depend on: adequate selection of content; indicating target psychological operations (e.g. cognitive behavior); knowledge about creating tasks; instructional knowledge; a repertoire of presenting and guiding the execution of learning tasks, knowledge about students, and typical behaviors for the learning task in question, including frequently made mistakes. The first three characteristics could, in principle, be taken care of outside the direct teaching situation, by curriculum experts and designers of teaching methods, in cooperation with panels of teachers. Yet, knowledge about content, about tasks as independent tools and about student thinking would constitute a basic teaching competency that was described as *pedagogical content knowledge* by Shulman (1986). Baumert et al. (2010) found evidence of considerable impact of this variable on student achievement.

Combination of content units and psychological elements bearing in mind pedagogical and didactic considerations are at the heart of instructional sub-disciplines as: curriculum development, teacher training and teacher professional development, lesson preparation, actual teaching and the monitoring of students' reactions to teaching (e.g. time on task), assessment of learning outcomes, and providing feedback on the basis of assessment.

When it comes to the coverage of the indicators in Fig. 4.2 by the "elementary parts of teaching" the sub-areas "professional knowledge", "pro-active strategies" and retro-active strategies can be subsumed under this content dimension. Taxonomies of educational objectives provide ranked continua.

A final observation is that didactic analysis offers an analytic structure that is helpful to the "skills debate" (e.g. Weinert, 2001). This debate addresses the question of the place of subject matter content in the teaching of skills. As other analysts, Weinert rejects the position that skills are "content free".

4.3.2 Pro-Active and Retro-Active Regulation in Teaching

Among the set of educational sub-disciplines that were mentioned when we dealt with the "elementary parts of teaching": curriculum development, teacher training and teacher professional development and lesson preparation could be said to have a *pro-active* orientation. Of actual teaching one could say that it has an *interactive* orientation while assessment and providing feedback have *a retro-active* orientation.

In this section pro-active and retro-active regulation will be compared; it should be noted that pro-active and retro-active regulation have a clear interpretation in core processes at school management and system level governance as well.

The ideal of "synoptic" planning is to conceptualise a broad spectrum of long-term goals and possible means to attain these goals. As such it contains the basic logic of social engineering and planned change, in our case design of teaching and learning situations. In models of planned change the various aspects of synoptic planning are usually structured as phase models; which basically distinguishing goal specification, means specification, implementation, evaluation and feedback, Ackoff (1981, 74, 75).

Applying feedback turns the sequence in steps into a circle that can go on and on. Many authors, including Ackoff, do not take the sequence of phases too seriously and say that they take place in any order. Others, however, see the way one "steps into" the planning, implementation and feedback circle as non-trivial. Borich and Jemelka (1982) see the planned change process as society's attempts to "maintain equilibrium when the system threatens to become disadvantageously influenced by forces whose effects were previously neglected or would have been difficult to predict" (ibid, 216). Next to the traditional pro-active approach, they discern a retro-active orientation.

In a retro-active regulation of teaching the assessment instrumentation, for example a large item-bank, could be legitimized as the intended curriculum. In the ideal situation of an exhaustive item-bank, "teaching to the test" could be seen as a legitimate and recommendable activity. A similar kind of reasoning could be applied to formative assessment, where assessment is expected to feed into ongoing teaching activity. The theme of proactive and retroactive control will be elaborated by referring to curriculum alignment and summative assessment, and to learning from feedback in formative assessment.

Instructional Alignment

The core element of educational alignment, either in the sense of curriculum alignment, or instructional alignment, is best known as "opportunity to learn" (OTL), defined as the matching of taught content with tested content. As such OTL is part of the larger concept of curriculum alignment in educational systems. When national educational systems are taken as multi-level structures, alignment is an issue at each specific level, but also an issue of connectivity between different layers. General education goals or national standards are defined at the central level (the intended curriculum). At intermediary levels (between the central government and schools) curriculum development, textbook production and test development take place. At the school level, school curricula or work plans may be used, and at classroom level, lesson plans and actual teaching are facets of the implemented, or enacted, curriculum. Test taking at individual student level completes the picture (the realized curriculum). This process of gradual specification of curricula is the domain of curriculum research, with the important distinction between the intended, implemented and realized curriculum, as a core perspective. This perspective is mostly associated with a proactive logic of curriculum planning as an approach that should guarantee a valid operationalization of educational standards into planning documents and implementation in actual teaching (Kurz, 2011; Luyten & Scheerens, 2021).

De Groot (1986) defined an overarching model of "didactic and evaluative specification of educational goals". Educational goals are based on perceptions of pupils' needs and societal needs. He then distinguishes two kinds of operationalizations, one leading up to the construction of curriculum products, such as learning programs, textbooks, and teaching methods, and the other to the development of examination and assessment programs. De Groot's framework underlines the analogy between curriculum and test design and offers criteria to determine the quality and alignment of these two construction processes. According to De Groot evaluative operationalization should happen first because curriculum design needs verifiable learning effects to adequately resolve issues of instrumentality, in other words, constructing means that are adequate to reach goals and intended effects. If the evaluative specification would follow the didactic specification there would be too big a chance of pressure to adapt tests to preferred methods, which he considers a form of goal displacement. Dilemma's for trying to accomplish curriculum and instructional alignment to enhance students' opportunity to learn in an organizational structure that is loosely coupled are discussed in Scheerens (2017). As an extreme measure to avoid all kind of intermediary control-fuzz and coordination, educational systems could forego curriculum development and concentrate on high quality high stakes tests and examinations. The invisible hand of "teaching to the test", would steer all intermediary players in a context of maximal autonomy (apart from the output control inherent in the setting of the high stakes test).

Learning from Feedback

In a context of formative assessment, the key mechanism linking assessment and teaching is feedback. The term feedback stems from control theory, with the functioning of the thermostat as the classical example to illustrate it. When the measuring device indicates that the room temperature is below a certain level, the regulating mechanism switches on the heating (De Leeuw, 1990, p. 126). Feedback loops can be positive or negative. An example of positive feedback would be the case when good results increase positive expectations about students' learning, which, in their turn lead to setting higher standards, a more optimistic, achievement-oriented climate, more self-confidence and achievement that is further increased). An example of negative feedback would be a teacher needing to increase his or her energy in keeping order, when the students' behaviour worsens (Clauset & Gaynor, 1982).

In a review of the impact of formative assessment Black and Wiliam (1998) conclude that, across the board, formative assessment and feedback are positively associated with student achievement. However, it is often difficult to separate the impact of assessment-feedback from other regulatory mechanism that are also active. This is illustrated in their analyses of feedback within the framework of Mastery Learning; a form of structured teaching comparably to direct teaching, as referred to in a previous section. Likewise, in reviews and meta-analyses effects of quantitative and qualitative aspects of feedback are sometimes not sufficiently separable.

In search for further insights into the specific characteristics of effective feedback from student assessment, Kluger and DeNisi (1996) underline the importance of instrumental feedback. The idea of instrumental feedback assumes that targets are identified as learning gaps and that there are ideas about mechanisms, means or techniques to bridge learning gaps. Experiencing of learning gaps is closely related to the role of standards and achievement expectations in teaching. Research on standard setting points out that learning gaps should neither be unattainably high nor low (cf. De Vos, 1989). The assumption of instrumentality and mechanisms to close learning gaps, is closely related to matching task characteristics to psychological operations of learners, and knowledge about frequently made mistakes.

In providing instrumental feedback teachers have the choice between providing complete solutions, heavily cued hints towards the correct solution, or an adaptive "scaffolding" response, in simpler terms students receiving as much help as they would need to solve the problem on their own.

4.3.3 Structure and Independence in Teaching

Having defined the nature of core instructional elements and the various subdisciplines in which they are given shape, it is time to turn back to the core idea of seeing teaching as a set of conditions that should facilitate and "boost" student learning. "Normal" structured teaching could be seen as compensating for lack of student control in learning, while a more reflective and process oriented teaching style could venture to actually teach student control strategies.

In a way student control strategies are the pendant of the main features of "structured teaching" and direct instruction, where it is the teacher who actively manages and controls the teaching and learning situation. When putting these two orientations next to one another, structured teaching on the one hand, and students effectively employing control strategies on the other, the following types of associations can be discerned:

– structured teaching happens as a *substitute* for student control strategies
– structured teaching happens as an *additional support* for student control strategies
– structured teaching happens as a *model and example* to enhance student control strategies (meta-cognition)
– structured teaching happens as a *suppressor* of student control because students are not given sufficient leeway to develop and manifest this behaviour themselves.

Weaker students in primary and secondary education are more likely to benefit from the first two alternatives, whereas the last two alternative combinations are more probable when dealing with better students in secondary education.

The above interpretations suggest a reconciliation in the controversy between structured and more open, discovery-oriented teaching approaches, by making it conditional on student aptitudes (cf the literature on aptitude treatment interaction research, Cronbach & Snow, 1981). Further on, in Sect. 5, didactic methods are discussed in which more structured and "open" learning arrangements are placed in sequence, with a gradual "fading" of structure as a bridging principle.

It is beyond the scope of this chapter to go into any kind of detail in contrasting the traditions of structured teaching, mastery learning and direct instruction on the one hand, with "constructivist ideas" about teaching and learning. See for instance, Gage's comparison of Progressive-Discovery-Constructivist models and Conventional-Direct-Recitation models (Gage, 2009, p. 62, 79; Kirschner et al. 2006; Messner & Blum, 2019). Earlier treatments of the issue suggest two outcomes:

1. Structured approaches, like direct teaching, have repeatedly been shown to be more effective than "open", "constructivist" teaching (Gage, 2009; Van der Werf, 2005; Hattie, 2009; Stockard et al. 2018). Brophy and Good (1986, p. 367) confirmed that highly structured teaching worked equally well for acquiring complicated cognitive processes in secondary education.
2. Elements of constructivism, like teaching learning strategies, and "cognitive activation" have blended in overarching conceptions of instructional effectiveness (e.g. Klieme, 2012; Praetorius et al., 2020).

We shall return to the issue by looking for a theoretical explanation of the success of direct teaching, further on (in Sect. 5), and leave it now by citing the main characteristics.

1. Teaching goals are clearly formulated.
2. The course material to be followed is carefully split into learning tasks and placed in sequence.
3. The teacher explains clearly what the pupils must learn.

4. The teacher regularly asks questions to gauge what progress pupils are making and whether they have understood.
5. Pupils have ample time to practice what has been taught, with much use being made of "prompts" and feedback.
6. Skills are taught until mastery of them is automatic.
7. The teacher regularly tests the pupils and calls on the pupils to be accountable for their work (Doyle, 1985).

The dimension structured independence covers "preferred teaching strategies" and "structure and independence in teaching", included as indicators in Fig. 4.2. It was argued that the dimension can be seen as a continuum that bridges guided "direct" teaching and more open instructional invitations to self-regulated learning.

4.3.4 Classroom Management

The three dimensions of teaching that were discussed in the previous paragraphs are abstract dimensions underlying important choices in teaching. "Classroom management" is to be seen as an overarching term to characterize teaching as a set of controlling and responding actions by teachers. Facets of classroom management can be thought of as implementing choices regarding educational objectives, content and skills to be acquired, degrees of structure in teaching and the application of planning and evaluation methods. Apart from an overall characterization and historical development specific attention will be given to two major facets: the management of classroom ecology and providing support in teaching.

Development of the concept of classroom management; from time-management to a comprehensive implementation of broad set of effectiveness enhancing teaching conditions.

A most relevant and influential model for research on teaching is the Carroll model, originally presented in Carroll (1963), and actualized by the author in Carroll (1989). The management of time is a key issue in the original model (Carroll, 1963; 1989).

The mastery learning model formulated by Bloom in 1976 was largely inspired from Carroll's model, and it is also related to 'direct instruction', as described by Rosenshine in 1983. Moreover, the model is often seen as the basis for more comprehensive models of instructional effectiveness, like Walberg's model of educational productivity (Walberg, 1984). In subsequent developments Carroll's original conception of "opportunity to learn" became a combination of time investment and "content covered", where the latter term became the more common interpretation. Some authors started to use the term "quantity of teaching" as the time spent on well-chosen content elements (i.e Creemers & Kyriakides, 2008).

A relatively narrow perspective of classroom management, true to the original Carroll model, is concentrated on the *management of time and learning opportunities,* with a specific emphasis on the prevention of disturbances and the monitoring of classroom rules.

The quality of instruction was relatively left undefined in the original Carroll model, but became gradually associated with models of structured teaching, like mastery learning and direct instruction. This led to a more comprehensive interpretation of classroom management, beyond time management. Baumert et al. (2001) mention clearly defined rules and procedures, prevention of disturbances, effective responses to critical events, routinization of basic social acts in the classroom, as well as providing aligned content and adequate pacing of instruction, and finally choosing adequate level of difficulty, clarity and structure in the presentation of material, adaptivity and individualization of instruction, and monitoring of student activities. In this way classroom management became associated with teachers' implementing a set of effectiveness enhancing conditions, confirmed by empirical research. Differentiation and adaptive teaching can also be discerned as challenges of classroom management.

Additional Facets of Classroom Management

Due to lack of space only a cursory review of other facets of classroom management, additional to the management of time and learning opportunities, will be presented (a more elaborate description is given in Scheerens, 2016).

The Management of Classroom Ecology

The management of classroom ecology deals with partly malleable composition effects of classrooms, like class size, SES composition, ability grouping, and the matching of teachers and classes (Opdenakker & Van Damme, 2001; Baumert et al., 2005; Willms, 2004; Luyten et al., 2005; Slavin, 1996; Monk, 1989, 1992).

Classroom Climate

Classroom climate can be defined as the general atmosphere in the classroom. When further analysed the major facets of a favourable, effectiveness enhancing climate are a supportive style in teacher student interactions, achievement orientation, clear disciplinary rules, and good student-student interrelationships. Some of these facets relate to more overtly "managed", "institutionalized", and "planned" aspects of teaching, others are more interactionist and "emergent" and part of the school culture (Maslowski, 2001; Scheerens, 2016, pp. 90–94).

Cognitive Support in Teaching

Cognitive support in teaching is associated with *active teaching* and cognitive activation. Active teaching is about providing a varied repertoire of presentation forms, alternative ways to group students, and different presentation media (Boekaerts & Simons, 1993; Slavin, 1995; Seidel et al. 2005, 129). Cognitive activation calls for stimulating higher order thinking, deep understanding of content, learning from mistakes, meaningful contexts, authentic instruction, relevance of content, and appropriate and high level of language (Klieme & Rakoczy, 2003).

Motivation and Emotional Support in Teaching

Motivation and emotional support in teaching are particularly sensitive in association with teacher expectations (e.g. the Pygmalion effect) and performance feedback (cf. De Vos, 1989). Paying attention to social-emotional attributes in teaching in a more general sense is addressed in Corcoran et al. (2018) and Scheerens et al. (2020), This theme will be taken up again in Sect. 5, as one of the examples, when searching for explanatory mechanisms in more partial theories on teaching.

Classroom management is the comprehensive orchestration of a broad set of facets of teaching, ranging from time and content management, aspects of classroom climate, achievement orientation, discipline, support, and ethos. It covers all teaching processes listed in Fig. 4.1 and all issues related to climate and student support. It is a collegiation of discrete elements, not a ranked continuum. It should be noted that classroom management as discussed in the above is considerably broader than 'classroom management aimed at optimizing active learning time and opportunity to learn', which is included in Fig. 4.1.

4.4 The Theoretical Meaningfulness of the Dimensions

The central question in this part of the chapter is whether summary categories of operational variables in teaching effectiveness can be interpreted as meaningful dimensions for a general theory on teaching. In the text-table below 3 main criteria to assess theoretical meaningfulness are listed, and afterwards explained.

(a) The comprehensiveness and parsimony of the complete set of dimensions
(b) The theoretical meaningfulness of each dimension (over and above a)
  – Potential for generating fundamental research
  – Linkage to more established theory
  – Potential for practice-oriented valorization
(c) Interconnectivity of the dimensions

Comprehensiveness is a criterion that should be applied to the whole set of dimensions. The expectation is that the three dimensions that are considered provide an exhaustive coverage of teaching effectiveness.

Parsimony would be challenged if the set of operational variables covered by each dimension would lack coherence, so that additional dimensions would be needed.

Potential for generating fundamental research is a demand that clearly goes beyond description and categorization. Ideally each dimension should be able to generate sufficient challenge and even controversy to suggest critical research questions.

Linkage to more established theory is an advantage if it helps in identifying explanatory mechanisms and covering laws.

Potential for practice- oriented valorization. Given the complexity and diversity of research outcomes in the field of educational effectiveness, evidence supported synthetic concepts are considered important in the communication with policy makers and practitioners.

Below, by way of a finger exercise, a first exploration will be made with respect to the feasibility of this approach to theory formation. This will be done by checking the criteria and applying them to the whole set of building blocks, or to separate dimensions.

The Comprehensiveness and the Parsimony of the Complete Set of Dimensions

The expectation is that the four building blocks provide an exhaustive coverage of teaching effectiveness. The comprehensiveness of the chosen set is challenged by Gage's inclusion of a dimension "student motivation and learning", and by Praetorius et al's incorporation of a dimension indicated as "students' direct learning-oriented reactions to teaching interventions". This latter dimension has indicators like "time on task" and "depth of processing". It could be argued though that teaching is about teaching interventions, while overt student reactions are learning activities. In a previous presentation I had subsumed such reactions under the heading of learning processes in a model of student learning (Scheerens, 2016, p. 29).

Parsimony would be challenged if the set of building blocks could be replaced by an even leaner set of dimensions. A possible step in this direction might be to set look at the integration of "the elementary parts of teaching" and "proactive and retroactive structuring. We shall return to this issue when addressing the interconnectivity of the set of building blocks.

The Theoretical Meaningfulness of Each Dimension

Potential for generating fundamental research is a demand that clearly goes beyond description and categorization. Ideally each dimension should be able to generate sufficient challenge and even controversy to suggest critical research questions. The formal characteristics of the dimensions in terms of unidimensional continua, bipolar scales or categorical sub-components may have implications for generating research questions. Teaching can *be more or less content focused* and address psychological operations of increasing complexity, as in taxonomies of educational objectives. Likewise, *structure vs independence in teaching* is a continuum with intermediary positions, like a gradual fading of structuring. Optimization of taking certain positions on the continuum can be seen as depending on situational characteristics, like student characteristics and school organizational conditions. This represents a perspective in line with "contingency theory" (see footnote 3), which is testable in what is known as a differential effectiveness approach. *Pro-active or retro-active emphasis in educational alignment* could-be addressed in a way that goes beyond a simple choice for the one or the other. Proactive and retro-active components will tend to be intermittently present in sequences of teaching events, and hypotheses may be posed about the preferable order and the predominance of the one or the other (Compare De Groot's position that evaluative specification should precede didactic planning, De Groot, 1986). *Classroom management* as presented here is a multi-dimensional “container”, for which three sub-dimensions were proposed (management of learning opportunities, management of classroom ecology and climate and support (cognitive and emotional). Research hypotheses will most likely be addressed at the level of the sub-dimensions. An example is given in Sect. 5 of this chapter on “partial” theories of teaching, where we will look at dynamic interaction between emotional and cognitive support. Still classroom management could also be studied at the dimension level, in hypotheses about the required dosage of components, and the effectiveness of control theoretical variations in management approach.

Linkage to a More Established Theory

The linkage to a more established theory is an advantage if it helps in identifying explanatory mechanisms and covering laws.

The degree to which teaching is more or less *focused on content and/or psychological operations* originates from didactic analysis, and is applied in taxonomies of educational objectives, like Bloom’s taxonomy and more recent forms as the RTTI approach (Drost & Verra, 2019). The debate on the feasibility of “content free” skills, versus the view that teaching is always associated with content is a fundamental debate in education (cf Weinert, 2001). When it comes to conceiving content-free skills, association with theories of intelligence and personality is relevant (Scheerens et al., 2020).

With respect to the dimension *structure and independence in teaching* a relevant attempt at linking “structuring” to covering laws is made by Gage (2009). In Sect. 5 of this chapter on partial theories we address linkage to learning theory and the information processing approach to cognition.

Pro-active or retro-active emphasis in educational alignment can be linked to variations of the rational planning model, like “bounded rationality” and the cybernetic principle (Scheerens et al., 2003, 2011).

As far as *Classroom management* is concerned, linkage to more established theory seems to make more sense for the sub-dimensions, and to partial theories associated with them. Development of the construct of cognitive activation would be an interesting case. In Sect. 5.2 we provide an example with respect to emotional support.

Potential for Practice Oriented Valorization

Potential for practice- oriented valorization has to do with the dissemination and communication with policymakers and educational practitioners and is here based on the believe that evidence supported synthetic concepts are important in these processes of dissemination and communication.

From my perspective on the international state of the art on effectiveness enhancing educational policies there are some major issues at stake for which the dimensions are relevant. I should say that my perspective is subjective and colored by the way I perceive developments in the Netherlands. Cryptically indicated, these issues are the neglect of the curriculum dimension in improvement models, resistances to external evaluation and assessment procedures, and an underscoring of the potential of the evaluation and feedback mechanism, the “traditional versus progressive education" debate and a phenomenon, which might be indicated with the label "unhyping soft skills" (Scheerens et al., 2020). It is beyond the scope of this chapter to discuss these observations in more detail.

The Interconnectivity of the Building Blocks

The two content dimensions, namely "the elementary parts of teaching", and "proactive and retroactive structuring" might be considered for further integration. The distinction of the elementary parts of teaching defined as the matching of content and psychological operations, could be seen as providing a grammar for defining taxonomies of educational objectives and educational alignment. In what is noted as "horizontal alignment" the matching between the formulation of educational standards and objectives on the one hand and high stakes assessment on the other is considered. The structure of content and psychological operations of objectives matches test matrices in which test items have a referent to content and psychological operations at a certain level. Tentatively a comprehensive content dimension labelled as "pro-active and retro-active structuring of the elementary parts of teaching" could be proposed. Alignment and learning from feedback could then be seen as partial theories within this dimension. This is visualized in Fig. 4.4. Other connections between the building blocks also suggest that the elementary parts of teaching function as a common referent among the other dimensions. When didactic operations are brought into the picture, the "elementary parts" are constituent elements of the concept of "pedagogical content knowledge", which could be given a "process interpretation" when teaching episodes are seen as "enacted pedagogical content knowledge". Didactic episodes, in their turn, are essentially determined by their degree of structure in teaching, in terms of opportunity to learn, and in terms of cognitive and emotional support. In this way, the three dimensions "pro-active and retro-active structuring", "structure and independence" and "classroom management" are united in being rooted in the dimension on the elementary parts of teaching.

Content Pro-active and retro-active structuring of the "elementary parts of teaching"	*Process* Structure and independence in teaching	Classroom management	*General theory*
- Alignment - Learning from feedback	- Constructivist teaching - Direct teaching	- Classroom ecology and climate - Learning opportunities - Cognitive and emotional support	*Partial theories*

Fig. 4.4 A hierarchical organization of dimensions and partial theories

In the discussion section of this chapter, I will try and make an overall assessment of the usefulness of this attempt at formulating building blocks for a general theory on teaching effectiveness.

In the next section we shall turn to partial theories of teaching.

5 Examples of Partial Substantive Theories of Teaching Effectiveness in the Domains of "Direct Teaching" and "Social Emotional Support"

In Sect. 4, I described a conceptual map of main components of teaching, which was considered as a contribution to a general theory on teaching effectiveness.

In this section I will turn to partial, substantive theories, defined within components of the conceptual map. Given the scope of the field, it will only be possible to give a few examples. Corresponding to the empiricist nature of the teaching effectiveness paradigm, each of these examples of partial theories is directly related to empirical research outcomes. The selected examples are theoretical conjectures in relationship to substantive results concerning "direct teaching" and "emotional support in teaching".

5.1 Direct Instruction

Overview

Direct instruction is a form of structured teaching that has repeatedly been shown as producing medium to large effects on student performance. (See the references in Sect. 1, and Zhang et al. (2021) for a more recent review. In this section I will show that the success of the approach can be explained by the information processing theory of cognition, more precisely the matching of teaching interventions to learning challenges derived from this theory.

Stockard et al. (2018), present a meta-analysis based on research outcomes collected over a 50-year period, with mean effect sizes in reading, mathematics, language and spelling that range from .50 to .66. Stockard et al. (ibid) discuss the "theoretical base" of direct instruction, by explaining the underlying philosophy and definitional characteristics. They say that direct instruction depends on the assumption that all students can learn with well-designed instruction. A first specification of what they mean by "well designed instruction" is that new material can be learned by students when (a) they have mastered prerequisite knowledge and skills and (b) the instruction is unambiguous. The underlying belief is that "students are inherently logical beings" (ibid, p. 480). Barbash (2012) speaks about direct instruction being based on an optimistic perspective. The main definitional characteristics that are outlined by Stockard et al. (2018, pp 480/481) are the following:

Mastery learning is a key element of direct instruction. “DI theory posits that when students become fluent in a new task, fully grasping a new concept or skill, it becomes part of an existing repertoire”.

Implications are the assumption that new learning is easier when it can be grounded in relevant subject matter that is fully mastered earlier and the observation that it is easier to learn a new concept, than to “unlearn” a faulty conceptualization.

A well-sequenced curriculum is an important basis for mastery learning.

A step-by step approach creates the possibility for continuous positive reinforcement throughout the instruction process.

Curricular materials are expected to provide highly structured guidance to teachers in the wording, sequencing, and review of material presented to students.

Curricula follow a tracked design in which “discrete skills and concepts are taught in isolation but are then brought together in increasingly more sophisticated and complex applications”.

Placement tests are included, and student progress is closely monitored.

Anchorage in Cognitive Information Processing Theory

It is quite interesting that Stockard et al. (2018) refer to Barbash for an explanation of the theoretical basis of direct instruction, because Barbash depicts it as opposed to “vague theories” of teaching and states that “Engelmann (as the founder of direct instruction, JS) did not formulate these principles from books or from abstract speculation about the way children learn”. He formulated them through a painstaking process of trial and error in the classroom, then applied them to create a series of unique programs that outperformed others in their power to teach many different subjects, to all kinds of children. So direct instruction was developed as an empirically supported practical program. Theorizing that connected the principles of structured education approaches as mastery learning and direct instruction to more encompassing concepts and established theory happened at a later stage.

Kirschner et al. (2006) offer a theoretical explanation based on the cognitive architecture of the human memory function. The relations between the short time (or ‘working’) memory and long-term memory, in conjunction with the cognitive processes that support learning are considered of critical importance. Guided instruction to novice learners, like explicit direct teaching, should facilitate storage in the working-memory. In the case of unguided ‘open’ instruction there is a great risk of cognitive overload. Cognitive overload prevents mobilizing the functioning of the long-term memory, in other words, that learning takes place. Learning is defined as a change in long-term memory. After guided instruction has helped in overcoming the information processing limitations of the short-term memory, learned information, stored in long-term memory, can be brought back from long term memory to working memory, more easily and over long periods of time. Open “constructivist” teaching which stimulates free exploration, on the other hand, may generate a heavy working memory load that is detrimental to learning. The more so in the case of novice learners, who lack proper schemas to integrate the new information with their prior knowledge.

Cognitive theory provides a basis for defining hypotheses about effective teaching interventions to stimulate student learning. These appear as the two sides of one coin[1]: when limited memory capacity is referred to as a relevant condition of learning, teaching is framed in a way to do justice to this principle, by not creating "cognitive overload", by means of a careful and prudent introduction of new subject matter, and ample opportunity to exercise and become familiar with the new content (cf Sweller, 1988). Similarly, the property that, once information is stored in long-term memory, it can be transferred back to the working memory relatively easily, supports tackling more complex learning tasks, A recent review by Kirschner et al. (2019) further illustrates how explicit direct teaching accommodates these more complex learning tasks, while matching the principles of cognitive information processing theories. They discuss increasingly complex cognitive processes, elaboration and transfer, problem solving and meta-cognition (Geary, 2008; Newell & Simon, 1972; Chi et al., 1981). The "answer" of teaching to facilitate these levels of learning is basically the same as in the case of avoiding cognitive overload in memory and reproduction of content: providing pre-structuring and support to learners. Rothkopf (1970), mentions orientation (attracting attention to what should be learned), selection (providing focus with respect to content and processes) and processing (calling on previous knowledge, raising questions). Dunlosky et al. (2013) discuss practices to enhance memory functions and retention, learning to learn effective approaches, repeating the subject matter of yesterday's lessons, the use of "exercise tests" and distributed practice, as effective teaching approaches. Ausubel 's well-known concept of "advance organizers" emphasizes the importance of activating previously acquired knowledge. as well as the importance of longitudinally connected content sequence (Ausubel, 1960). Rothkopf (1966) discusses the use of "test-like events" and asking questions to stimulate learning, Hattie and Timperley (2007) refer to the "power of feedback", and Black and Wiliam relate feedback to formative assessment. Clark (1989) connects assessment of entrance behavior to teaching that is adaptive to initial differences.

All of these contributions (collected in Kirschner et al., 2019) underline the importance of the kind of structured teaching that characterizes direct instruction.

A Constructive Solution to the Confrontation with Constructivism

Direct teaching is often contrasted with "open", teaching, discovery learning and self-regulated learning (e.g. Vander Werf, 2005; Kirschner et al., 2006). According to Stockard et al. (2018, 482) ". the theory underlying DI lies in opposition to developmental approaches, constructivism, and theories of learning styles, which assume that students' ability to learn depends on their developmental stage, their ability to construct or derive understandings, or their own unique approach to learning". Still

[1] Compare the following citation from Gage (2009), as cited in Praetorius and Charalambous (Chap. 1): 'if we have an adequate theory of learning, then the teacher must of necessity act upon that theory, without employing any separate theory of teaching. The teacher, if he is to engender learning, must of necessity do what the theory of learning stipulates as necessary for learning to occur. Teaching must thus be a kind of 'mirror image' of learning".'

there is some common ground as there is room for independent practice in the direct instruction model, and according to Stockard et al. “like the constructivist approach, DI assumes that students make inferences from examples that are presented to them” (ibid, 482). When teaching moves to providing episodes of more independent learning this needs to be prepared by structured teaching in the form of worked out examples, partially worked out examples, and with a gradual “fading” of support and scaffolding. This gradual fading of support can be seen as a bridge between structured teaching and independent and discovery learning. In the same vein Messner and Blum (2019) discuss what they call “the myth of open education” and conclude that “openness” and structuring should not be considered as complete opposites, but as inherently connected, since “open” “independent learning” in academic subjects without initially guiding instruction by the teacher, is completely unfeasible. The realization that structured teaching can also be seen as supportive of higher order learning (Brophy & Good, 1986, p. 367) further enforces the relevance of the approach. Still, it seems a better perspective not to depict “structured” and “open” learning as diametrical opposites but rather as a continuum, where moments of direct teaching, an independent learning can have different emphasis, depending on all sorts of deliberate considerations and contextual conditions. This is why I proposed “structure and independence in teaching” as one of the basic defining dimensions of teaching.

5.2 Emotional Support in Teaching

In their book “Soft skills in education. Putting the evidence in perspective” Scheerens et al. (2020) discuss the research evidence with respect to social emotional attributes in education. On the one hand these are seen as outcomes in their own right, and featuring as the dependent variables in intervention studies, and on the other hand, they are treated as instrumental to academic outcomes. An intriguing finding was that social emotional learning programs were shown to have effect sizes on cognitive outcomes as large as, or even larger than, dedicated cognitive interventions. Although bias in the empirical studies could not be ruled out as an explanation for this surprising finding, the authors felt stimulated to look for theoretical explanations related to the “workings” of social emotional interventions. In doing so they focused on the interplay of cognitive teaching and stimulation of socio-emotional learning. After considering distinct explanations, one based on econometric modelling by Cunha et al. (2010) and from OECD (2015, p 39), and another on Bandura’ theory on self-efficacy (Usher & Pajares, 2008; Bandura, 1986, the authors thought an approach from social psychology particularly interesting. Yeager and Walton (2011) reviewed empirical studies that had shown that seemingly “small” social-psychological interventions in education—“that is, brief exercises that target students’ thoughts, feelings, and beliefs in and about school—can lead to large gains in student achievement and sharply reduce achievement gaps even months and years later” (ibid p. 267) Inspired by modelling studies by Cohen et al. (2009), Yeager and

Walton conclude as follows. "A key to understanding the long-lasting effects of social-psychological interventions is to understand how they interact with recursive processes already present in schools, such as the quality of students' developing relationships with peers and teachers, their beliefs about their ability, and their acquisition of academic knowledge. It is by affecting self-reinforcing recursive processes that psychological interventions can cause lasting improvements in motivation and achievement even when the original treatment message has faded in salience" (ibid, 268). Scheerens et al., 2020 conclude that the study by Jaeger and Walton reflects two features that are most interesting for embedding social emotional learning in the every-day school context. Firstly, social psychological learning is targeted to the social emotional facets of school life and school learning. Secondly the way they are seen as interacting with regular content related teaching offers a tentative explanation for the finding that some evaluations of SEL programs and intervention showed significant improvement of academic outcomes.

In the previous sections I have approached the theme of "theorizing teaching" from three angles: meta- theory (the educational effectiveness research paradigm), general theory of teaching (major dimensions of teaching as building blocks for such a theory), and partial theories. The approach is in line with the tradition of research on teaching and research on educational effectiveness, in which theory development is explicitly rooted in empirical research. The main function of theory is to generate conjectures that provide explanations for the empirical findings (why what works), and which are expected to drive further empirical research.

It is important to note that "theory" is sometimes conceived in an entirely different way. One example is when issues of educational quality and equity are approached from the perspective of theories of social justice (Francis et al., 2017; Kelly, 2020). Another example are different brands of "critical theory", which, like the social justice perspective, focus on value-laden, normative, and even political facets of effective schooling and effective teaching (e.g Holborow, 2018). A third example is "non-affirmative theory", a pedagogical theory developed by Uljens and Ylimaki (2017).

6 Discussion

In this chapter the question "What is a theory of teaching" was answered by distinguishing three levels of theory: meta-theory, general theory, and partial theories (as explanations of empirical evidence). The follow-up question on what theory at each level should contain has different answers for each of the levels. At the level of meta-theory "teaching" was framed in accordance with the educational effectiveness research paradigm. This choice yielded a conceptual ground structure, based on a model from systems theory and reference to the scientific method as the epistemological and methodological background. The level of general theory was conceived as containing a potentially exhaustive limited set of sub-theories of effectiveness enhancing teaching processes. The third level, indicated as "partial theories", refers to more specific explanatory mechanisms intricately linked to empirical research outcomes. Theory at each of these levels was considered generalizable across major subject matter areas, like reading, language, mathematics, and spelling. The empirical evidence is seen as supporting the assumption that the foundational concepts and explanatory mechanisms work about equally well across these subject matter areas (Scheerens, 2016). This choice was pragmatic and should not be read as a denial of the relevance of studying eventual subject specific conditions (and differences between primary and secondary schools), it was seen as beyond the scope of this chapter. Before addressing the yield and potential products of theory at each of these levels in more detail, a general observation should be made.

The presentation underlined what was already concluded in earlier reviews (Scheerens, 2013, 2015), namely that educational effectiveness, including teaching effectiveness is a predominantly empiricist field of inquiry. "Theory" is mostly treated, inductively, as reconstruction "after the fact" instead of deductive in generating hypotheses for further empirical research. Ideally these two orientations should follow-up on one another, but my impression is that theory driven effectiveness research is relatively rare. The interaction of conceptual development and empirical research associated with the Dynamic Model of educational effectiveness by Creemers and Kyriakides (2008), is one of the positive exceptions. Despite occasional calls for more theory driven research (e.g., Reardon, 2011) theory is getting a stepmotherly treatment in the educational effectiveness research community. Hopefully, the present volume will turn the tide! In any case some of the perspectives, documented in this chapter, are seen as useful to furthering theory. Even when theory development remains limited to induction and reconstruction after the fact, it contributes to the "supportive understanding" of empirical results, to strengthening the conceptual identity of the field, to parsimonious summary of major outcomes and as a basis for communication with education practitioners and decision-makers. More specifically the current presentation has tried to provide the following inroads to stimulate a more active use and application of theory in this field.

First, the distinction between meta-theory, general theory and partial theories on teaching is offered as a vehicle to treat theory comprehensively.

Secondly, at the level of meta-theory, the presented research paradigm offers a conceptual ground structure of all possible associations between context-input-process-and outcome components. A worked-out example is provided by Gage, in reference to his "paradigm for the study of teaching", when he lists the relationships between all possible pairs of categories (Gage, 2009, pp. 55–56). Elsewhere, (Scheerens, 2016) I have discussed the most relevant associations between the components, when the CIPO structure is applied in a multi-level framework.

Thirdly, at the level of the conceptual "building blocks" for a general theory of teaching four dimensions, or building blocks, were distinguished: "the elementary parts of teaching", "pro-active and retro-active regulation", "structure and independence" and "classroom management". An attempt was made to enhance the heuristic function of these core dimensions of teaching, by explicitly addressing their exhaustiveness as a set, the "theoretical meaningfulness" of each dimension and the interconnectivity and internal structure of the set. All this against the background of Snow's developmental sequence of levels of theory. I found that the dimensions showed potential for generating fundamental research, could incidentally be linked to more established theory, and spoke to important "societal" debates on educational quality and effectiveness. In the process of verifying these criteria, particularly when addressing the inter-connectivity of the dimensions, I came to the conclusion that "the elementary parts of teaching" and "proactive and retroactive structuring" show a particular connectivity, which might be considered as a ground for integrating them in one dimension. (compare Fig. 4.2).

The dimensions that were considered as building blocks for a general theory on teaching could be used as a basis for directing comparative research on dimensions like "structure and independence", the relative effectiveness of pro-active and retroactive regulations dependent on contextual conditions, curriculum alignment as a content-based encompassing strategy to optimize opportunity to learn, and potential constructive interaction between cognitive and emotional support in classroom management. To the degree that these "building blocks" would be supported as an exhaustive coverage of teaching, they could provide new input to comprehensive school and teaching improvement projects.

Fourth, only two illustrative examples were given of more specific partial theories, intricately connected to empirical research outcomes. Results on structuring and direct teaching could be credibly explained on the basis of principles from the information processing approach to cognition. Insights from social psychology seemed to have potential for explaining interactions between cognitive and emotional support in classroom management.

Despite the potential of developments in the realm of a general theory on teaching, this last level of partial theories is seen as having the most potential in furthering theory formation and application in teaching effectiveness research. This is due to the established empiricist tradition of the field, and the expectation that piecemeal progress is the most realistic expectation in a loosely defined and fragmented, multidisciplinary research community. And, finally, finding fruitful conjectures to generate new research is also inspired by surprising research outcomes, and this occurs most likely, "close to the data", in more specific partial domains.

I would like to finish this chapter by addressing the five questions that the editors wanted to be commented on by all contributors to this volume.

What is a theory of teaching? In this chapter this question was addressed by distinguishing meta-theory, general theory, and partial theories.

What should it contain? The answer differs for meta-theory on the one hand and substantive theory (both general and partial) on the other. Meta-theory contains first principles, such as logical ground structures, epistemological preferences, methodologies and ontological considerations (defining characteristics). Substantive theory in relation to the educational effectiveness research paradigm is strongly rooted in empirical evidence, distinguishes descriptive components and relationships between these, as well as explanatory conjectures that explain hypothetical as well as empirically supported relationships.

Can such a theory accommodate differences across subject matter areas and student populations taught? I would say the answer is expected to be yes for a general theory on teaching, while one way of seeing theories as partial is the degree of their being restricted to a specific context.

Do we already have a theory on teaching? There is growing consensus on core sub-theories on teaching in the sense Gage refers to these, while others prefer to speak of core dimensions (examples and references have been given in the text of my chapter). Still some contributions might not be called theories by everyone. In an earlier contribution. I concluded that conceptual maps and dimensional models reflect the state of the art. Snow's levels of theory development supports calling models, and "summaries" of empirical findings "theories" be it at a low level on his scale. Occasional applications of "eclectic" use of more established theory from basic disciplines is seen as an instance of gradual progress towards a higher level of theory. From the perspective of the educational effectiveness paradigm the key issue is the explanation of the findings by means of a plausible and established causal mechanisms.

In the future, in what ways might it be possible, if at all, to create a (more comprehensive) theory of teaching? I see this as a continuation of a piecemeal, bottom up development, rooted in the analysis and synthesis of empirical research outcomes. Making sense of the enormous quantity of research outcomes by means of meta-analyses and research reviews stimulates reflection on what is generalizable and what is helpful for further research. Last but not least, the answers that policy makers and practitioners want from researchers call for conceptual synthesis and theoretically meaningful interpretation of the evidence. Again: nothing more practical than a good theory.

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Chapter 5
Establishing a Comprehensive Theory of Teaching and Learning: The Contribution of the Dynamic Model of Educational Effectiveness

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Abstract The chapter refers to the evolvement of Educational Effectiveness Research (EER) during the last 40 years that begun from the mere identification of correlations among factors and led to the development of integrated models of effectiveness. Then, the chapter refers to the development of the dynamic model of educational effectiveness which emerged from a critical review of integrated models of effectiveness and a synthesis of studies testing the validity of these models. The teacher factors of the dynamic model are presented and their relations with theories of learning are identified. We also refer to longitudinal studies conducted in different countries to test the validity of the dynamic model. The findings of these studies generated empirical support to the main assumptions of the model. Stages of effective teaching were also identified. In the final section, issues of equity are discussed taking into consideration that EER has evolved beyond the sole search of 'what works' in education to also providing answers to questions such as 'for whom does it work' and 'under which conditions does it work'. Finally, we discuss the possibilities of developing a more comprehensive and dynamic theoretical framework of teaching and learning that can be used for improvement purposes.

Keywords Dynamic model of educational effectiveness · Educational effectiveness research · Teaching quality · Equity

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1 Educational Effectiveness Research: The Theoretical Development of the Field

Educational Effectiveness Research (EER) has long dealt with identifying factors operating at the different levels of education that may contribute in explaining the variation observed in student outcomes in an attempt to identify 'what works' in education. As similarly stated by Scheerens (this volume), "educational effectiveness would seek to determine the "net" effect of malleable educational conditions, defined at different levels, on outputs, while controlling for relevant antecedent conditions at the level of individual participants". Research during the past 35 years has led to the demonstration of a number of teaching factors that are positively related to student outcomes (e.g., Brophy & Good, 1986; Creemers, 1994; Doyle, 1986; Galton, 1987; Muijs & Reynolds, 2003). Originally, the attention given to EER was a result of the early sociological and psychological studies of Coleman et al. (1966) and Jencks et al. (1972), respectively, which concluded that education had a very small contribution on student outcomes especially when student background characteristics were taken into consideration. These results were also reinforced by the failure of large-scale programmes applied in schools, such as the "Headstart" and "Follow Through", which aimed at reducing the initial differences between students and address equity issues. These disappointing results led to reactions, both among practitioners as well as among researchers, who opposed the idea that schools had few to offer in improving student outcomes (Stringfield & Teddlie, 2011). These studies and the reactions their results caused were thus a catalyst for the development of a line of early studies in the field of EER which revealed that differences in school effectiveness exist even when controlling for student background characteristics, assuming that these differences could be attributed to differences in the quality of education offered by schools (Goldstein & Woodhouse, 2000). In spite of the methodological weaknesses of these studies, their optimistic results which showed that effective teachers and schools play an important role in student achievement, gave thrust to further research in the field of educational effectiveness which then raised questions towards explaining those differences (Creemers & Scheerens, 1994).

In the second phase of EER, researchers aimed at explaining the reasons for which these differences exist and identify factors that explain variation in student outcomes (Levine & Lezotte, 1990; Sammons et al., 1995; Scheerens & Bosker, 1997). Thus, a series of process-product studies have taken place and led to the identification of a list of factors that link specific teaching behaviors and characteristics to student outcomes (Doyle, 1986; Brophy & Good, 1986; Reynolds & Stoll, 1996; Borich, 1996; Galton, 1987; Evertson et al., 1980). One of the first studies that were conducted and has led to the identification of five factors which were considered to be correlated with each other and linked to better student outcomes was a study by Edmonds (1979). Edmonds' "five-factor model" included the following factors: (a) strong educational leadership, (b) high expectations of student achievement, (c) emphasis on basic skills, (d) safe and orderly climate and (e) frequent evaluation of student progress. However, the study was heavily criticized for its methodological weaknesses (e.g., Ralph & Fennessey, 1983). The methodological criticism of the studies conducted during the first and second phase of EER had gradually shifted the focus of researchers to not only the possible identification of isolated factors which could explain variation in student outcomes, but also to the demonstration of causal relations between factors and achievement. This turn in focus was based on the framework developed by Scheerens and Creemers (1989), which called attention to the possible contribution of the different levels of education to student outcomes.

In the third phase of EER, researchers moved from identifying effectiveness factors to explaining why specific factors are associated with student achievement gains (Scheerens & Bosker, 1997). In this context, three basic approaches have been used to identify the reasons for which certain factors or characteristics contribute to educational effectiveness.

The first approach lies on the *economic aspects of education* and focuses on the relationship between schooling inputs and educational outputs controlling for the influence of several background characteristics (Monk, 1992; Hanushek, 1997). This approach places emphasis on the educational costs and attempts to identify their linkage with student outcomes assuming that increased inputs can lead to improved outcomes. However, education production studies were not in a position to reveal the school inputs that can contribute to maximizing student gains from education (Monk, 1992) especially since process variables, such as the quality of teaching, were not considered. This implies that the relationship between inputs and outputs in education is more complex than assumed (Creemers & Kyriakides, 2008).

The second approach focuses on the *sociological perspective* of EER. This approach refers to factors relating to students' background characteristics as well as other social and cultural factors which could possibly affect student outcomes. Based on this approach, the possibility of adjusting for these background and social differences through education is examined. Therefore, apart from quality in education, another aspect that gradually started to gain attention was the equity dimension which led to several studies searching for the differential effectiveness of schools in regard to different student populations (e.g., Campbell et al., 2004; Strand, 2010) and the effect of contextual factors on student outcomes (Opdenakker & Van Damme, 2006).

Finally, the third approach lies on the *psychological perspective* of EER that focuses on student background factors associated with motivation and learning aptitude, as well as with the learning process itself. Therefore, this approach called for more attention on the two main actors involved in the teaching and learning process (i.e., students and teachers), and led to a list of teacher behaviors in the classroom which were found to be related to student achievement gains. Such factors include management of the classroom, expectations of student performance, structuring of lessons, questioning skills, and immediate exercise after presentation, as well as evaluation, feedback, and corrective instruction (Creemers, 1994). Management of the classroom is linked with "opportunity to learn" (i.e., the opportunities given to students to engage with learning activities) and "time on task" (i.e., the time students are actually engaged with learning tasks) which have been consistently found to positively influence learning (Brophy & Good, 1986). This implies that teachers who are effective in dealing with student misbehavior help their students to stay on task. Along with dealing with student misbehavior, research in the field of teacher effectiveness has indicated that the establishment of a well-structured and orderly climate, in which interactions among students are encouraged and learning occurs effortlessly through maximizing student collaboration and eliminating excessive competition among students, can contribute to maximizing student gains (Muijs & Reynolds, 2003). The focus during that time was to identify generic factors that may have an impact on student outcomes, meaning that they may have an impact in different contexts, subjects and age-groups of students.

In the fourth phase of EER, researchers have attempted to respond to a major criticism that was made against early EER concerning the failure of the field to substantially contribute to the establishment of strong links between research on effectivenessfactors and actual improvement in the quality of education. With respect to this, a dynamic perspective of education is now being incorporated more explicitly into the theoretical models of EER and the concepts of change and adaptation are more widely taken into consideration both in terms of theory development as well as to the use of theory for improvement purposes into changing contexts (Kyriakides et al., 2021; Scheerens, 2013).

In this chapter, we therefore discuss the possibilities of developing a comprehensive theoretical framework of teaching that may be used not only for addressing issues of "what works" in education, but also for "whom" and "under which conditions"and may also contribute to teacher and school improvement efforts. Thus, when referring to theories of teaching, we refer to factors that may depict characteristics of effective teaching, without however neglecting the impact that student and system level factors may have on the teaching and learning situation. We also expect that the ultimate aim of theories of teaching would be to help schools become more effective in terms of improving student outcomes. We also stress the need for developing such a comprehensive theoretical framework by using the knowledge base of EER and more specifically, by taking into consideration theories that have received sufficient empirical support and factors that have already been found to affect learning outcomes. At this point it is important to stress, that when considering the development of a comprehensive framework of teaching and learning we do not only refer to one single theory or model of teaching. We rather refer to the use of the different theories of teaching and learning within the field of EER from which the main elements that have received empirical support may be retrieved, to provide a basis for the development of a comprehensive framework. Regarding the characteristics of such a theoretical framework, we argue that these should be at least the following. First, it should take into account the nested nature of education and depict the role that different factors at the upper and lower levels of education play in explaining student learning outcomes. To identify factors operating at different levels, the comprehensive framework of teaching and learning should draw on all three dominant perspectives of educational effectiveness. Second, the comprehensive theory should explicitly provide information on the linkage between the factors included and student learning outcomes. Namely, reference to the relevant theories of learning and schooling that are considered in defining each factor should be made. Third, the comprehensive theory of teaching and learning should refer to the impact that each factor may have across subject matters and student populations. The extent to which specific factors and their measurement dimensions matter more for specific groups of students should be made explicit. In this way, a comprehensive theory of teaching and learning could also address issues of equity and not only issues of quality, as most existing theories within the field of EER have done so far. Finally, the dynamic nature of education should be considered in developing a comprehensive theory of teaching and learning. Therefore, we argue that the dynamic model of educational effectiveness (Creemers & Kyriakides, 2008), which belongs to the fourth phase of EER, may be used as a starting point for developing a comprehensive theoretical framework of teaching and learning. We argue for the use of the dynamic model as it refers to factors that may affect student learning and it is based on empirical data. We therefore present its main characteristics in the next section.

2 The Dynamic Model of Educational Effectiveness

In this section the main elements and rationale upon which the dynamic model has been developed are presented. The factors included at the classroom level are analyzed and their main features are explained. Despite the fact that the dynamic model is multilevel in nature, in this chapter we only focus on the classroom level and present the teacher factors as these have been systematically shown to have a greater effect on student learning than factors located at the upper levels (i.e., school and system). For more information on the factors included in the dynamic model at the upper and lower levels see Creemers and Kyriakides (2008).

2.1 Main Elements and Rationale

The development of the dynamic model took into account the criticism on the earlier models of EER and incorporated the findings of studies conducted in regard to the factors that have an influence on student outcomes (Creemers & Kyriakides, 2006). It was developed based on the main principles of the Creemers' Comprehensive model (Creemers, 1994), providing however clearer definitions of the factors included at the different levels, as well as a more elaborated description of their measurement. In addition, the dynamic model takes into account the "new goals of education", which means that apart from its reference to the cognitive outcomes of schooling, it also refers to other outcomes, such as affective, psychomotor and new learning outcomes (e.g., metacognition). Additionally, the dynamic model is multilevel in nature. Specifically, it refers to factors operating at the four different levels shown in Fig. 5.1 (i.e., student, classroom, school and system). The dynamic model does not only refer to factors operating at the classroom level but also at the school

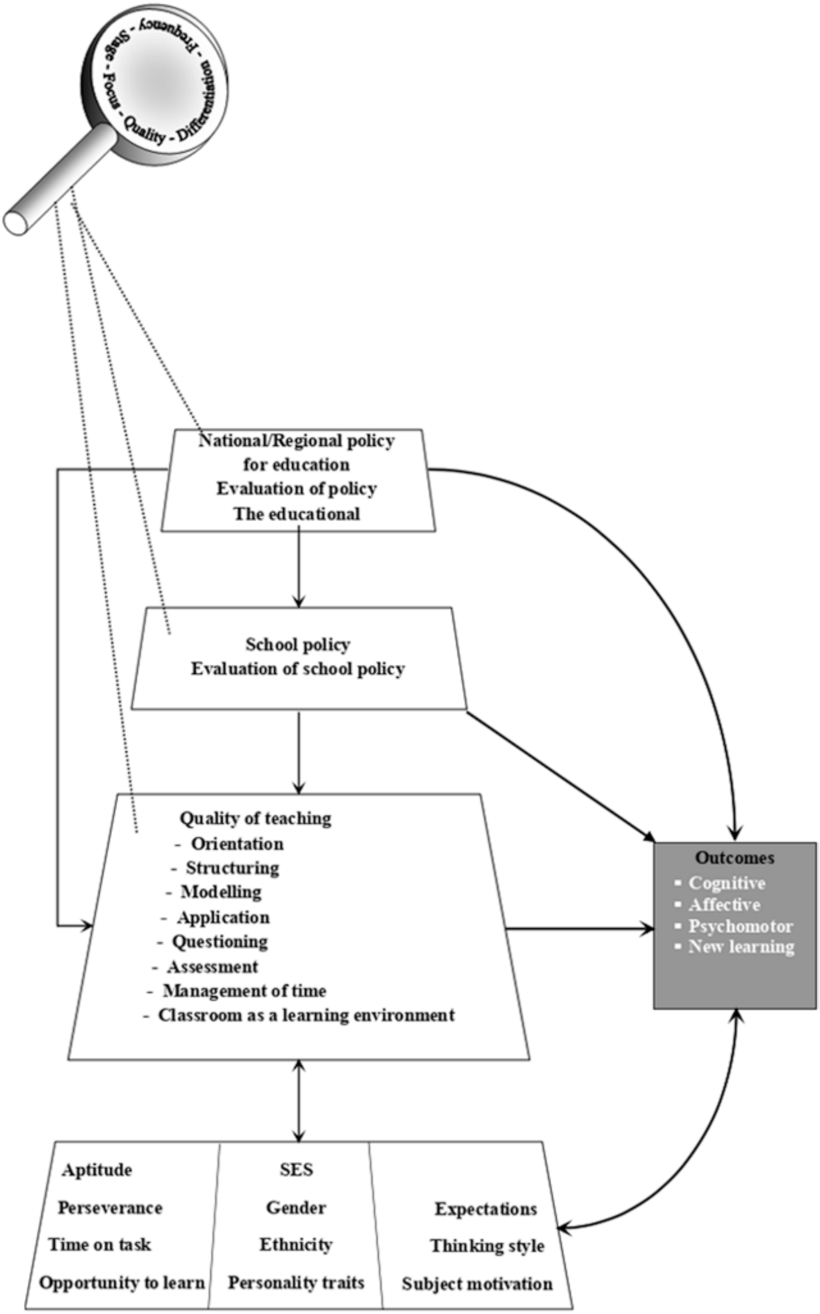

Fig. 5.1 The dynamic model of educational effectiveness

and system levels, recognizing on the one hand the direct effects of teachers' instructional behavior on student learning outcomes and on the other hand, the mainly indirect effects of the system and school factors, through facilitating quality of teaching. This implies that any attempt to develop a comprehensive theory of teaching should recognize the impact that the school and system level factors have on quality of teaching and should therefore have a multilevel structure. This impact is also acknowledged by Scheerens (this volume), who also refers to the need of considering the influences of factors located at the upper and lower levels of education, on the classroom level. In addition, the dynamic model was developed based on the notion that the basic aim of the school is the promotion of learning and therefore, includes factors that have been found through empirical studies to affect learning.

The dynamic model considers effectiveness factors as multidimensional constructs (Kyriakides & Creemers, 2008) and proposes the following five measurement dimensions which are assumed to provide more information concerning not only the quantitative, but also the qualitative aspects of the factors: *(a) frequency, (b) stage, (c) focus, (d) quality* and *(e) differentiation* (Creemers & Kyriakides, 2008). The five measurement dimensions will be further elaborated in the next section of this chapter.

In addition, the dynamic model gives emphasis on providing a clear description of quality of teaching through eight factors included at the classroom level and assumes that there are relations between factors operating both at the same and different levels. Such relations were also demonstrated through earlier models such as Walberg's (1984) who indicated that aptitude, instruction and the psychological environment influence one another and are also influenced by feedback on the amount of learning that occurs. Thus, the concept of grouping of factors was introduced.

Finally, the dynamic model was designed in such a way that can be used not exclusively for research and theory purposes, but also for promoting improvement in education (Creemers & Kyriakides, 2015; Savage, 2012). The practical use of the model for improvement purposes, both at the classroom and school level, has already been explored through several experimental studies (for a review of these studies see Kyriakides et al., 2021).

2.2 Classroom-Level Factors in the Dynamic Model

The dynamic model acknowledges the role that teacher has to play in order to initiate, promote and evaluate student learning (Scheerens & Bosker, 1997; Teddlie & Reynolds, 2000). Specific teaching activities that teachers perform during lessons are taken into consideration instead of teacher background characteristics, such as gender, age, education, beliefs and motivation. Despite the fact that the background characteristics of teachers are widely discussed in the literature, research findings provide contradictory results in relation to the magnitude and the nature of the impact of those characteristics (Creemers & Kyriakides, 2015). Therefore, these characteristics are not included in the dynamic model since it is mainly concerned with teacher factors that were found to directly affect learning through research in the field of teacher effectiveness (e.g., Brophy & Good, 1986; Doyle, 1986; Emmer & Stough, 2001; Muijs et al., 2014; Muijs & Reynolds, 2001; Rosenshine & Stevens, 1986). Based on the main findings of TER, the eight factors included in the model are as follows: *orientation, structuring, questioning, teaching-modelling, application, time management, teacher role in making classroom a learning environment, and classroom assessment*. More information on the foundations and limitations of TER, can be found in Vieluf and Klieme (this volume). The eight factors do not only refer to one approach of teaching, such as structured or direct teaching (Joyce et al., 2000), or to approaches associated with constructivism (Schoenfeld, 1998). An integrated approach to defining quality of teaching is adopted (Elboj & Niemelä, 2010), similarly to other frameworks, such as the theory of basic dimensions of teaching quality (TBD) (see Vieluf & Klieme, this volume). Specifically, the dynamic model refers not only to skills associated with direct teaching and mastery learning, such as structuring and questioning, but also to orientation and teaching modelling, which are in line with theories of teaching associated with constructivism. Particularly, these factors have been included in the model and defined by considering the main theories of learning such as behaviourism, cognitivism, constructivism and human/motivation theories. For example, orientation was treated as a teacher factor by taking into account motivation theories. Application was also used as a teacher factor by considering the cognitive load theory. It is also supported, that these factors are generic in nature, assuming that since they were found to promote the cognitive learning of students, they are also able to promote non-cognitive learning. Despite the fact that these factors can be considered generic in nature in terms of having an effect on student learning despite time, place, age and other student population characteristics, studies investigating differential teacher effectiveness have revealed that teacher factors may have a stronger impact on the learning of specific groups of students (Campbell et al., 2004). More information on the individual characteristics of each factor included in the dynamic model is provided below.

(A) Orientation: It refers to teacher behavior in providing the students with explanations in regard to the reason(s) for which a particular activity or lesson or series of lessons occur and/or actively involving students to the identification of the reason(s) for which a lesson includes a specific task. Through this process it is expected that the activities that take place during a lesson and/or series of lessons will become meaningful to students and consequently increase their motivation for participating actively in the classroom (e.g., De Corte, 2000; Paris & Paris, 2001). It is also supported that orientation tasks should take place in not only one part of the lesson but be evenly distributed among the different parts of a lesson or series of lessons (e.g., beginning, middle, and end).

(B) Structuring: It is a factor for which research in the field of educational effectiveness has had early indications in regard to its contribution to student learning. Even from the mid-80 s, attention was called to the fact that student learning is positively influenced when teachers actively present materials and structure them by: (a) beginning with overviews and/or review of objectives; (b) outlining the content to be covered and signaling transitions between lesson parts; (c) calling attention to main ideas; and (d) reviewing main ideas at the end (Rosenshine & Stevens, 1986). In addition, research has shown that student outcomes can be amplified when teachers provide them with summary reviews, as they are expected to contribute to the grouping and outlining of main points (Brophy & Good, 1986). The fore mentioned structuring tasks aim at assisting students develop links between the different parts of lessons, instead of dealing with them as isolated units. Finally, the structuring factor is not limited to the mere linkage among the different parts of lessons and/or series of lessons, but also refers to the gradual increase of the lessons' difficulty level which is expected to provide all students, irrespective of their abilities, with the opportunity to engage in the lesson's processes (Creemers & Kyriakides, 2006).

(C) Questioning: This factor is defined according to five elements. Firstly, effective teachers are expected to not only provide a large amount of product questions which require students to respond in a single way, but also focus on expecting students to elaborate on their answers and provide details indicating the mental course they followed to reach their answer (i.e., by also posing process questions) (Askew & William, 1995; Evertson et al., 1980). Secondly, it is anticipated that teachers grant students with enough time to think before calling for their answers with the amount of time given depending on each question's level of difficulty. Thirdly, it should be established that the questions posed by the teacher are clear to the students so that no misconceptions or misinterpretations are caused. Fourthly, when posing a question, the teacher should consider students' ability to respond, avoiding too difficult questions that would inevitably cause complete failure to respond (Brophy & Good, 1986). Finally, it is outlined that an important aspect of this factor is the way teachers deal with student responses. Specifically, correct responses should be acknowledged so that it is established that all students are aware of the correct answer at the end of the discussion. In case a student's answer is not fully correct then the teacher should acknowledge whatever part may be correct, and assist the student in discovering the correct answer or provide an improved response, through the provision of clarification or helpful guidelines.

(D) Teaching-modeling: An aspect of education that has received increased attention in the last two decades is that of self-regulated learning due to the extensive policy emphasis given on the achievement of the new goals of education (Muijs et al., 2014). Taking the above into consideration, the teaching-modeling factor is included among the teacher factors of the dynamic model. This factor anticipates that effective teachers are promoting students' use of learning strategies and/or development of their own strategies in order to address different types of problems (Grieve, 2010) and develop skills promoting active learning. Thus, depending on the problem addressed, teachers may follow two alternative approaches. The first approach concerns the teacher's presentation of a problem-solving strategy without asking for any student input. The second approach demands more active student participation and begins in a rather backward manner, since students are encouraged to describe ways of how they themselves would address a specific problem. Then the teacher is expected to make use of that information for promoting the idea of modeling and encourage the development of the students' own problem-solving strategies (Aparicio & Moneo, 2005; Gijbels et al., 2006).

(E) Application: Providing students with practice and application opportunities can enhance learning outcomes (Borich, 1996). Learning new information cannot be a constant process, since according to the Cognitive Load Theory the working memory can only process a limited amount of information at each given time (Kirschner, 2002; Paas et al., 2003). It is also argued that application tasks should not only constitute a repetition of the material that students were taught in classroom but should move a step forward adding more complex and mentally stimulating elements. Thus, application activities should provide the trigger for further knowledge, contributing to the linkage of the units taught in one lesson or series of lessons with the following. Effective teachers are expected to not only observe students engaging in application tasks, but also to actively contribute to their learning by supervising their progress and providing students with constructive feedback (Brophy & Good, 1986; Creemers et al., 2013).

(F) The classroom as a learning environment: This factor consists of five components: a) teacher-student interaction, b) student-student interaction, c) students' treatment by the teacher, d) competition between students, and e) classroom disorder. Classroom environment research has evidence showing that these five elements can be considered as important aspects of this factor. Specifically, the first two of these elements refer to the type of interactions that exist in a classroom and can be seen as important for measuring classroom climate (for example, see Cazden, 1986; Den Brok et al., 2004; Harjunen, 2012), especially since learning takes place through interactions. The other three elements refer to teachers' efforts to create a well-organized and accommodating environment for learning in the classroom (Walberg, 1986).

(G) Management of time: To address this factor the amount of time used per lesson for on-task behavior is investigated. It is anticipated that effective teachers are able to organize and manage the classroom environment reducing any purposeless loss of learning time, maximizing engagement rates. Thus, the main interest of this factor is whether students are on task and whethertheir teacher is able to deal effectively with any kind of classroom disorder without wasting the teaching time. It is also important to investigate whether teachers manage to decrease loss of time for different groups of students by taking into consideration their different learning needs and abilities (e.g., by allocating supplementing work to gifted students that finish work earlier than others).

(H) Assessment: Assessment is seen as an essential and integrated part of teaching (Stenmark, 1992). Especially formative assessment has been found to be one of the most important factors associated with effectiveness at all levels, especially at the classroom level (e.g., De Jong et al., 2004; Kyriakides, 2008; Shepard, 1989). Therefore, the dynamic model places emphasis on student assessment and argues that the information collected though assessment is expected to be used by the teacher for at least two reasons. The first reason is related to the identification of particular student needs so as to proceed with the provision of feedback and corrective measures where needed. The second reason lies on the teachers' self-evaluation since student results may reflect possible weaknesses in teaching practice and indicate areas for improvement. It is thus stressed that assessment data should be examined in terms of quality (i.e., whether they are reliable and valid) in order to promote the formative rather than the summative purpose of assessment.

As has been mentioned in the first part of this section, the dynamic model assumes that each factor can be defined and measured according to five dimensions: *frequency, focus, stage, quality, and differentiation*. These dimensions may assist the more effective description of the functioning of a factor and make it easier to use the results of the evaluation of the functioning of each factor for improvement purposes. The importance of taking each dimension of the teacher effectiveness factors into account is illustrated below.

– *Frequency* is a quantitative means of measuring the functioning of each factor. However, the other four dimensions which refer to the qualitative characteristics of the functioning of the factors reveal that effectiveness is more complicated than assumed by previous theoretical models and studies.
– *Focus* can be defined by taking into account two different facets. The first one refers to the specificity of the activities associated with the functioning of a factor, namely whether they can be considered as specific in terms of solid activities or policies; or more general, in terms of not providing adequate details to the different stakeholders on the application processes of an activity. The second aspect refers to the purpose for which an activity takes place by looking whether an action aims at achieving one or several purposes. The dynamic model argues that there should be a balance in the specificity of the teaching tasks and this assumption is in line with the synergy theory (see Kyriakides et al., 2021).
– *Stage* is closely related to the time at which tasks associated with a factor take place. It is assumed that the application of a factor in only one point in time may not constitute an effective way of dealing with the factor in terms of increasing the positive effects resulting from its implementation. Thus, the factors need to take place over a long period of time to ensure that they have a continuous direct or indirect effect on student learning.
– *Quality* refers to the properties of the specific factor itself, as they are discussed in the literature. For instance, in regard to the assessment factor, as it is stated through literature, formative assessment is expected to be more beneficial to students than summative and facilitate both learning and teaching (Black & Wiliam, 2009; Hattie & Timperley, 2007; Wiliam et al., 2004).
– *Differentiation* refers to the extent to which activities associated with a factor are applied without any discretion for all the subjects involved with it (e.g., all the students, teachers, schools) irrespective of their needs and/or abilities. It is expected that adaptation to the specific needs of each subject or group of subjects will increase the successful implementation of a factor and will ultimately maxi-

mize its effect on student learning outcomes also addressing issues of equity (Creemers & Kyriakides, 2006). Taking in mind that students learn best when their teachers become accustomed to the differences in their readiness levels, interests and learning needs and make an effort to adjust their teaching in order to satisfy them (Tomlinson, 2005), the need for examining the functioning of the different factors in terms of differentiation is amplified.

In this section, the main assumptions and rationale upon which the dynamic model was developed were discussed. In the next section, a brief description of the main studies that have provided empirical support to the main assumptions of the model at the classroom level is provided.

3 Empirical Support Provided to the Main Assumptions of the Dynamic Model at the Classroom Level

Some research findings supporting the validity of the dynamic model have been produced since 2003, when the model was developed. Specifically, 16 empirical studies and one meta-analysis have been conducted to examine the main assumptions of the dynamic model at classroom level (for a review of these studies see Kyriakides et al., 2021). These empirical studies as well as the meta-analysis have provided support for the importance of factors included in the dynamic model at classroom level and their measurement dimensions. Empirical studies have also revealed relationships among factors operating at the classroom level, which help us define stages of effective teaching. Table 5.1 provides a summary of the findings of these studies, indicating the type of support that each of the assumption in the model has received. It is important to note that none of these studies or meta-analyses has generated negative results with regard to any assumption of the dynamic model. Moreover, all studies have provided empirical support to the multilevel nature of the dynamic model since factors operating at different levels have been found to be associated with student achievement.

Table 5.1 Empirical evidence supporting the main assumptions of the dynamic model at the classroom level emerging from empirical studies and a meta-analysis

Assumptions of the dynamic model	Empirical studies	Meta-analysis
1. Multilevel in nature	All	17
2. Five dimensions can be used to measure the teacher factors	1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 16	
3. Impact of teacher factors on learning outcomes	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16	17
4. Relationships between factors operating at the same level: Stages of effective teaching (including assessment)	1, 4, 5, 6, 7, 8, 9	17
Negative results in relation to any assumption	None	None

Studies:

1. A longitudinal study measuring teacher and school effectiveness in different subjects (i.e., mathematics, language and religious education) and different learning domains (cognitive and affective) (Kyriakides & Creemers, 2008).
2. A study investigating the impact of teacher factors on achievement of Cypriot students at the end of pre-primary school (Kyriakides & Creemers, 2009).
3. A European study testing the validity of the dynamic model at teacher, school and system level (Panayiotou et al., 2014).
4. A study in Canada searching for grouping of teacher factors included in the dynamic model and revealing specific stages of effective teaching (Kyriakides et al. 2013a).
5. An experimental study investigating the impact upon student achievement of a teacher professional development approach based on the dynamic approach (Antoniou & Kyriakides, 2011).
6. Examining not only the impact but also the sustainability of the dynamic approach on improving teacher behaviour and student outcomes (Antoniou & Kyriakides, 2013).
7. Searching for stages of teacher's skills in assessment (Christoforidou et al., 2014).
8. The effects of two intervention programmes on teaching quality and student achievement revealing the added value of the dynamic approach (Azkiyah et al. 2014).
9. Using the dynamic model to identify stages of teacher skills in assessment in two different countries (Cyprus and Greece) (Christoforidou & Xirafidou, 2014).
10. Using observation and student questionnaire data to measure the impact of teaching factors on mathematical achievement of primary students in Ghana (Azigwe et al., 2016).
11. Examining the impact of teacher behaviour on promoting students' cognitive and metacognitive skills (Kyriakides et al., 2020).
12. Investigating the impact of teacher factors on slow learners' outcomes in language (Ioannou, 2017).
13. Integrating generic and content-specific teaching practices when exploring teaching quality in primary physical education (Kyriakides et al. 2018b).
14. A longitudinal study investigating for the short- and long-term effects of the home learning environment and teacher factors included in the dynamic model on student achievement in mathematics (Dimosthenous et al., 2020).
15. A case study of policy and actions of Rivers State, Nigeria to improve teaching quality and the school learning environment (Lelei, 2019).
16. Do teachers exhibit the same generic teaching skills when they teach in different classrooms (Kokkinou & Kyriakides, 2018)

Meta-analysis:

17. A quantitative synthesis of 167 studies investigating for the impact of generic teaching skills on student achievement (Kyriakides et al. 2013b).

3.1 The Impact of Teacher Factors on Student Learning Outcomes

Table 5.1 shows that the results of 16 empirical studies demonstrate that teacher factors in the dynamic model are associated with students' achievement gains. It is also important to note that different types of learning outcomes were used as criteria for measuring teacher effectiveness. Specifically, these studies were able to demonstrate the impact of teacher factors on promoting not only cognitive, but also affective (e.g., Kyriakides & Creemers, 2008) psychomotor (e.g., Kyriakides et al. 2018, b) and meta-cognitive learning outcomes (e.g., Kyriakides et al., 2020). One can also see that the studies presented in this table collected data on achievement in different subjects (i.e., language, mathematics, science, religious education, and physical education) and from students in different phases of education (i.e., pre-primary, primary, and secondary education). Therefore, these studies provided some empirical support for the assumption that teacher factors can be considered to be generic, especially since these factors were found to be associated with student achievement gains with respect to different learning outcomes and in different phases of education. It is finally important to note that these studies took place in different countries (mainly in Europe), and the significance of teacher factors when it comes to explaining variation in student achievement gains in different educational contexts has to some extent be demonstrated. It is important to note that one of these studies was conducted in Ghana and the teacher factors of the dynamic model were found to provide an even more convincing explanation for variation in student achievement rather than in any of the European countries from which data on teacher factors have been collected (Azigwe et al., 2016). The findings of these empirical studies seem to be in line with the results of the meta-analysis which was conducted in order to test the validity of the dynamic model at the teacher level (Kyriakides et al. 2013b).

3.2 Using a Multidimensional Approach to Measuring the Functioning of Teacher and School Factors

The studies that took place so as to assess the validity of the model, have revealed that the proposed dimensions should be taken into account in the field of EER. Namely, these studies made use of the proposed measurement framework to design instruments that would evaluate the functioning of the teacher factors in relation to the five dimensions. By employing structural equation modelling techniques, the construct validity of these instruments was demonstrated. It was therefore possible to treat each factor as a five-trait construct (consisting of each of the five dimensions of the model) and generate relevant scores rather than treating the factor as a unidimensional construct. In addition, the added value of using the five dimensions to measure teacher factors has been demonstrated, especially since, when all five dimensions of teacher factors were considered, a much larger variance of student achievement gains could be explained rather than when only one or even some dimensions of the teacher factors were included in the multilevel model. What is, however, more important is that in some studies it was not possible to see the effects of some factors when only the frequency dimension was considered, but variation in student achievement was explained when the other four dimensions of these factors were taken into account (e.g., Kyriakides & Creemers, 2008, 2009). This implies that if these studies were only concerned with the frequency dimension of these factors, it would not have been possible to demonstrate the effects of these factors, and the importance of the factors could have been misinterpreted (Creemers & Kyriakides, 2015).

3.3 Searching for Relationships Among Teacher Factors: Establishing Stages of Effective Teaching

The dynamic model argues that factors operating at the same level are related to each other. Thus, the concept of grouping of factors is introduced. In this part, we refer to the main findings of studies investigating relationships among teacher factors, which were able not only to empirically support this assumption of the model, but also to identify stages of effective teaching. The first study that revealed relationships among the teacher factors (Kyriakides et al., 2009) was conducted in order toidentify the impact of the eight teacher factors and their dimensions on student achievement gains in different subjects (i.e., language, mathematics and religious education) and on different types of learning outcome (i.e., cognitive and affective). This study tested the validity of the measurement dimension framework proposed by the dynamic model and made use of the Rasch model to identify the extent to which the five dimensions of the teacher factors could be reducible to a common unidimensional scale. By analyzing the data that emerged from the observation instruments used to measure the performance of the teacher sample in relation to the eight teacher factors and their dimensions, it was discovered that the data fitted the Rasch model, and a reliable hierarchical scale of teaching skills was established. Then, by using cluster analysis, it was found that the teaching skills could be grouped into five levels of difficulty that could be taken to stand for different types of teacher behavior, moving from relatively easy to more difficult and spanning the five dimensions of the eight teacher factors included in the dynamic model. In the next step of the analysis, the Saltus model was used to discover the depth of the divide separating the five types of teacher behavior, which emerged from cluster analysis and which could be ordered into different levels according to their difficulty. Finally, the study examined whether classification of teachers into the five levels (identified through the cluster analysis) could help us explain variance of student achievement in relation to each outcome of schooling considered in this study.

The first three levels are mainly related to the direct and active teaching approach, moving from the basic requirements concerning quantitative characteristics of teaching routines to the more advanced requirements concerning the appropriate use of these skills as measured by the qualitative characteristics of these factors. These skills also gradually move from the use of teacher-centered approaches to the active involvement of students in teaching and learning. The last two levels are more demanding since teachers are expected to differentiate their instruction (level 4) and also to demonstrate their ability to use the new teaching approach (level 5). Multilevel analysis of student achievement also showed that teachers situated at higher levels are more effective than those situated at the lower levels. This association is found with respect to achievement in all three different subjects and also both cognitive and affective outcomes (see Kyriakides et al., 2009).

Similar results emerged from a study conducted in Canada which made use of student ratings to measure the skills of teachers in relation to each teacher factor and its dimensions (Kyriakides et al., 2013a). In this case the stages which were identified also moved gradually from skills associated with direct teaching to more advanced skills involved in the constructivist approach and differentiation of teaching. This indicates that teachers may also move gradually from one type of teacher behavior to a more complex one. However, data that emerged from cross-sectional studies were more likely to identify differences in performance of teachers and that these findings do not necessarily imply that transitioning from one stage to another occurs in a stepwise manner. Given that the aim of these two studies was to test the validity of the dynamic model and illustrate the importance of grouping teacher factors into types of teacher behavior, teaching skill acquisition over two (or even more consecutive school years) was not investigated. Therefore, a question that arises is whether stepwise development of types of teacher behavior can be achieved through participation in programs of teacher development. An experimental study investigated the impact of offering the teacher improvement programs based on the dynamic approach for a longer period rather than just a single school year (Kyriakides et al., 2017). This study revealed that a stepwise progression of teachers' skills took place (over a period of three school years) and thus supported the generalizability of findings of the studies seeking to identify stages of effective teaching.

4 Establishing a Comprehensive Theoretical Framework That Can Be Used for Improvement Purposes

The historical review of EER presented in the first part of the chapter reveals that different models have been developed during each of the four phases of EER, aiming at first to answer the question of why specific factors are associated with student achievement gains and then to search for the conditions under which certain factors could contribute to student learning. Different approaches have also been used so as to identify the reasons for which certain factors or characteristics contribute to educational effectiveness (i.e., the economic, sociological and psychological). Therefore, one may realize that when considering the development of a comprehensive framework of teaching and learning we do not only refer to one single theory or model of teaching but to the development of a framework that takes into consideration the different theories of teaching and learning that have been developed during the past years within the field of EER and which have received empirical validity in terms of their main assumptions and factors included. In the first section of the chapter, we also drew attention to the need of incorporating the three different approaches to educational effectiveness especially since teachers are not equally effective when they are expected to teach in different school settings. Factors that may influence teaching that are situated at the school and system level and are in line with either the sociological or the economic perspective of educational effectiveness need to be considered in developing the comprehensive framework of teaching and learning. For instance, organizational theories that derive from the field of sociology and – depending on their focus – refer to the structure, functioning and performance of an organization and the behaviour of individuals and groups within it, need to be taken into consideration when deciding on the school level factors that are to be included in such a comprehensive framework (Cheng & Tsui, 1999; Hoy & Miskel, 2005; Kuh, 1996; Scheerens & Bosker, 1997). The Human Capital Theory (Kiker, 1966), which lies under the economic approach and places emphasis on the investments that can be made for the evolvement of the individuals within an organization for example, through education and training, enabling improved levels of quality and production should also be considered as the influence of the Human Capital Theory is considerable (Gillies, 2015). In addition, theories of learning within the psychological approach, such as motivation theories, should be considered when taking decisions on the factors to be included in this framework, since factors such as orientation which derive from motivation theories and the field of psychology were found to be associated with student learning (Green et al., 2006; Weiner, 1990).

In addition, since studies have shown that factors beyond those located at classroom level may also affect the learning of students, either directly or indirectly, the multilevel character of education should be considered when developing a comprehensive framework of teaching and learning. In this way, the synergy theory will also be accounted for which, if translated at the educational setting, suggests that the combined value of taking into consideration factors deriving from different levels of education will be greater than in the case of considering the individual factors of each level separately for explaining effects on student learning (Liu & Jiang, 2018; Scheerens, 2016). When referring to learning, it should be clarified that recent theories do not only refer to cognitive, but also to non-cognitive, psychomotor and meta-cognitive outcomes. Thus, the importance of considering more than cognitive outcomes, should be taken into consideration when developing such a comprehensive framework.

In the previous section, we argued for the importance of developing not only an integrated multilevel model for describing effective teaching and learning, but also on the need to consider the dynamic nature of education when doing so. In this context, the dynamic model of educational effectiveness was described which may be seen as a starting point for establishing a comprehensive framework of teaching and learning that can ultimately be used for promoting quality and equity in education. The dynamic model is proposed as a starting point for the development of the comprehensive framework since its main assumptions and the impact of the teacher factors on different student learning outcomes have received empirical support thought the studies and meta-analysis discussed earlier. The dynamic model also includes factors deriving from the different approaches discussed above and different theories (e.g., motivation theories, Cognitive load theory etc.) and therefore it may provide a starting point for the development of a comprehensive framework of teaching and learning. However, the limitations of the dynamic model should also be acknowledged and suggestions for further research to develop a comprehensive theory of teaching and learning are provided.

Firstly, it should be noted that the conditions under which specific effectiveness factors included in the dynamic model may be more important in promoting learning have not yet sufficiently been examined. Therefore, the issue of differential effectiveness which has been raised by researchers within the field of EER (e.g. Teddlie & Stringfield, 1993; Borich, 1996; Watkins & Mortimore, 1999; Hopkins & Reynolds, 2001; Muijs & Reynolds, 2001), should be considered when developing a comprehensive framework of teaching and learning. With regard to the effect of the teacher factors included in the dynamic model, by comparing the effect of each factor on each outcome at the primary and pre-primary school level it was shown that two of the factors of the dynamic model which are strongly associated with the constructivist approach to learning (i.e., modelling and orientation) were not found to be associated with achievement of pre-primary students. However, they were found to be associated with achievement in mathematics and Greek language at the end of primary school. This implies that the generic nature of these two factors could be questioned since an argument that these factors are not important for younger students could emerge. The effects of all dimensions of the application factor and also teacher assessment on achievement of pre-primary students in each outcome were found to be much stronger than those of the primary-school study. This implies that these factors are associated with achievement at both phases of schooling, but have a stronger effect for one group of students, indicating the possibility of having differential effects.

In addition, a study conducted by Kokkinou and Kyriakides (2018) which was concerned with differential teacher effectiveness in relation to classroom composition, searched for whether secondary teachers who teach in different classrooms exhibit the same teaching skills in regard to the factors included in the dynamic model irrespective of the classroom composition. Despite the fact that almost all teacher factors were found not to be influenced by any classroom context variable measuring student background characteristics (i.e., gender, ethnicity, and prior achievement), this finding should not imply that teachers should use the same teaching tasks in teaching different groups of students especially since differentiation is one of the five dimensions used to measure the functioning of each factor. However, the results of this study provided further support to the generic nature of the factors included in the dynamic model at secondary education in terms of the impact that they have on promoting different types of learning outcomes of different groups of students (including age group). The results also stress the need to differentiate teaching in order to conform to the learning needs of each specific group of students. When establishing a comprehensive theory of teaching and learning, researchers should therefore take into consideration aspects of the classroom context which may influence the functioning of factors and use relevant designs to detect effects of student factors (especially background factors) on the functioning of teacher factors.

Secondly, apart from searching under which conditions certain factors may better promote the learning outcomes of different students or groups of students, issues of differential effectiveness should also be taken into consideration when establishing theories of teaching. In developing and testing a comprehensive theory of teaching and learning, one should take into consideration that effective teachers are not only those who manage to contribute to the promotion of learning outcomes for all (quality) but also those that manage to reduce differences in student learning outcomes between groups of students with different background characteristics (equity). This argument is in line with those who support the equalitarian view of equity which implies that the main responsibility for achieving equity in education should be that of society. However, another view of equity exists which refers to the meritocratic view. The meritocratic view assumes that student learning outcomes reflect each student's talents and the efforts being put into learning (Gulson & Webb, 2012; McCoy & Major, 2007). Despite, however, these assumptions EER revealed that the reasons causing variation in student learning outcomes are more complex and cannot simply be attributed to one's talents and efforts. This can be seen as especially important when considering that other student background factors, such as socioeconomic status (SES), gender and ethnicity may impact on a student's efforts or ability to evolve his/her talents. The egalitarian view of equity having acknowledged the background differences of students supports the notion that society – and to that respect national/state agencies and schools – can be considered primarily responsible for achieving equity through the provision of mediating measures and further support to disadvantaged groups of students who are more likely to obtain lower educational outcomes (Kelly & Downey, 2010). Quantitative syntheses of educational studies also revealed that the SES of students has a relatively strong impact on student achievement (Sirin, 2005; White, 1982). Therefore, we argue that teachers and schools should not only help students achieve learning outcomes but they also need to function in a way that students' success in learning is not determined by their background characteristics, including SES (Kyriakides et al., 2021).

Most studies in EER have however, focused on examining issues of quality rather than equity in education. This lack of interest in identifying factors associated with the equity dimension can be partly attributed to the fact that there is no consensus about the way that equity can be defined and measured (see Kelly, 2012; Nachbauer & Kyriakides, 2020). Similarly, studies conducted in order to test the validity of the dynamic model were exclusively dealing with issues of quality rather that equity and therefore, the factors of the dynamic model (or even other factors not included in the model) that may be used to better promote issues of equity have yet to be determined (see Kyriakides et al. 2018a).

When developing a comprehensive framework of teaching and learning that could be the result of collaboration among researchers within the field of EER and merging of different existing theoretical models, factors of effectiveness should be treated as situational in character. Differential effects of these factors should, therefore, be investigated. The dynamic model which may be used as a starting point for the development of such a comprehensive theory assumes that the differentiation dimension of the eight factors included at the classroom level may affect aspects of equity and therefore relevant research questions can be raised. For example, is orientation or modelling equally productive in classes with a high variation in terms of student abilities or socioeconomic background? By providing answers to such questions, the impact of teacher factors on promoting both quality and equity could be better realized and factors deriving from different models of effectiveness which are able to promote equity may be used in developing a comprehensive framework of teaching and learning which will be able to move a step forward and expand the dynamic model.

Finally, it should be acknowledged that the dynamic model only refers to generic factors at classroom level and does not consider the effects of domain specific factors on teacher effectiveness. However, various frameworks and models have been developed during the past 30 years in the field of educational effectiveness which have taken into account the results of research in the field of TER, as well as the results of the dominant meta-analyses conducted in the field. These frameworks were either more generic in nature given that they aimed to describe teaching more universally or more domain-specific. Despite the mostly common starting point of these frameworks, one could notice that emphasis on different aspects of teaching have been placed. Therefore, the question of whether different models may be combined – either generic or domain-specific – so as to provide a more complete illustration of effective education and guide improvement actions has been raised by researchers (Charalambous & Praetorius, 2018). By acknowledging the limitations of existing models (including the ones of the dynamic model), a theory that may be used so as to provide a basis for educational improvement purposes can be developed. In addition, other models and theories within EER place emphasis on different generic factors which are considered important for learning. The possibilities of combining factors deriving from different models should thus by examined. For the measurement of the effectiveness factors included in the different models, different instruments are used. One should, therefore, examine whether using all of the instruments provided by each model to measure quality of teaching can provide a more comprehensive feedback to teachers for designing their own improvement actions. This may be seen as a crucial issue, especially since research has been often criticized for being developed without providing sufficient linkage with practice and, consequently school improvement.

By using a combination of instruments, which take into consideration different aspects of teaching, more information may be provided on the weaknesses and strengths of the lessons and therefore the information collected may be more effectively used for designing teacher professional development activities. In addition, the use of different instruments deriving from different frameworks may overcome the weaknesses of instruments coming from just a single framework. For example, the dynamic model assumes that when measuring the functioning of a factor we should take into consideration both, its quantitative and qualitative characteristics. Apart from frequency therefore it also foresees the measurement of factors through four dimensions which examine the qualitative characteristics of the functioning of a factor. On the contrary other models and theories only take into account the frequency dimension when measuring the functioning of the different factors. Furthermore, combination of different models may provide a broader view of teaching and take into consideration a wider range of factors. Factors that may not be taken into consideration in assessing the quality of teaching by one model may be included in another and therefore using different models to develop a comprehensive framework of teaching and learning may provide a better linkage between different approaches to teaching. Despite the advantages of combining different models for measuring quality of teaching the weaknesses of this approach should also be acknowledged. For example, practical limitations may arise in using the classroom observation results for providing feedback to teachers for professional development purposes. By observing the functioning of a large number of factors the focus of the observation is widened and less specific suggestions could therefore be generated for improvement purposes. In addition, one could also argue that we need a more precise definition of the generic and domain-specific factors and a systematic comparison of these factors, which may reveal the extent to which there is an overlap between some generic and domain-specific factors. It should also be examined whether domain-specific factors could be included in generic models such as the dynamic model and also if these factors can also be grouped into stages of effective teaching. The possibilities of the development of a comprehensive framework for measuring quality of teaching through combining both generic and domain-specific factors should be examined.

It is however stressed in this chapter, that this comprehensive theory of teaching and learning is not only expected to refer to more factors rather than those included in a single model of educational effectiveness such as the dynamic model. This chapter argues that this theoretical framework should have at least four characteristics. First, it should be multilevel in nature by considering the impact that school and system level factors may have on teacher factors. To identify factors operating at different levels, all three dominant perspectives of educational effectiveness (presented in this chapter) should be considered. Second, the proposed theory should help researchers, policymakers, and practitioners understand why the factors included in this theory are associated with student learning outcomes. Therefore, the relevant theories of learning and schooling that are considered in defining each factor should be made explicit. Third, the comprehensive theory of teaching and learning should address two very important questions about the impact of each factor which have to do with the conditions under which each factor matters and the extent to which specific factors and their measurement dimensions matter more for specific groups of students. In this way, a comprehensive theory of teaching and learning could refer to factors and their measurement dimensions that are related not only with the quality but also with the equity dimension of effectiveness. Finally, the dynamic nature of education should be considered in developing a comprehensive theory of teaching and learning. For this reason, the dynamic model of educational effectiveness could be considered as a starting point for establishing such a theory of teaching and learning. By considering the dynamic nature of education, the effort to establish a comprehensive theory of teaching and learning should not only help us develop a better understanding of the nature of educational effectiveness but also to identify ways of using that theory for improving quality of teaching and through that promoting both quality and equity in education.

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Chapter 6
A Theory of Teaching

Alan H. Schoenfeld

Abstract Whether one can claim to have a theory of teaching depends on what one takes to constitute teaching and what one means by theory. This chapter characterizes both. Given those characterizations, I claim that we already have a theory of teaching, which specifies that teachers' in-the-moment classroom decisions can be modeled by attending to three major factors: the resources at the teachers' disposal (both their knowledge and material resources), their orientations (beliefs, preferences, values, etc.), and their goals (which exist at multiple levels and change dynamically according to evolving events). Beyond that, the Teaching for Robust Understanding (TRU) framework indicates that the following five dimensions of learning environments are consequential and comprehensive – the degree to which the environment: (1) offers affordances for rich engagement with content; (2) operates within the students' zone of proximal development; (3) supports *all* students in engaging with core content; (4) provides opportunities for students to contribute to classroom discourse and develop a sense of agency and disciplinary identity; and, (5) reveals and responds to student thinking. Combining these two theoretical frames yields a theoretical specification of what has been called "ambitious teaching." There is much more to be concerned with, however. In general, the field's understanding of relevant knowledge and resources for ambitious teaching is weak, a problem exacerbated by the widespread adoption of virtual instruction due to the presence of Covid-19. Moreover, little is understood regarding teachers' developmental trajectories. Such knowledge will be necessary to establish effective long-term professional development efforts.

Keywords Ambitious instruction · Models of teaching · Teaching for robust understanding · Teachers' decision making · Theories of teaching

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1 Introduction and Overview

This essay grapples with the framing questions offered by the book's editors:

- What is a theory (of teaching)?
- What should it contain and why?
- Can such a theory accommodate differences across subject matters and student populations taught? If so, how? If not, why?
- Do we already have a theory/theories on teaching? If so, which are they?
- In the future, in what ways might it be possible, if at all, to create a (more comprehensive) theory of teaching?
- In a concluding discussion I also address some of the larger issues of context raised in Hill and Lampert's foreword

For the purposes of this paper I will use the standard dictionary definition of what it means to teach. The Merriam-Webster dictionary (2020) defines "teach" as follows: "to cause to know something… to guide the studies of… to impart the knowledge of (e.g., teach algebra) to instruct by precept, example, or experience… to conduct instruction regularly in teach school" (https://www.merriam-webster.com/dictionary/teach). It goes without saying that there is more to the totality of teaching than this – for example, planning, creating materials, and meeting with students outside of class, to name but a few. But the common-sense definition of teaching is "the act of instructing students in the classroom." That definition frames most of what follows.

To put my theoretical cards on the table: There does exist a theory of human in-the-moment decision making in complex social contexts (Schoenfeld, 2011). This empirically validated theory includes as a subset the decision making by teachers during the act of instruction– that is, "teaching" in the sense characterized above. As elaborated in Sect. 2, the theory says that it suffices to understand teachers' resources, orientations, and goals in order to model teachers' choices during instruction. Hence, we already have a theory of teaching. I suspect, however, that such a value-neutral question was not the sole intention of the editors. The question most people are interested in is, do we have a theory of "good teaching" (or, as characterized below, "teaching for robust understanding")?

A theory of teaching as framed above does not address the question of what the appropriate goals for instruction should be, or how to achieve them. By analogy, consider the fact that there has been a theory of internal combustion engines for almost two centuries: Samuel Brown obtained a patent for an internal combustion engine suitable for industrial use in 1823, and Gottlieb Daimler and Karl Benz patented gasoline engines in the late 1870s. Thus in a sense, there was a "theory of cars" a century and a half ago. Nonetheless, the contexts in which automobiles operate and the goals for automotive performance have evolved continuously over the decades. The relevant question for automobiles is, what are current or emerging performance goals (including safety, etc.) and how can they be achieved?

With regard to teaching then, the question is what goals are appropriate for learning environments – in the sense that if learning environments attain those goals, students will emerge from them being knowledgeable and agentive thinkers and problem solvers. Notice the fundamental shift in frame. The key question is not "what should a teacher do," which is teacher-focused, but "what properties should the learning environment have?", which focuses on the experiences of students. It goes without saying that the teacher is the key agent in establishing and maintaining the learning environment – but the goals for the teacher are then focused on how students experience it.

Here too, there exists a theoretical framing that addresses the issue in principle. The Teaching for Robust Understanding (TRU) Framework (Schoenfeld, 2014; Teaching for Robust Understanding Project, 2018) identifies key dimensions of productive learning environments. As such it serves to establish appropriate teaching goals. See Sect. 3.

Such a theoretical framing, however, leaves much work to be done. There are questions of how to frame materials and learning experiences for teachers, so they can develop the resources to attain the goals specified in Sect. 3. And there are questions about next steps in an R&D agenda that pursues these issues. See Sect. 4.

2 A Theory of In-The-Moment Decision Making

I begin with a characterization of "theory." The web definition provides a good start: "a supposition or a system of ideas intended to explain something, especially one based on general principles independent of the thing to be explained."[1] The implied generality in this definition is important, in that a theory applies to a class of objects, actions, and relations: "under certain circumstances, specific objects interact in specific ways." The National Academy of Sciences (1999, p. 2) elaborates, "Theory: In science, a well-substantiated explanation of some aspect of the natural world that can incorporate facts, laws, inferences, and tested hypotheses." Popper (1963) goes further, arguing that theories should be *falsifiable*. The idea is that (*pace* Schrödinger) most theories should enable predictions in a wide range of cases. With each confirmation, if it comes, there is more reason to believe in the robustness of the theory.

With these characterizations in mind I discuss the idea of a theory of teaching – more generally, a theory of knowledge-based decision making in complex social contexts. The general question is as follows. Suppose you are trying to explain/predict the decisions made by an individual while they are engaged in a "well practiced" endeavor – something they're been doing for a while, so they have a body of knowledge and routines at their disposal. In general, what would you have to know about that person, and the context, in order to explain/predict that person's decision making? Specifically in the case of teaching, what would you have to know about a

[1] See Google "define theory".

teacher in order to explain or predict what a teacher does when confronted by various circumstances as instructional activities unfold?

The key idea is that human decision-making is *goal oriented* and can be modeled as such. In-the-moment decision making in any context can be modeled as a function of three categories of things:

– The decision maker's goals in that context at that time.
– The decision maker's orientations (beliefs, preferences, values, tastes, biases, etc.), which shape the choice and prioritizing of goals and
– The resources (mostly knowledge, but also material resources) available in the context where the decision making is taking place.

The fundamental mechanism governing decision makers' choices is outlined in Fig. 6.1.

A comprehensive case for this theoretical framing is provided in Schoenfeld (2011), which offers a series of models of teachers' decision making. A few examples will convey the ways in which goals, orientations and resources operate.

First, goals operate at multiple levels and multiple goals may be activated at the same time. A teacher may want to cover the curriculum, teach for understanding,

How People Make Decisions (including decisions while teaching)

- An individual enters into a particular context with a specific body of resources, goals, and orientations.
- The individual takes in and orients to the situation. Certain pieces of information and knowledge become salient and are activated.
- Goals are established (or reinforced if they pre-existed).
- Decisions consistent with these goals are made, consciously or unconsciously, regarding what directions to pursue and what resources to use:
- If the situation is familiar, then the process may be relatively automatic, where the action(s) taken are in essence the access and implementation of scripts, frames, routines, or schemata.
- If the situation is not familiar or there is something non-routine about it, then decision-making is made by a mechanism that can be modeled by (i.e., is consistent with the results of) using the subjective expected values of available options, given the orientations of the individual.
    - Implementation begins.
    - Monitoring (whether effective or not) takes place on an ongoing basis.
    - This process is iterative, down to the level of individual utterances or actions:
- Routines aimed at particular goals have sub-routines, which have their own subgoals;
- If a subgoal is satisfied, the individual proceeds to another goal or subgoal;
- If a goal is achieved, new goals kick in via decision-making;
- If the process is interrupted or things don't seem to be going well, decision-making kicks into action once again. This may or may not result in a change of goals and/or the pathways used to try to achieve them.

Fig. 6.1 How people make decisions, in outline Reprinted with permission from Schoenfeld (2011, p. 18) prepare students for an upcoming test, create a welcoming environment, help students become reflective learners, and more (see, e.g., Lampert, 2001). Second, prior to entering the classroom, the teacher may have a plan that establishes top-level goals and subgoals: "I want to introduce this material today. I'll review the homework, spend the bulk of time on the new material, and close by assigning homework."

The selection of goals and their prioritization is shaped by the teacher's orientations (primarily belief systems, which evolve over time), as is the set of resources the teacher will bring to bear in any context. For example, one teacher taught a particular class in a very procedural manner: "Step 1, do this. Step 2, do this…" Asked if he would consider asking the students an open question, his response was "Not these students, it would confuse them. I do that with my honors students." That is, his beliefs about appropriate pedagogies for students with different "abilities" resulted in his choosing different pedagogies for teaching them (Schoenfeld, 1988).[2] Equity-oriented goals may result in the prioritization of particular classroom routines, as will goals of "teaching for understanding" rather than being "mastery oriented." At a more fine-grained level, seeing a typically quiet student volunteer may lead the teacher to call on that student *and* frame the interaction with the student in ways that support the student differently than the teacher would approach an interaction with a student who is more voluble. Thus, goals are very much context-dependent, grounded in history and immediate constraints. (And, I note, they are grounded in the teacher's perceptions of what is possible given their understanding of the environment. That's the issue of beliefs, discussed immediately below.) Nonetheless, the evidence is clear that the set of highly activated goals at any particular time is the fundamental shaper of which resources will be selected and employed.

Belief systems and orientations develop slowly over time, and they are developed (often unconsciously) as a result of experience (see, e.g., Cooney, 1985; Kuhn, 1996; Patterson & Norwood, 2004; Philipp, 2007; Richardson, 1996; Thompson, 1985, 1992; Usó-Doménech & Nescolarde-Selva, 2016). Likewise, the establishment of a rich body of knowledge for teaching develops slowly over time. The very notion of pedagogical content knowledge (Shulman, 1986, 1987) is testimony to the evolution of a special teaching-specific kind of learning: beginning teachers who are at first surprised by a student writing "$(a + b)^2 = a^2 + b^2$" will, after a few years of teaching experience, have a repertoire of responses to choose from.

Moreover, as elaborated below, belief systems and pedagogical resources are interwoven in development. A classic example of this is "Mrs. Oublier" (Cohen, 1990), a teacher who aspired to implement "reform" ideas but some of whose pedagogical practices were so grounded in established networks of beliefs that her ongoing teaching did not yet reflect those aspirations. For all of these reasons, change is hard – a topic to which we will return toward the end of this chapter. For the moment, however, the key point is that a goal-oriented architecture, as described in Schoenfeld (2011), provides the foundation of a theory of teaching. The next question is, *what*

[2] Please not that I am not endorsing this perspective, just reporting it.

is a relevant set of goals, orientations, and resources that produces desirable teaching outcomes?

Before proceeding, however, it is essential to note that this question, as important as it is, is different from a theory of teaching. A theory of teaching describes the mechanisms by which teaching takes place. As such, the theory is value-neutral: it should enable one to characterize teaching that one finds laudable but also teaching that one finds problematic. Once one asks about "ambitious" or "effective" teaching – whatever one's definition of those terms may be – one is asking a different type of question.[3] One way to frame the question of ambitious or effective teaching is, "what kinds of actions on the part of teachers result in powerful learning? As will be seen below, I believe it is much more profitable to address that question in stages.

One can first ask, what are the properties of learning environments from which students emerge as knowledgeable and agentive learners? This is a theoretical question, which can result in a theory of learning environments. Then, one can reframe ambitious teaching as the decisions make while creating and maintaining productive learning environments. With that framing, one can revisit the theory of decision making described above and ask, *what sets of goals, resources and orientations result in the creation of powerful learning environments – environments from which learners emerge as knowledgeable and agentive thinkers and problem solvers?* That is the approach taken here.

3 Establishing Goals for "Ambitious Teaching" (Key Dimensions of Productive Learning Environments) and Thinking About the Development of Orientations and Resources

3.1 Goals

We begin with a discussion of the goals for teaching. Historically the focus of instruction has been on disciplinary content. That is a desired aspect of learning, of course, but this framing is far too narrow. For one thing, goals for mathematics instruction have expanded from "mastering" content to becoming proficient at both the content and the practices that typify rich mathematical understanding (Common Core State Standards Initiative, 2010; National Council of Teachers of Mathematics, 1989, 2000). But this is just a start: it is in our classrooms that students develop their beliefs about the nature of mathematics and their relationship to it; where they come to see themselves as agentive (or not) in mathematics; where they develop their sense of mathematical identity; where they are positioned by others; and much more. When thinking about learning as a whole, it is best to think about the

[3] Such questions are value-laden, depending on what one considers to be important student learning outcomes. My stance is made clear in the next paragraph.

opportunities the learning environment provides for growth along all these dimensions. The teacher is responsible for orchestrating all of this. Hence a more encompassing definition of "ambitious" teaching or "teaching for robust understanding" is: *Teaching for robust understanding is the shaping of learning environments and interactions in them, in ways aimed at enhancing student learning.*

The key question for powerful learning – for teaching for robust understanding – then becomes:

> What are the attributes of powerful learning environments – learning environments from which students emerge as agentive, knowledgeable and resourceful thinkers and problem solvers?

An answer to this question provides the goals for a theory of productive teaching (a theory of teaching aimed at desirable teaching outcomes, as suggested in Sect. 2).

To cut to the chase, the Teaching for Robust Understanding (TRU) Framework (Schoenfeld, 2013, 2014; Teaching for Robust Understanding Project, 2018) provides the answer to the key question above. Here as in Sect. 2 the discussion will be telegraphic, with references to sources that provide the analytic and empirical justifications of the claims made.

Schoenfeld (2013, 2014) documents the process by which the extensive literature on "what counts" in ambitious teaching was distilled into five essential dimensions of classroom practice and subjected to empirical testing. The result of that work, the Teaching for Robust Understanding (TRU) Framework, provides evidence that students will emerge from learning environments as powerful, agentive, and empowered thinkers and learners to the degree that the five dimensions highlighted in Fig. 6.2 are consistently reflected in instructional practice.

Before incorporating the substance of Fig. 6.2 (and Fig. 6.3 to come) into a theory of powerful teaching, I briefly summarize some of the properties of the framework. For extensive detail, see the TRU Framework web site (https://truframework.org/).

– For purposes of specificity and because of its historical origins, Fig. 6.2 describes powerful learning environments in mathematics. In fact, the framework is general: replace "mathematics" by "X" and the TRU framework provides a characterization of learning environments from which participants emerge aspowerful and agentive learners and practitioners of X.
– All five dimensions are necessary, and learning outcomes will be significantly weakened if the learning environment does not do well along any of those dimensions. That is: If the mathematics is not rich; if activities are not crafted in ways that support all students in engageing productive struggle; if some students are not engaged with core content; if some students do not have opportunities co contribute to discussions and the mutual refinement of ideas; or if the environment does not adapt in meaningful ways to what students reveal of their thinking, then at least some students will be significantly shortchanged.
– The five dimensions are sufficient for the desired outcomes, a fact that comes from the derivation of the framework (Schoenfeld, 2013, 2014; Schoenfeld et al., 2018) and from empirical testing (Prediger & Neugebauer, 2021; Schoenfeld, 2016, 2018).

The Five Dimensions of Powerful Mathematics Classrooms				
The Mathematics	Cognitive Demand	Equitable Access to Content	Agency, Ownership, and Identity	Formative Assessment
The extent to which classroom activity structures provide opportunities for students to become knowledgeable, flexible, and resourceful mathematical thinkers.Discussions coherent,providing opportunities to learn mathematical ideas,techniques, and perspectives, make connections, and develop productive mathematical habits of mind.	*The extent to which student have opportunities to grapple with and make sense of important mathematical ideas and their use. Students learn best when they are challenged in ways that provide room and support for growth, with task difficulty ranging from moderate to demanding.The level of challenge to what has been called "Productive struggle".*	*The extent to which classroom activity structures invite and support the active engagement of all of the sudent in the classroom with the core mathematical content being addressed by the class.Classrooms in which a small numberof students get most of the "air time " are not equitable, no matter how rich the content: all students need to be involved in meaningful ways.*	*The extent to which student are provided opportunities to "walk the walk and talk the talk"- to contribute to conversations about mathematical ideas, to build on others' ideas and have others' build on their - in ways that contribute to their development of agency (the willingness to engage), their ownership over the content, and the development of positive identities as thinkers and learners.*	*The extent to which classroom activities elicit student thinking and subsequent interactions respond to those ideas, building on productive beginnings and addressing emerging misunderstandings. power instructions "meets student where they are" and gives them opportinities to deepen their understandings.*

Fig. 6.2 Five dimensions of powerful mathematics classrooms. (Reproduced with permission from the TRU Observation Guide, p. 1)

Observe the Lesson Through a Student's Eyes	
The Content	• What's the big idea in this lesson? • How does it connect to what I already know?
Cognitive Demand	• How long am I given to think, and to make sense of things? • What happens when I get stuck? • Am I invited to explain things, or just give answers?
Equitable Access to Content	• Do I get to participate in meaningful math learning? • Can I hide or be ignored? In what ways am I kept engaged?
Agency, Ownership, and Identity	• What opportunities do I have to explain my ideas? In what ways are they built on? • How am I recognized as being capable and able to contribute?
Formative Assessment	• How is my thinking included in classroom discussions? • Does instruction respond to my ideas and help me think more deeply?

Fig. 6.3 Framing lesson goals, from the student perspective. (Reproduced with permission from the TRU Observation Guide, p. 2)

– There is no claim that the five dimensions reflect a unique distillation of the literature. They are best thought of as analogous to “basis vectors,” spanning the space of powerful (or if you prefer, “ambitious”) teaching. Other decompositions are possible, and they might highlight different aspects of teaching. One feature of this choice of five dimensions, however, is that they have been chosen in ways that they can each be the focus of meaningful professional development.
– The description of each dimension with a short phrase that is given in Fig. 6.2 provides merely the briefest characterization of the explicit and implied contents of the dimension. For instance, “students feeling safe to venture ideas” is a necessary condition for Dimension 4, opportunities for the development of agency, ownership over content, and the development of positive disciplinary identities. Likewise, much more can be said about the richness of disciplinary content (e.g., the role of mathematical representations, mathematics as a language, what it means to understand content deeply, etc.) or any of the other dimensions.
– The framework is not prescriptive. That is, it does not imply that one must teach in any particular way in order to achieve positive outcomes. (We have all observed wonderful teachers whose styles and classroom routines are very different.) Rather, the five dimensions of TRU can be seen as representing five key principles underlying ambitious, powerful, or robust instruction. There are as many ways to live up to those principles as there are superb teachers.

Again, it is essential to note that the TRU framework focuses on the attributes of the learning environment and the affordances it offers students for their learning and development. Figure 6.3 is useful in reminding us of the goals of instruction, when seen from the student’s perspective.

With this as background, it is now possible to begin to flesh out some of the goal structure for a theory of ambitious (mathematics) teaching.[4] In what follows I will focus on decisions during the act of teaching – but as elaborated in Sect. 4, these goals are relevant both in planning instruction and in reviewing instructional events afterward. Once again, this discussion will be somewhat terse; more detail can be found in Schoenfeld (2020b).

3.1.1 Mathematics-Related Goals

First, let us consider goals for the student’s engagement with mathematics. High priority goals include that the student will experience/learn about, and come to internalize:

– Mathematics as a sense-making discipline, not one of memorizing facts and procedures
– Big mathematical ideas – that students see “what counts” and don’t get lost in minutia

[4] Analogous characterizations can be developed for every discipline.

– Reasoning and problem solving
– Ties between concepts and procedures
– Multiple representations
– Productive patterns of mathematical thinking (Schoenfeld, 2017)

Moreover, these goals operate at multiple levels: the student should experience these at the micro-level when engaging in any day's lesson, and experience them at aggregate (topic and unit) levels. Ultimately, students should come to see (and experience) mathematics as a sense making enterprise.

Once again, I stress that these are the very top-level versions of the goals. In any particular context (say a particular day's instruction), they would be elaborated with regard to that day's instruction – e.g., "what are the opportunities for sense making with regard to today's content, and how can students be positioned to experience them?; how can the lesson support students in engaging with and understanding the big ideas?", etc.

These are just the beginnings of questions. In Sect. 4 we will introduce the TRU Conversation Guide (Louie et al., 2016) and the TRU Observation guide (Schoenfeld and the Teaching for Robust Understanding Project, 2016), which elaborate on the bullet points immediately above. Each of those can be used to generate a more refined set of goals regarding the students' mathematical experience.

3.1.2 Cognitive Demand-Related Goals

The top-level goal for cognitive demand (see Fig. 6.2) is that students should be in a position to engage productively with the central mathematical ideas of the lesson – with the level of challenge being such that the students are stretched, and that they grow from their sense making experience. The key idea is to sustain "productive struggle." Some subgoals can be inferred from Fig. 6.3: giving students time to engage with the challenges, providing scaffolding in ways that keep tasks within reach but don't turn them into rote exercises; asking for explanations rather than simply for answers.

The challenge is to maintain cognitive demand in the moment, as students are working together. This can implicate task design, in planning – for example, a task that has multiple entry points or employs multiple representations can be approachable in different ways, and these different handholds can allow students to find places to engage meaningfully with the mathematics. Likewise, different classroom activity structures can offer different affordances for meaningful engagement. Of course, most of these goals are emergent – it's when one sees a student bored or struggling in what seems to be an unproductive way that the goals for cognitive demand get activated.

3.1.3 Equitable Access-Related Goals

One key point with regard to dimension 3 is that the equity-related goal is not simply to keep students engaged; it is for all students to be engaged with the core content of the lesson. A classroom is not equitable if, by virtue of the activities they engage with, the "rich get richer and the poor get poorer." So, the goal in that regard is to find and implement activities that engage every student meaningfully with the big ideas. A second key point, of course, is that there are various ways to participate in classroom activities: responding to questions, participating in discussions, volunteering ideas, and more. As implied by Fig. 6.2, all students should have opportunities for significant amounts of "air time" – a top-level goal not just for whole class discussions but for small group activities as well. And as implied by Fig. 6.3, another major goal is for all students (even those who are initially reluctant) to be supported in engaging meaningfully.

As in the case of all of the TRU dimensions, some of the more fine-grained questions elaborating the top-level goals can be found in the TRU Conversation guide (Louie et al., 2016). For example, the first few reflection questions related to agency, ownership and identity,

- What is the range of ways that students can and do participate in the mathematical work of the class (talking, writing, leaning in, listening hard; manipulating symbols, making diagrams, interpreting text, using manipulatives, connecting different ideas, etc.)?
- Which students participate in which ways?
- Which students are most active, and when?
- In what ways can particular students' strengths or preferences be used to engage them in the mathematical activity of the class? (TRU Conversation guide, page 8)

give rise to opportunities for lesson planning and for modifying the lesson as a lesson unfolds.

3.1.4 Agency, Ownership, and Identity-Related Goals

There is a large literature documenting the negative impacts of mathematics instruction – the very existence of "math anxiety" as a phenomenon (see https://en.wikipedia.org/wiki/Mathematical_anxiety) gives testimony to the often negative impact that mathematics instruction has on students. Goals related to Dimension 4 move in precisely opposite directions:

> One goal is for students to feel mathematical *agentive:* "I can do mathematics, and I'm willing to jump in and give it my best."
>
> Another is for them to take possession of knowledge by making it their own – "I figured this out; it makes sense; it's not simply what 'they' told me is true."
>
> A third is for their mathematical Identities to flower: "I like math and look forward to doing it – it makes sense and I can figure things out."

It goes without saying that the development of positive agency/ownership/identity hinges on having had some degree of success in facing and working on mathematical challenges – not necessarily solving all of them, but having frequent opportunities to venture ideas, critique and build on others' ideas, and have one's own ideas both critiqued and built upon. Thus, highly dialogic classrooms are essential (see, e.g., Mercer et al., 2019); top-level goals are to create and sustain classroom practices that provide *all* (cf. dimension 3) students opportunities to generate, expand on, and explain their own ideas, responding in kind to the ideas of others. Additional goals (again, see the TRU Conversation Guide) include developing students' capacity to do so, by opening up the kinds of ideas students have opportunities to generate and share (concerning, for example, strategies, connections, partial understandings, prior knowledge, and representations), placing responsibilities of evaluation and response more in students' hands, and increasing the depth of expected explanations.

3.1.5 Formative Assessment-Related Goals

For an extended discussion of formative assessment see Burkhardt & Schoenfeld (2019). The first major goal related to formative assessment is to elicit student thinking and have it become public. This provides a clear example of how goals and subgoals cascade: students who fear being embarrassed by incorrect answers are not going to venture away from safe territory, so top-level goals for formative assessment activate a series of subgoals regarding classroom climate. Finding ways to reveal what students think is also a major component of dimension 2: it's hard to know what level of cognitive demand to aim for if you have little idea of what students are thinking! A second major goal is for those student thoughts to be pursued in ways that advance individuals', groups', and the whole class's mathematical agenda. Some of this is suggested by the last row of Fig. 6.3. But there is more. One misconception regarding formative assessment is that once student misunderstandings are revealed, it is the teacher's responsibility to set everything straight. (One teacher with whom we worked complained that, now that she was aware of student misconceptions, she felt like she was playing whack-a-mole: as soon as she addressed one student's misconception, another cropped up!) This framing neglects the fact that the students themselves can serve as tremendous resources for each other. They can often "hear" each other's misunderstandings in ways that the teacher, who is trying to attend to all of the students in the class, may not hear them, and they can respond in student language and often at each other's level. Regarding formative assessment, student goals from the TRU Observation Guide include:

- Taking ownership of the learning process in planning, monitoring, and reflecting on individual and/or collective work
- Asking questions and making suggestions that support analyzing, evaluating, applying and synthesizing ideas
- Building on the contributions of others and helping others see or make connections

– Holding classmates and themselves accountable for justifying their positions, through the use of evidence and/or elaborating on their reasoning. (TRU Observation Guide, p. 4)

Thus, another major goal for formative assessment is for the teacher to create an environment in which students become skilled in working toward the goals above.

3.2 Orientations

The task of identifying high priority goals – the focus of Sect. 3.1 – is relatively easy. It should be noted, however, that the goals highlighted in Sect. 3.1 reflect a particular set of *values,* those embodied by the TRU framework. The premises that:

– mathematics learning should result in deep and connected understandings, above and beyond a set of well honed skills
– the learning environment should be tailored to support all students as opposed to letting "natural ability" separate those who should pursue mathematics from those who should not
– *all* students should have opportunities to engage meaningfully with mathematics, at all levels
– a major goal of mathematics instruction should be the development of productive mathematical identities
– teachers are responsible for ongoing monitoring of student understanding and adjusting their instruction so that students have maximal opportunities for sense making, as opposed to being responsible for presenting the mathematics clearly (with the responsibility for making sense of the mathematics, once presented, falling on the shoulders of the students)

are consistent with the idea of "ambitious" or "powerful" instruction and are consonant with much of the "reform" movement in the U.S., but they are not universally shared.[5] That said, suppose we stipulate the kinds of goals discussed in Sect. 3.1. That is still the easy part: the challenge is the development of orientations and resources that enable the implementation of activities to attain those goals.

As explained in Schoenfeld (2011), there are multiple interactions between goals, orientations, and resources. For purposes of exposition, I have chosen to begin with goals. Part of what makes things challenging, however, is the fact that (cf. Fig. 6.1) the goals one establishes in the moment are a function of one's beliefs and orientations, which are a function of one's history – and beliefs are formed over time, often unconsciously. Recall the teacher who taught his regular students in a very step-by-step manner, because anything less rigid would "confuse" them. That's

[5] In fact, the "math wars" were the result of opposing positions on points such as these. (Schoenfeld, 2004)

a matter of beliefs. Moreover, beliefs operate as parts of belief *systems*, but specific beliefs may be triggered by specific events and override other beliefs.

For example, Cohen (1990) tells the story of "Mrs. Oublier," who espouses the rhetoric of reform but doesn't live up to it. The point I wish to make is that this kind of situation is not only natural, but to be expected. The decisions that teachers make are a complex combination of their goals, their belief systems and orientations, and the mental and material resources at their disposal.

Consider a teacher in transition, akin to Mrs. Oublier. This teacher wants to do less "telling" and open up her classroom to contributions from students, as suggested by the literature and the professional development she has experienced. She has students discuss their work in groups and has students come to the board to present their work. So far, so good. But then, what a student writes on the board is incorrect – say a typical error such as "$(a + b)^2 = a^2 + b^2$". Now what does the teacher do?

This teacher may have a previously established set of beliefs and orientations that get triggered by this error, and a set of goals and actions that correspond to them. For example, the teacher may have a cluster of beliefs related to the idea that "it's bad to have incorrect mathematics written on the board, especially because students may copy it into their notebooks." As a result, the teacher may move almost automatically to have the student erase the incorrect statement from the board. This action, so natural for the pre-transition teacher, well may undermine the teacher's currently espoused goal of having students engage in mathematical sense making.

When things function smoothly in decision making, it's because nested clusters of goals and subgoals are largely consistent with comparably nested clusters of beliefs and orientations, and the teacher's repertoire of techniques (resources) includes a collection of actions consonant with those orientations and goals. That's the baseline for "well practiced" behavior as captured in Fig. 6.1.

It goes without saying that building a (mostly) coherent repertoire of linked resources, goals, and orientations is a long and slow process. That, in part, is what lies behind the notion of "pedagogical content knowledge" (Shulman, 1986, 1987), the idea that "mere" content knowledge is far from enough for effective teaching. Shulman's key idea was that the wisdom of practice is represented by the accumulation, over time, of ways to respond to student understandings. The first time a teacher sees a student make a particular error, the teacher may be floored, and make up something on the spot. Over time, the teacher builds a repertoire of responses, and chooses from them when the need arises.

What goes beyond Shulman's notion, however, is that the different responses serve different goals and orientations. The teacher who is invested and well practiced in "mastery" may well provide a reminder of the formula, possibly with a justification for it, and give students some practice so that they are more likely to remember the formula. The teacher who is invested and well practiced in "teaching for understanding" may ask the student to check the formula and then work through something like an area model to build or strengthen the linkage between the distributive law and underlying representations of it. That is, different resources are not value-neutral: the decision to call upon them is tied to clusters of orientations and goals. For the well practiced teacher in a familiar content arena, these clusters cohere and the chain of decisions described in Fig. 6.1 proceeds smoothly. For the novice teacher, sparse resources can lead to challenges (Schoenfeld, 2011). For the teacher in transition, the challenge is not only to construct the relevant resource-orientation-goal clusters, but to supplant some of the clusters that are already well engrained.

That said, we can return to the question of orientations and resources relevant for teaching for robust understanding. In the remainder of this section I point to challenges in characterizing them. In the following section I discuss some tools that hold promise for progress.

A key issue about beliefs and orientations is that they are formed slowly over time. They may be held unconsciously, and thus challenging to address – it can be hard to alter an orientation you are not aware of! (Schoenfeld, 1985). Thus, either consistent experience for an extended period of time or an eye-opening experience that casts some currently held beliefs into doubt are the catalysts for change.

As a thought experiment, consider the set of goals identified in Sect. 3.1. At the very top level, teaching for robust understanding requires a fundamental shift in perspective, from thinking about the central question of teaching being "what activities do I prepare for my students?" to "how are my students experiencing the classroom activities and environment? This is a major shift, which entails changes in beliefs and orientations in all five dimensions of TRU. To mention just one example regarding Dimension 1, consider beliefs regarding the nature of problem solving and the kinds of experiences that would enable students to make progress on problems that they have not been shown how to solve. Understanding that this is a major curricular goal and that it requires a different kind of student experience is not only challenging at the top level, but (as discussed above) requires families of context- and content-specific beliefs and orientations consistent with that perspective. (For example, what is the appropriate kind of response when students run into difficulty?) Employing formative assessment (Dimension 5) in order to adjust the level of cognitive demand (Dimension 2) requires some faith in students' abilities to figure things out by themselves (recall the teacher who said that he would give his honors students room to explore, but not his regular students – "it would just confuse them") and the belief that students can serve as meaningful resources for each other (Black & Wiliam, 1998; Burkhardt & Schoenfeld, 2019; Swan, 2006). Likewise, there are huge numbers of beliefs about race, tracking, differentiation, deficit perspectives, and more that impede the consideration and implementation of activities that could enhance equitable access to core content for *all* students. Constructing an environment that is conducive to the development of agency, ownership, and identity means believing that students are capable of making progress on complex issues, that they can be supported in making conjectures, building on each other's ideas, etc. Believing that there is value in handing over some of the responsibility for learning to the students, and that – appropriately supported – they can interact in ways that lead not only to understanding rich mathematical content but becoming agentive and "owning" the content they generate, can require a significant leap of faith. In short, identifying and then supporting the development of beliefs and orientations that support teaching for robust understanding is a decidedly significant challenge. Developing them is that much more of a challenge.

3.3 Resources

Some key points with regard to resources are as follows. It should be noted that although some teaching routines (obviously central resources) are general, for example asking students "Can you tell me what you're thinking," the vast majority of resources are content- and context-specific. I touched on content-specificity with regard to the algebra error "$(a + b)^2 = a^2 + b^2$". That error springs from a particular small grain-size piece of content. There are thousands of such, as, to give but one example, Brown & Burton's (1978) pioneering error analyses in elementary subtraction indicate. Context and history matter, in that what was said yesterday may shape how one interprets what students say today.

In Schoenfeld (2019) I considered the issue of resources raised by the TRU Framework, highlighting issues that could profit from investigation. What follows are some of the main ideas.

3.3.1 Mathematics-Related Resources

At least two major issues regarding the practice of mathematics need to be addressed. First, although more that 30 years have passed since the NCTM (1989) *Standards* called for an increased emphasis on mathematical processes such as problem solving and reasoning, there is not nearly as much attention given to supporting students as reasoners and problem solvers – and in engaging more generally in powerful patterns of mathematical thinking (PPMT) such as problem solving, habits of mind, representation and modeling, abstracting, reasoning and proof as there should be (Schoenfeld, 2017). Far less attention is given to mathematical processes and practices than should be the case (Schoenfeld, 2020a). Teachers need both material resources (curricular support) and rich experiences in problem solving, conjecturing and proving, and abstracting and generalizing in order to develop those mathematical habits of mind and the wherewithal to teach them.

Second, mathematics instruction, abetted by standards and testing, tends to emphasize a rather fine-grained level of curriculum and instruction – "this list (e.g., the Common Core State Standards for Instruction, 2010) identifies the skills we will teach and hold students accountable for." This has long been a problem, as evidenced by what has been called the "summer slump," the fact that students forget so much of what they learned the previous year over the few summer months they are away from school. The details don't necessarily matter; the ideas behind them do.

For example, there are classical "work problems" such as this:

> Pipe A can fill a swimming pool in 6 h. Pipe B can fill it in 8 h. How long does it take to fill the pool if both pipes are open simultaneously? If you don't remember the formula, think about the problem.

Many years ago my research group included a graduate student who had recently been a high school teacher and an established mathematician visiting on sabbatical. The graduate student said "You use the following formula for problems like this" as found the answer in no time. The mathematician said, "I haven't worked problems like this in 40 years. There's a formula, but I don't have a clue what it is." Then he thought about what he could combine. Not hours, not pools, but… rates do combine. In 1 h, Pipe A fills 1/6 of the pool; in 1 h, pipe B fills 1/8 of the pool; hence the two together fill (1/6 + 1/8) = 7/24 of the pool. So, it takes 24/7 h to fill the pool.

The key point to observe is that the mathematician's knowledge was *generative*. Unlike "summer slump" students who are at a loss when something falls out of memory, the mathematician remembered central ideas and principles that enabled him to regenerate the formula when he needed it.

A quick look through the curriculum yields myriad examples where the memory load placed on students is immense, and an understanding of key underlying ideas could ease that burden substantially. For example, many students memorize a range of formulas for determining the equation of a line in the plane: the two-point formula, the point-slope formula, the general formula, etc. It's much more useful to understand that any two non-redundant pieces of information determine a line, and that one can find any of the formulas from any of the others.

It's an open question as to what the most robust understandings of any body of content could or should be based on, and how to put these at the center of mathematics instruction.

3.3.2 Cognitive Demand-Related Resources

The goal for the cognitive demand dimension is "productive struggle," based on the idea that if students are working productively within their zone of proximal development (Vygotsky, 1962, 1978), they will build the kinds of knowledge that extends what they know in meaningful ways.

The challenge, then, is to arrange the *environment* so that each student has opportunities to make reasonable and reasoned progress. The word environment is stressed for multiple reasons. It includes both the tasks and the ways the students are set up to engage with them. For example, tasks that are simple exercises provide little opportunity for growth. The same is the case for tasks that are not within reach. However, a lot of this challenge can be mitigated both by task design and by classroom activity structures. If a task can only be solved in one way, then the solution is either within reach or not. But if a problem can be approached in multiple ways, or can be illuminated by employing multiple representations, then there are a range of ways in which students can engage with it profitably. Yet this is only the beginning, because the framing thus far invokes the image of an individual students working on the task in isolation. Things get much richer when students work on problems in collaborative groups. For one thing – and this can't be stressed enough – students can serve as resources for each other. An individual teacher can only devote limited time to any student, but that student's classmates are much more available. There is much to be learned from asking questions of or explaining to one's classmates, and even more when one is collaborating with them. If a group of students is probing or building on each other's ideas, the students are much more likely to be working within their zones of proximal development. In addition, comparing and contrasting the approaches they have taken to problems that support multiple approaches enhances the mathematical richness of the conversations. Thus crafting and using tasks that support rich conversations and implementing classroom activity structures that engage students productively with their fellow students are some of the cognitive demand-related resources teachers need to develop. (Cohen & Lotan, 2014; Cohen et al., 1999; Mercer et al., 2019).

3.3.3 Equitable Access-Related Resources

The key idea is that every student must have ample opportunity to engage meaningfully with the central mathematical content that is the focus of the lesson or unit. That means much more than some, perhaps peripheral, engagement with the topic. For example, the Wikipedia definition of "differentiated instruction"[6] says:

> Differentiated classrooms have also been described as ones that respond to student variety in readiness levels, interests, and learning profiles. It is a classroom that includes and allows all students to be successful. To do this, a teacher sets different expectations for task completion for students, specifically based upon their individual needs.

The difficulty here lies in the phrase "a teacher sets different expectations for task completion for students." If some students in a classroom are practicing factoring whole numbers while others are factoring quadratic polynomials, or some do just the first step of a procedure while others are expected to complete it, the students may all be engaged, but not in ways that does justice to each and everyone. The challenge is that there are many hidden biases, as revealed for example in the classic AAUW volume *How schools shortchange girls* (American Association of University Women, 1992). Data from that volume indicate that girls were called on less frequently than boys and asked lower-level questions. Bias and discrimination can be subtle or overt and occur across all ethnic and racial, gender and gender orientation, linguistic proficiency, and untold numbers of other categories. There are a wide range of equity-oriented tools and practices, including Complex Instruction (Cohen & Lotan, 2014; Cohen et al., 1999), Equity Pedagogy (Banks & Banks, 1995) and Equity Analytics (Reinholz & Shah, 2018). A first challenge is to become aware of such resources, a second to build classroom cultures that make productive use of

[6] https://en.wikipedia.org/wiki/Differentiated_instruction

them. This is highly context-sensitive. And it's just the beginning, given the close links between Dimensions 3 and 4.

3.3.4 Agency, Ownership, and Identity-Related Resources

As noted in Sect. 3.1, ambitious instruction aims for students to be agentive; for them to learn the mathematics in ways that gives them ownership over it; and for them to develop positive mathematical identities. The path to AOI lies in successful mathematical experiences, so the relevant resources consist of ways of crafting the learning environment in ways that are likely to improve them. Some of those resources include those mentioned for Dimension 2 – rich mathematical tasks with multiple entry points and classroom activity structures that support students in venturing and building on ideas are relevant. Likewise, the activity structures mentioned in Dimension 3, which focus on making sure that all students are engaged in significant ways, set the stage for AOI. Ultimately, however, supporting students' development of AOI depend on a large set of resources deployed in the moment. Consider the questions given in Fig. 6.4, drawn from the TRU conversation guide (Louie et al., 2016). Many can be planned for in advance, but many require real-time decision making based on what the teacher sees in classroom interactions. That brings us to Dimension 5.

Agency, Ownership, and Identity

Core Questions: What opportunities do students have to see themselves and each other as powerful doers of mathematics? How can we create more of these opportunities?

Things to think about

- Who generates the ideas that get discussed?
- What kinds of ideas do students have opportunities to generate and share (strategies, connections, partial understandings, prior knowledge, representations)?
- Who evaluates and/or responds to others' ideas?
- How deeply do students get to explain their ideas?
- How does (or how could) the teacher respond to student ideas (evaluating, questioning, probing, soliciting responses from other students, etc.)?
- How are norms about students' and teachers' roles in generating ideas developing?
- How are norms about what counts as mathematical activity (justifying, experimenting, connecting, practicing, memorizing, etc.) developing?
- Which students get to explain their own ideas? To respond to others' ideas in meaningful ways?
- Which students seem to see themselves as powerful mathematical thinkers right now?
- How might we create more opportunities for more students to see themselves and each other as powerful mathematical thinkers?

Fig. 6.4 Things to think about, re AOI. (Reprinted with permission from the TRU Conversation Guide, p. 10)

3.3.5 Formative Assessment-Related Resources

As indicated by Fig. 6.5, Formative Assessment can be thought of as the glue that holds everything together in classrooms from which students emerge as mathematically powerful thinkers and learners.

Learning mathematics means not only understanding content, but equally important, becoming proficient at mathematical processes and practices (conjecturing, reasoning and proving, problem solving, etc.). Supporting students to become effective mathematical thinkers (TRU Dimension 1) requires making their thinking available to others and interacting with it in the moment – the very definition of formative assessment. Similarly, cognitive demand (Dimension 2) is impossible to adjust unless student thinking is made public; providing equitable access (Dimension 3) requires constant attention; and as discussed immediately above, equitable access is only the gateway to the kinds of opportunities for sense making that support students in developing agency, ownership over content, and positive mathematical identities (Dimension 4).

As with the other dimensions, there are both material and pedagogical resources to be marshalled in the service of formative assessment. One set of material resources is the Formative Assessment Lessons (FALs) produced by the Mathematics Assessment project. These lessons, also known as classroom challenges, are available at no cost from https://www.map.mathshell.org/. Independent evaluations of the FALs indicated that including 10–12 days worth of FAL-based instruction in the mathematics curriculum resulted, on average, in 4.6 months of learning gains (Herman et al., 2014, Research for Action, 2015) – a gain likely attributable to the inference that teachers' pedagogy during their regular lessons changed as a result of their being supported in different pedagogical practices while teaching using the FALs. But one should not give the impression that building the knowledge and pedagogical habits to employ formative assessment is straightforward. The FALs had the impact they did as the result of a quarter century of research and development, including content-specifics regarding typical student misconceptions and productive ways to structure classroom interactions to counter them. Developing such

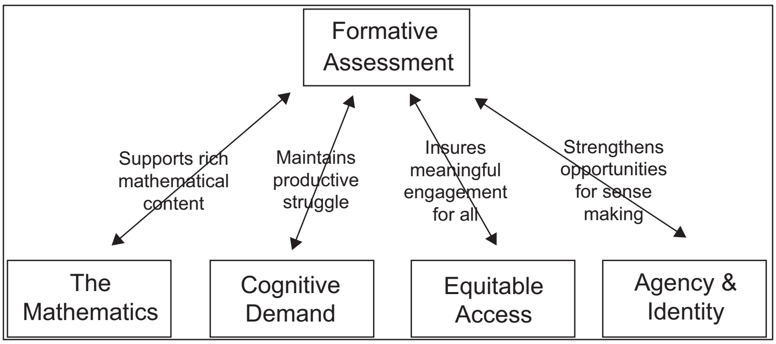

Fig. 6.5 The key roles of Formative Assessment. (Reprinted with permission from Burkhardt & Schoenfeld, 2019, p. 43)

pedagogical content knowledge on one's own is a long, slow process, as is developing the habits of mind that orient one to such knowledge (Black & Wiliam, 1998; Burkhardt & Schoenfeld, 2019).

4 Summary and Next Steps

This concluding discussion summarizes the main theoretical points in this chapter. I revisit the issues raised by the editors, pointing also to some resources and next steps in a research and development agenda.

4.1 What Is a Theory (of Teaching)?

I hope to have addressed that question thoroughly – well, as thoroughly as one can in a few pages – in Sect. 2. My book *How We Think* (Schoenfeld, 2011) offers a comprehensive theory of knowledge intensive and socially intensive in-the-moment decision making. That theory is a theory in the scientific sense. It specifies objects and the relations between them, specifying a mechanism by which in-the-moment decisions are made. The theory described in Sect. 2 is general, and it supports the creation of models that test the theory.

4.2 What Should It Contain and Why? Do We Already Have a Theory/Theories on Teaching? If So, Which Are They?

As noted in Sect. 2, an individual's in-the-moment decision making can be characterized and modelled by focusing on that individual's resources, orientations, and goals, using a decision mechanism akin to (but obviously more detailed and fine-grained than) Fig. 6.1. In that sense there does exist a robust and empirically verified theory of teaching. As discussed in Schoenfeld (2011), this theory is general; it generates models of particular teachers that apply in a wide range of situations.

As noted, however, I suspect that the editors really intended for the authors of this volume to address the issue of "ambitious" or "powerful" teaching – instruction from which students emerge as knowledgeable, resourceful, and agentive thinkers and problem solvers. This is a very different question, because what one takes as important depends on one's goals and values; it is no longer simply a question of theory. To invoke the automotive metaphor once again: one can have a theory of internal combustion engines (and theories of aerodynamics, etc.) but one will build very different cars if one's goal is (a) to win the Indy 500, where cost is no object, or (b) to build a comfortable and profitable family sedan.

That said, there is an empirically validated theory of "teaching for robust understanding" and a framework that identifies what matters in ambitious instruction. As described in Sect. 3, the TRU framework (Teaching for robust understanding project, 2018) indicates that a learning environment will be successful in producing powerful thinkers and learners to the degree that (1) the content and practices with which students engage is disciplinarily rich; (2) students engage in sense making within their zones of proximal development; (3) *all* students engage with core content and practices; (4) students have opportunities to contribute to discussions and progress in ways that support the development of agency, ownership over content, and the development of disciplinary identity; and (5) student thinking is made public and the learning environment adjusts accordingly.

It should be clear that there is no one "right" way to teach; teachers with very different styles and routines may be successful along all five dimensions of the TRU framework, just as somewhat different automobiles can vie for "best in class."

Nonetheless, the combination of the theory of decision making in Sect. 2 and the TRU framework as discussed in Sect. 3 provides the mechanism for constructing a theory of ambitious teaching, a.k.a. Teaching for Robust Understanding. The question is, what are combinations (note the plural) of resources, orientations, and goals that would support teachers in constructing learning environments that do well in the five TRU dimensions? This was the issue pursued in at least some depth in Sect. 3. That discussion just scratches the surface. It will be pursued in Sect. 4.4, which identifies directions for further work.

4.3 Can Such a Theory Accommodate Differences Across Subject Matters and Student Populations Taught? If So, How? If Not, Why?

In a word, yes. The theory of decision making elaborated in Sect. 2 applies to well-practiced decision making in all knowledge-intensive domains. Schoenfeld (2011) provided detailed models of beginning and experienced teachers at the elementary and secondary levels, an indication that neither level of expertise nor grade level is a theoretical obstacle. The TRU framework was developed in mathematics, but it is domain general – it is a theory of powerful learning environments, independent of content domain and age level. That is not so say that content specifics or student population don't matter. To create a powerful learning environment in physics, chemistry, or English Language Arts, one needs to have a rich sense of the content and practices in those domains. To be an effective teacher of any group of students, one needs to know those particular students and have a sense of what supports their learning. But those are details – the details of the resources, orientations, and goals relevant for any particular model one wishes to build in detail. That is a huge empirical challenge, but it is not a theoretical challenge.

4.4 (From the Editors:) In the Future, In What Ways Might It Be Possible, If at All, to Create a (More Comprehensive) Theory of Teaching?

As indicated above, the issues facing us as a field are not theoretical: the theory of in-the-moment decision making during teaching and the TRU framework, together, provide a comprehensive theoretical framework regarding teaching for robust understanding. The issue before us is: what would be useful to know in order to flesh out the details of that theoretical framework and provide mechanisms to help teachers move in productive directions? Thus, I would reframe question 4.4as:

4.5 (Reframed:) In the Future, In What Ways Might It Be Possible, If at All, to Elaborate and Support the Mechanisms of Teaching for Robust Understanding, and to Understand the Impact of the Contexts Within Which Teaching Takes Place?

In the balance of this section I briefly identify four arenas essential for progress.

4.5.1 Research and Development on Resources for Teaching for Robust Understanding

Section 3.3 characterized some of the cognitive resources that can support teachers in teaching for robust understanding. The list in that section is just a "starter set" – as noted above, pedagogical content knowledge comes with experience, and is tied very specifically to the content that one teaches. A major question is how to catalyze the development of such resources.

That question is intimately tied to the issues of material resources and professional development. As an example of the former, consider the Formative Assessment Lessons (FALs) available at https://www.map.mathshell.org/. Each these 100 lessons provides direct curricular support for teaching key content using formative assessment. The lessons are aimed at unearthing student thinking related to the content and building on it. The support materials included as part of the lessons (which take 2 to 3 days each to implement) include diagnostic tasks that reveal student misunderstandings to teachers, tables of "common student issues" and ways to lead students to address them, and very detailed lesson plans. The lessons themselves bolster content and process understandings for teachers. By virtue of orienting teachers to common student misunderstandings and providing mechanisms for addressing them, the lessons scaffold the development of teachers' pedagogical knowledge. In fact, each of the FALs *embodies* pedagogical content knowledge with regard to the content and practices at hand. (See Swan, 2006, 2017; Swan & Burkhardt, 2012, 2014). A major issue is scaling up: the FALs, which required a highly skilled design team, were based on decades of research and cost upwards of $6 M USD to produce, only address a subset of the central topics in the high school curriculum.

But there is more to be said about the FALs. The lessons were designed to help teachers learn key aspects of formative assessment, in the expectation that some of the productive pedagogical habits learned by teaching the FALs would become parts of the teachers' general repertoire. Although the evidence to date is still thin, it appears that that is the case. Kim (2017) documents the changes over the course of a year as a teacher taught five of the FALs. After the first FAL, there was little or no change in the teacher's pedagogy: the lesson she taught the next day very closely resembled in style the lessons she had taught before teaching the FAL. However, there were some slight changes after the teacher taught the second FAL, and by the end of the year the teacher was doing significantly less "telling" and providing students with a great deal more time to raise questions and discuss them among themselves. This experience was hardly an unalloyed success; the loss of the previously rigid structure the teacher had employed resulted in challenges in classroom management, for example. But the fact that the pedagogical strategies implemented in the FALs influenced the teacher's regular lessons indicates that it is possible for such materials to have an impact on teachers' pedagogical practices. Indeed, such "travel" is the most likely explanation for the findings in Herman et al. (2014), that Kentucky teachers who taught 10–12 days of FALs saw their students gain an additional 4.6 months in terms of mathematics learning. The students only experienced 10–12 days of FAL content, but they most likely experienced a significant amount of FAL-related (and TRU-consistent) pedagogy.

Note that these are largely conjectures at this point, and a great deal more needs to be studied.

Along similar lines but not on nearly as large a scale, the Teaching for Robust Understanding project has created a number of tools for teachers' professional development: see https://truframework.org/. Figures 6.2 and 6.3 were drawn from the TRU Observation Guide (Schoenfeld & the Teaching for Robust Understanding Project, 2016), and Fig. 6.4 from TRU conversation Guide (Louie et al., 2016). These tools have been used in a wide range of professional development projects (See Schoenfeld et al., 2020, ; see also Schoenfeld et al., 2019 for a description of Teaching for Robust Understanding with Lesson Study.) These projects, in general, are aimed at helping teachers develop richer pedagogical resources and orientations consistent with the TRU Framework. Two new books (Schoenfeld et al., 2023a, b) provide additional tools and support for professional learning communities.

Over time, it will be valuable to flesh out the knowledge and orientation base that supports teaching for robust understanding. This is both a theoretical and engineering exercise. For example, there is much to be learned about how belief systems are formed and operate (e.g., how orientations prioritize resources) and how to unpack and support student thinking (the what and how of content-specific formative assessment). For a more detailed view of desirable R&D, see Schoenfeld (2020b) and Burkhardt & Schoenfeld (2019).

4.5.2 Issues of Developmental Trajectories

The field lacks good data on how teachers grow with regard to the key dimensions of TRU, especially in environments meant to foster their growth. There is a literature on teacher growth. In broad brush strokes, that literature (see, for example, Fuller, 1969; Hord et al., 1987; Ryan, 1986; Smith, 2000) suggests that teachers tend to spend the first few years of their careers mastering issues of classroom management, after which they increasingly get involved in using and sometimes developing engaging mathematical activities. Along the way they develop pedagogical content knowledge (in the arenas they teach, consistent with their orientations and practices) and some small percentage of teachers become adept at focusing on student thinking.

Such trajectories are hardly inevitable, however. Management is an issue if students are not engaged. Thus, an early focus on rich and engaging materials and activities may both lessen challenges of classroom management and hasten the growth of pedagogical content knowledge. Moreover, having your teacher focus on your thinking and ideas is very engaging for students – so teachers whose classrooms feature formative assessment early on may display (currently) non-normative developmental trajectories. Studies of how teachers' understandings and practices develop, under what conditions, could help to optimize professional development.

4.5.3 Theoretical and Pragmatic Challenges in an Increasingly Virtual Instructional World

The coronavirus pandemic has thrown teachers around the world headlong into virtual instruction, whether they were ready for it or not – and few were. We thus face the massive challenge of reconceiving teaching within a radically different social, technological, and instructional context. The key point I wish to make here is that two things remain the same as we consider these changes. The first is that the mechanisms of decision making during instruction remain the same. What teachers will do in the moment is a function of their goals, the resources available, and their orientations. Without doubt, the material and social resources available in virtual environments differ substantially from those in in-person instruction. But what a teacher chooses to do will be a function of that teacher's resources, orientations, and goals. Second and perhaps more important in this context, the teaching for Robust Understanding Framework applies to *all* learning environments, including virtual learning environments. What that means is that TRU can be used to problematize virtual learning. The key questions to confront are:

How can whatever mode of instruction teachers are employing – whether it is in-person, virtual, or blended – be configured so that …

- students engage in deep ways with disciplinary content and practices
- cognitive demand is adjusted so that students engage in productive struggle
- *all* students are meaningfully engaged with core content
- all students have opportunities to contribute to exchanges in ways that support the development of agency, ownership over content, and the growth of positive disciplinary identities and identities as learners
- student thinking is made public and instruction responds in ways that supports the first four bullets above?

This is a huge challenge in in-person instruction and will be that much more of a challenge as we take on the new challenges of virtual instruction. But the framing given above highlights what is important and points us to the research and development that will help us to address the challenge.

4.5.4 Broader Issues of Context

The focus of this chapter has been on elaborating a theory of what the teacher does, inside the walls of the classroom. It goes without saying that everything that takes place inside schools is shaped by myriad societal forces. Issues susch as the "savage inequalities" of school funding (Kozol, 1992) and pervasive racism, to name just two, are critically important. For a preliminary discussion of the impact of such issues and how to link them to the issues discussed in this chapter, see Schoenfeld (2022).

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Chapter 7
Keeping Theorizing in Touch with Practice: Practical Rationality as a Middle Range Theory of Mathematics Teaching

Patricio G. Herbst and Daniel Chazan

Abstract This chapter characterizes the practical rationality of mathematics teaching as a middle range theory, a theory that is developed through the practice of research. We argue that a middle range theory of teaching permits theorizing that keeps in touch with practice, the exploration of complementarities and mutual sharpening of competing constructs, and the pursuit of an agenda of scientific research on mathematics teaching. We illustrate how empirical research on practical rationality has enabled not only the progressive characterization of phenomena hypothesized by the basic concepts of the theory (e.g., what are the norms of instructional situations) or the uncovering of relationships among those concepts (e.g., complementarities and tensions among contractual and situational norms) but also the drawing of relationships with other constructs (e.g., teachers' beliefs and knowledge). We use this example to argue that progress in theorizing teaching can benefit from a middle-range theory, to illustrate in what way subject-specificity and subject-genericity can complement each other in theorizing, and to speculate on what the field needs from different theorizations to advance toward better understanding of the practice of teaching.

Keywords Practical rationality · Instructional norms · Professional obligations · Middle-range theory · Didactical contract

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1 Teaching as an Object of Study and Our Position as Researchers of Mathematics Teaching

Theorizing is a crucial activity among researchers' efforts to understand the world. The identification of the chunk of the world on which to focus our understanding efforts, the means we use to endeavor in such understanding efforts, and the content and form of such understanding are all tasks that call for the involvement of theory. Because education researchers are part of the social world they seek to understand, theorizing assists those who study education phenomena in the struggle against an *illusion of transparency* caused by the immediacy and practical validity of the knowledge of the world that enables us, as participants, to live in it (Bourdieu et al., 1991).

The practice of teaching is one chunk of the world that can use theorizing, if anything because the existence of the social role of teacher makes it all too easy to think one knows what teaching is. Older and well developed fields of scholarship such as psychology, sociology, and economics have been considering education for decades, reducing education to objects and methods of study from their disciplines. In theorizing the practice of teaching, however, we claim that this practice deserves to be constructed into an object of study, to have its own special gaze or regard, one that draws from other disciplines but is not reducible to them. Thus, to the question that Hill (this volume) imagines David Cohen asking, why would you want to develop a theory of teaching (hereafter, Cohen's question), our answer is, simply, to understand the practice. Vieluf and Klieme (Chap. 3, this volume) ascribe such a goal to practice theory applied to teaching; in our case, the notion that ours is a practice theory of mathematics teaching is an important modifier that, as we show below, connects more specifically to Cohen's notion of instruction.

Our research program pursues a basic or fundamental understanding of the practice of teaching through theorizing of a particular kind. In Chazan et al. (2016) we described a fundamental approach to the study of teaching in contrast to an instrumental approach. An instrumental approach to the study of teaching would be interested in teaching as a variable that can be manipulated in order to optimize some of its outcomes (e.g., meaningful learning, student achievement, equitable opportunity, etc.). Research on what kind of teaching produces desired outcomes (e.g., Hiebert & Grouws, 2007), or instrumental research on teaching, is important and necessary for improving education (see Hiebert & Stigler, Chap. 2, this volume). However, instrumental research does not necessarily construct teaching as an object of study and does not provide a basic understanding of the sort of practice that teaching is. A fundamental approach, in contrast, sees teaching as a phenomenon in the social world that exists in response to societal and institutional conditions of existence just as much as an expression of the will and technical knowledge of its actors and enablers. A cornerstone of our theorizing about teaching is the commitment to understanding the teaching practice that exists as a result of those conditions. At the same time, we also seek a way of theorizing that allows the practice we aim to understand to speak back to our theorizing and keep it grounded.

One resource we have in this regard is our own identities and experiences. We identify as former teachers of secondary and college level mathematics courses.[1] In both of our cases, our transition to becoming mathematics education scholars resulted from our commitment to understanding the practice we were engaged in, an understanding that could use the resources of the academy—including its time, community, and stringent criteria for intellectual work. Indeed, for Chazan, this transition included an extended opportunity to engage in scholarly inquiry into teaching by teaching (Chazan, 2000), what Ball (2000) calls first-person research on teaching.

Thus, we find ourselves in the position of aspiring to study a field of practice of which we have intimate knowledge having been its agents. At the same time, in our study of that practice, we aspire to the goals of science, to describe, explain, and predict. We seek to use those resources to produce accounts of the field of mathematics teaching that, like those of Simon and Tzur (1999), explicate the teacher's perspective from the researchers' perspective. In doing so, there are two traps into which we must not fall. On the one hand, as articulated earlier, we must not fall prey to the illusion of transparency and assume that our experiences as teachers are best described as we experienced them when we taught. On the other hand, we must not assume, either, that the external descriptions of teaching that we are now able to craft as observers obviate the need to consider the experiences of practitioners.

Put another way, we must apply to ourselves Bourdieu's (1990) simultaneous critiques of structuralism and phenomenology. Theorization of the social world requires a critique of the objectivizing dispositions of researchers who may propose structures in the social world partly because their social position allows them to extricate themselves from practice. Theorization of the social world also requires a critique of the subjectivizing dispositions of participants who may promote the epistemological status of their lived experience without consideration of the social conditions and constraints that made such experience and reflection possible. We apply those requirements to ourselves as former mathematics teachers-become-social researchers. We bring to our theorizing both personal experience as mathematics teachers living the tension between the compulsion of sociotechnical norms and the sometimes frustrated and sometimes successful motives of individual agency and our present ability to contemplate that reality as outsiders not immediately engaged in it. Furthermore, that ability is supported by the resources of our present positions, including the relative intellectual autonomy and abundant scholarship available to tenured university faculty in the United States.

We are therefore disposed to see and propose structures to which we can now see ourselves having been adapting when we were teachers; at the same time, we cannot shed the sense of the agency and responsibility we felt we had as teachers and for the study of which other constructs (e.g., teacher beliefs) and measures have been

[1] It has become common in education research for scholars to state their positionality, particularly with regard to their race, gender, and social class and how those situate them in relation to the communities they address in their writing. We adopt that practice in a slightly different manner to disclose our connection to the practice we seek to study.

developed. We see the work of teaching as including making decisions in spaces where there are normative expectations, as well as publicly justifiable alternatives. In describing our theorization in terms compatible with those of Simon and Tzur (1999), we use both our personal experience as decision agents and the conceptual and methodological tools social research has for objectifying the world to explicate the teacher's perspective from the researchers' perspective.

Hence, our theorizing efforts are, as von Glasersfeld (1991) would have it, adapted to fit our experiential world rather than to discover an objective reality. Along those lines, theorizing teaching is akin to an observer's modeling of their experience observing teachers' actions. This modeling includes ongoing empirical research and responsive theorizing moves. On the one hand, empirical research on provisional versions of a theory may generate perturbations to those initial versions. On the other hand, theorizing may respond by adapting the theory to neutralize the perturbations generated by empirical research. Put another way, through empirical research, practice can speak back to theory and enable theory to respond. The potential result of such a dialectic is theorizing that is in closer contact with the practice it theorizes. Thus, empirical research can play a crucial role in the development of a theory.

This chapter illustrates that dialectic: In particular, it illustrates how reliance on empirical work to support and constrain the production of theory is a crucial element in constructing a theory of teaching practice that accounts for the perspective of the practitioner.

2 Practical Rationality, Theorization, and Middle Range Theories

Our contribution to this book on theories of teaching makes use of our research aimed at the development of a theory of, what we call, the *practical rationality of mathematics teaching*. By that name we allude to the basis upon which the practice of mathematics teaching can be understood as rational or sensible. We have explained practical rationality elsewhere (e.g., Chazan et al., 2016; Herbst & Chazan, 2003, 2011, 2012), so this chapter does not do that. Rather, this chapter takes practical rationality as a case of a particular kind of theory (middle range theory; Merton, 1967) and shows examples of what theorizing looks like in that kind of theory. The examples we present serve to argue for the development of a middle range theory of teaching as the way to mitigate the illusion of transparency.

In characterizing theories of the middle range, Merton (1967) was distancing himself from specific hypotheses and grand theories—with the former amenable to be tested empirically and the latter being large sets of ideal constructs designed speculatively to be used to read the world. We are aware that aspects of our theorizing represent strong commitments we have and that might be spun into grand theories. For example, we are committed to understanding teaching as an outcome or a result of complex processes, rather than reducing it to being a voluntary expression of individual teachers; to give up this commitment would represent a change of focus. Other aspects of our theorizing are more responsive to empirical work. The specific concepts that flesh out our basic commitments have not been defined apriori of empirical research operations but rather in relationship with empirical research operations. Also, constructs proposed and empirical research results obtained outside practical rationality (e.g., in theories of mathematical knowledge for teaching) can be engaged to inform, challenge, or complement such theoretical development. Along those lines we consider practical rationality to be an example of what Merton (1967) called a *theory of the middle range*, a theory that is developed through the practice of research.

In saying that practical rationality is a middle range theory, we take distance from grand theorizing. However, we are less interested in classifying practical rationality among theories than in demonstrating how the use of an initial set of commitments and a perspective to steer empirical research on mathematics teaching support theorizing that keeps in touch with practice. The latter includes, in particular, reconciling empirical facts that may be couched in different uses of language, seeking to understand relationships with other theoretical constructs, and organizing them in larger systems of ideas and questions that could guide researchers toward the understanding of general constructs. In our interpretation, the name *practical rationality of mathematics teaching* neither points to a well outlined system of abstractions made from speculation nor does it identify a specific assertion as amenable to being tested empirically. Rather, as the name of a middle range theory, *practical rationality* designates a shell within which we are developing empirical research that seeks to enable theorizing as a means of understanding.

In this chapter, we reflect on a number of aspects of the continued development of practical rationality that illustrate the mutually reinforcing relationships among theorizing teaching, practitioners' tacit knowledge of teaching practice, and empirical research. We argue that a middle range theory of teaching permits theorizing that keeps in touch with practice, the exploration of complementarities and mutual sharpening of competing constructs, and the pursuit of an agenda of scientific research on mathematics teaching (Shavelson & Towne, 2002). There is a parallel between our approach and what Cai and colleagues (Chap. 8, this volume) propose when they describe theories of teaching as including two dynamic processes of *theory for teaching* and *teaching for theory*, in that both their proposal and ours make room for practitioners' knowledge in the development of theory. The difference is in the intent; while Cai et al. (Chap. 8, this volume) and to some extent also Schoenfeld (Chap. 6, this volume) and Hiebert and Stigler (Chap. 2, this volume) assume that the development of theories of teaching seeks to guide the practice of teaching, our intent is more proximal, to understand the practice of teaching in order to further guide research on teaching. Along those lines, coming back to Cohen's question, our goal to develop a theory of mathematics teaching has been to enable research on mathematics teaching to attend to the mathematical specificity of the work of teaching which can be noticed by teachers.

3 Practical Rationality as a Scientific Effort to Study the Work of Mathematics Teaching

In this section, we provide just the theoretical material needed to later describe the empirical work in which our theoretical ideas have been tested and from which the theory has been receiving feedback to pursue theorizing. In later sections we exemplify how this empirical work has supported three different kinds of theoretical developments within practical rationality and the building of connections with two other theoretical perspectives.

3.1 Focusing on Institutionalized Mathematics Teaching

Our work theorizing the practical rationality of mathematics teaching was stimulated not only by our goal to understand the work of mathematics teaching but also by the challenge in Shavelson and Towne's (2002) call for scientific research in education (Herbst & Chazan, 2011). Seeking to avoid interpreting scientific education research solely as evaluation of education interventions, our image of what it means to do scientific, fundamental research in education is tightly connected to Merton's (1967) description of middle range theories and to an interplay of theorizing and testing of theory as means to construct a scholarly understanding of the phenomenon of mathematics teaching. Over time, as a result of both the identification of the constructs that articulate practical rationality and the understanding of relationships among those constructs and the more individual-centered constructs others have proposed, we have come to conjecture that the work of teaching involves decisions and actions that can be explained in terms of a combination of factors. Figure 7.1, below, shows this and also provides a basis for understanding how our

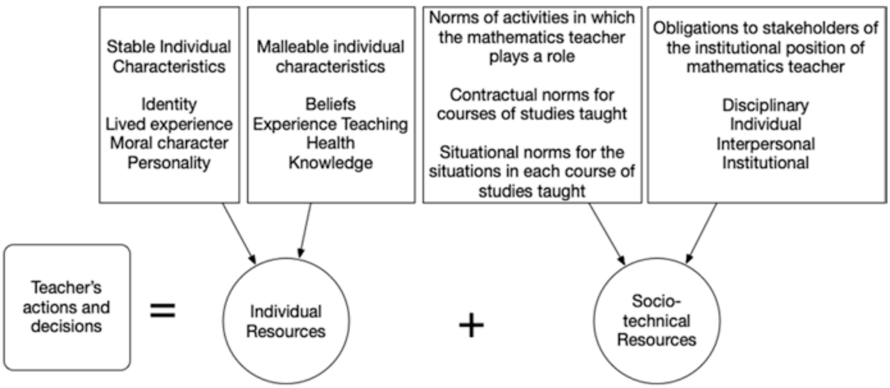

Fig. 7.1 Practical rationality's account of decision making

approach can answer the questions posed by Charalambous and Praetorius to the authors of chapters in this volume.

Our efforts to develop a theory of the practical rationality of mathematics teaching draw from Cohen's (2011) definition of teaching in which he takes distance from both teaching as an accomplishment (i.e., teaching is that which produces learning; see also Scheffler, 1960) and as an occupation (i.e., teaching is what teachers do). Cohen (2011) constructs teaching as an object of study, defining it as the work that teachers do which is deliberately oriented to—even if not effective in—producing learning.

Our theorizing effort focuses on teaching practice in the context of mathematics instruction, while remaining aware that teaching practice responds to other demands. In order to maintain attention to the work a teacher does to support the learning of mathematics, while recognizing the legitimacy of other work teachers do which might be oriented to students' learning of other things (e.g., students' self-concept, social values, other disciplines), we elaborate on the definition of teaching Cohen proposed. Our elaboration of Cohen's (2011) definition of teaching takes advantage of Cohen et al.'s (2003) definition of instruction as a system of interactions among teacher, students, and content in environments, often referred to as the instructional triangle. According to Cohen et al. (2003), instruction is a complex activity in which teachers play a role; in instruction, teaching involves what a teacher does with content and what the teacher does with students in environments. These environments are sociocultural as well as institutional. Applying this definition of instruction to mathematics as the content of instruction in educational institutions allows us to propose a distinction between the overall work of teaching and the work of teaching in mathematics instruction. The work of teaching involves a teacher in many roles in a range of activities that can be oriented to students' learning of something (not necessarily disciplinary content); mathematics instruction is one of those activities. Mathematics teaching is the work a teacher does which is deliberately oriented to students' learning of the mathematical content at stake in instruction. This focused distinction of mathematics teaching from the whole of teaching relies in particular on the institutionally sanctioned content of studies.

Our attention to mathematics teaching is a commitment not only to a focus but also to a gaze or perspective. As noted above, we attend to the work of teaching in mathematics instruction by articulating a gaze that is mathematically specific–that attempts to see the mathematical specificity of mathematics teaching as this is noticeable (even if not always noticed) by teachers. We commit to articulating how mathematics is needed as a resource in the effort of describing, explaining, and predicting the work of mathematics teaching. More succinctly, we seek a subject-specific theory of mathematics teaching. We do not expect that every topic of content taught needs to be part of the theoretical language used to describe the work itself, but we do expect that the theoretical language to describe mathematics teaching will be mathematical in some way and that the discovery of how mathematics needs to be involved in the development of such theoretical language will be shaped by the expectation that such language should show value in the ways that are usually expected of scientific theories—enabling description, explanation, and prediction.

We are also committed to acknowledging the role that institutions like the department, the school, and larger educational systems play in influencing mathematics teaching. Our experiences as teachers of mathematics, where we taught the same material to different groups of students and coordinated work with other teachers of the same material, make us especially aware that an account of the practice of mathematics teaching that explicates the perspective of the teacher from the researcher's perspective needs to be more general than an account of the teaching of a particular group of students and more specific than an account of the teaching of mathematics in general. The institutionalized existence of mathematics instruction provides the course of study as a more or less stable unit for such accounting; courses of study have standard durations (e.g., a semester, a year), a target student population, and a relatively stable share of the curriculum in terms of scope and sequence. Thus, we start from the assumption that the practical rationality of teaching different courses of mathematical studies may have similarities and differences. A natural direction for research is to find out more about those similarities and differences. What ideas are useful to create accounts of the work of teaching across courses of mathematical study, and what distinctions are needed in order to improve explanation and prediction of what a teacher would do in those courses?

We apply Cohen et al.'s (2003) definition of instruction to model instruction in courses of mathematical study within the educational institutions that provide environments for such instruction. This allows us to restrict the content of instruction to that which is institutionally sanctioned as content for a course of mathematical study. For us, mathematics instruction concerns the interactions among teacher, students, and the mathematics content at stake in a course of study, or the knowledge designated to be learnt, in an educational institution (Herbst & Chazan, 2020; see also Chevallard, 1991). Therefore, building on Cohen (2011), when we talk about the work of teaching in mathematics instruction, we limit it to the work that teachers do which is deliberately oriented to—even if not effective in—producing the learning of the mathematical content at stake in a course of study. This definition allows us to describe the work of teaching (within mathematics classrooms) as involving tension between playing the role of teacher in mathematics instruction (i.e., managing transactions of content) and playing the role of teacher in other activities that (legitimately) depart from mathematics instruction (e.g., talking to the class about appropriate use of language or supporting a student's self concept). Such tensions create complexities that teachers must manage, as Hill and Lampert (this volume) remind us.

The distinction between instruction (as a focused activity) and other activities of teachers and the notion that all these activities legitimately compete for the time and energy of the teacher is not meant to discount the possible synergies among those activities (e.g., building students' self-concept might support students' doing the mathematical work related to the knowledge at stake). It does not mean we discount aspects of the teacher's work which are tangentially related to mathematical content; instead, the distinction provides us with analytic power. The distinction helps us describe variability in the work teachers do and build models of decision making in mathematics teaching that attend both to matters that are specific to the knowledge at stake and to matters that are more general about the institutionally sanctioned work of teachers. In turn, this helps us prevent too early a subsumption of subject-specific variability under larger, more general concepts. In examining the practical rationality of mathematics teaching, we center our efforts on the work the teacher does in mathematics instruction, the work the teacher does which is oriented toward students' learning of whatever mathematics is at stake at the moment and define this work to be the management of transactions of content with students.

3.2 Instructional Exchanges, Instructional Situations, and Instructional Norms

An important goal of our research within practical rationality has been to identify and confirm the existence of instructional norms, in particular norms that regulate what teachers are expected to do in instruction. In seeking to identify norms we have looked at them as reference points or benchmarks around which individual differences in practice distribute, even if individuals are not consciously aware of these norms. Because we seek a subject-specific language of description of teaching practice, we have been attentive to the role that mathematics plays in identifying those norms.

The notions of *instructional exchange* and *instructional situation* are the building blocks of a subject-specific theory of mathematics teaching in instruction, including their genealogical relationships with the more widely used notions of *task* (Doyle, 1983; Stein et al., 1996) and *didactical contract* (Brousseau, 1997). Later in this chapter, we describe how empirical research on instructional situations operationalizing associated ideas such as *norm*, *breach*, and *repair* supported creating local, descriptive, and testable models of teaching specific subject matter.

In other writing we have explained how the work of teaching in instruction involves the management of transactions of content with students and that these transactions include enabling and confirming instructional exchanges between two manifestations of content: content as instructional goals at stake and content as the specific mathematical work (the enacted mathematical tasks) to do or be done on behalf of the former (see also Chazan et al., 2016; Herbst & Chazan, 2012, 2020). Whereas the notion of didactical contract (Brousseau, 1997) has inspired our identification of some general norms for those instructional exchanges (e.g., the teacher has the right and is expected to pose problems to students; students are expected to show their work on problems), we have been more interested in norms that regulate specific, recurrent instructional exchanges. The notion of *instructional situation* (Herbst, 2006) designates local contracts for recurring instructional exchanges (e.g., solving equations, doing proofs; see Chazan & Lueke, 2009; Herbst et al., 2009) that frame expectations about specific mathematical work. Our research on instructional norms has, therefore, aimed at identifying the norms of instructional situations (also known as situational norms).

Our reading of the notion of didactical contract and offering of the notion of instructional situation help us operationalize three key commitments of our perspective on theorizing teaching. First, the norms we aim to identify and organize are subject-specific constructs in the sense that they make use of mathematics in the description, explanation, and prediction of teaching. Second, these norms are practice-specific in the sense that they find mathematical specificity in the practice of teaching mathematics rather than import this specificity from outside with categories brought over from the discipline of mathematics, even if our familiarity with the discipline helps us identify those norms. Third, these norms are instruction specific in that they account for the work of teaching in instruction, defined as the management of transactions between content as instructional goals and content as mathematical work inside educational institutions.

One can note something of a tension between commitments to subject-specificity and practice-specificity, which highlights why we have started this chapter with a discussion of our position as secondary-mathematics-teachers-become-education-researchers. In principle, that tension may be resolved subjectively. Both of us can commit to enforce self discipline in avoiding reductions of the practice of teaching mathematics to either a generic practice of teaching that brackets the content or to a mere application of mathematics that brackets the activity of teaching. Yet the management of that tension is also aided by the cognate theoretical constructs that in some cases we build on (e.g., contract, task, norm) and in some cases we differentiate from (e.g., activity structure) which require us to look at mathematics teaching practice from the stance of a detached observer. In what follows, we speak at length about instructional norms as one of the sociotechnical factors that help account for the work of teaching; they are sociotechnical in the sense that they describe ways in which humans handle knowledge in organizations.[2] The other set of sociotechnical factors we allude to includes the professional obligations of mathematics teaching (elaborated at length in Chazan et al., 2016) which include an obligation to the discipline of mathematics, to students as individuals, to the societal values and needs at stake in classroom interaction, and to the institutions of schooling.

The management of that tension is also aided by the expectations around scientific research in education (Shavelson & Towne, 2002). The extent to which the notions of didactical contract and instructional situation can be grounded empirically and evince some degree of intersubjectivity is precisely the purpose of the empirical research we have done and a crucial resource to build a theory of the middle-range.

3.3 *Coordinating Individual and Socio-technical Factors to Understand Teacher Decision Making*

The socio-technical factors alluded to above and discussed below in Sect. 7.4 are one set of elements we bring to understanding the work of teaching. The metaphorical equation in Fig. 7.1 shows how the constructs of practical rationality explain the

[2] A useful example to anchor the meaning of instructional norm is the statement that when solving equations in one variable teachers expect students to manipulate algebraically both sides of the equal sign.

actions or decisions a teacher makes (or will make) as dependent on two sets of factors. On the one hand, there are individual factors that the actions or decisions of a teacher can be seen as expressing. Knowledge, beliefs, and experience teaching are malleable examples of these individual factors that may change over time; other individual factors are more stable examples of those individual factors such as lived experience (e.g., as a member of a social group) or personality (Goe, 2007, calls the first group qualifications and the second characteristics). On the other hand, there are socio-technical factors that describe the context in which the individual is operating and that enable or constrain the actions of the teacher. The institutional position, within educational institutions of a society, is one source of description of the context; stakeholders of those institutions obligate the teacher as a professional. These obligations are identified generically by the four obligations named above, but the extent to which teachers are beholden to each of those obligations may vary (e.g., by school level, by culture). Within an educational institution, there are several activities that a teacher engages in to respond to some of those obligations (e.g., stewarding prosocial behavior is part of what American teachers are expected to do in high schools). Instruction is a particularly central one of those activities, and practical rationality seeks to account for the decisions and actions a teacher makes when engaging in this activity. To support accounts of how the activity of instruction impinges on the actions a teacher takes when engaging in that activity, practical rationality models that activity in terms of systems of norms—expectations on how teacher and students are to manage the content of studies. These norms include the contractual norms of a course of studies, and within a course of studies, the situational norms associated with the instructional situations in that course of studies. The socio-technical resources available to account for teacher action and decision making vary both by the mathematics being taught (different courses of study may include different instructional situations and hence different norms) and the institutional contexts within which mathematics is being taught (different institutions in different cultures may obligate teachers differently to their various stakeholders).

In our empirical work, we have been especially interested in explaining what decisions teachers make in lessons, particularly regarding how they present problems to students and how they respond to students' contributions. In that context, the metaphorical equation of Fig. 7.1 would describe the decision of what move to make as dependent not only on individual teacher resources (e.g., their resources, orientations, and goals, as described by Schoenfeld, Chap. 6, this volume) but also on the norms of the course of study in which the lesson is taught and the professional obligations of the teacher. The norms of the didactical contract may constrain, for example, what kind of problem might be posed and how the problem might be posed. The professional obligations associated with the role of teacher in school can serve to justify any departures from norms incurred by the decision to pose that problem. The instructional situations available in that course of studies may serve as resources for the teacher to frame, and therefore enable, the students' work on the problem, and the norms of the situation may condition how the teacher responds to what students produce. Those demands are socio-technical in the sense that they concern social as well as technical (especially mathematical but also psychological and legal[3]) expectations of how teachers do their work. Like in other settings, it is clear that individual agents might be able to act in ways that deviate from norms or that fail to abide by obligations, likely with the assistance of personal resources, and that actions that deviate from those expectations will require special justification, while actions that fulfill expectations may go without comment.

Both the metaphorical equation in Fig. 7.1 and its use to explain the decisions a teacher makes illustrate how practical rationality handles various types of specificity in describing teaching. The institutionalized nature of some mathematics teaching in schools, for example, as contributing to the societal function of schooling, in contrast with other kinds of mathematics teaching (e.g., in camps, clubs, or at home), is represented by the professional obligations. Those who teach outside of schooling institutions may be subject to obligations to other or fewer stakeholders. In particular, society as the source of the interpersonal obligation[4] may act as a stakeholder of mathematics teaching in different ways in different countries, promoting the classroom cultivation of different social values in different societies, and within a given society, different school organizations (e.g., primary or secondary schools, universities) may obligate teachers differently. Within a kind of organization (e.g., secondary schools), the didactical contract may have different norms in different courses of study and within a course of study, different instructional situations may create different expectations (e.g., the norms a teacher recognizes for how they have to outfit a diagram when including it in a geometry problem may depend on whether the diagram will be used in a proof, a calculation, or a construction).

3.4 One Reason to Create a Middle-Range Theory of Mathematics Teaching

In developing practical rationality, we were mindful that we wanted to affirm the role of mathematics in the description of the work of mathematics teaching in such a way that this role would persist when data was aggregated to construct measures and test hypotheses. Instructional situations are a key element of the theory in that they afford ways of focusing on teacher decision making about mathematics and ways of finding commonalities across different instances of mathematics teaching. Toward this goal, an important contribution of our work has been the identification and empirical demonstration of the norms of instructional situations (or situational

[3] The technical part of sociotechnical alludes to all the disciplinary bases of professional practice. The mathematical basis of professional practice is salient for mathematics teachers, but insofar as legitimating how teachers are supposed to attend to the needs of children or conduct themselves within the confines of the workplace, other technical bases are relevant (e.g., psychology and the law).

[4] Chazan et al. (2016) name the interpersonal obligation to describe how society obligates teachers to steward social values and needs (e.g., social equity, work ethic, civic and prosocial behavior, etc.).

norms). These are subject-specific statements, in the sense that the statements of the norms use mathematics to describe the work a teacher or their students are expected to do. They are also empirically verifiable statements, in the sense that we can demonstrate at scale that teachers reliably recognize the differences stated by those norms across instances of teaching work that have other surface similarities and differences (Boileau, 2021).

Going back to the statement of our positionality, as mathematics-teachers-become-researchers, we are disposed to see and propose structures to which we can now see ourselves having been adapting when we were teachers. At the same time, we cannot shed the agency and responsibility we perceive we had as teachers, which included making consistent mathematical considerations across instances not only in consciously drawing on the resources we had available but also in tacitly adapting to the instructional contexts in which we were working.

Our positionality, in turn, enables us to see the work of teaching as the making of decisions in spaces where there are normative expectations as well as justifiable alternatives. Situational norms are represented in observer statements that describe what, as practitioners, we may have experienced as compelling demands without having mental representations of them but that now, with the support of scholarly uses of intellectual assets like norm, experimental design, instrumentation, psychometrics, Systemic Functional Linguistics, and so on, we can turn into measurable constructs (namely, we can define, detect, and measure practitioners' recognition of a norm). In doing that, we expect that such knowledge will help explain what actions practitioners take in the field, without presupposing that the practitioners themselves are, or need to be, explicitly aware of the norm statements we make to describe the regularities of those actions.

Thus, at its core, practical rationality suggests that we can do scientific research that builds a mathematically specific theory of mathematics teaching. But while the possibility of such an account is apparent, the necessity of such an account may seem compelling only for researchers who are disposed to using the resources of social research to model the perspective of the practitioner in accounting for the practice of mathematics teaching. This is one obvious way in which practical rationality is value laden, like any theory. In our view, the representation of the mathematics teacher's perspective on mathematics teaching articulated from the researchers' perspective using the theoretical resources represented in Fig. 7.1 is a compelling way to construct mathematics teaching as an object of study, a way to represent the work of mathematics teaching that overcomes the illusion of transparency. The value of such an endeavor, for us, lies in the possibility of creating a basis for research, instructional improvement, and teacher advocacy that is rooted in what a mathematics teacher can perceive and appreciate, given the conditions and constraints in which they work. Those eventual ends (instructional improvement, teacher advocacy) resemble those proposed in other chapters (e.g., Cai et al., Chap. 8, this volume; Hiebert & Stigler, Chap. 2, this volume). However, along the lines that practical rationality is not a grand theory but rather a theory of the middle-range, the ideas sketched out above regarding norms, obligations, and the way they may complement personal resources in accounting for actions in teaching only provide language to scope a terrain of work, they do not flesh out the theory. Rather, the theory is built through the practice of research scoped by those ideas. To exemplify that, we now show how the theoretical ideas of instructional situation and norm have inspired empirical research and how this empirical research has begotten insights that expand the theory of practical rationality.

4 Empirical Research on Situational Norms in Instruction

Having introduced key elements of practical rationality, we now illustrate its character as a theory of the middle range by demonstrating how empirical research has supported its growth. Because these examples illustrate how empirical research has supported the development of our understandings of instructional norms, in this section we elaborate on the notion of instructional norm and describe how we have studied the recognition of norms empirically.

By norm we mean the statement, made by an observer, of what participants in a social setting behave *as if* they held as appropriate and expected to do when they relate to each other and to the stuff they handle (including mathematical stuff). In making that definition, our use of *statement* aims to take stock of the critique of objectivism formulated by Bourdieu (1990; Taylor, 1993). This notion of norm emphasizes the role of the observer in stating what may not exist as a rule statement in the participants' social experience and may not even be stateable as a rule for participants because participants never experience the need to make such a statement. In this sense, the norm statements an observer makes may be tacit knowledge (of the *collective tacit knowledge* type; Collins, 2010). Such statements reveal themselves as knowledge to an observer because participants acquainted with the practice act in ways that others do not.

The following considerations of the definition of norm are important in order to understand the type of empirical research on norms we have engaged in. Since the word *norm* is charged with a variety of meanings, we underscore that, in our usage, norms are observer constructs and contrast with two other usages which have valid but limited associations. On the one hand, the word *norm* tends to be associated with what is correct and with prescription. The association here is valid in the sense that an observer who states a norm, states that participants behave as if doing what the norm states is correct and as if that is what participants think they are expected to do. However, the association is not valid in the sense that in stating the norm the observer is not rendering their own judgment as to the appropriateness of those actions or of the expectations recognized by participants. The observer's statement is descriptive of what appears to be a prescription (albeit, often tacit) for participants.

On the other hand, the word norm tends to be associated with frequency and with a distribution of observations. The association here is valid in the sense that an observer should expect actions that take place at moments when a given norm would be activated to form a distribution. However, it is not the case that these actions have to be exact instances of behaviors described in a norm statement for an observer to record an instance that might count toward documenting the actual hold of the norm in practice. As Garfinkel (1967) and others have noted (Mehan & Wood, 1975), participants often use repair strategies when their actions depart from the norm, thereby signaling that a norm is being breached. In order to use a frequentist interpretation of norm, an observational approach to research on norms should attend not only to the presence of compliant actions but also to the presence of repair strategies.

Although we have used video records of instructional practice and analysis of those video records to support the statement of norms through abductive reasoning (Dimmel & Herbst, 2018; Herbst et al., 2009), our empirical work on instructional norms does not define norms as descriptions of what the majority of people do. Rather, norms represent socially shared expectations of what people ought to do. The gathering of empirical evidence that could enable us to claim that these norms describe what participants experience as expectations has required some innovation.

4.1 Virtual Breaching Experiments: Designing Studies of Instructional Norms

Building on Garfinkel's ethnomethodology (Garfinkel, 1967; Mehan & Wood, 1975), we developed a methodology of virtual breaching experiments (Herbst & Chazan, 2015) that consisted of engaging practitioners with representations of practice in which hypothesized norms of practice had been complied with or breached. We attended to the descriptions of and reactions to the represented practice that practitioners offered. In such discourse and evaluations, we found evidence toward confirming the hypotheses made.

Our virtual breaching experiments first used video records (Nachlieli et al., 2009) and animations of classroom scenarios (Chazan & Herbst, 2012; Chazan et al., 2012; Herbst et al., 2011) with focus groups of teachers. Then the virtual breaching experiments used online scenario-based questionnaires responded to by individual teachers, where scenarios of practice were represented using storyboards of cartoon characters (Buchbinder et al., 2019; Dimmel & Herbst, 2017, 2018; Herbst et al., 2018). The decision to engage empirically with norms in these ways aligns with the goal of maintaining the subject-specificity of the norms on which we focus. The statements of the norms of instruction refer to elements of the instructional situation that regulates a type of instructional exchange, hence they use mathematically-specific as well as practice-specific language. The decision to engage empirically with norms in this way has also allowed us to control for surface content variations (e.g., topics, task statements) that would inevitably have to be dealt with if using a frequentist notion of norm and an observational research approach.

Our empirical work has been oriented to establishing the viability of norms, namely the extent to which a norm statement fits (as opposed to matches; see von Glasersfeld, 1991) the practice that it describes, as this practice is attested to by practitioners. Because these norms may be tacit knowledge from the perspective of practitioners, we could not trust the efficacy of traditional surveys that might pose general statements of the norm and ask practitioners to rate whether they agreed that those statements described actions they considered normative. This critique of traditional surveys follows the goal to overcome the traps of objectification and subjectification noted above—neither the reflected experience of practitioners nor the explicit language of researchers are adept to study the practical rationality of mathematics teaching.

Virtual breaching experiments confronted practitioners with multimodal representations of instances of the practice (initially video records or video animations, later storyboards with cartoon characters) in which the participant expected the norm to apply, but the norm had been breached. These experiments produced artifacts in which we could observe the participants' reactions to those representations. How these reactions were mediated mattered in how the viability of a norm was assessed. We used three kinds of artifacts: (1) group conversations in which verbal reactions and commentary to videos or animations were offered; (2) individual written reactions to storyboards in response to prompts to describe what they saw in an episode or to say more about a rating they provided; (3) individual ratings of the appropriateness that the participant attributed to actions represented in storyboards. In all cases, these breaching experiments were virtual because they confronted participants not with actual events where a norm was breached but with representations of those events. The nature of the data collected required us to distinguish different operational constructs that bridged the general notion of a situational norm to the particulars of the data we collected.

Our earlier work with virtual breaching experiments was done having groups of teachers of a course of study engage with video records or animations. Kosko and Herbst (2012) exemplified how we drew from Halliday's systemic functional linguistics (SFL; Halliday & Matthiessen, 2004), especially from what SFL calls the *modality* system of language, for linguistic indicators that participants were repairing on the breach of a norm. Modal verbs (e.g., should) and adverbs (e.g., always) were used as possible indicators of what Lemke (1998) called attitudinal meanings. When these modality resources were associated with actions of the teacher (or student) in events where a norm had been breached, we took that as possible evidence of participants' recognition of the breach of a norm. While this data modeling allowed for some quantitative analysis (Herbst & Kosko, 2014a), there were limitations, both in the data model and in the sample size, that threatened the construct and internal validity of any claims that norms were viable descriptions of participants' expectations of practice. Specifically, our data reduction model attended to a limited set of lexical items in turns of speech within a group conversation. Consequently, we could not consider the sample as composed of individual teachers but as composed of interactions among teachers in a single group. Group sessions could be parsed into smaller intervals demarcated by participants' own ways of organizing interaction and then intervals of conversation could be inspected for evidence of repair of the breach of a norm (Herbst et al., 2011), but this method lacked any systematic search for counterfactuals. Some advances in linguistics and our own move to developing multimedia surveys using storyboards with cartoon characters allowed for us to improve the methods used.

As we moved to analyzing data that included written descriptions of storyboards (paragraphs authored by a person in response to an online storyboard of instruction), we were able to ascribe orientation toward a norm to an individual based on what they wrote and collect such responses in larger numbers. Martin and White's (2005) appraisal theory, a contribution to a systemic functional analysis of discourse, was key for us to grasp the discursive—as opposed to merely lexicogrammatical—nature of the linguistic realization of repair of a breach and move beyond modality as indicator of attitudinal meanings. Two different empirical manifestations of the norm became useful to consider. On the one hand, participants' descriptions of what they saw happening in a scenario had the chance to include discursive elements that alluded to the aspects of the norm that had been breached. They could also use discursive resources to indicate their attitudes toward those events. Coders could reduce that data accordingly, distinguishing individuals' recognition of the norm in their responses to scenarios. On the other hand, participants were asked to rate the appropriateness of the teaching they had observed. We were able to create similar scenarios that did not stage breaches of a norm and asked the participants the same questions, which helped provide a baseline against which to measure the effects of breaches of norms. These online questionnaires were eventually used with a nationally distributed sample of high school mathematics teachers (Boileau, 2021; Herbst et al., 2018).

5 How the Analysis of Research Data Contributed to Theory Development

In this section we discuss how the analysis of empirical data collected to examine viability of norms contributed to the theorization of practical rationality. We present three cases. In the first, the study of a norm in algebra led to our better understanding of how norms of the global didactical contract and norms of the instructional situation interact. In the second, the study of a norm in geometry led to revisions and elaboration of the norm itself. In the third, the study of repairs of a norm led to proposing the professional obligations as a new construct.

5.1 Becoming Aware of Tensions Between Situational and Contractual Norms

Our study of teachers' recognition of the norms in solving equations in algebra focused on what norm teachers recognize for responding to students' solving of equations. As in other cases, teachers were offered opportunities to react to scenarios that either breached or did not breach the norm, and we coded the participants' descriptions of scenarios for evidence of recognition (or lack thereof) of norms when norms were (vs. were not) breached. The coding of participants' descriptions required us to attend to four basic contingencies: whether actions described by the norm are present or absent in the representation provided to the participant and whether the actions described by the norm are present or absent in the participant's description.

Some norms further complicated matters in terms of participants' repair of what was expected of the teacher. These were norms that we came to call *tactical*, inasmuch as they described what the teacher was expected to do in response to possible student actions.[5] In representing the work to be described, both the student actions calling for the teacher's work and the work of the teacher need to be included, and doing this required attending to more than two theoretically distinct possibilities: whether the response from the teacher could be normative or not and whether the student work to which the teacher was responding could be normative or not. In coding the descriptions of those events, coders needed to be attentive to whether and how participants described the events that called for the teacher's intervention, as well as whether and how they described the teacher's intervention. An early example of how empirical work led us to advance the theory comes from the examination of participants' responses to the way a teacher responded to students' use of alternative solution methods in solving equations in one variable.

Our work on the solving of equations has focused on the solving of linear equations in one variable, where a *canonical method* for solving equations has developed as the teaching of algebra has become a part of institutionalized schooling (Buchbinder et al., 2015). This canonical method involves manipulating the expressions on both sides of the equal sign in a set order: gathering linear terms on one side and constants on the other first, operating on those separately, eventually dividing the constant by the coefficient of the linear term. In our modeling of this instructional situation (Chazan & Lueke, 2009), the instructional exchange involves students submitting work that uses the canonical method to solve linear equations and the teacher's judging students to have learned to solve equations. Building on a variety of calls to reform the teaching of the solving of linear equations (Star & Seifert, 2006; Yerushalmy & Gilead, 1997) as a way to breach our model of the situation, we represented student work that offered other mathematically correct, symbolic solutions that nevertheless did not follow the canonical method. These included, for example, dividing an equation through by a common factor or simplifying the equation by an implicit change of variable (e.g., treating $x + 1$ as a variable).

Our survey instrument of norms in the instructional situation of solving equations explored the hypothesis that participants would consider appropriate for a teacher to discourage solutions that did not use the canonical method, requesting a more usual solution regardless of whether the answer found was correct. By

[5] Tactical norms are circumstance-dependent norms, while strategic norms are goal-dependent norms.

contrast, the depicted teacher's response to canonical solutions was to accept the solution and to move on to a new problem. Our hypothesis was that, when asked to judge the appropriateness of the teacher's response to the student's work, teachers would find it more appropriate to dwell on students' use of the canonical method. Yet not all responses to the non-canonical solutions fit our hypothesis. In some cases, the teacher's shifting of the class's attention away from alternative solutions and towards the canonical method were evaluated as somewhat inappropriate (Buchbinder et al., 2019). Our qualitative analysis of the open-ended responses suggested that participants were taken aback by the teacher's lack of acknowledgment of the correctness of the student's response. For example:

> The teacher was too dismissive, not acknowledging Blue's correct answer.

> 'Usual way' says to the student that they did something wrong, when in fact their math was correct. Suggesting or hinting that a student did something wrong mathematically is wrong and will cause students to shut down.

These critiques were of how the depicted teacher had spoken to the student but did not suggest that the depicted teacher had missed an important opportunity to engage the class in justification of methods used for solving equations. In other words, the teacher was not doing something wrong in terms of the requirements of the instructional situation. There was something else they were violating. These comments were not directly targeted at the negative reaction to the student's method, which they might agree did not use the expected method. The comments were instead targeted at the teacher's lack of acknowledgment that the students had produced a (correct) answer to the problem. In terms of instrument design, this observation was developmental for us at the pilot study stage and suggested that before responding to what method the student had used, the depicted teacher should thank the student for their contribution. However, the observation raised a more important theoretical point, which had to do with the interaction between contractual and situational norms.

The expectation that the teacher should respond to students' contributions has been documented in the literature as part of the default pattern of interaction in classroom recitations, whereby the teacher is expected to evaluate what students say in responses to questions (Mehan, 1979). Over the years, professional development on classroom discourse has sought to provide teachers with resources to respond which provide better alternatives to Evaluation (e.g., Milewski & Strickland, 2020). Therefore, it is reasonable to assume that didactical contracts may still lay on teachers the expectation to respond to students' contributions, although the expectation that such response be an evaluation of the student's contribution may be more variable. These observations about norms of the didactical contract present an interesting backdrop against which to set observations about the instructional situation of solving equations. Inasmuch as the initiation by the teacher, posing an equation to be solved, may frame students' work in the context of this instructional situation, there are expectations on the student as well as on the teacher. Some of those expectations are contractual (e.g., students have to do work and offer it for scrutiny), and some are specific to the situation (e.g., in solving equations, the students have to use the canonical method). Our participants' expectation that the teacher would acknowledge students appropriately for volunteering work in response to a problem is an example of a norm of the didactical contract. This is made even more important when, as in the storyboard used in this case, the work students had done resulted in the correct value for the unknown in the equation, albeit through non-normative means. The framing of the work as solving equations also activated the expectation that teachers would use cases of solving equations to provide students with practice in a method of solving equations, but the specific equations and the specific values of the unknowns in those equations were not expected to have intrinsic value. Our participants therefore put us before an interesting theoretical problem that seems to have some generality within the theory.

The problem is in general one of how contractual and situational norms interact. Our stumbling upon it revealed that we had made an assumption about the relationship between contract and instructional situation, and that assumption should be questioned. In proposing instructional situations as local contracts for recurrent instructional exchanges, we seemed to have assumed that the relationship between situational norms and contractual norms is one of inclusion, namely that every situational norm is a perhaps more specific instance of a contractual norm and that compliance with a situational norm would imply compliance with a contractual norm. In the example being used here, providing corrective feedback on the lack of use of the canonical method for solving equations seemed like a teacher's compliance with the contractual expectation to evaluate students' work.

The data from the participants in the algebra survey not only brought that assumption to question but also reinforced two important points at the base of the theory itself. The first point is one that Brousseau (1997) made, that the relationship between the teacher, student, and content needs to be maintained against all odds. A breach of contract rarely ushers in a state of anomie; instead, it calls for a negotiation of a new contract, even if this negotiation is reduced to the teacher's statement of a new rule or making a new allowance. This seems to be highly visible in how our participants expected the teacher to respond, facing the fact that students had voluntarily offered contributions that, though correct, were not the preferred ones. Their responses, facing a teacher who had actually complied with the expectation to discourage students' dispreferred even if correct and effortful responses, was to propose more sympathetic reactions, acknowledging the students' responses. Our participants seemed aware that the hypothetical teacher's interactions with the students would continue and the teacher would need to procure students' participation in the future. This required the teacher to acknowledge the students' responses. As a result, revisions of the items included first some gratitude from the teacher for having done work, followed by feedback on the way the student had solved the equation. However, the second point suggested that the assumption of alignment between situational and contractual norms is itself questionable; this suggested the need to revisit the theory.

The second point is that an instructional situation involves students in work with some specific content that instantiates not only the content at stake but also, possibly, other valuable mathematical properties. Although the equations presented put at stake knowledge of solving equations and had been assigned as opportunities for students to practice the canonical method of manipulating both sides of the equal sign (Chazan & Herbst, 2012), they also put in play objects like specific expressions, numbers, and operations and their specific relationships (e.g., numbers might have common factors, expressions might have common factors). The work with these specific objects may therefore elicit valuable knowledge from students and, as Herbst and Chazan (2020) note, knowledge that may only come up in the context of work assigned for the sake of opportunity to learn something else. In the case of these students' non-canonical solutions of equations, not only had they found the correct number for the unknown but they had also used properties (e.g., factoring numbers or expressions) that could be valuable within the contract at large. Thus, a teacher that enforced the norm of the situation by noting the dispreferred nature of the students' work might be seen as breaching a contractual norm by not allocating value to what the students had done, which might also be contractually valuable. More generally, this data suggested to us that while norms of a situation may be related to norms of the contract along the lines of specific (situational) to general (contractual), compliance with a situational norm may still involve a breach of the didactical contract and call for negotiation. Recommendations for teachers to use problems that allow for several solution approaches are instructional circumstances where such conflicts may occur regularly for teachers. The elements of the theory, specifically the notion that situational and contractual norms may oppose each other, seem like a useful analytic tool to describe those experienced conflicts.

5.2 Developing a More Precise Formulation of a Situational Norm: The Diagrammatic Register

In the second example of how theorization benefited from empirical work, we briefly recount a story told by Herbst et al. (2013) about the development of a more precise formulation of a situational norm as a result of difficulties instrumenting the study of its less precise version. From the analysis of teachers' responses to animations, Weiss and Herbst (2007) had proposed the norm that *proof problems in high school geometry are presented in a diagrammatic register*[6]—by which they referred to a difference with how geometric theorems and their proofs are presented in the discipline (e.g. Hilbert, 1902). In the discipline, geometric theorems and their proofs rely on an interaction between two registers: a conceptual register, in which theorems state general properties of concepts and a generic register, in which generic objects that represent those concepts are selected in order to be used in the proofs. While theorems in high school geometry are often also stated in conceptual terms, proof problems are often not; rather, they are stated in terms of particular objects

[6]The use of the word register in this context is connected to that of Duval (2006). We have not worked out its compatibility with the SFL notion of register (see also Morgan, 2006).

(Otten et al., 2014). Moreover, these objects are usually not generic but diagrammatic, in the sense that they avail themselves of properties not only by what is explicitly predicated of them but also by how they are presented in a diagram (Laborde, 2005). We formulated the hypothesis that in assigning proof problems to students, a teacher is expected to present those problems using a diagrammatic register.

With that general conceptualization in mind, we created storyboards in which a teacher assigned proof problems but breached the diagrammatic register norm. At the time, our attempts to operationalize what a breach of the diagrammatic register norm could be were only guided by a general sense of what the diagrammatic register was. We thought, for example, that not including a diagram or referring to a given diagram using the names of the concepts involved in the problem would constitute breaches of the norm. Yet we did not have a precise statement of the diagrammatic register norm. The instrument we created included a set of five storyboards representing breaches of that sense of the diagrammatic register norm, each of which required the participant to describe what they saw happening and to rate the appropriateness of the way the teacher had presented the problem. When we looked at the pilot data results, we noticed very low internal consistency among the appropriateness ratings for those items. This low internal consistency prompted us to ponder whether we really had clearly identified the properties of the diagrammatic register. We thus attempted to spell out what "complying with the diagrammatic register norm" could mean in terms of simple clauses and arrived at six of those that, while expectably related in practice, could be separated for analysis. In order to study them empirically, we designed a different type of instrument with questions that asked participants to choose between two ways of presenting a proof problem and where in each choice only one of the hypothesized properties of the diagrammatic register was the source of the difference between the problem presentations. As a result of analyzing responses to that instrument, we arrived at a third specification of the norm that maintained the five properties of the diagrammatic register that could be confirmed.

Our current conceptualization of the diagrammatic register norm includes five assertions about how proof problems are presented: (1) a diagram is included to represent the figure alluded by the proof problem, (2) the diagram represents with relative accuracy the properties that are true about the figure alluded by the proof problem, (3) the diagram has labels for the points referred to in the proof problem and for others which are useful for the proof, (4) the statement of the proof problem refers to geometric objects using the labels in the diagram, and (5) the statement of the proof problem asserts properties about congruence, parallelism, and perpendicularity while it does not state explicitly (but relies on the diagram to communicate) properties of incidence, collinearity, and separation. A sixth assertion, that the diagram includes diacritical markings to represent properties of congruence, parallelism, and perpendicularity given in the problem statement, was not confirmed to be normative. This identification supported our design of new scenarios for implicit norm recognition that resulted in a set of items with better internal consistency. Eventually these revised items enabled us to show that teachers are more likely to react to the breach of the diagrammatic register norm (recognizing the breach of any of the five components) than to scenarios in which all components of the diagrammatic register norm have been complied with (Herbst et al., 2016).

This second example shows how instrument development and empirical research on norms has been useful, not only to confirm aspects of the theory but also to refine the theory by helping us arrive at a more specific statement of the norm. The second example also shows that situational norms can be tacit and subject specific. The diagrammatic register norm illustrates how participants may reliably recognize aspects of the norm when they are breached even if these are not explicit to them when they construct their practice. The diagrammatic register norm also illustrates the subject-specific nature of the norm—it describes the acts of teaching in terms of actions on geometric diagrams and ways of referring to and reading them. These expectations on how a teacher has to present a proof problem do not easily or validly generalize to considerations of communication modality or literacy but rather require attention to geometry and proof, while supporting some generalization across geometric figures and across the properties of those figures being proved. The diagrammatic register norm is, therefore, not only an example of how research on practical rationality supports the development of the theory of practical rationality but also of how this theory of teaching pursues subject specific statements of norms made by an observer to describe teachers' acting as if they were following them. Furthermore, the example shows that this subject-specificity of the theory in describing teaching is not reducible to combining generic pedagogical moves with specific mathematical topics. Rather, our subject specific approach requires a disposition to generalize across similar instructional exchanges.

5.3 After Detecting Breaches of Norms: Justifying Actions and the Professional Obligations

The third example illustrates how empirical research on situational norms led to our proposal of new elements of the theory. The technique of virtual breaching experiments (Herbst & Chazan, 2015) has been used to confirm that our proposed norms of instructional situations fit with the reactions from teachers to representations of practice (Boileau, 2021; Dimmel, 2015). But the study of how participants responded to breaches of norms also provided more concrete insights into the rationality of teaching. Brousseau's argument that the didactical relationship between teacher and student needs to be maintained at all costs can also serve to understand what may happen if a task is originally framed in the context of an instructional situation but its norms are breached. Consider, as an example, an episode we recorded on video, where a student was doing a proof at the board and after making a statement could not come up with a justification for it. Instead of insisting that he justified the statement, inviting another student to it, or providing the justification himself, the teacher encouraged the student to move along with the proof, making the next statement, while leaving the justification blank with the idea that they would come back later to the missing justification (Herbst & Chazan, 2003). When we used this episode in virtual breaching experiments with teacher focus groups, we noticed that participants not only indicated discomfort or pointed to what the teacher had done as being unexpected, they also provided justifications or rationalizations either for what had been done or for what they thought could have been done instead (Nachlieli et al., 2009).

We started documenting these rationales when introducing the general idea of practical rationality (Herbst & Chazan, 2003) with the intention of mapping the competing commitments and dispositions that often justify different decisions in teaching. We expected then that, while individual teachers might differ in what they decide to do, the grounds they use to justify what they decide to do in front of colleagues might have some commonalities. We then named those commonalities *the professional obligations of mathematics teaching* (Herbst & Chazan, 2012) and identified four: disciplinary, individual, interpersonal, and institutional. Subsequently, Chazan et al. (2016) elaborated on the conceptualization of the obligations as sources of public justification for teachers even though those sources may not obligate individual teachers, or groups of teachers across institutions or cultures, in the same way. Chazan et al. (2016) elaborated theoretically on how the same obligation could relate different dispositions (or commitments). For example, a disposition to challenge individual students intellectually and a disposition to care for students' emotional wellbeing might justify alternative decisions, but the common obligation to individual students could serve as the grounds upon which to compare and critique those alternative decisions, and perhaps also find a compromise.

In the intervening years, the concept of professional obligations has been used to investigate sources of justification for instructional decisions that deviate from the norm (Bieda et al., 2015; Chazan et al., 2012). We have also developed instruments that could detect participants' recognition of the different obligations. The PROSE (Professional Obligations Scenario Evaluation; Herbst et al., 2014; Herbst & Ko, 2018) instrument is made of items in which a scenario is provided wherein a teacher is seen departing from a contractual norm in a way that we might consider attends to a professional obligation, and respondents are asked to indicate their degree of agreement with a statement that says the teacher should have stuck to the instructional goal. This instrument has been used both with high school mathematics teachers and university instructors, and we have found not only that it is possible to measure recognition of the obligations using it but also that these items may be used to compare recognition of obligations across instructors of different levels of schooling (Ko et al., 2021).

6 Theorizing by Connecting Practical Rationality Constructs to Those from Other Theories

An important goal of practical rationality is to explain the work of teaching, especially the decisions that teachers make and the actions they take in instruction. The concepts of instructional situation, norm, and obligation that have been developed through our research account for the socio-technical characteristics of the work of teaching, providing tools for understanding structures that form the context of instruction.

In characterizing practical rationality as a middle range theory we indicated two aspirations. One is to develop the constructs of practical rationality in relationship with research operations, as illustrated in Sect. 7.5. The other is to accommodate relationships with constructs from other theories. Section 7.5 provided three examples of the first aspiration, this section now turns to the relationships between constructs we have developed and existing constructs.

The individual resources teachers bring with themselves to the work of teaching have been a focus of research on mathematics teaching for decades, especially through programs of research that focused on teachers' beliefs and knowledge (see the review by Herbst & Chazan, 2017). Theory that explains teaching as an expression of teachers' individual characteristics and resources (e.g., Schoenfeld, Chap. 6, this volume) has been in the mainstream of research on mathematics teaching since the mid 1980s and has provided important constructs and measures. But these individual-centered approaches have shown limits, theoretically, in failing to sufficiently account for how various interpretations of context affect what individuals believe, know, and do. More limited are their practical implications; individual-centered accounts of teaching can lead to descriptions that highlight deficits in individual teachers and support policies for instructional improvement that rely only on improving individuals by developing in them the proper beliefs, knowledge, or skills.

Rather than ignoring individual-based explanations, we have been interested in investigating how individual-based explanations of the work of teaching could be connected to explanations that use the constructs of practical rationality to describe the socio-technical context of the work of teaching. By attending both to the individual resources teachers bring to the work and to the ways in which those resources adapt to the socio-technical characteristics of the work itself, we aim to craft better descriptions of teacher decision making.

6.1 Connecting Mathematical Knowledge for Teaching to Practical Rationality

The interest in explaining the work of teaching as requiring professional knowledge has been a mainstream trend in research on mathematics teaching and teacher education in the last three decades. Highlights have been the conceptualizations of mathematical knowledge for teaching (MKT; Ball et al., 2008) and scales to measure it (Hill et al., 2004). Our work has sought to investigate relationships between the construct known as MKT (mathematical knowledge for teaching; Ball et al., 2008) and practical rationality.

This rapprochement started with a modest theoretical reconciliation aimed at developing a measurement instrument; we adopted the domain definitions and heuristics for item development from Hill et al. (2004) to create items that measured knowledge at stake in the U.S. high school geometry course of studies, which resulted in the MKT-G test (Herbst & Kosko, 2014b). The use of this instrument permitted us to observe significant associations between experience teaching geometry and MKT-G scores that could not be accounted for by experience teaching secondary mathematics in general. Furthermore, Herbst and Kosko's (2014b) examination of single item responses led to the conjecture of a relationship between instructional situations and teacher knowledge. The effects of experience teaching geometry were especially noticeable in MKT-G items that were contextualized in instructional situations that recur in geometry courses (e.g., geometric calculation), whereas items contextualized in novel tasks were equally difficult for teachers with different experience teaching geometry. In an effort to better connect MKT with instructional situations, Ko (2019) was able to show that it is possible to create psychometrically distinguishable scales to measure the mathematical knowledge for teaching needed in different instructional situations (including geometric calculation and doing proofs).

6.2 Connecting Teachers' Beliefs to Practical Rationality

As another example of how research on practical rationality has looked for ways to reconcile the constructs we developed with those that sought to account for the work of teaching using teacher beliefs. The relationship between beliefs and practice has been a persistent theme in mathematics education research on teaching since the 1980s (Leder et al., 2003). Some researchers have inferred beliefs from practice, while others have used the inconsistency between beliefs and practice as a source for questioning the conceptualization of teacher beliefs (Philipp, 2007). The theme is also present in Schoenfeld's ROG theory (Chap. 6, this volume).

Shultz (2020, 2022) explored relationships between university instructors' recognition of professional obligations, beliefs they hold about teaching and learning, and their use of particular instructional practices. She used our PROSE instrument for college instructors along with Clark et al.'s (2014) beliefs questionnaire and her own INQUIRE instrument which gathers instructors' self-reported use of inquiry-oriented instruction practices. Her findings show the potential for obligations to explain why inquiry-supporting beliefs espoused by instructors might not be reflected in their reported use of inquiry-oriented practices. For example, the practice of having students make presentations was less present than expected based solely on student-centered beliefs (e.g., that students should be allowed to struggle), but a moderate negative correlation with recognition of the disciplinary obligation helped explain it—instructors with high recognition of the disciplinary obligation would gravitate less to having students give presentations, regardless of their beliefs that students need to struggle (Shultz, 2020).

We bring this short example here to show how, as expected from middle range theories, practical rationality is capable of assimilating constructs developed outside of this theoretical perspective (e.g., beliefs, inquiry oriented instruction) and offer a possible solution to pre-existing theoretical problems (namely, the inconsistency between beliefs and practices could be reconciled by accounting for a measure of recognition of the disciplinary obligations).This study has helped support a basic proposition of practical rationality, whereby the decisions that teachers make are explained in relation to a combination of individual factors (the knowledge or beliefs individual instructors have) and social factors, including ones associated with the role of the teacher in instruction and ones associated with the position of the teacher in an educational institution.

6.3 The Uses of Practical Rationality

Beyond its scientific contribution to the understanding of mathematics teaching practice, practical rationality has much to offer to the work of researching the connection between instruction and learning, as well as professionalizing the practice of mathematics teaching and improving this practice. The parsing of instrumental research on teaching proposed by Hiebert and Stigler (Chap. 2, this volume) between theories that describe how teaching produces student learning opportunities and theories that describe how those learning opportunities produce student learning allows us to locate practical rationality as providing an instance of the first group of theories. The research agenda of practical rationality can serve to explain the learning opportunities afforded by intact lessons and identify grain sizes for local instructional theories (e.g., instructional exchanges) and variables that can be manipulated (e.g., norms) to investigate the viability of generating conceivable opportunities to learn (similar to "teaching for theory" in Cai et al., Chap. 8, this volume). Basic research characterizing instructional contracts and situations and their norms across courses of study, school levels, and cultures is an important prerequisite for that kind of improvement-oriented research.

Hiebert et al. (2002) have argued for the need for a professional knowledge base for teaching and highlighted the role of lessons in that knowledge base (see also Cai et al., Chap. 8, this volume). The concepts of practical rationality are useful to conceive of those lessons in terms of choices made from systems of possibilities, where those possibilities are borne of personal and socio-technical resources. Hiebert and Stigler (2017) have recommended that improvement efforts shift from being focused on improving teachers to improving teaching. Practical rationality can support a focus on improving teaching by improving the teaching of lessons, as the theory provides means for mapping the choices available for teachers as they manage a lesson. The notions of instructional situation and professional obligations can be articulated to form local instructional theories (Gravemeijer, 2004; cf. Cai et al., Chap. 8, this volume, notion of "teaching for theory") in a mathematical course of study and for specific conceptual development. The choices offered by the theory may become usable for teachers in the form of conditional rules for their management of a lesson (e.g., whether to frame work using one or another instructional situation) and may also be inscribed in artifacts (worksheets, diagrams, software applications) that the teacher can choose to use to support their work. The subject-specificity of the theory is essential not only for identifying the pertinent choices a teacher can make when teaching the lesson but also to orient the choice of lessons that might be useful to work on as contexts for improving teaching. It is worth stressing that reform notions like engaging students in productive struggle or in cognitively demanding tasks are observer-centered notions. For them to be operational for teachers, they need to be anchored in practice—the norms of instructional situations are such anchors. Both research questions (e.g., how does engaging students in productive struggle vary in teaching difficulty or in the qualities of the student learning opportunities created across the instructional situations of a course of studies) and improvement questions (e.g., what does it take to enable teachers to engage students in productive struggle across the instructional situations of a course of study?) are feasible to ask using the concepts of practical rationality.

The involvement of practical rationality in designing the improvement of teaching, however, requires better understanding the relationships between teaching practice and students' learning from teaching (Hiebert & Grouws, 2007; Hiebert & Stigler, Chap. 2, this volume). A possible direction ahead includes reconciling our account of practical rationality with theories of student learning from teaching and of teacher learning in teaching. Given specific goals for students' learning, practical rationality concepts, such as the notion of instructional exchanges, may support the creation of content-specific infrastructure to support teachers in managing such exchanges (Olsher et al. 2016) and chart what teachers may need to learn from teaching practice in order to enable such student learning. The development of new instructional situations, their expansion via breaches and repairs of norms, and their complementation with existing instructional situations are basic, general ways of thinking about how teaching can produce students' learning opportunities. The cost to that operation is, however, the turning of the theory into explicit teacher knowledge, which raises the questions of whether, how, and when teachers can (and should) be expected to hold on to and make productive use of a theory that represents practice as intellectually and morally complex.

At the same time that it offers means to work on the improvement of teaching, practical rationality also provides intellectual resources to build a professional discourse of advocacy for mathematics teachers. Too often policymakers make individual teachers responsible for enacting reforms. The concepts of norms and obligations are useful to account for what enables and constrains teaching; they could also be helpful in developing a public discourse about teaching that focuses less on burdening or shaming teachers and more on advocating for adjusting the systems in which teachers work.

7 Conclusion: Addressing the Questions Posed

In their invitation to write a chapter for this book, Charalambous and Praetorius asked us to address questions about the nature of theorizing about teaching. Stepping back from the particular empirical studies that have helped develop constructs of practical rationality, against the background of this chapter, here are responses to five of their questions:

- *What is a theory (of teaching)?*

We use practical rationality as a theory of teaching as a resource for our response. We have described practical rationality as a middle-range theory of teaching oriented to the fundamental, scientific aims of describing, explaining, and predicting mathematics teaching as a phenomenon that results from a combination of expression of individual resources and adaptation to socio-technical context. Unlike other authors in this volume, we did not assume that the theory should guide teaching on how to achieve particular kinds of learning; rather, along the lines of what Vieluf and Klieme (Chap. 3, this volume) call practice theory, practical rationality provides intellectual resources to understand mathematics teaching practice from a perspective that reconciles structural and agentic perspectives. Such a theory of teaching is a growing organization of constructs, assumptions, and empirical statements that seeks to describe the natural variability in the work of teaching, explain how differences observed in that variability are related to other phenomena, and predict changes in aspects of that variability as a result of natural or provoked changes in the related phenomena. Whereas much of that definition could describe theories in general, what makes this a theory of teaching is its fundamental aims; it takes the work of teaching as the object of study and makes its purpose to explain the variability of teaching, as potentially caused by other phenomena. It is middle-range in that it grows through the work of empirical research, and it is fundamental because it seeks to provide the means to understand all teaching rather than to specify a desirable kind of teaching (what we would call a prescriptive theory). As noted above, however, an application of practical rationality to the improvement of teaching can lead to the use of practical rationality concepts in the design of local instructional theories that might have more of a prescriptive orientation.

In appealing to socio-technical resources (norms and obligations) as sources of explanation, practical rationality proposes rational (not causal) explanations for variability observed in the work of teaching. The specific mechanisms that link those socio-technical resources to individuals' actions need to be discovered as they might hold keys for ways in which the work of teaching could be improved. Thus, a path for growth in this theory of teaching involves reconciling our theory of the rationality of practice, which pays attention to the public justification of actions in teaching, with theories of teacher thinking and decision making that account for the cognitive, neurological, or socioemotional mechanisms that explain causally how practitioners make decisions in teaching (e.g., Kaplan & Garner, 2018; Schoenfeld, 2010; Sherin et al., 2011).

- *What should a theory of teaching contain and why?*

A theory of teaching should be a theory of the practice in which teachers engage as opposed to a theory of the individuals who do the practice, though it may articulate with ways of describing the individual resources people bring to teaching. It should aim to describe, explain, and predict this practice. As far as description, it should include resources for representing the practice of teaching that permit one to draw similarities across some instances of the practice while also sustaining differences across some other instances of the practice, both within and across the practices of individual teachers. It should contain some technical language and other semiotic tokens whose definitions are provided, some technical uses of language whose definitions are sought through research, and nontechnical uses of language that support reading and writing without calling attention to themselves.

As far as explanation, a theory of teaching should provide the means to express relationships that connect instances of practice, not only in terms of similarity or difference but also more generally in terms of how categories of instances of practice form larger systems of practice such as lessons, units, courses, and programs of study. A theory of teaching should identify some sources or dimensions of complexity as ones that will not be reduced but whose texture is to be dissected and understood. A theory should contain connections among constructs of the theory and other phenomena, both possible causes and possible consequences.

As far as prediction, a theory of teaching should contain connections among constructs of the theory and sources of empirical evidence or measures of those constructs. It should contain empirically falsifiable propositions and experimentally falsifiable explanations. It should articulate how the interplay of theorization and empirical research enables theorists to manage critically the objectifying and subjectifying tendencies of social research.

At the same time, descriptions and predictions should at least be expressible in ways that practitioners can adjudicate their face validity, but we do not expect that practitioners will come to adopt the language of educational theorists. This raises the question of whether our field might develop a semiotic infrastructure that goes beyond language and permits researchers and teachers to transact practice without having to rely solely on words (see Herbst et al., in preparation). Such possibilities suggest the need for mathematics educators to continue to elaborate theoretically the notion of representations of practice (Herbst et al., 2016).

- *Can such a theory accommodate differences across subject matters and student populations taught? If so, how? If not, why?*

From our experience developing practical rationality, we can answer this question both in the affirmative and the negative. Some of the procedures for developing theory and some of the constructs of the theory can be applicable across subjects and student populations, while others may need to be specialized for different subjects. The question itself is interesting, also, inasmuch as it ignores other sources of possible difference across teaching practice such as cultures or institutions that are important to investigate as well. At some level of theorization, a theory of teaching practice could take all those layperson sources of difference and elaborate them theoretically.

Our own work studying teaching across high school algebra and geometry shows that the constructs of practical rationality are useful across courses of studies, which suggests that while the specific instructional situations and their norms may not translate from subject matter to subject matter, the notion that there are instructional situations that frame instructional exchanges and that such situations are regulated by norms may be useful across subject-matters. At the very least, we believe that practical rationality can be used to study mathematics teaching in different courses of study in educational institutions, as long as there are institutional mechanisms for identifying what knowledge is at stake in instruction. In particular, we believe practical rationality can account for the work of teaching mathematics at all levels of compulsory schooling, as well as in university mathematics courses.

We think it is possible to posit equivalent constructs regulating the teaching of other fields of knowledge. The instructional situations we have identified (e.g., solving equations, doing proofs) are specific to mathematics, but the notion of instructional situation could be applied in other fields of knowledge (e.g., physics or history). In school subjects such as social studies or science, there may be a need to stipulate more than one disciplinary obligation to account for the various sources of epistemological vigilance of each of those school subjects. Indeed, it is a compelling theoretical question for us to investigate the purchase that these ideas have in helping understand similarities and differences in the teaching of mathematics and other school subjects—not only subjects associated with academic disciplines like physics or biology but also very different subjects, such as the performance or visual arts. What could a comparative study look like that aimed at understanding the teaching of different disciplines (e.g., history or painting) in regard to how instructional transactions are managed? Documenting the range of applicability of instructional exchanges as the cornerstone of a theory of teaching practice seems more interesting to us, however, than finding a general theory of teaching.

- *Do we already have a theory/theories of teaching? If so, which are they?*

There are multiple kinds of theories of teaching. Some theories describe the work of teaching. Herbst & Chazan (2017) reviewed how different theories rely on different conceptualizations of teaching, behavioral, cognitive, social interactionist, sociocultural, and more. Practical rationality aspires to explore complementarities and contrasts with all of those. There also are descriptions of teaching that attempt to prescribe what teaching should look like in order for it to achieve some desired ends. While not often called theories, expressions like ambitious instruction, complex instruction, direct instruction, equitable practice, inquiry-oriented instruction, student-centered instruction, and others have been used to designate some aspirational kinds of teaching that can have the force of prescriptive theory. Insofar as practical rationality is a fundamental theory of teaching, its goals are to describe, explain, and predict all kinds of teaching, not to prescribe a particular kind of teaching. However, the concepts of practical rationality can be used to study the implementation of more prescriptive approaches to teaching. In particular, these concepts can be used to explain and predict what aspects of reform in teaching may be more or less viable, illustrating the value of a fundamental theory of teaching and enabling a discourse of teaching advocacy to complement the discourse of teaching imperatives often present in reforms and policy documents.

- *In the future, in what ways might it be possible, if at all, to create a (more comprehensive) theory of teaching?*

Some commitments have played important roles in our development that might not be as fundamental for other theorists, but we have made them explicit in this chapter: (1) the commitment to understanding the teaching of mathematics and to use mathematical resources to describe its teaching, (2) the recognition of teaching as complex systemic work describable by modeling the perspective of the practitioner but irreducible to the characteristics or the lived experience of the actors, (3) the fundamental research orientation to describe and explain all kinds of teaching and predict the outcomes of improvement efforts, (4) the commitment to avoid voluntarism and deficit-thinking in improvement design, and (5) the embracing of social science methods including the provisional acceptance of some amount of reduction are all commitments we have embraced.

For our field to make progress toward a theory of teaching, we need theorists to make explicit the commitments on which they build. We need to develop instruments that can gather information on constructs from different theories so that we can use them to develop a better understanding of how competing constructs are related and have a publicly accessible source of data that many people can contribute to steward and mine. We need to pre-register experiments that will allow different theories to compete to explain or predict the outcomes of these experiments. Framing all that, we need a scientific consensus, not only on the need to articulate commitments but also on shared rules of engagement (e.g., to recognize our scholarly practice also as complex and demanding us to hold on to the tensions among sets of competing values such as ecumenism and consistency, complexity and parsimony, and so on) in order to make such progress.

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Chapter 8
Theory for Teaching and Teaching for Theory: Artifacts as Tangible Entities for Storing and Improving Professional Knowledge for Teaching

Jinfa Cai, Stephen Hwang, Matthew Melville, and Victoria Robison

Abstract In discussing theories of teaching, we take the position that there is a two-way street between what we call *theory for teaching* and *teaching for theory*. We articulate the linkages between these two dynamic processes through a particular conceptualization of professional knowledge for teaching carried by tangible artifacts. Within this context we have tried to answer a set of questions about theory and teaching: (1) What is a theory (of teaching)? (2) What should it contain and why? (3) Can such a theory accommodate differences across subject matters and student populations taught? If so, how? If not, why? (4) Do we already have a theory or theories on teaching? If so, which are they? (5) In the future, in what ways might it be possible, if at all, to create a (more comprehensive) theory of teaching? To answer these questions, we draw on the lens of Confucian learning as well as examples from Chinese and U.S. mathematics education to elaborate on understanding, assessing, and accumulating professional knowledge for teaching.

Keywords Teaching for theory · Theory for teaching · Confucian teaching · Professional knowledge for teaching · Artifacts · Teaching case

In this chapter, we take the position that there is a two-way street between *theory for teaching* and *teaching for theory*. Our goal is to articulate the linkages between these two dynamic processes through a particular conceptualization of professional knowledge for teaching. Within the context of this conceptualization of professional knowledge for teaching, we address a set of questions about theory and teaching: (1)

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What is a theory (of teaching)? (2) What should it contain and why? (3) Can such a theory accommodate differences across subject matters and student populations taught? If so, how? If not, why? (4) Do we already have a theory or theories on teaching? If so, which are they? (5) In the future, in what ways might it be possible, if at all, to create a (more comprehensive) theory of teaching? We draw on the lens of Confucian learning as well as examples from Chinese and U.S. mathematics education to elaborate on understanding, assessing, and accumulating professional knowledge for teaching. In addition, we describe how our conceptualization of theories of teaching relies on the creation, evolution, and sharing of artifacts that embody the active processes of theorizing and teaching. The examples that we share are based on research involving Chinese and U.S. students and teachers that some of the authors have been heavily involved in.

This chapter is structured to address each of the above questions in a separate section. The exception is Question 4, for which our response is integrated throughout the paper in the form of examples, such as in our discussion of professional knowledge for teaching and our discussion of effective mathematics teaching.

1 What Is a Theory (of Teaching)?

Speaking very generally, a theory of teaching is a system of ideas that helps to explain the mechanisms of teaching and its effects on students' learning. This allows for a broad range of things to count as a theory of teaching, from theories that are narrowly focused and tailored to explain teaching phenomena in particular contexts to theories that explain much wider categories of teaching phenomena across many different contexts. Nevertheless, for every theory of teaching, we do expect that the system of ideas includes some explanatory principle that broadens the field's understanding of teaching in general, and we also expect that it can help inform the actions and decisions of teachers in classrooms on some level (ranging from a general principle to specific guidance). At the general level, a theory of teaching could promote ideas about what kind of teaching or what ways to teach would be best and most effective. An example of this general level might be the idea that the more teachers know about students' thinking, the better they can teach those students. Although this is a principle that may be broadly applicable, at this level of generality, the idea may not necessarily be directly related to teachers' teaching; the generality means that the specific implications for practice are not sharply in focus. A narrower theory of teaching might tighten the focus to a particular context or a specific phenomenon happening in a classroom. At this level, the theory would speak more directly to teachers' planning and to what they actually choose to do in their classrooms.

The connection (or lack of connection) between theories of teaching and the actual practice of teaching has been a topic of interest and concern to scholars in mathematics education and education more broadly for many decades. Silver and Herbst (2007) took a "practice-oriented perspective" centered around an active approach to theory development and use in mathematics education (p. 39). They acknowledged that theory, especially as it relates to mathematics education, takes many forms that have different uses according to the situation at hand. They found commonalities across these various forms and presented a framework aimed at decreasing the divide between those for whom theory is not theoretical enough (e.g., researchers) and, conversely, those for whom it is not practical enough (e.g., teachers). They noted the growing importance of theory in the field and the growing number of studies in mathematics education that include theoretical considerations as well as growing diversity among the theories drawn upon, ranging among psychological, sociological, sociocultural, linguistic, and others. In fact, they claimed that "a *theoretical perspective* (as opposed to a *practical perspective*) currently dominates the process of scholarly publication in mathematics education" (Silver & Herbst, 2007, p. 43). The framework they presented places theory and theory making at the center of the triangle of relationships between problems, practices, and research, with theory acting as the mediator for the bidirectional relationships between all of the vertices of the triangle.

Although Silver and Herbst (2007) described the role of theory in mathematics education in general, we focus this chapter specifically on teaching. Moreover, we propose that it is most important to focus not on the entire category of theories *of* teaching but on the critical subset that we describe below—theories *for* teaching that are specifically intended to inform and improve teaching by enriching our (teachers' and researchers') collective understanding of some aspect of teaching, how and why that aspect matters, and how it might be leveraged to create richer learning opportunities for students. We choose to focus our gaze on these kinds of theories because they tend to take seriously the challenge of harmonizing the perspectives of teachers and researchers in a way that can ultimately contribute to a usable base of practical professional knowledge (the idea of building a professional knowledge base is also taken up by Hiebert & Stigler, this volume, and Herbst & Chazan, this volume). In addition, we posit that it is not feasible to discuss theories for teaching without also discussing its dual, what we refer to as teaching for theory. More than simply advocating for greater connections between theory and practice, we believe it is necessary for the field to consider both of these together because although they appear to be fundamentally different constructs, they are unified in a perpetual cycle of interaction, development, and evolution—a two-way street. Indeed, from an Asian perspective, the greater connections between theory and practice as a two-way street are viewed as part of the identity of Asian mathematics education (Leung, 2001). Thus, for the remainder of this chapter, when we refer to a "theory of teaching," our conceptualization of this term should be interpreted not as the more general case but as a specific instance of the unification of both theory for teaching and teaching for theory.

2 A Two-Way Street: Theory for Teaching and Teaching for Theory

By a theory for teaching, we mean a theory that is designed to provide guidance for creating more and better learning opportunities for students. The choice of the word "for" is deliberate; it is meant to highlight this purpose of the theory. Theories for teaching can build on a variety of foundations such as theories of learning and major components of the practice of teaching. For example, learning can be conceptualized as both an individual and a social process (Cai, 2003; Cobb, 1994a). Correspondingly, theories for teaching would need to address how to create the kinds of learning opportunities in which students are able to construct their own knowledge as well as address how to create a social environment for learning, establish classroom norms, and reach shared understanding (Cobb, 1994b). Other elements of the classroom experience might motivate theories for teaching that address the nature of instructional tasks or the characteristics of classroom discourse (e.g., Hiebert & Wearne, 1993; Stein & Lane, 1996) because these are also fundamental to how teachers organize classroom teaching to promote students' learning. Each of these theories is fundamentally aimed at improving teaching by better understanding some aspect of teaching and showing how leveraging that aspect can change teaching for the better. In essence, theories for teaching can provide essential information about what is worth trying, what is unlikely to work, and whether an instructional design is based on theoretically sound principles because such research is deliberately framed to guide or shape teaching (Burkhardt & Schoenfeld, 2020).

Similarly, we use "for" in the expression "teaching for theory" to signify that we are focused on a kind of teaching that is for a particular purpose in addition to the immediate and usual purpose of helping students learn. If theory for teaching refers to the theories which are drawn upon to teach well so that *students* learn, then teaching for theory refers to teaching that is deliberately designed to generate, elaborate, and test theory so that the *field* learns. In educational research, teaching experiments are a well-known mechanism for using teaching to help generate, develop, and articulate theory (Steffe & Thompson, 2000). However, the usual image of teaching experiments is not the only kind of teaching for theory that can be invoked here. Rather, we include in this category a wide range of activities in which teaching produces professional knowledge that accumulates and gives new insights into the problems of practice, including the iterative design and implementation cycles of design-based research (Cobb et al., 2017) and the "rapid prototyping followed by iterative refinement cycles in increasingly realistic circumstances" of the engineering research approach (Burkhardt & Schoenfeld, 2020). Of course, not every theory in education is built through this kind of deliberate accumulation of professional knowledge through teaching, but we explicitly highlight this mechanism for two reasons. First, our perspective is informed by the emphasis on codependency between practitioners and researchers among some Asian cultures (e.g., Fan et al., 2004). Second, even when a theory of teaching is constructed through other means, it must still at some point survive contact with actual practice. Teaching for theory can provide critical feedback that defines or constrains the validity and applicability (or generality) of a given theory.

Given our definitions of theory for teaching and teaching for theory, there are two natural corollaries. The first is that these two things are not static objects but instead dynamic, evolving processes. Theory for teaching is, perhaps, more properly expressed as "theorizing for teaching"—engaging in a constant process of evaluating and reevaluating assumptions and connections to refine our understanding of teaching. And, teaching for theory is an ever-iterating process of shaping teaching so that it provides new data, new hypotheses, and new ways to teach that enrich the theorizing. Ultimately, theories for teaching must have practical implications for teaching, but they must also evolve in response to teaching for theory.

For example, in the era of the COVID-19 pandemic, the model for teaching has had to completely change in many places. As Engelbrecht et al. (2020) acknowledged, COVID-19 has drastically changed teaching and learning as we know it; thus, some of the preexisting theories for teaching no longer apply. In this environment, teaching for theory takes on an important role in stimulating the generation of new theories about the best ways to teach through online or virtual learning. In addition to the logistical hurdles of obtaining equipment and access and learning new technologies, the importance of digital communication and the home environment (including physical, social, and family resources) has never been more front and center as classrooms have switched to blended and online learning environments. And, the potential for educational technologies to facilitate student-centered learning is preeminent. Adapted theories for learning will be required to account for these radical changes in teaching and learning. For example, in their examination of how students expand their mathematical knowledge through their collaborative creation of mathematics videos, Oechsler and Borba (2020) demonstrated how digital technology can fundamentally change not only the educational problems that are to be addressed in the learning of mathematics (the problems of practice; Cai et al., 2018a) but also the roles of teachers and students (e.g., expanding students' responsibility for their own learning).

It is reasonable to ask why it is important to highlight theories *for* teaching within the larger set of theories *of* teaching (taken in the broader sense). Our perspective comes from foregrounding the practical aspect of teaching—it is an applied science that involves doing. Thus, theories related to teaching must guide practice in teaching and not simply involve the generation of theories purely for human beings' curiosity without any implications or realization:

> Teachers' expertise can play a leading role in identifying and formulating important problems of practice. Teachers directly interact with students around mathematics, and they are well positioned to raise red flags when those interactions consistently go awry or fail to produce the desired outcomes. Because teachers are necessarily focused locally, what they see is framed by their students, their lesson, their curriculum, their classroom, and their school. Moreover, teachers' conceptions and beliefs about mathematics, teaching, and learning influence how they perceive and identify instructional problems. (Cai et al., 2018a, p. 515)

Included among the theories for teaching are a number of theories that are concerned with the kinds of knowledge that are needed for teaching. Many of these theories have stemmed from Shulman's (1987) seven categories: subject-matter content knowledge; general pedagogical knowledge; curriculum knowledge; pedagogical content knowledge; knowledge of learners and their characteristics; knowledge of educational contexts; and knowledge of "educational ends, purposes, and values, and their philosophical and historical grounds" (p. 8). The field has seen extensive development of these constructs, such as Mathematical Knowledge for Teaching (MKT; Hill et al., 2008), which includes several aspects of both subject matter knowledge and pedagogical content knowledge; extensions of MKT to geometry (e.g., Herbst & Kosko, 2014; Mohr-Schroeder et al., 2017) and algebra (e.g., McCrory et al., 2012); and teachers' general pedagogical knowledge (e.g., Döhrmann et al., 2012; Tatto et al., 2012), which includes knowledge like classroom management techniques.

In a series of editorials, Cai et al. (2020) discussed professional knowledge for teaching from several angles centered around the divide between isolated teaching practice by individuals in unique contexts and practice that is built on shared knowledge gained from collective profession. As models of teaching and learning change, as in the case of the response to COVID-19, teachers must be able to adapt their professional knowledge for teaching on a rapid, iterative basis. Cai et al. (2018b) proposed how the use of a professional knowledge base storing lessons and instructional adaptations that are aggregated over time and that involve teacher–researcher partnerships could have direct implications for developing professional learning. Cai et al. (2020) discussed how researchers must work to supplement and build teachers' specific, lesson-level professional knowledge to create learning opportunities for students as well as how to share this knowledge and make it accessible. Regardless of the form they take, theories for teaching must be very practical, useful, and accessible for teachers.

3 Components and Generality of a Theory of Teaching

In this section, we continue this line of reasoning by considering what components a theory of teaching should contain as well as how such theories can accommodate differences across subject matters and student populations. As a reminder, we are using the term "theory of teaching" to refer specifically to the pairing of theory for teaching and teaching for theory. That is, the theories of teaching that we are concerned with are specifically those that reflect the combination of both sides of the two-way street.

3.1 Components of a Theory of Teaching

As noted above, we take a broad view of what counts as theory with respect to its grain size. Whether a theory of teaching is broad and concerned with a widespread teaching phenomenon or narrowly focused on a local problem of practice, it must address some aspect of teaching, big or small. Moreover, to improve the quality of learning opportunities for students, a theory of teaching must exist in a form that supports teachers to think through, evaluate, and translate into actions the ideas about teaching that the theory comprises. As Biesta (this volume) argues, the knowledge generated by science "can never tell teachers what they should do, but can at most inform their judgments" (p. 273). Thus, a theory of teaching that builds on a continual process of formulating and testing hypotheses in actual practice must exist in a form that teachers can make sense of and draw on to craft instruction. Indeed, without the ability to provide such support for teachers to engage with the ideas of the theory, a theory of teaching cannot easily benefit from the process of teaching for theory because it becomes difficult to frame useful hypotheses related to the theory that can be informed by carefully planned teaching experiences. This means that a theory of teaching should provide a framework that teachers can use as they think through principles of the best ways to teach in a given situation. In addition, it has to have some operational aspects that address the practical translation of principles into actions. These two components, a framework for thinking about teaching and an operational side, are both needed for a theory of teaching to provide guidance for teaching.

As an example, consider the dimensions for examining the effectiveness of mathematics instruction (Cai, 2003). These dimensions address three critical aspects of effective classroom instruction: (1) students' learning goals, (2) instructional tasks (both as set up by teachers and as implemented in the classroom), and (3) classroom discourse. The role of teachers is to select and develop tasks that are likely to foster students' development of understanding and mastering procedures in a way that also promotes their development of abilities to solve problems, to reason, and to communicate mathematically. We examine each of these dimensions in greater detail to highlight how this theory includes both a framework for supporting teachers as they think about their teaching and an operational aspect.

3.1.1 Learning Goals for Students

It is assumed that effective teaching is related to the goal of high achievement for all students (National Academy of Education [NAE], 1999). Effective teaching requires that teachers understand what students know and need to learn and what challenges and supports their learning (National Council of Teachers of Mathematics [NCTM], 2000). What teachers do in the classroom depends on the nature of their learning goals for their students, and there are important connections between goals for learning and teaching practices that affect students' abilities to accomplish these goals (Bransford et al., 2000). In particular, the learning goals teachers set influence both their planning for each lesson as well as how they make in-the-moment decisions to address the unexpected to guide students toward the learning goals. As Schoenfeld (this volume) puts it, teaching involves knowledge-based decision making in complex social contexts, and this decision-making process depends fundamentally on teachers' goals (as well as the resources available). So, when planning a lesson, teachers must take into account the learning goals as well as the knowledge and experiences their students bring with them. They use that information, along with their curricular resources, to choose appropriate instructional tasks that can help their students build on their existing knowledge to achieve the learning goals. Thus, the nature of the learning goals has a large influence on the shape of the lesson and on the mathematics that students have the opportunity to learn. In addition, when actively engaged in teaching, teachers frequently make in-the-moment instructional decisions in response to what students are doing, especially when something unexpected arises. These in-the-moment decisions, which include such choices as how to respond to students' questions, how to react to or make use of students' responses and mathematical work, and when to provide additional guidance or additional encouragement to persevere, serve to shape the ongoing enactment of the lesson so that it continues to orient students towards the learning goals.

Given the role of learning goals in shaping lesson planning and enactment, it follows that teaching benefits from teachers setting productive learning goals—ones that result in learning opportunities that encourage students to develop conceptual understanding, mathematical reasoning, and positive relationships with mathematics. Setting productive learning goals requires teachers to draw on their knowledge of mathematics, the curriculum, their students as learners, and pedagogical strategies. In addition, teachers' beliefs about mathematics and conceptions about teaching mathematics also factor into teachers' decisions about learning goals for their students. Thus, on one level, the inclusion of learning goals as an aspect of effective classroom instruction provides a general guide to teachers that it is important to carefully consider the kinds of learning goals they explicitly set for their students.

On an operational level, how might the learning goal aspect of effective classroom instruction address teachers' actual day-to-day practice? One example comes from a comparative study of U.S. and Chinese students' problem-solving abilities. Although we know that in mathematics it is important for students to have basic algorithmic knowledge to solve many kinds of problems, this does not ensure that they have the conceptual knowledge to solve nonroutine or novel problems (Cai, 2000; Hatano & Inagaki, 1998; Steen, 1999; Sternberg, 1999). In one of a series of studies examining U.S. and Chinese sixth-grade students' mathematical problem solving and problem posing (Cai, 2001), four types of tasks were used: multiple-choice tasks measuring basic computation skills, 18 multiple-choice tasks measuring simple problem-solving skills, process-constrained tasks measuring complex problem-solving skills, and process-open tasks measuring complex problem-solving skills. *Process-constrained* tasks refer to problems that can be solved by executing a "standard algorithm." In contrast, *process-open* tasks are problems that usually cannot be solved by an algorithm and more typically require novel exploration of the problem situation. Furthermore, a process-open task usually lends itself to a variety of acceptable solutions.

The Chinese students in the study scored significantly higher on average than the U.S. students on the computation tasks, the simple problem-solving tasks, and the process-constrained tasks. However, the U.S. students scored significantly higher on average than the Chinese students on the process-open tasks. Indeed, on average, the U.S. students scored highest on the process-open tasks and lowest on the computation tasks, whereas the Chinese students scored highest on the computation tasks and lowest on the process-open tasks. Reported 20 years ago, these results reflected then-prevalent characteristics of teaching in the United States and China (in particular), specifically with respect to cultural differences in teachers' beliefs about the relationships between developing basic skills and higher order thinking skills in mathematics (Fan et al., 2004) and the kinds of learning goals teachers set for their students.

Twenty years later, data gathered from the same Chinese schools using the same tasks reflect a major shift in learning goals for students in China; students' learning goals now include explicit attention to process-open complex problem solving. Since 2001, teaching in Chinese schools has thus shifted to include a focus on process-open tasks so that these tasks are now a specific part of mathematics teaching and built into teachers' day-to-day lessons. Comparing the performance of current Chinese students to their predecessors, we see relatively similar performance on computation, simple word problem solving, and process-constrained complex problem solving (from 88% to 82%, from 77% to 70%, and from 75% to 78%, respectively) and a sharp increase in performance on process-open complex problem solving (from 57% to 75%) that exceeds even the earlier U.S. students' performance on those tasks. Clearly, the operationalization of this evolution in students' mathematical learning goals has come with a parallel evolution in students' learning.

3.1.2 Instructional Tasks

As we noted above, teachers choose instructional tasks to create opportunities for students to move towards the desired learning goals. Instructional tasks provide the intellectual environments for students' learning and the development of their mathematical thinking. Broadly, instructional tasks include such things as projects, questions, problems, constructions, applications, and exercises in which students engage. Doyle (1988) argued that tasks with different cognitive demands are likely to induce different kinds of learning. Indeed, tasks influence students' attention to particular aspects of content and the ways they process information. In particular, instructional tasks that are truly problematic for students have the potential to promote their conceptual understanding, foster their ability to reason and communicate mathematically, and capture their interest and curiosity (NCTM, 1991). It is recommended that students in classrooms be exposed to truly problematic tasks so that mathematical sense-making is practiced (NCTM, 1991, 2000). Thus, a framework for thinking about the characteristics and impact of instructional tasks on students' learning can be helpful for teachers to be sensitive to the nature of the tasks they use and to differentiate between tasks that will or will not help their students to achieve the learning goals. For example, Stein and Lane (1996) highlighted the importance of the level of cognitive demand that an instructional task supports. They classified tasks into four increasingly demanding categories of cognitive demand: memorization, procedures without connections, procedures with connections, and doing mathematics. Tasks with higher levels of cognitive demand can support students to engage in higher level thinking and problem solving (Cai, 2014). Thus, as an aspect of effective teaching, the nature of instructional tasks is a key dimension for teachers to attend to.

Operationally, teachers must have ways to decide which instructional tasks to select or what tasks to develop in order to meet the specific learning goals of a lesson. For example, Lappan and Phillips (1998) proposed a set of characteristics that could be used to evaluate whether a problem was worthwhile for students to engage with:

– The problem has important, useful mathematics embedded in it.
– Students can approach the problem in multiple ways using different solution strategies.
– The problem has various solutions or allows different decisions or positions to be taken and defended.
– The problem encourages student engagement and discourse.
– The problem requires higher level thinking and problem solving.
– The problem contributes to the conceptual development of students.
– The problem connects to other important mathematical ideas.
– The problem promotes the skillful use of mathematics.
– The problem provides an opportunity to practice important skills.
– The problem creates an opportunity for the teacher to assess what his or her students are learning and where they are experiencing difficulty.

Although textbooks can be a useful resource for selecting worthwhile instructional tasks, teachers can use criteria such as these to evaluate the suitability of problems for supporting effective teaching. In addition, teachers can draw on these criteria to develop additional worthwhile and interesting mathematical tasks by modifying problems from textbooks.

In our recent work on mathematical problem posing, we have begun to work with teachers to revise or develop problem-posing tasks to teach mathematics (Cai & Hwang, 2021a, 2023). By "problem-posing tasks," we refer to instructional tasks that engage students in generating new problems and questions based on given situations (including mathematical expressions or diagrams) or changing (i.e., reformulating) existing problems (Cai & Hwang, 2023; Silver, 1994). As we have argued in Cai and Hwang (2023), because problem-posing tasks are cognitively demanding, such tasks can engage students in productive struggle with challenging mathematics so as to maximize their learning opportunities. Although problem-posing activities are cognitively demanding tasks, they are also adaptable to students' abilities and thus can increase students' access such that students with different levels of understanding can still participate and pose potentially productive problems based on their own sense-making.

3.1.3 Mathematical Discourse

Worthwhile instructional tasks and rigorous goals alone do not guarantee effective teaching and students' learning. Even the most worthwhile tasks that have been designed to help students move towards important learning goals may fail to play out in the classroom as intended. For example, Stein and Lane (1996) found that only about 50% of the tasks that were set up to require students to apply procedures with meaningful connections were implemented effectively. A key factor lies in the choices that teachers make when organizing mathematical discourse in their classrooms, including choices like how long to wait for students to respond. Therefore, in the classroom, students' actual opportunities to learn depend not only on the type of mathematical tasks that teachers present but also on the kind of discourse that teachers orchestrate to implement the tasks in support of the learning goals (Cazden, 1986). More generally, discourse refers to the ways of representing, thinking, talking, and agreeing and disagreeing that teachers and students use to engage in instructional tasks. Considerable theoretical and empirical evidence exists supporting the connection between classroom discourse and student learning. The theoretical support comes from both constructivist and sociocultural perspectives of learning (e.g., Cobb, 1994a; Hatano, 1993). As students explain and justify their thinking and challenge the explanations of their peers and teachers, they are also engaging in clarification of their own thinking and becoming owners of "knowing" (Lampert, 1990). Indeed, patterns of discourse in classrooms can serve both to position students as knowers and doers of mathematics as well as to establish classroom norms (Wagner & Herbel-Eisenmann, 2009). The empirical evidence supporting the positive relationships between teachers asking high-order questions and students' learning can be found in Hiebert and Wearne (1993) and in Redfield and Rousearu (1981). Thus, if teachers do not orchestrate discourse effectively, it is possible that students will miss many learning opportunities.

Given the potential power of well-orchestrated classroom discourse and the relative lack of such discourse in many classrooms (Spillane & Zeuli, 1999; Stigler & Hiebert, 1999), it is particularly important to provide an operational aspect of this dimension of the theory to support teachers' efforts. An operationalization of this can be seen in the work of the Mathematics Discourse in Secondary Classrooms (MDISC) project (Herbel-Eisenmann et al., 2013). In developing professional development experiences for teachers around discourse, MDISC described six "teacher discourse moves" (Herbel-Eisenmann et al., 2013, p. 183): waiting, inviting student participation, revoicing, asking students to revoice, probing a student's thinking, and creating opportunities to engage with another's reasoning. They provide transcripts illustrating the various moves as materials for teacher discussion as they think about how they can intentionally use powerful mathematics classroom discourse. In addition, MDISC describes interpretive lenses to help teachers notice and interpret the productivity and power of discourse patterns that they observe.

3.2 Generality of a Theory of Teaching

One quality of a theory that is typically prized is its generality—the breadth of the set of conditions to which it applies. In the context of our discussion of theories of teaching, the relevant question regarding generality is whether a theory of teaching can accommodate differences across subject matters and student populations. Again, because our definition of a theory of teaching admits both theories with broad scope and much more narrowly focused theories, the answer to this question depends on the particular theory.

Some theories of teaching are focused broadly, and by their nature they span different subject matters, grade levels, and even cultural contexts. For example, a theory that claims that teaching needs to build on students' prior knowledge and thinking to be effective in teachers' design and delivery of lessons is a very general theory of teaching that can apply to students in different subject areas, grade levels, and cultures. As another example, consider higher order thinking skills in mathematics. According to Resnick (1987), higher order thinking incorporates the following:

1. Is *non algorithmic*. That is, the path of action is not fully specified in advance.
2. Tends to be *complex*. The total path is not "visible" (mentally speaking) from any single vantage point.
3. Often yields *multiple solutions*, each with costs and benefits, rather than unique solutions.
4. Involves *nuanced judgment* and interpretation.
5. Involves the application of *multiple criteria*, which sometimes conflict with one another.
6. Often involves *uncertainty*, not everything that bears on the task at hand is known.
7. Involves *self-regulation* of the thinking process.
8. Involves *imposing meaning*, finding structure in apparent disorder.
9. Is *effortful*, a considerable mental work involved in the kinds of elaborations and judgments required.

This list clearly shows that higher order thinking skills involve the abilities necessary to think flexibly to make sound decisions in complex and uncertain problem situations. Resnick's list does not include the ability to collaborate with others, but being able to work together with others is also one of the characteristics of having higher order thinking skills (Chi, 2009). Through students' collaborative work, they can think together about ideas and problems as well as challenge each other's ideas and ask for clarification and further explanation. The theory of higher order thinking can be used as a way to analyze and improve teaching so that students engage with higher quality learning opportunities. For example, curriculum developers could make use of the characteristics of higher order thinking to guide instructional task design so that tasks are likely to foster these higher order thinking skills. Or, teachers may draw on the characteristics to evaluate their own instructional decisions and to guide how they choose tasks, launch them in class, and organize discourse around them. In these senses, the theory of higher order thinking can act as a theory for teaching as we have described above. Moreover, the theory is broad enough that it has been applied to different subject matters, grade levels, content areas, and cultures (e.g., mathematics education (Stein & Lane, 1996), science education (Barak et al., 2007), and with students at various academic levels (Zohar & Dori, 2003)).

On the other end of the spectrum are theories of teaching that are very narrowly focused on a particular teaching phenomenon in a specific context. By nature, these kinds of theories for teaching are not apparently very general. They do not necessarily accommodate differences across subject matters and student populations. Here, however, the idea of generality comes from the ongoing evolution of these theories for teaching through teaching for theory. Although a particular theory may have arisen from addressing a specific local problem of practice, many such problems exist across contexts and classrooms. Indeed, teachers commonly face many problems of practice that are closely related to one another; such problems are found repeatedly in many places. Examples of common problems of practice abound in mathematics teaching and learning, including difficulties teaching students about adding and subtracting fractions, developing students' understanding of triangle congruence theorems and their use, and dealing with common student errors related to place value in multidigit multiplication. Extremely small-grained theories of teaching may involve something as limited as one teacher's hypothesis that a particular instructional task or approach will help his or her students realize that a key point of the triangle congruence theorems is that they each identify a minimal amount of information needed to determine a particular triangle. By implementing this task or approach to test the hypothesis, the teacher engages in a local instance of teaching for theory. But, because this problem exists in many contexts, other teachers may also try such an approach with their students. Their experiences, that is, their own teaching for theory, help to define the boundaries of generality of the original teacher's hypothesis—under what conditions it holds or does not hold. Moreover, adaptations of the approach may expand the theory to cover more contexts. Thus, there is the potential to link small-grain-size theories for teaching to each other by the common aspects of the problems they address. A local theory of teaching may be expanded by other teachers teaching for theory in different (though possibly similar) contexts who attempt to apply the local theory to their own classrooms and contexts. In this way, the boundaries of local theories can be iteratively mapped so that, as Kyriakides et al. (this volume) emphasize, we can better know for whom and under what conditions a theory is useful.

4 Theories of Teaching: East Meets West

Given the examples we have discussed above, it seems that theories of teaching span a wide range of grain sizes and attend to many different aspects of teaching. One key aspect of teaching that we have not yet specifically addressed is the fact that teaching is a cultural practice: It is a practice embedded within a larger cultural milieu. Teaching is thus also shaped by cultural expectations, and, consequently, theories of teaching may naturally end up reflecting the cultural practices of the context in which they are conceived, used, and refined. Indeed, the influence of culture on theories of teaching can be striking; it can shape, for example, conceptions of effective instruction.

As an illustration of this influence, consider the following story recounted by Howard Gardner, a distinguished professor and scholar from Harvard University. In the spring of 1987, Gardner was visiting China to study arts education in kindergartens and elementary schools. During the visit, he, his wife, and his son (Benjamin) stayed in the Jinling Hotel in Nanjing. The key to their hotel room was attached to a large plastic block that made noise when it was shaken. Benjamin loved to carry the key chain around, shaking it vigorously. He also liked to try to place the key into the slot. Because Benjamin was very young, it was a challenge to correctly orient the key into the slot. However, Benjamin seemed to enjoy the sound it made when the key banged against the slot, and he also loved this exploratory activity. Because Gardner and his wife were not in a hurry at the time, they allowed Benjamin to have a good time. But they soon observed an intriguing phenomenon. Any Chinese attendant nearby would come to watch Benjamin. At one point, an attendant noticed Benjamin's lack of initial success in placing the key into the slot, so she would hold onto Benjamin's hand and directly help Benjamin insert the key. Then she smiled at Gardner or his wife, as if having done a favor for them and awaiting a "thank you." Interestingly, neither Gardner nor his wife appreciated the intervention of the attendant since what mattered to them was that Benjamin was having a good time exploring. Later Gardner realized that this incident pointed to important differences in the educational and artistic practices between the United States and China. After studying Chinese education in general and arts education in particular, the world-renowned scholar wrote: "Some of my most entrenched beliefs about education and human development had been challenged by my observations in Chinese classrooms" (Gardner, 1989, pp. vi).

Gardner's story provides an insight into the cultural practices of education in China and how they differed from his Western expectations. The attendant's reaction to Benjamin reflects a set of expected behaviors rooted in a Confucian cultural perspective. The Confucian model of education is "centered on the teaching and learning of *ren*, the benevolent relationship among human beings" (Chan et al., 2017, p. 21). By this notion, all individuals regardless of background can engage in the pursuit of advancing personal and moral character through diligent practice and harnessing their unique potential (Chan et al., 2017). Li (2003) found that Chinese students' conceptions of learning suggested a "person orientation" in which knowledge is a part of the person's life and a cognitive, social, and moral process of seeking rather than an externally existing object or absolute truth. These are in line with a Confucian philosophy of learning, which is based on the lifelong process of seeking toward self-improvement, available to anyone who sets their intentions on this path. The teacher's role in this process is to serve as a model who exemplifies the process of and commitment to learning and to guide students on their individual paths to enlightenment (Tan, 2017), just as the attendant in Gardner's story sought to guide Benjamin. Indeed, Confucian teaching and learning are two sides of the same coin. Many of these ideas are reflected in Chuang's (2012) study of Western and Confucian-influenced graduate students' educational philosophies, with the Confucian-influenced students' philosophies reflecting the notion of lifelong learning; the goal of self-cultivation to achieve personal virtue and collective harmony; and the approaches of observation, listening, questioning, memorization, experience, and deference to the teacher.

Confucianism emphasizes the role of environment and practice on peoples' development of skills and knowledge. Through learning and practice, people develop different ways of being and thinking, and every source of observation is a potential teacher, whether it be books, peers, and so on. Central to this process is the role of critical thinking in the acquisition of knowledge and skills as well as their application to real life and localized problems to verify that what is learned is accurately reflected in subsequent observations. Thus, it is a learning based on meaning and synthesizing multiple ideas and perspectives.

This characterization of learning in a Confucian perspective may seem at odds with the example of Chinese teaching and learning of mathematics in the past as being focused on computation and process-constrained tasks rather than the kinds of open-ended tasks that would benefit from a focus on meaning and synthesis. However, the evolution over decades to a model of teaching in Chinese schools that also focuses on process-open tasks reflects the two-way street between theory for teaching and teaching for theory. In fact, as we indicated before, Chinese students were able to perform better than U.S. students even on process-open tasks in recent years.

In a comparison of U.S. and Chinese teachers' instructional methods, Cai et al. (2014) found that Chinese teachers focused more on addressing student thinking and challenging students in fostering deep synthesis between interconnected mathematical ideas and conceptual structures. Similarly, Cai and Wang (2010) found that, compared to U.S. teachers, Chinese teachers emphasized connecting different conceptual ideas to foster students' mathematical understanding.

According to Cai and Wang (2010),

> For Confucius, knowledge and truth should be acquired by learning from authority figures/masters (e.g., a teacher) rather than being generated by the learners themselves. In teaching and learning, the Confucian tradition emphasizes teacher's authority and students' hard work. (p. 284)

Thus, the role of the teacher in the learning process is that of a mentor or disciple who serves as a model and resource for their students. On a survey of U.S. teachers' reactions to Confucian teaching philosophies and methodologies, Chan et al. (2017) identified these philosophies as follows: promoting character education, teaching students from all backgrounds, improving teacher knowledge and skills, perseverance in teaching, and teaching with no reservations in sharing personal experiences. These philosophies translated into different methodologies, including: providing differentiated instruction potentials, stimulating student learning, teaching students by role modelling, and teaching with a step-by-step approach.

Notably, despite the orientation towards learning from authority figures, the Confucian theory of learning is actually conducive to a student-centered approach to teaching. Teachers are encouraged to guide all individuals regardless of background in their educational pursuits and to know their students well so they can adjust their methods according to the individual needs of the learner (Chan et al., 2017). The teaching methods, resources, and approach are customized to maximize each individual learner's self-cultivation process; through observing each student's learning status and characteristics, the teacher can provide a personalized response that best fosters their educational attainments (Tan, 2017). Rather than merely dictating educational content, the teaching process depends on guiding the students to play an active role in their own learning through appropriate prompts that facilitate students' reflection and critical thinking skills (Tan, 2017). Reflection, then, is a key component of both the teaching and learning process: Both the teachers and the learners rely on a regular process of reflection to see where the learner's current stage of knowledge is and where it has gaps or conflicts. Tan (2017) mentioned two specific techniques that exemplify this process: the questioning technique, whereby teachers engage students in questions and prompts, and peer learning, whereby students are encouraged to discuss among themselves in pairs or groups to sort out their understanding of the content.

5 Artifacts That Embody and Bridge Theory for Teaching and Teaching for Theory

Thus far, we have described the relationship between theory for teaching and teaching for theory as a two-way street. That is, these two constructs exist in a reciprocal relationship in which each is a driving force that stimulates progress in the other. In practice, however, it can be difficult to establish this kind of pairing of theory for teaching and teaching for theory. Theorizing for the purpose (at least in part) of informing the decisions of practice is an ongoing, dynamic act; similarly, teaching for the purpose (again, at least in part) of informing the growth of theory is active. Capturing what is happening in both of these activities so that they may mutually support each other requires a third element—a way of embodying them and making them tangible and accessible to the teachers and researchers who are engaged in the processes.

Elsewhere, we have discussed the need for artifacts—tangible products—that can store professional knowledge and that can form the foundation of a knowledge base for the profession (Cai et al., 2018b). Such artifacts are a way to give a physical reality to the dual processes of theory for teaching and teaching for theory; they act as "carriers" that facilitate the storing, sharing and growth of professional knowledge. Figure 8.1 shows our conception of how such an artifact works. The strip includes both theory for teaching and teaching for theory, apparently on opposite sides. However, this is a Mobius strip, and the two apparent sides are, in fact, the same side, flowing in an infinite cycle. The artifact, then, serves as an embodiment of both processes simultaneously, capturing their mutual development, interaction, and influence. This conception of an artifact bears some similarity to what Burkhardt and Schoenfeld (2020) have described as "replicable materials" to support implementation that would integrate (or embody) a set of engineering principles, including being "grounded in robust aspects of theory from prior research," "flexibility … that affords adaptation to the range of contexts across the intended user community," and "continued refinement on the basis of post-implementation feedback 'from the field'" (p. 8). Similarly, Hiebert and Stigler (this volume) discuss how lesson plans may serve as an artifact that records, preserves, and shares information across classrooms while remaining at a grain size that is amenable to the work of teaching.

Below, we will elaborate on the idea of artifacts by describing one possible form that such artifacts can take—continuously developed teaching cases produced by teacher–researcher partnerships—as an example that is currently embedded in an Eastern culture of teaching. We will then consider the more general question of what features an artifact might need to have to fulfill this function, whether in an Eastern or Western cultural context. Finally, we will look to the future and suggest

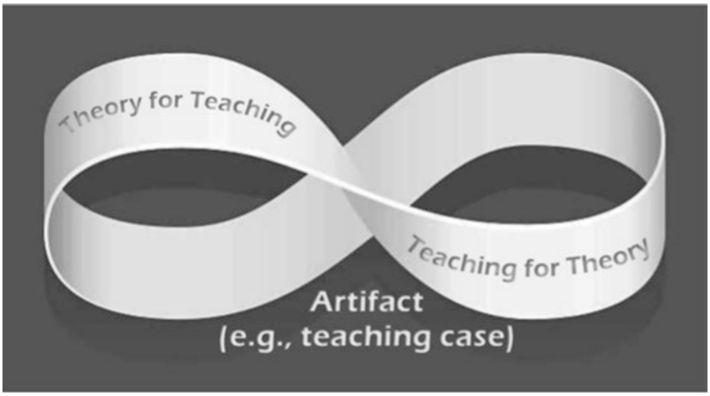

Fig. 8.1 A diagram illustrating the relationship between theory for teaching and teaching for theory as embodied in a tangible artifact. The Mobius strip represents the artifact. It is the medium in which theory for teaching and teaching for theory exist and interact. The two are not on opposite sides of the artifact (there is only one side) but rather flow continuously into one another. Teaching cases (considered as dynamic, evolving objects) are a specific example of such an artifact

some considerations that we believe the field will need to focus on to make theory for teaching and teaching for theory feasible, if not commonplace, mechanisms for improving the quality of teaching and learning.

5.1 Teaching Cases in Chinese Mathematics Education

In China, there is a multitude of lesson plans that have been developed by award-winning teachers. This type of lesson plan is often produced from a focus lesson that is developed through the work of a teacher research group and incrementally improved upon until the lesson is ready for others to examine and use as a model. Thus, the development and refinement of individual lessons through the work of a teacher research group is a normal part of the work of teachers in Chinese mathematics education. Indeed, this kind of work has strong parallels with activities such as lesson study, a process that has been a longstanding part of teacher learning and professional development in Japan (Becker & Shimada, 1997) and which has been studied as a potential avenue for teacher professional development in other countries (e.g., Lewis & Perry, 2017). Those related activities also embody connections between research for teaching and teaching for research, but here we will focus on the specific example of China to illustrate our argument. In particular, we argue that the process of refining focus lessons can be further developed and built upon systematically to create the kinds of artifacts that would capture theory for teaching and teaching for theory.

A longitudinal research project based in a school district in Hangzhou, China, aimed to develop elementary and middle school teachers' ability to use mathematical problem posing to teach mathematics (Cai & Hwang, 2021a; Zhang & Cai, 2021). As part of the project, the teachers participated in professional development workshops in which they learned about mathematical problem posing and how it can be used to teach mathematics, and they designed mathematics lessons in which problem posing was used as an instructional tool. In addition to the workshops, a central element of the project was a collaboration between the participating teachers, teacher researchers, and teams within each of the teachers' schools to develop problem-posing teaching cases based on lessons (and entire units of lessons) that the teachers designed.

In this project, the initial conception of teaching cases draws both on the typical Chinese form of teaching cases as a way to share professional knowledge and on Western conceptions of case-based education (e.g., Smith & Friel, 2015; Stein et al., 2000). Moreover, the teaching cases being developed are more than simply a collection of lesson plans or a single report on a lesson and its implementation. Indeed, the teaching cases are dynamic objects that grow as lessons evolve and that, once shared, may continue to grow through adaptations from others (as well as the originators). When a teaching case is published, what is shared with the reader is an instantaneous snapshot of one part of the full, dynamic teaching case. To embody the support that theory for teaching and teaching for theory offer to each other, these teaching cases include multiple components. The first component explains the mathematical learning goals for the lesson, including a description of what it means to understand the content topic. In addition, this component includes a mathematical analysis that situates the content within the mathematical framework of the curriculum. The second component is a cognitive analysis of the learning goals and content, focusing on potential difficulties for students and the prior understanding and knowledge students need to succeed in the lesson. The third component is a description of the major components of the lesson, broken down by instructional task (mainly problem-posing tasks, but not all tasks are necessarily problem-posing tasks). This includes a rationale for each problem-posing task that explains the purpose of the task and what students should take away from it. In addition, the description includes details on implementation, including potential student responses (e.g., posed problems), ideas about how the teacher could deal with those responses, and specific reflections from experiences with implementing the lesson. The fourth component is an overall reflection and summary of how the lesson fostered students' mathematical understanding and what other teachers might want to pay attention to when using the lesson. The teaching cases (and all four components) are iteratively and continuously improved as the lessons (and units) are repeatedly implemented so that they embody the best of what the teachers and researchers learn as they work towards refining the lessons and units.

The teaching cases are dynamic physical artifacts that store professional knowledge that comes from both theory for teaching and teaching for theory. Theory for teaching informs the elaboration of the mathematical learning goals, including helping to define what it means to understand the mathematical content in the lesson. In addition, theory provides useful perspectives for the cognitive analysis of the learning goals and content, such as specifying necessary prior knowledge and understanding that students will need to take advantage of the learning opportunities in the lesson (e.g., by drawing on a learning trajectory) and identifying common misconceptions that students may develop. Moreover, theory for teaching provides explanatory power (possibly specific to the context) for reflecting on how the lesson fostered students' mathematical understanding. Thus, theory for teaching is embedded in the teaching cases through multiple components as well as in the design of the lesson itself. At the same time, the teaching cases embody what is being learned through teaching for theory. Each time the lesson is implemented, there are opportunities to test small, local hypotheses about how attributes of tasks or instruction may influence students' learning in the particular context. Through teaching the lesson, teachers accumulate additional professional knowledge such as how students respond to tasks, what kinds of conceptions (productive or counterproductive) that students generate, and what teaching moves best make use of students' responses to move the class towards the learning goal. Again, the teaching case provides a dynamic, tangible resource that can help store this knowledge gained from teaching for theory and, in turn, allow teachers and researchers to use that knowledge to extend theory for teaching.

Because they serve as a tangible carrier of theory for teaching and teaching for theory, the teaching cases are also natural mechanisms for sharing and disseminating professional knowledge beyond the immediate context in which they were created. Many of them have been disseminated widely through practitioner-focused journals in China, although a published teaching case is, as noted above, only a snapshot of the full, dynamic teaching case artifact. These journals reach teachers throughout China. The articles in these journals are typically lesson focused with analysis of real teaching so that teachers who read the articles will be able to visualize what the lessons look like in practice. Moreover, the teaching cases have also provided the foundation for further development of theory in research-focused journals. For example, the development process that led to one teaching case has also led to the further development of theory for teaching—specifically, an analysis of the factors that are critical for implementing new pedagogical approaches (Cai & Hwang, 2021b).

5.2 Features of Artifacts That Embody and Bridge Theory for Teaching and Teaching for Theory

Thus far, we have used the example of teaching cases in the context of Chinese mathematics education to illustrate how an artifact may serve as a tangible representation of professional knowledge by embodying the dynamic between theory for teaching and teaching for theory. Although teaching is a cultural activity, and the teaching cases described above are certainly rooted in the norms of Chinese mathematics education (Huang & Bao, 2006), we suggest that this dynamic can exist across different cultures and thus can similarly be embodied through an appropriate artifact. The teaching case is only one example of such an artifact. This prompts the question of what features an artifact must have to suitably embody and bridge theory for teaching and teaching for theory so that it can represent the ongoing growth of professional knowledge. In this section, we propose three characteristics that can exist across cultures and which seem to be necessary for such an artifact.

The first characteristic is that the artifact must be able to include both the operational details of teaching and the principles that guide those details in ways that are interpretable by both teachers and researchers without extensive translation. To be useful to teachers, the ways of teaching that are captured in the artifact need to be accessible and directly applicable to teachers' practical work. As with the task-by-task descriptions in the teaching cases and the information about students' responses, an artifact that supports teaching for theory needs to paint a clear picture of the procedural details of teaching—what teachers can do in their own classrooms to create the desired learning opportunities. However, those details and procedures are not arbitrary. They are guided by principles—the theory that motivates the choice of actions. Clear explanations of how and why particular actions should produce the desired learning opportunities enable both teachers and researchers to make informed hypotheses that they can test through teaching (i.e., teaching for theory).

A second critical characteristic is that the artifact must be able to evolve over time. As we noted, both theory for teaching and teaching for theory are dynamic processes, not static objects. Thus, an artifact that embodies them and their relationship cannot be static either. For observers of lessons and for the teachers themselves, once an activity is implemented, a lesson is taught, or a unit is completed, there must be a way to capture what is learned from that teaching, both the practical knowledge and the theoretical advances, and to revise the artifact so that it carries the history of learning. Without this feature, the artifact cannot support the further development of either theory for teaching or teaching for theory.

The third necessary characteristic is that the artifact must be sharable. Expertise and experience that is entirely bound up in a local context does not ultimately contribute to the wider knowledge of the profession. But there are simply too many possible problems of practice to solve to count on every local context to individually address every problem. Sharing the work of building professional knowledge and solving the problems of practice allows the profession to make shared progress. However, because the artifact is the embodiment of the dynamic processes of theory for teaching and teaching for theory, requiring that the artifact be sharable means that both of those processes must also be designed to be sharable in some sense. Of course, there are local aspects of the theory for teaching and teaching for theory that are necessarily rooted in the context in which the theory and practice were developed. However, by including in the artifact information about what aspects of the local context seemed to be important for the success of instruction and what aspects were not so important, it is possible to allow others who use the artifact to generate their own hypotheses about what will work in their own local context. Some aspects may be universal, such as a lesson needing to have a clear way for the teacher to understand the students' thinking during the teaching process so that the teacher can make adjustments based on different students, countries, or textbooks.

6 Future Directions for Research: Spiralling Up the Two-Way Street

In the future, in what ways might it be possible to create a more "comprehensive" theory of teaching? Given a system oriented towards artifacts that embody theory for teaching and teaching for theory, what would it mean for theories of teaching to evolve to be more comprehensive? Following the characterization we have given of theories of teaching, we take it to mean that a theory of teaching grows in generality to accommodate differences between subject matter, grade levels, and cultural aspects and grows in connection to other theories of teaching. Growing in generality means that although a theory should span these different areas, we have to keep in mind the specific character and requirements of each of them. For example, the level of higher order thinking between elementary and secondary students is not the same, but the theory of using higher order thinking should still be adjusted to fit the needs of the students. Growing in connectedness means that we should strive to find commonalities and parallel ideas across theories of teaching. For example, despite the seeming lack of overlap between Confucian and Western modes of learning, there may be areas of connection. Zhao (2013) identified four areas of overlap between Confucian concepts and other theories of education such as those based on Dewey and Freire, suggesting areas for cross-cultural integration of theories: "mutual learning, integration of theory and practice, importance of reflection in teaching and learning, and democratic purpose of education" (p. 9). Moreover:

> Despite the differences between Confucius and critical educators, due to vastly different social contexts, there exists a strong resemblance between the two in terms of integration of theory and practice, reflective teaching and learning, teachers as learners (mutual learning) and social transformation. (Zhao, 2013, p. 23)

Ultimately, although we believe that the theory of teaching can become more comprehensive, we continue to stress that there is a two-way street. Thus, theory keeps evolving along with teaching, and we do not anticipate there will ever be an end-all, be-all comprehensive theory for teaching. Rather, as teaching and theory co-evolve, we anticipate continuous improvements in both.

In describing the role that an artifact can play in supporting the mutually reinforcing activities of theory for teaching and teaching for theory, we have drawn on ideas similar to those of others who have highlighted the potential role of artifacts or instructional products to act as a central focus for the work of educational improvement (e.g., Cai & Hwang, 2021b; Huang & Bao, 2006; Lewis & Tsuchida, 1999; Morris & Hiebert, 2011; Rothkopf, 2009). However, much more work is still needed to address critical questions about how such artifacts can be conceptualized, developed, and used more broadly. Our aim here is to call the field's attention to these questions. We suggest four specific directions where further work is needed: (a) conceptualizing the construct of artifacts more precisely and in greater detail; (b) understanding the mechanisms by which partnerships between teachers and researchers can work productively; (c) exploring the wider impacts on instruction and students' learning when researchers and teachers engage with artifacts that embody theory for teaching and teaching for theory; and (d) understanding how artifacts such as the ones we have described fit, practically speaking, into the complex ecosystem of existing curriculum materials, guidelines, and resources.

Although we have highlighted the example of teaching cases in China and discussed features that potential artifacts must have to successfully embody the dynamic relationship between theory for teaching and teaching for theory, we do not claim that we have fully conceptualized or characterized the artifact as a construct. We have merely sketched an outline of how to make the two-way street a productive reality. We believe that there remains much work to better define the essential elements of artifacts that serve this purpose in and across many different contexts. What other features are necessary characteristics? For example, how should such artifacts embody learning over time—the steady accumulation of professional knowledge without losing "institutional memory"—in a way that still allows for sharing that learning across contexts? In other words, what does the artifact have to be like to reach and connect a broader set of researchers and teachers engaging in theory for teaching and teaching for theory? The teaching cases described here begin to move in that direction through publication in practitioner-focused journals, but this is still a somewhat haphazard way of broadening the base of professional knowledge. Not every teacher who needs to will encounter the relevant teaching case for their situation.

Because the dynamic relationship between theory for teaching and teaching for theory is based on the assumption of close collaboration between teachers and researchers, the mechanisms for such partnerships also need to be better understood (Kilpatrick, 1981). What are the characteristics of productive partnerships, and what are the conditions needed to support their work? Cai et al. (2018a, 2019) have described how the roles of researchers and teachers might need to be reconceptualized and how alternative research pathways might be needed for the work of teacher–researcher partnerships to be fully developed. Fundamental changes to incentive structures and institutional norms could encourage the productivity and longevity of such partnerships. Ultimately, the potential of teacher–researcher partnerships to improve instruction and students' learning may depend on attending to many factors, including cognitive, affective, and structural considerations (Cai & Hwang, 2021a, b).

Indeed, another area for future work is to understand and measure the potential of this kind of work for improving teaching and learning. How will collaboration around artifacts actually effect change? To what degree will incremental accumulation of professional knowledge improve the kinds of instructional decisions that teachers and researchers can make when planning and implementing instruction? Because change (and improvement) is likely to be incremental and slow, it is likely that longitudinal studies will be needed to analyze how collaborative work around artifacts—that is, engaging in the two-way street of theory for teaching and teaching for theory—actually affects how teachers teach and how and what students learn.

Finally, any attempt to embody theory for teaching and teaching for theory in an artifact will intersect with existing elements of curriculum. There is an abundance of curriculum materials, including textbooks, teachers' guides, supplemental resources, and online resources. How will a shared artifact that both includes curriculum (e.g., by documenting lessons) and embodies a great deal of additional work around curriculum fit into this landscape? What are the practical considerations for teachers who wish to engage with these artifacts in addition to or alongside their existing curricular resources? If the field is to pursue theories of teaching that continuously evolve through artifacts that embody the two-way street of theory for teaching and teaching for theory, these and many other operational aspects of engaging in this kind of work will need to be systematically explored.

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Chapter 9
Outline of a Theory of Teaching: What Teaching Is, What It Is For, How It Works, and Why It Requires Artistry

Gert Biesta

Abstract This chapter provides an outline of a theory of teaching through a discussion of three questions: what teaching is, what it is for and how it works. I discuss two popular myths about teaching: that teaching is outdated and that teachers should rather focus on supporting students' learning, and that teaching is the most important factor in the production of measurable learning outcomes. Both views see teaching as a form of control, which is either rejected or embraced. The theory of teaching I outline, sees teaching as an act of communication which seeks to focus the attention of students, without assuming that such attention or what students do with it can be or should be entirely controlled. The purpose of teaching is to contribute to students' qualification, socialisation, and their existence as responsible subjects of their own lives. Teaching requires structure and direction, but too much structure and direction turns teaching into indoctrination. Teachers need the ability to make situation-specific judgements about how to act and what to act for, which requires artistry or craftsmanship. Attempts to turn teaching into an evidence-based profession not just undermine teachers' professionalism but also misrepresent what teaching is and ought to be about.

Keywords Teaching · Educational purposes · Artistry · Complexity reduction · Indoctrination

1 Introduction

At one level, everyone knows what teaching is. This is not least so because almost everyone has some experience of teaching, in most cases as a pupil or student, although teaching is such a large profession that many also have an experience of teaching in their role as teachers. Given this, there hardly seems to be a need for

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developing a theory of teaching, let alone to ponder the question whether there should only be *one* theory of teaching or whether it makes sense to have many. Yet on closer inspection, teaching turns out to be a much more difficult concept to pin down. Or put more positively: on closer inspection, teaching turns out to be a much more interesting, multi-layered and multi-faceted phenomenon than everyday accounts and understandings of teaching seem to suggest. From this angle, therefore, there is every need to not just 'do' teaching, but also to deepen our theoretical understanding of what teaching is and what it may be, also because it may have significance for what we do when we engage in teaching.

In this chapter I seek to contribute to this endeavour by developing an answer to three questions, namely the question what teaching *is*, the question what teaching is *for*, and the question how teaching *works*. My answers to these questions, taken together, outline a theory of teaching and in a final step I will make a case why teaching so conceived requires 'artistry' from teachers, rather than the mechanistic application of alleged 'evidence' about what supposedly 'works.' I preface my explorations with some brief observations about two different views about teaching that seem to be prominent in contemporary discussions about education. I refer to both views as 'myths' because I think – and will argue in more detail throughout this chapter – that they miss something important about teaching by depicting teaching as a form of control. While some take this as a reason for doing away with teaching and turn towards learning, others embrace it because they believe that teaching should be a form of control, particularly the control of student learning.

In this chapter I will argue that teaching cannot and should not be enacted as a form of control. Yet rather than drawing the conclusion that this means that we can and should do away with teaching, I seek to highlight the importance of teaching vis-à-vis the purposes that education should be concerned about. I do not claim that this chapter provides a comprehensive account of everything there is to say about teaching, but do hope that it provides helpful directions for the ongoing need to gain precision in our conversations about teaching.

Any account of teaching does, of course, highlights particular aspects and dimensions of teaching and in this regard can be said to be selective. Such selectiveness is partly pragmatic, as it is not possible to take all possible dimensions and aspects of teaching into consideration in a chapter-length discussion. Such selectiveness is also contextual, as research and academic writing more generally always intervene in and respond to ongoing trends, discussions and conversations in a field. In this chapter, for example, I position my reflections vis-à-vis the problem of 'control' in discussions about education and teaching. I respond both to those who criticise teaching as a form of control and those who favour teaching as a form of control, as I think that both views tend to miss something important about teaching. In doing so, I also respond to those who think that education is first and foremost about learning and to those who argue that theories of teaching can and ought to be derived from theories of learning. My discussion about how teaching 'works' is meant as a critique of and alternative to those traditions in research, policy and practice that focus on question of teaching and teacher effectiveness, quite often on the assumption – mistaken in my view – that there is some kind of causal connection between teaching and learning.

The main 'selection' at work in this chapter is that I clearly demarcate teaching, and education more generally, from indoctrination, as I do not believe that indoctrination can ever be a legitimate purpose for education. This is, of course, a value-laden assumption, but to suggest that this would make the position put forward in this chapter biased, would be as nonsensical as criticising medical doctors for being concerned about the promotion of health or criticising the legal profession for their interest in pursuing the case of justice. Education, in other words, is not just a technical 'intervention' that can be put to use for any conceivable purpose. Education has its own 'integrity,' so to speak, and teaching needs to be connected to the 'point' – or in more theoretical language: the *telos* – of education.

Others may look differently at these matters, and the chapters brought together in this book do exemplify an interesting range of accounts of teaching and a range of views about how and for what purposes teaching can and ought to be theorised. In this chapter I seek to challenge assumptions that seem to have driven much research and policy on teaching over the last few decades. I hope that this may help readers of this volume and scholars in the field of research on teaching more generally to come to their own judgement about how, why and for what purposes teaching matters and their own judgements about what theoretical resources are helpful in relation to this, and which theoretical accounts or perspectives may run the risk of distorting what education is for and about.

2 Two Myths About Teaching

Over the past decades two remarkable ideas about teaching have become quite influential in educational circles. One is the idea that teaching is outdated – the phrase that is often used is that of 'traditional teaching' – and that in education we should focus on students and their learning rather than on teachers and their teaching. Some even have heralded the shift from teaching to learning as a new 'paradigm' for education (see Barr & Tagg, 1995) and many have argued that it is a welcome and long overdue 'upgrade' of educational thought and practice. The fact that the educational conversation nowadays is full of talk about learning – learners, learning environments, learning communities, self-regulated learning, the learning sciences, teachers as 'facilitators of learning' – suggests that the 'learnification' (Biesta, 2009) of educational discourse and practice has been successful and that it has fundamentally altered our outlook on education.

Whereas on the one hand teaching appears to have been discredited, the other remarkable idea which has surfaced over the past two decades, rather emphasises the importance of teaching. The argument here is that research evidence allegedly reveals teaching as the most important 'in-school factor' in student achievement or, to be slightly more precise, the most important 'in-school factor' in the production of a specific set of measurable 'learning outcomes' (see, e.g., OECD, 2005; McKinsey & Co., 2007; Hattie, 2008). This line of thought has brought about a world-wide educational evidence industry that seeks to find out, through large-scale randomised controlled experimental studies, ‘what works’ in education. Moreover, the ambition seems to be that such research can tell teachers what they should do in order to increase student achievement, operationalised, as mentioned, in terms of measurable learning outcomes (for a recent discussion see Thomas, 2021; see also Biesta, 2007; Davis, 2017; and for an illuminating conversation see also Hattie & Nepper Larsen, 2020).

The simultaneous existence of two very different ideas about teaching is remarkable, at least at first sight. The main impetus for the critique of teaching has to do with the view that teaching is *bad* because it is an act of top-down control that ultimately limits students and their ‘freedom to learn’ (for this phrase see Rogers, 1969). Some even have argued that teaching limits the freedom of students altogether and should therefore be abandoned (the point has been made by the anti-education movement that emerged in the wake of ‘1968’; see, e.g., Von Braunmühl, 1975). The main impetus for the enthusiasm about teaching, on the other hand, seems to stem from the idea that teaching is *good* because the very point of education is to control student learning, that is, steer it towards particular outcomes, and the more teachers can do so, the better it is. Whereas these two views disagree in their opinion about whether teaching-as-control is desirable or not, the thing they seem to agree on is their belief that teaching is an act of control.

What concerns me most about the current state of affairs with regard to teaching, is that both accounts rely on a rather shallow understanding of teaching and of education more generally. This is why I refer to them as two ‘myths.’ Those who are *against* teaching seem to be unable to grasp the liberating and emancipatory potential of teaching (see Biesta, 2017) and, more importantly, seem to believe that if we leave children and young people to their own devices everything will be fine – a naïve and rather dangerous idea (on this point see Mollenhauer, 1983). Those who are in favour of teaching, seem to get stuck in the idea that teaching is some kind of ‘intervention’ that in some way produces ‘effects’ somewhere down the line. In doing so they not only rely on a rather mechanistic view of the dynamics of education but also run the risk of reducing the teacher to a mere ‘factor’ in a production process rather than seeing them as thoughtful, agentic professionals (on teacher agency see also Priestley et al., 2015). What is lacking in both accounts is a sufficiently nuanced, a sufficiently elaborated, and sufficiently suitable *conception* of teaching, and, beyond this, a sufficiently nuanced, elaborate and suitable *theory* of teaching.[1] To begin with, then: What is teaching?

[1] A conception of teaching has to do with the question how we might understand what teaching *is*, whereas a theory of teaching has to do with the question how teaching *takes place* (on the distinction between conception and theory see also Biesta, 2013a).

3 What Is Teaching?

A good place to start in answering this question, is with the word 'teaching' itself, which comes from the Old English word *tæcan*. *Tæcan* carries such meanings as 'to show,' 'to point out,' to instruct,' 'to warn' and 'to persuade,' which all have something to do with common sense understandings of teaching. The word *tæcan* is itself related to another Old English word, *tacen*, which means 'sign' or 'mark' (think of the word *token*). This suggests that teaching has something to do with providing signs[2] or, as Hansen (1995, p. 1) has put it, with the "outward expression of what one knows." This idea is echoed in Stenhouse's observation that "teachers express, in a form accessible to learners, an understanding of the nature of what is to be learned" (Stenhouse, 1988, p. 46).

Fenstermacher (1986) refers to this kind of analysis of the idea of teaching as a 'generic-type analysis' – the phrase comes from Soltis (1978) – which is aimed at teasing out "the root meaning of the term 'teaching'" (Fenstermacher, 1986, p. 38) without already engaging in questions about what would count as good or desirable teaching. Fenstermacher presents the following generic-type analysis of the concept of teaching (ibid., p. 38):

1. There is a person, P, who possesses some
2. content, C, and who
3. intends to convey or impart C to
4. a person R, who initially lacks C, such that
5. P and R engage in a relationship for the purpose of R's acquiring C.

While this analysis captures something important about teaching – namely that teaching is an act of providing content to students – and while his definition remains open with regard to what content or what kind of content is being provided to students, it is, nonetheless, limited. This is not just because of the use of the word 'content,' which fits well when we think of teaching in terms of the provision of knowledge but already fits less well when teaching is about providing access to skills or attitudes or dispositions. It is also because this definition restricts teaching to the transfer of something – almost in the literal sense of some 'thing' – from teacher to student, thus excluding more 'evocative' enactments of teaching. In such enactments teaching is not a matter of the transportation of something from teacher to student, but rather is about teachers seeking to evoke a response from their students through their teaching. This is teaching that asks something from students, so to speak, rather than teaching as giving something to students.

[2] The connection between teaching and signs is particularly prominent in Roman languages: in French, *enseigner* (French), *ensinar* (Portuguese), *enseñar* (Spanish), and *insegnare* (Italian).

3.1 Teaching as Attention Formation

A more encompassing and, in a sense, also more open conception of what teaching is, has been proposed by Benner in a discussion of notions of teaching in the work of Plato, Socrates and Aristotle (see Benner, 2020, pp. 15–23). The key idea Benner is putting forward can be found in Plato's *Republic* where he actually seems to argue against the very idea of teaching as the transmission of content (albeit that Plato's understanding of knowledge entails more than just content). Plato writes: "(W)e must conclude that education is not what it is said to be by some, who profess to put knowledge into a soul which does not possess it, as if they could put sight into blind eyes" (Plato, 1941, p. 232). Plato rather assumes "that the soul of every man does possess the power of learning the truth and the organ to see it with" (ibid.). Teaching – or as Plato emphasizes: the *art* of teaching – is therefore not about putting "the power of sight into the soul's eye, which already has it, but to ensure that, instead of looking in the wrong direction, it is turned the way it ought to be" (ibid.).

Whereas we can assume, therefore, that human beings are capable of directing their own gaze – which, in a slightly more contemporary formulation can be stated as the assumption that everyone can learn (but see below for problems with the language of learning) – teaching is the art of *(re)directing* the gaze of someone else (in German: 'die Kunst der Umlenkung des Blicks'; see Benner, 2020, p. 21). Benner emphasizes that this redirecting is not caused by teaching and also cannot be enforced by teaching (ibid., p. 17), which means that, at most, it can be *evoked* by teaching. There is, therefore, always a 'gap' between the 'work' of the teacher and the 'work' of the student. Prange (2012, p. 58) refers to this gap as the 'educational difference' (in German: 'pädagogische Differenz').

Whereas Benner approaches teaching in terms of the (re)direction of the student's gaze and thus approaches teaching first and foremost in terms of *looking*, a slightly broader term that is useful here is that of *attention*, as one could argue that the basic gesture of teaching is that of trying to (re)direct the attention of the student to something. This 'something' can, of course, be content or knowledge or some specified task. But teaching can also be about (re)directing the attention of students to themselves, for example in order to encourage them to pay attention to their own actions or to consider their own complicity in a particular situation.

The idea that the basic 'gesture' of teaching is that of *(re)directing the attention of the student*, plays a central role in the work of Klaus Prange who, in a number of fascinating publications, has argued that in order to understand what education is, we should focus on the *form* of its enactment (see, e.g., Prange, 2012, p. 20).[3] The key idea of his 'operational theory of education' ('Operative Pädagogik') is that central to all education is the act of *pointing* (in German: 'Zeigen'; see ibid., p. 65),

[3] In German Prange writes: "das Fundament für die Begriffsbildung liegt primair (…) in den Formen ihrer Ausübung" (Prange, 2012, p. 20).

which is indeed a matter of (re)directing the attention of students.[4] There are of course further questions to be asked, for example what teachers should be pointing towards, and also with what intentions teachers should engage in pointing. I will return to these issues in more detail in the next section. The general point I wish to make here is that we can assume that teachers engage in acts of pointing in order to focus the attention of students on something worthwhile, with the hope and expectation that this will contribute to how students will direct their own attention in the future. This formal conception of teaching thus suggests that the overall ambition of teaching so conceived is not just to engage in *attention (re)direction* but, through this, also to engage in *attention formation* (on the latter idea see Rytzler, 2017).

3.2 Teaching as Occupation, Enterprise and Act

One ambiguity with regard to the word 'teaching' which I wish to mention briefly, has to do with the fact that the word 'teaching' can be used at a number of different 'levels.' Komisar (1968) has helpfully suggested to make a distinction between teaching as an *occupation*, as a general *enterprise*, and as an *act* (and most of what I have said so far focuses on acts of teaching). Occupation, enterprise, and act provide three different answers to the question what a person is doing when we say they are teaching. Either it can mean that the person is a teacher (occupation), or it can mean that the person is engaged in the practice of teaching. With regard to the latter Komisar suggests that we should distinguish between the general 'enterprise' of teaching and particular 'acts' of teaching. Teachers spending an hour with their students may be engaged in the enterprise, but not everything they do may count as an act of teaching.[5]

In addition to the distinction between occupation, enterprise and act, a further important distinction is that between teaching as *task* and teaching as *achievement*, the difference having to do with so-called 'task verbs' such as 'to race,' 'to seek,' and 'to reach,' and 'achievement verbs' such as 'to win,' 'to find,' and 'to grasp.' The point here is that the word *teaching* can be used to refer both to a *task* and to an *achievement*, and that using the word to refer to the task of teaching does not necessarily imply that the task will lead to achievement. To say "I taught him Latin for years, but he learnt nothing" (Peters, 1967, p. 2), is a correct way to use the word

[4] The German word 'Zeigen' can also be translated as 'showing.' While I do agree that the point of pointing is to show something, that is, to bring something to the student's attention, I prefer to use the word 'pointing' because it refers more explicitly to the form of teaching, whereas 'showing,' in a sense,' says more about a particular attention we may have with our pointing.

[5] Komisar gives the interesting example of a situation where a teacher has been expressing his own prejudices about a topic but then stops doing so "and is finally teaching again" (Komisar, 1968, p. 174). This suggests that to identify a particular act as an instance of teaching is not a factual matter but implies a *judgment* about the intentions of the act, for example, in order to distinguish teaching from indoctrination.

teaching in the task sense of the word. If, on the other hand, we would shift to the achievement sense, we would probably say something like, "I *tried* to teach him Latin for years, but he did not learn anything."

If the foregoing provides a sufficiently developed idea of what teaching *is* – a *conception* of teaching – there are three formal characteristics of all teaching that can be deduced from this. The first is that teaching implies a *relationship*between teachers and (their) students or, more bluntly, that it takes at least two to teach. The second is that teaching implies *intentionality* in that those who teach do so deliberately, not accidentally. The third is that teaching entails a sense of *purpose*, which means that it is done for a reason and, more specifically, that teaching entails expectations from those who teach about what may happen at the side of (their) students – although it remains open whether this will or will not happen and also to what extent this should be controlled or not. This then brings me to the question of purpose in teaching, which is the question what teaching is *for*.

4 What Is Teaching *For*?

Teaching doesn't happen by accident. While there may be situations in which someone might say something like "I was just doing things and suddenly I realised that I was teaching," even such a statement suggests that teaching is something more specific than just 'doing things' or, because all teaching needs at least two, teaching is something more specific than just 'doing things *together*.' It may be worthwhile to do things together, and even teachers and students can do worthwhile things together, but teaching is more intentional than that. This means that teaching is at the very least *a-doing-things-together-with-a-particular-purpose.* This doesn't mean that the 'doing' of teaching always has to be a matter of speech and action, that is, a matter of talking and pointing. Teachers may also have good reasons for remaining silent, for not saying anything, for letting students explore and finding things out for themselves, or even for them to encounter obstacles and experience frustration. But even in those situations – if they are to count as instances of teaching – teachers should have good reasons for what they do and don't do. They need, in other words, to proceed with a sense of purpose.[6]

So what is the purpose of teaching? What, in other words, is teaching *for*? The popular answer nowadays is 'learning,' and the frequent occurrence of the phrase 'teaching and learning' in the English language does indeed seem to suggest that the two are inseparable. In my view, however, this is a mistake, and it is actually quite worrying that the language of learning has become so prominent in contemporary education. Why is this a problem? There are three points I wish to make to answer

[6] I am not suggesting that students shouldn't have a say in answering the question what teaching is *for*, but whether students should or should not be included in pondering this question is itself a decision for teachers to make with reference to the question whether or not it will benefit the educational endeavour.

this question; one about the word ‘learning;’ one about the purposes of teaching; and one about the relationship between teaching and learning.

4.1 The Problems with ‘Learning’

Despite its ubiquity, the word ‘learning’ is actually remarkably ambiguous and vague. One problem has to do with the fact that in English – but also in other languages – learning can refer to (a) an activity (such as ‘student learning’); (b) a process (as in ‘the study of learning processes’); and (c) a result or outcome (as in ‘the point of education is that students learn from it’). This already shows that the word ‘learning’ is not very precise as an answer to the question what teaching is for. But there are further problems with the different usages of the word ‘learning.’

The problem with using ‘learning’ to refer to an *activity* becomes clear when we imagine a teacher saying to her students: “For the next 30 minutes I want you all to learn.” Most likely the students will look puzzled and will ask: “But what do you want us to do?” This shows that there actually is no generic activity called ‘learning,’ and that, in guiding our students, we should rather say what we want them to *do* – such as: read this, listen to that, try this, practice that, remember this, make that, pay attention to this, show that, and so on – and provide them with reasons why we think that it might be good for them to do so.

Just as there is no generic *activity* called ‘learning,’ there is also no generic *process* called ‘learning.’ If we think of meaningful ways of using the word ‘learning’ – such as in ‘learning to ride a bike,’ ‘learning that two and two equals four,’ ‘learning to be patient,’ ‘learning that you are not good at something,’ ‘learning to teach’ – we can immediately see that the processes that ‘learning’ seems to refer to in these statements differ widely. At the very least this suggests that there is not one learning process but that there are several and, most likely, many. But we could even question whether the word ‘learning’ refers to any process at all in these statements, because ‘learning’ actually doesn’t mean more than stating the fact that at a certain point in time someone was unable to do something and that at a later point in time the person was able to do something. What made this transition possible is, of course, an important question, but using the blanket term ‘learning’ doesn’t really add anything to our understanding (see also Prange, 2009 for a similar line of argument).

How then about learning as result or outcome? This is, in my view, the most meaningful way to use the word ‘learning,’ although even here there are some important issues that need to be considered. The idea of ‘learning’ as a result or outcome is captured in a widely used definition of learning as any more or less durable change that is not the result of maturation (see, e.g., Borger & Seaborne, 1966, p. 16; see also Jarvis et al., 2003). ‘Learning’ thus refers to *change* – for example change in knowledge, understanding, disposition, attitude, capacity, outlook, resolve or attention – and, more importantly, change brought about as a result of ‘encounter’ with something ‘external’ (which is the reason why learning is defined as change that is not the result of maturation). Some argue that this always requires activity on the side of 'the learner,' and this idea has become very popular over the past decades, particularly due to the influence of constructivist thinking. A case has also been made, however, that what is learned comes from the 'outside,' as a gift (see Biesta, 2013b, 2020a, 2021), and thus entails passivity and receptivity rather than activity on the side of 'the learner.' Roth (2011) has tried to capture this with the word 'passability,' which has to do with the human ability 'to be affected' (Roth, 2011, p. 17).

One interesting implication of the definition of 'learning' as durable change that is not the result of maturation is that we can only say *in retrospect* whether any change has occurred or not, but that when we're in the middle of a situation or activity we can never say whether that situation or activity will or will not result in change. We can never say, in other words, that we are *currently* learning; we can only say, looking back, that learning has taken place or that we have learned something (or not, of course). We could say, therefore, that 'learning' is not a noun – it is not the name of an object or event – but can best be understood as an *evaluative term*.[7] After all, to say that someone has learned something, to claim that one has learned something, means to identify some change as desirable (if we value the change) or as undesirable (if we don't value it, for example, when someone has picked up a bad habit).

These observations show that the word 'learning' is not as simple and straightforward as its frequent use suggests. This also implies that to argue that the purpose of teaching is learning, is actually not very meaningful or informative. So what then might we say in response to the question what teaching is for?

4.2 Teaching and the Purposes of Education

Although teaching can, in principle, happen in many settings, it seems meaningful to focus on teaching in the context of formal education, that is, the teaching that takes place in schools, colleges, and universities. While it is often suggested, as I have already mentioned, that the point of education in such settings is that children and young people learn, this suggestion is not sufficient in the case of education. In addition to all the provisos already mentioned about the concept of 'learning,' it seems reasonable to suggest that the point of education can never be that students just learn – after all, if they want to learn, they don't need to go to school, as learning can happen anywhere. Rather, the point of education is that students learn *something*, that they learn it for a *reason*, and that they learn it from *someone*. Put differently, education is never about learning 'in general' – which, after all, can go in any direction – but always raises questions of *content* (in the broadest sense of the word), *purpose* and (educational) *relationships*. And it is here that teaching comes

[7] The fact that there is no generic activity called 'learning' also suggests that 'learning' is not a verb.

in, because whereas students can learn all kinds of things from being in educational contexts and settings – including, for example, how to cheat or how to pass an exam with minimal effort – it is the work of teachers to direct the attention of students, and to do so for a reason, that is, with a particular purpose in mind.

Elsewhere (see for example Biesta, 2009, 2010a, 2020b) I have suggested that when we look at the question of the purpose of education more widely, we can make a case that there are actually three purposes (or as I prefer: domains of purpose) that are always at stake when education takes place. One important reason why we engage in education and why societies invest significant amounts of time and money in education is because education is about making knowledge and skills accessible to students. We can refer to this as knowledge acquisition, but it is perhaps better to say that one important purpose of education is *qualification*, that is, providing students with knowledge, skills and other things they may need – such as attitudes and dispositions – in order to do something. This 'doing' can either be quite specific and precise, such as becoming qualified for a particular job or profession; but it can also be understood more broadly, such as the way in which schools seek to equip children and young people for their life in complex modern societies. Qualification should not be conflated with qualifications, that is, the diploma's and degrees students acquire, other than that obtaining such qualifications is proof that students have become qualified in particular areas or domains.

Some would argue that qualification is the sole purpose of education, that is, that education is only about providing children and young people with knowledge and skills and supporting them in the acquisition of what is being provided. Those who argue that schools, colleges and universities should only focus on knowledge and skills, often do so because they are worried that anything else gets education into difficult normative questions, and these are better left to the family or community context. This may sound reasonable, but the problem is that education is unable to provide children and young people with all the knowledge that is available – Comenius was probably the last educational scholar who had the hope that education could and should provide an overview of *everything* (see Comenius, 1658) – so there is inevitable selection going on in education. Put differently, in everything we do in education we present out students with a particular 'selection' of the world and, more positively formulated, with a particular *representation* of the world, and the ways in which we do this inevitably influences our students in some way. Normative questions are therefore inescapable, even if education would be confined to the domain of knowledge and skills.

In the literature the (re)presentation of the world, or the presentation of different representations of the world, is known as *socialisation*. Some highlight the ways in which this goes on, even behind the backs of our students – an idea known as the hidden curriculum. Yet we can also think more positively about this, and see socialisation as an important second purpose of education, where we try to provide our students with an orientation in the world, which comes with the invitation to find their own place within it. Providing our students with a sense of orientation is, for example, the important work of the history curriculum, that tries to provide insight in how the world has become what it has become. But one can even say that the whole curriculum actually contributes to this task. Socialisation also plays an important role in vocational and professional education, where we introduce our students into particular vocational and professional traditions and practices, so that they do not just become qualified as, say, a nurse, but also get a sense of what nursing as a tradition and practice is, and develop their own professional identity in relation to this.

Education as socialisation is, in other words, about providing our students with an orientation into existing cultures, traditions and practices, with the invitation – and in some cases the insistence – that they locate themselves within them. In 'stronger' forms of socialisation this can become a rather one-way process, where educators already know where they want their students to end up, what kind of identities they want them to develop, and what kind of values and norms they want them to adapt. This is not entirely problematic, because professional fields have their own values, norms and standards – think of the Hippocratic oath in medicine and similar codes of conduct in other professional fields – and it is important that those who want to become part of the profession adhere to them. The same can be said for the domain of citizenship education, where a strong rationale can be developed for suggesting that everyone who wants to benefit from the rights and freedoms a democratic society offers to its citizens, also has the responsibility to adhere to its underlying values and legal structures. But the issues here are never easy, which becomes visible, for example, when we think of such domains as environmental education, sex and relationships education, or anti-racist education, not just because there are ongoing discussions about how such topics can best be included in the curriculum, but also because there are ongoing discussions about whether such topics should be part of the school curriculum in the first place. Notwithstanding all this, socialisation is an important second domain of purpose for all education.

Discussions about socialisation, particularly strong(er) and (more) directive approaches, raise an important further question, which has been part of the modern educational conversation at least since the Enlightenment, and most likely already earlier than that.[8] The question here, to put it briefly, is whether education can and should approach students as 'objects' that need to be(come) qualified and socialised, or whether education always also has work to do to make sure that children and young people can become subjects of their own life. This is partly a very complicated and deeply philosophical question, but it is also a very simple question which many educators will immediately recognise. After all, in all education we want to make sure that students stop relying on our help and input and become able to do things for themselves. To think for themselves, to make their own judgements, and to be able to act and to act well. A big question is whether students should be able – and be 'allowed' – to think for themselves in all domains of life, or only in specific domains. One might assume that a car mechanic in North Korea should be able to do his job in the same way as a car mechanic in South Korea, but that there is a big

[8] I am thinking here, for example, of discussions about religious freedom that emerged during the Reformation.

difference with regard to their freedom of thought and action in relation to other domains of life.

There are different ways in which we can refer to this third domain of educational purpose. I tend to prefer to refer to this domain with the word '*subjectification*,' which is perhaps a rather odd word in English, but precisely refers to the ambition that students end up as subjects of their own life. It therefore stands in sharp contrast to education that aims for objectification, that is, education which is only interested in controlling students and their acting, thinking and judgement. Of course we cannot force our students to be subjects of their own life – and in many instances one could even argue that it is much easier to follow other people's orders and directions than constantly having to come to your own judgement – but we can, in all kind of ways, 'remind' our students of this possibility to be(come) a subject of their own life, and we can provide them with many opportunities to encounter and practice with the complexities of what this means (see Biesta, 2020b, for more detail). Dietrich Benner has suggested the phrase 'Aufforderung zur Selbsttätigkeit' as a way to capture the special character of educational work in this domain (see, for example, Benner, 2015). This can be translated as 'summoning to self-action,' although the 'summoning' may sound a bit strict, and we might also use a word like 'encouragement' here. Self-action should not be understood as the encouragement to be yourself, and also not the encouragement just to become active. It is perhaps best to see this as the injunction to be *a* self, that is, to try to be a subject of your own life, with all the complexities and responsibilities that follow from it, rather than remain an object of influences outside of you.

Benner has also introduced another set of concepts that is helpful in looking at these three domains of educational purpose and their relationship. This is the distinction between affirmative and non-affirmative education (see Benner, 2015, pp. 146–155). Whereas qualification and socialisation are, to a large degree, affirmative, in that they start from certain ideas about what education should achieve and where children and young people should end up, the domain of subjectification is precisely the opposite of this, because here it is not for educators to tell children and young people how they should be and become, but rather to provide opportunities for them to figure out for themselves how to live their own lives in the best way possible. That is why the educational work vis-à-vis this domain has to be non-affirmative and has to proceed with caution.

I wish to suggest that qualification, socialisation and subjectification are not only three *legitimate* purposes of education; in a sense they are also three *inevitable* purposes of all education. After all, in all instances of education there is always something for teachers to offer to students and for students to acquire to their benefit – be it knowledge, be it skills, be it attitudes, be it a combination of the three, and in this regard education always has an orientation towards qualification. Because qualification always represents (aspects of) the world in a particular way, there is always also socialisation going on. And all this also has an impact on the student as subject – on the student's subject-ness we might also say – to begin with because becoming more knowledgeable or skilled (qualification) and gaining orientation in a particular domain or field (socialisation) provides students with increased possibilities for thinking, judgement and action, which are at least important preconditions for their existence as subject of their own life.

The fact that these three purposes – or as mentioned: domains of purpose, because in each domain further concretisation is always possible and in most cases needed – are inevitable, suggests three things. It first of all suggests that the three domains are always entangled with each other; they cannot exist separately, because every act of qualification is also an act of socialisation and also impacts on the student's subject-ness, positively or negatively. It suggests, secondly that in the design and enactment of education teachers should always consider what they seek to achieve – or what they seek their students to achieve – in relation to each of these domains. Thirdly, although the three domains are always 'in play' in education, it doesn't mean that they can exist in perfect harmony. There are always potential tensions between, say, what one seeks to achieve in the domain of qualification and what is possible in the other domains. There can be synergy – understanding subject-matter well also provides a degree of orientation and contributes to one's agency – but there can also be conflicts – for example when a too strong push on the domain of qualification undermines students' agency and their possibility to exist as subject of their own life, because they are being told that the only thing that matters is how well they perform on a test or exam.

The challenge for teaching, therefore, is not just to begin to think and act in a three-dimensional way, that is, with an eye on the three domains of educational purpose. The challenge is also to try to secure a meaningful balance, and think carefully about the costs of emphasising one domain to the detriment of the other domains. This, as I will argue below, is one important reason why teaching needs to be understood as an art and why teachers need artistry rather than techniques.

4.3 What should Teachers Aim for?

Before I move to the question how teaching 'works,' there is one more aspect of the question what teaching is for, which I wish to discuss briefly. This is the question what teachers should *aim* for. What, in other words, should be the object of their actions? The question what teachers should aim for should be distinguished from the question about the purposes of teaching. Purposes, to put it briefly, have to do with the general *enterprise* of teaching; they give meaning and direction to the whole educational 'set up.' The question what teachers should aim for, on the other hand, is a question at the level of *acts* of teaching.

I have already raised quite a lot of concerns about the notion of learning, so that to suggest that acts of teaching should focus on student learning is actually a problematic idea. This is not just because teachers cannot *cause* learning, but also because the word 'learning' actually doesn't refer to an activity; it doesn't refer, in other words, to something that students can *do* but it best understood as a possible result of what students do. Since we can only identify such results 'after the event,' that is, when we look back and realise that, over time, some (desirable or undesirable) change has happened, it doesn't make much sense, then, to suggest that teaching should aim at students' learning, which is a further reason why the phrase 'teaching and learning' is unhelpful and even misleading. So what, then, should acts of teaching aim at and, more importantly, what should teachers aim at in their teaching?

A very helpful suggestions with regard to this question has been made by Fenstermacher (1986). In discussing the generic analysis of teaching mentioned above, he argues that "the teacher does not convey or impart the content to the student [but] rather instructs the student on how to acquire the content from the teacher, text, or other source" (Fenstermacher, 1986, p. 39). What teaching should aim for, what the intention of teaching should be, is therefore *not* to bring about or produce learning but to bring about or induce what Fenstermacher suggests referring to as "studenting" or what B. Othanel Smith has suggested we call "pupiling" (see Fenstermacher, 1986, p. 39), that is, to focus on the 'work' we expect students to do rather than on what this 'work' may or may not bring about (see also Prange, 2009). With this concept Fenstermacher is able to say in a much more precise manner what teaching is about, namely, "instructing the learner on the procedures and demands of the studenting role, selecting the material to be learned, adapting that material so that it is appropriate to the level of the learner, constructing the most appropriate opportunities for the learner to gain access to the content monitoring and appraising the student's progress, and serving the learner as one of the primary sources of knowledge and skill" (Fenstermacher, 1986, pp. 39–40).

By making the distinction between studenting and learning, Fenstermacher not only introduces a concept that allows us to say with much more precision what teachers should intend to bring about. He also makes it possible to identify with much more precision who in the educational relationship is responsible for what, and therefore also who can be held accountable for what. He explains this as follows:

> On this new scheme, the teacher is held accountable for the activities proper to being a student (the task sense of "learning"), not the demonstrated acquisition of content by the learner (the achievement sense of "learning"). Thus a learner who fails a reasonably valid and reliable test of content covered in instruction must accept a major share of the responsibility for this failure. To the extent the student lacks the skills of studenting needing to perform well on this test, is given no opportunity to exercise these skills, or is in no helpful way encouraged to engage the material to be learned, the teacher must accept a major share of responsibility for the student's failure. (Fenstermacher, 1986, p. 40)

The notion of studenting thus helps to create some distance between teaching and learning, albeit that for Fenstermacher the outcome of the act of studenting is still described as learning – which explains why he refers to the person doing the studenting as a learner rather than as a student – and not in terms of more precise purposes of education relating to qualification, socialization, and subjectification.

Komisar (1968) went one step further when he not only stated explicitly that "learning is not what the 'teacher' intends to produce" (Komisar, 1968, p. 183) but also suggested that the intention of teaching might best be captured in terms of "awareness," that is, of an "auditor" (note that Komisar tried to stay away from notions such as learner and student) "*who is successfully becoming aware of the point of the act* [of teaching]" (Komisar, 1968, p. 191; emph, in original).

While the discussion about what the proper intention of teaching should be may sound very technical – which it is of course as well – the points raised do matter to both practitioners and researchers for at least three reasons. First, to repeat it one more time, it helps to stay away from the mistaken idea that teaching can cause learning — an idea that particularly seems to inform currently education policy that precisely seeks to make teachers responsible for the production of learning rather than, with the word of Fenstermacher, the promotion of studenting. Second, it can help teachers to think more clearly and precisely about what it actually is that they intend to bring about and what the role and place of learning in this constellation are, if learning is no longer the intended 'outcome.' And thirdly, it opens up a new perspective on research, one that goes beyond the idea that research should identify the factors that cause learning but rather focuses on relationships between teaching and studenting.

5 How Does Teaching Work?

So far I have given an indication of what I think that teaching is, arguing that the basic gesture of teaching is that of (re)directing the attention of the student and, through this, to contribute to attention formation. I have also looked in more detail at the question what teaching is *for*, arguing against the idea that teaching should bring about learning. In addition to problems with the very idea of 'learning,' I have suggested that teaching should be orientated towards three domains of educational purpose – qualification, socialisation and subjectification – and that the work of the teacher should be focused on studenting, that is, on providing students with guidance for the work they should do so that their education may result in something, be it qualification, be it socialisation or be it subjectification and, ideally, a meaningful combination of the three.

5.1 The Problem of Causality in Education

In exploring these ideas, I have mentioned several times that the idea that teaching *causes* learning simply doesn't make sense. Along similar lines we can also conclude that teaching doesn't cause studenting. Notwithstanding all this – and in a sense this is quite remarkable – there is ongoing research around the world that seeks to find connections between educational 'inputs' and educational 'outcomes,' on the assumption that the more knowledge we gain about these connections, the better we will understand how teaching works and the better we will able to tell teachers 'what works' in bringing about particular 'learning outcomes.' So why do so many researchers seem to think that there is some kind of causal connection between teaching and learning, when all the arguments point in the opposite direction? Why is this myth, as I have called it above, being repeated? Is this a case of something that doesn't work in theory but does work in practice? After all, if the work of teachers wouldn't make any difference for their students, why then do we continue doing so, century after century?

The quickest way into this discussion is to see that the meaningful question here is not *whether* or not teaching 'works' – and 'works' here refers to teaching as a main causal 'factor' in the 'production' of 'learning outcomes' (I put many terms in quotation marks in order to highlight that they are all misleading and inappropriate when we talk about education and teaching) – but *how* teaching works, that is, how any connection between the work of teachers and what happens on the side of students is brought about. A helpful way to engage with this issue, is to begin with the question under what conditions causality actually occurs, and then to ask whether it can be realistically assumed that those conditions are also present in education (for more detail see also Biesta, 2016, 2020c).

With regard to the first question, the answer is that causality – that is, when one event always and necessarily brings about another event at a later point in time – only occurs in closed systems that operate in deterministic and unidirectional ways. The best example of such a system is probably the clockwork, where all the cogwheels are interconnected and where, when one cogwheel moves, it sets into motion a series of further cogwheel movements, ultimately resulting in the hands of the clock moving in a particular direction at a particular pace. As long as there is no interference from the outside, there will be a perfect correlation between the movement of the first cogwheel and the movement of the hands. Moreover, because we can trace all the interlocking movements and connections, it is clear that the movement of the first cogwheel *causes* the movement of the hands.

5.2 Education: An Open, Semiotic and Recursive System

While under such conditions causality does happen, such conditions are simply not present in the case of education. I wish to suggest that what characterises education systems is that they are *open* systems which function in *semiotic* ways and are characterised by a phenomenon called *recursivity*, and that it is precisely because of these characteristics that education systems do not and never will work in causal ways. And the fact that this will not happen, is not a lack of the system that in some way needs to be 'fixed,' but is precisely what makes education systems into *education* systems. The reason why we can characterise education systems as open systems is for the simple fact that what happens in education – in the classroom, in the relationship between teacher and students, during school time – is subject to many other influences from the 'outside,' so to speak. The simple fact that students go home after school, already shows that what happens in education and, more specifically what happens as a result of acts of teaching, is only a small part of everything that students encounter, in their schools lives and their lives outside of school.

While the openness of education systems may be seen as a practical matter – I will return to this below – the more fundamental reason why education doesn't function in a causal way, is because the connections between its 'elements'(teachers and students) are not a case of mechanical push and pull, but are a matter of communication and interpretation. They occur because of the fact that students try to make sense of what their teachers say and do, and because of the fact that teachers try to convey in words and deeds, with as much clarity and detail as possible, what they want their students to do or refrain from doing, and why this might be important. But the relationship between the acts of teachers and the acts of students is not deterministic because it relies on acts of interpretation and sense making, to put it briefly.

To this comes the fact that, unlike the movement of cogwheels in a clockwork or the movement of planets in the solar system, the 'elements' of education systems (teachers and students) are reflective agents, which is a theoretical way for saying that they can think and can act and, most importantly, can make up their own minds and act accordingly. How the system will evolve over time – how teachers establish relationships with students; how a group of individuals begins to gel – depends crucially on the decisions teachers and students make and the ways in which they use their freedom of action. Unlike the cogwheels, which can only move in the direction they are being pushed into, human interaction can move in many ways, 'forwards' but also 'backwards' (and what counts as forward and what counts as backward is, of course, a matter of judgement).

While closed, unidirectional, deterministic systems will function in predictable ways, there are no such predictable, unidirectional connections in open, semiotic, recursive systems and for this reason the assumption that teaching causes learning (or in the words of Fenstermacher: that teaching causes studenting) simply doesn't make sense. There is, to put it differently, a fundamental gap between the 'work' of the teacher and the 'work' of the student – a fundamental 'educational difference' (Prange's 'pädagogische Differenz').

5.3 Making Education Work: The Risk of Indoctrination

This, however, is not the end of the story. Whereas a causal conception of the dynamics of education doesn't make sense – the conditions under which such 'strong' causality can emerge are simply not present in education – the interesting and in a sense really important thing about seeing that education systems are open, semiotic, recursive systems, is that it makes it possible to explain in much detail how the functioning of such systems can become more predictable. Moreover, and this is important with regard to education systems, the explanation of how such systems can become more predictable – how, in other words, regularities between the work of teachers and the work of students can begin to emerge – also brings into view how and when this is educationally *desirable* and how and when we end up in a situation that is educationally *undesirable*. Let me briefly discuss what I have in mind.

While the behaviour of open, semiotic, recursive systems may be quite unpredictable given the large number of possible influences and options at each point in time, these insights into the specific characteristics of education systems also helps to see what needs to happen to make the behaviour of such systems more predictable. The main way of doing this, is by reducing the degrees of freedom of the system, to put it in abstract terms, and through this, to reduce the complexity of the overall functioning of the system (on the latter idea see also Biesta, 2010b). One way in which we can make education systems more predictable is by *reducing the openness* of the system, that is, by limiting the possible influences upon the system and upon the actors within the system. In theoretical language this may sound rather abstract, but this is exactly the reason why we have schools, school buildings, classrooms, timetables, and so on. Through this, that is, through the ways in which we *organise* schooling, we reduce the number of possible influences upon students, which is not just a matter of *limiting* what students are exposed to, but at the same time may help in (re)directing and *focusing* their attention. And we generally do this for good reasons, related to the purposes of education (but see below).

We do the same with regard to semiosis, that is, the processes of communication and interpretation that are central to the functioning of education. We use textbooks, practical exercises, curricula, tests and exams in order to 'frame' what we are talking about. And while we may want to encourage our students to make active sense of everything they encounter, and would even encourage them to make their own sense, this doesn't mean that there is or should be total freedom of interpretation. Creativity can only go so far in education, because it is important that students 'get it' and that they get it 'right,' without suggesting that it's always easy to figure out what 'getting it' and 'getting it right' is. Yet again, by limiting the scope for interpretation, we try to focus our students' attention, and we have good, educational reasons for doing so.

The same also holds for recursivity, that is, the reflexive agency of the 'elements' in the system. While we should valueagency and reflexivity, we do want to make sure that the ways in which our students think of school and schooling and their own role in it 'makes sense' for the purposes of the overall endeavour, just as we want teachers to think of themselves as teachers, and not just as friends of their students or facilitators of learning. By focusing the reflexivity of teachers and students we thus reduce the degrees of freedom of the system which, again, contributes to a more predictable functioning of the system as a whole. And once more, we do this for good, educational reasons.

There is much more to say about all this, but the basic point I am seeking to make is that open, semiotic, recursive systems do not necessarily behave erratically and in a totally unpredictable manner, precisely because it is possible to reduce openness, interpretation and reflexivity of the agents that make up the system. Moreover, I have tried to indicate that this is what we are doing all the time in education, first and foremost because education is not just everything – it's not just a being together – but it's the very least a being together framed by particular purposes and to the benefit of students.

My formal point here, is that education systems can become more predictable in their behaviour when we begin to reduce its degree of freedom – the reduction of openness, the reduction of interpretation, and the reduction of reflexive agency – and that much of the work we do to organise education and to make it happen is precisely about this. In this way, then, we can see what it takes to make education 'work.' One thing that is important with regard to this, is that this account of how education might 'work' does not rely on untenable assumptions about alleged causal relationships between 'inputs' and 'outcomes,' but gives a precise account of how more predictable and 'stable' relationships between the work of teachers and the work of students might be achieved.

The other thing that is important about the account I am presenting, is that it allows us to see that when we go too far in our attempts at reducing the degrees of freedom of the education system, we will reach a 'tipping point' where we can no longer legitimately refer to what is happening as education, but have turned education into *indoctrination*. After all, if we totally cut off the school from any environmental influences – that is, lock up students for 24 hours a day, 7 days a week, all year round – and if we only allow for one way to interpret what they are encountering there – that is, complete eradicate any opportunities for sense making – and if we also reduce the opportunities for reflexive agency to zero, we have created an indoctrination machine that may work perfectly, but has nothing to do with education.

The bottom line, then, is that we can make education work, and that, by being precise about the characteristics of the dynamics of education rather than approaching it with untenable assumptions about alleged causality, we can see much better what the 'drivers' for making education work are, but that any attempt to do so always comes at a price, including the possibility that education ceases to be education. I also wish to highlight that this way of understanding how education 'works' and can be made to 'work,' that is, become more predictable in its operation, has important implications for much more meaningful research than the search for 'strong' correlations between 'inputs' and 'outcomes.' And this brings me to the final point I wish to make in this chapter, which has to do with the need for 'artistry' in teaching.

6 Why Teaching Needs Artistry

One of the main messages that is emerging from the exploration of teaching I have offered so far, is that teaching cannot and should not be enacted as a form of control or, to be more precise, as a kind of intervention that, under 'ideal' circumstances and based upon the best 'evidence' about what 'works,' should be aimed at producing pre-specified learning outcomes. This is not to suggest that everything should be open, which is the mistake of those who denounce teaching in favour of learning. But it is to challenge the view that education is ultimately a causal system (an ontological claim) and that, once we have perfect knowledge about the mechanics of the system (an epistemological claim), teaching can become a matter of administering those interventions that produce the desired outcomes (a praxeological claim). Ihave shown that social systems such as education do not operate in a causal manner, but that this doesn't mean that the behaviour of such systems is entirely unpredictable and erratic. I have also shown that teaching should not be understood as the production of outcomes, because the whole point of teaching is to educate human being so that they become more qualified, that is, become more about to think and act, gain an orientation in the world and, through this, take upon themselves the challenge of being subjects of their own lives, rather than objects of forces outside of them.

6.1 An Epistemological Point

The question this raises, and this is the final step I wish to take in my exploration of teaching, is what teachers need in order to navigate this complex domain called 'education.' This brings me back to a rather old discussion which centres around the question whether teaching should be understood as a science or as an art. William James, in his *Talks to Teachers* (1899), had a very clear opinion about this, which he expressed in the following way.

> Psychology is a science, and teaching is an art; and sciences never generate arts directly out of themselves. An intermediary inventive mind must make the application, by using its originality.

The most such sciences can do is to help us to catch ourselves up and check ourselves, if we start to reason or to behave wrongly; and to criticize ourselves more articulately after we have made mistakes.

> To know psychology, therefore, is absolutely no guarantee that we shall be good teachers. To advance to that result, we must have an additional endowment altogether, a happy tact and ingenuity to tell us what definite things to say and do when the pupil is before us. That ingenuity in meeting and pursuing the pupil, that tact for the concrete situation, though they are the alpha and omega of the teacher's art, are things to which psychology cannot help us in the least. (James, 1899, pp. 14–15)

The point James makes here could be characterised as an *epistemological* point, as he indicates the gap between the general knowledge the science of psychology can generate, and the specific knowledge teachers need in each concrete situation. Looking at it in this way, we could say that the knowledge science can generate about teaching is never sufficient. Or, looking at it from the other side, such knowledge can never tell teachers what they should do, but can at most inform their judgements. Whereas this line of thought leaves open the possibility that a science of teaching might be possible – and in a sense only makes the point that scientific knowledge and practical knowledge are of a different category – the question about the difference between ‘science’ and ‘art’ goes deeper than that, and the thinker who, in my view, still provides the most helpful way to understand what the issues are, is Aristotle. For Aristotle the difference between ‘science’ and ‘art’ is not a matter of different kinds of knowledge, but is first and foremost a matter of different kinds of reality and of what it means to act in relation to these different kinds of reality.

6.2 *The Praxeology of Education*

With regard to this issue, Aristotle makes a very helpful and important distinction between what he refers to as the theoretical life (the ‘bios theoretikos’) and the practical life (the ‘bios praktikos’). The theoretical life is concerned with “the necessary and the eternal” (Aristotle, 1980, p. 140), that is, with those aspects of reality that do not change, such as the movement of the planets or the stars in the sky. He refers to knowledge about this reality as ‘episteme,’ which is often translated as ‘science’ (although the translation can be a bit misleading in light of modern connotations of the word). ‘Episteme’ is knowledge about what is necessary and eternal and given that the reality that this knowledge is about doesn’t change, the knowledge we have about this reality, once it is accurate, will not change either. From this we have an idea of true knowledge as 100% stable, secure and certain.

Aristotle’s main insight, however, is that most of what our lives are about doesn’t take place in relation to what is necessary and eternal, but takes place in the domain of the ‘variable’ (for this term see ibid., p. 42), that is the domain of possibility and change. It is the world in and upon which we act and in which our actions have consequences, but where there is no guarantee that our actions will always have the same consequences. It is, in other words, the domain of actions and possible consequences, but not the domain of certainty. Knowledge in this domain is therefore not knowledge about an unchanging reality ‘out there,’ but is knowledge about the relationships between our actions and the possible consequences of our actions.[9]

This is so for our interaction with the material world (technology), with the living world (that is with plants and animals) and in the social domain (our interaction with other human beings). In all cases we may bring much knowledge gained in previous situations to the new situations we encounter, but there is always the question whether the knowledge we gained in the past is applicable to and relevant

[9] Aristotle did assume that part of the universe is eternal and another part subject to change, and thus made a distinction between two kinds of knowledge. John Dewey would later argue that actually all our knowledge is of the second kind, that is, all we know about the relationships between actions and the consequences of our actions (see Biesta & Burbules, 2003). Whereas Aristotle may have argued that the ‘quest for certainty,’ as Dewey called it, makes in the domain of the eternal but not in the domain of the variable, Dewey argued that the quest for certainty doesn’t make sense at all.

for the new situation we are encountering. This means that acting in the domain of the variable is never about following prescriptions and recipes, but always requires ‘happy tact and ingenuity’ (James) and judgement. And it is precisely there that we find the main difference between ‘science’ and ‘art,’ the latter being about our actions in the domain of the variable.

What is interesting about Aristotle’s explorations of our acting in the domain of the variable, is that he makes a distinction between two ‘modes’ of acting and hence between two forms of judgement. The distinction Aristotle makes is between *poiesis*, which Carr (1987) has helpfully translated as ‘making action,’ and *praxis*, which Carr translates as ‘doing action.’ *Poiesis* is about the making of things – such as, for example, a saddle or a ship – although I prefer to think of it slightly more widely, that is, as action that brings something into existence. We might also call it ‘productive action.’ As Aristotle puts it, *poiesis* is about “how something may come into being which is capable of either being or not being” (which means that it is about the variable, not about what is eternal and necessary), and about things “whose origin is in the maker and not in the thing made” (which distinguishes *poiesis* from biological phenomena such as growth and development) (see Aristotle, 1980, p. 141). *Poiesis* is, in short, about the creation of something that did not exist before.

The kind of knowledge we need for *poiesis* is what Aristotle refers to as *techne*, which he defines as “knowledge of how to make things” (ibid, p. 141). *Techne* therefore is about finding the means that will bring about what one seeks to bring about, to put it in general terms. *Techne* encompasses knowledge about the materials we work with – and we can take ‘materials’ in the broad sense of the word[10] – and about the techniques we can apply to work with those materials. Yet making something, such as a saddle, is never simply about following a recipe. It involves making judgements about the application of our previous knowledge and experience to *this* piece of leather, for a saddle to fit *this* particular horse, and for *this* particular person riding the horse. So we make judgements about application, production and effectiveness in our attempts to bring something into existence. The best English word for *techne* is probably craftsmanship although in a slightly narrower translation we can also think of it as consisting of practical knowledge – about how to do things – and practical judgement.

The domain of the variable is, however, not confined to the world of things and matters of making. It is not confined, in other words, to productive action, but also includes the social domain as social domain, that is, the world of human action and human interaction. It is here that a second art is called for: the art of *praxis*. The orientation here is not towards the making of things but towards the promotion of the human good (the Greek term is *eudaimonia*, which is not so much happiness, although it is sometimes translated in that way, but comes closer to the virtuous life,

[10] These can be physical materials such as wood, stone, clay, and so on, or living materials such as plants, but also social and human ‘materials’ (even if the word ‘material’ is a bit odd to use here). I am making the case here that teaching entails a large degree of craftsmanship, but will also mention below that students can never be treated as objects, and that precisely at that point the difference between *poiesis* and *praxis* emerges.

the life lived well). *Praxis*, Aristotle writes, is "about what sort of things conduce to the good life in general" (ibid, p. 142). We could say that *praxis* is about good action, but good action is here not to be understood as a means for bringing about something else – that is the domain of *poiesis* which "has an end other than itself" (ibid., p. 143). "Good action," on the other hand, "itself is its end," as Aristotle puts it (ibid, p. 143). What we need to proceed here is not judgement about how to do things, but rather judgement "about what is to be done" (ibid.). Aristotle refers to this kind of judgement as *phronesis*, which is usually translated as practical wisdom.[11]

6.3 Art and Artistry in Teaching

Aristotle thus provides a powerful argument for the idea that teaching is an art and not a science and also provides us with precise definitions of 'art' and 'science.' The key insight here is that teaching takes place in the domain of the variable, that is, the domain of actions and possible consequences, and the reason for this, to put it bluntly, is that in teaching we work with 'living material,' that is, with human beings who are capable of their own thought and action. What is also interesting about Aristotle's approach, is the distinction he makes between two different arts, that is, between two different ways of proceeding in the domain of the variable. One is the art of making, for which we need *techne*, which is the practical knowledge and the practical judgement about how to do things, and the other is the art of doing, for which we need *phronesis*, which is practical wisdom we need to judge what is to be done, which is the question what education is *for*. In this regard we could say that teaching is a 'double art,' which requires both educational craftsmanship – the 'techne' of teaching – and educational wisdom.

The final point to make here is that the 'how' of teaching and the 'what for' of teaching should not be seen as disconnected from each other. It is not that in education we can first set the goals and then just find the most effective and efficient way of getting there. The reason for this lies in the simple fact that the ways in which we proceed in education, the ways we teach, the ways we engage with our students, the ways we focus their attention, the ways we encourage them to study, are not just more or less effective interventions that happen behind the backs of our students. On the contrary, they are in full view of our students, and contain important messages for our students as well. This means that in addition to judgements about the purposes of our teaching, judgements about the way we try to balance the different domains of purpose, and judgements about possible trade offs in achieving a balance, we also need to judge the ways in which we teach. And this judgement is not just technical – is it effective or not for what we seek to achieve – and also not just

[11] Aristotle gives the following, more precise definition of *phronesis* as a "reasoned and true state of capacity to act with regard to human goods" (ibid, p.143).

moral – are the ways in which we teach morally acceptable – but also need to be educational, that is, to be judged in terms of the ways in which they may or may not contribute to the overall ambitions we have with our teaching. Put simply: punishment may be an effective means to achieve certain 'outcomes,' but is morally unacceptable. Using rewards (like paying our students for their efforts) may be effective and morally acceptable, but doesn't make sense educationally, because it treats students as objects rather than subjects in their own right.

If teaching is an art and, more specifically a 'double art' of craft and wisdom, then it is important that teachers keep working on their own educational 'artistry' (for the term see Stenhouse, 1988; Eisner, 2002), that is, their ability to make situated judgements about educationally desirable ways of acting in the always new situations they encounter. It is here that the whole question of the ongoing improvement of education finds its 'home,' so to speak, because, to quote Lawrence Stenhouse, "improving education is not about improving teaching as a delivery system [because] crucial is the desire of the artist to improve his or her art" (Stenhouse, 1988, p. 50).

7 Concluding Comments

In this chapter I have provided an outline of a theory of teaching. In terms of the overall ambitions of this book, I have argued that a *theory* of teaching needs to start with a *conceptualisation* of teaching, as it is only once we have an account or proposal of what teaching is, that we can begin to ask such questions as what teaching is for our how teaching takes place. With regard to the former question, I have suggested to conceptualise teaching as the art of (re)directing the attention of another human being aimed at what we might term 'attention formation.' Answers to the latter questions – such as what teaching is *for* and how teaching *takes place* – constitute (elements of) a theory of teaching.

In this chapter I have suggested that with regard to the question what teaching is *for* we should always consider three domains of purpose (qualification, socialisation and subjectification), whereas with regard to the question how teaching takes place I have suggested a theorisation of teaching that sees education as an open, semiotic and recursive system that operates with the principle of 'complexity reduction,' bearing in mind that if the complexity of the education system is reduced too much, education turns into indoctrination and thus loses its educational 'identity,' so to speak. It becomes, in other words, a different system.

The theorisation of teaching that I have proposed and presented in this chapter is subject-matter- and student-independent. It applies, in other words, across a wide range of subject-matters, perhaps first and foremost because it doesn't consider teaching in terms of the transmission and acquisition of particular subject-matter, but in terms of three domains of purpose. The question of what particular subject-matter should be presented to students is secondary to the question what we seek our students to achieve vis-à-vis the three domains. It also applies across different student populations, as it describes the dynamics of teaching. The question how we might direct or redirect the attention of our students in concrete situations with concrete students is a question that belongs to the domain of the artistry of teachers. This will require different 'solutions' depending on the focus and purpose of a particular session, curriculum or course, and depending on who the students are, what their background is, and so on, but it doesn't alter the general conceptualisation and theorisation of teaching itself.

The chapter thus show that we already have theories of teaching and in the theorisation I have presented I have relied upon theories of teaching that have been developed in the past, going back, to begin with, as far as Plato's account of teaching. A major concern underlying this chapter is that in the past decades the focus of many educators and educationalists and educational researchers has shifted from teaching to learning. In my work, including the work presented in this chapter, I have tried to redirect the attention of the field back to teaching as a key and, in my view, foundational and essential element of education (see also Prange, 2012). The work on theorising teaching doesn't stop here, of course, and whether the field of educational theory, research and practice will converge on conceptualisations and theories of teaching or will diverge, remains to be seen. From my own perspective any contribution that helps to restore the balance between the discourse on teaching and the discourse on learning would definitely be welcome.

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Chapter 10
Drawing on the Delphi Technique to Explore Areas of Convergence and Divergence Among Expert Opinions in the Field of Teaching

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Abstract The chapter brings together the individual chapter perspectives on theorizing teaching and thus initiating exchanges among the authors on outstanding issues and discrepancies to provide insights for how research on teaching may move forward. The Delphi study conducted for this aim was based on summaries of the answers of all individual chapters on three questions; authors were asked to rate and comment on each other's ideas. Comparing ratings and comments exposed the variability in the contributors' perspectives on (a) the existence, degree of development, and grain size of theories of teaching (first question), (b) the attributes of theories of teaching (second question), and (c) the process of developing theories of teaching (third question). We identify general trends with respect to these issues, leaving a more in-depth discussion for the next chapter.

Keywords Delphi study · Theories of teaching · Theorizing teaching

In the preceding chapters each author/author group presented their own views on theorizing teaching. Obviously, the authors highlighted different ideas on theorizing teaching and accordingly structured their chapters differently. Therefore, we initiated an exchange of ideas on theorizing teaching among the authors on the most

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critical issues on theorizing teaching. The chapter presents the results of this initial exchange whereas the next chapter discusses the convergent and divergent views presented herein in more depth.

1 The Approach Taken

The editors invited the contributors to participate in this synopsis and comparison exercise. They were all kind enough to agree and are thus listed, in alphabetical order, as co-authors for the chapter.

The editors selected three of the five questions all contributors had been given as a guide for writing their individual chapters (for the questions, see Sect. 2). The exercise was restricted to the three questions which were essential to the project since a follow-up exercise addressing all five questions would have been too burdensome. Also, the selected questions had elicited the most detailed responses and thus lent themselves to a more comprehensive analysis of the convergence and divergence of views.

For each chapter, the editors produced a synopsis of how the selected questions had been addressed by the author. For two of the questions, they also developed tables that summarized, rephrased, and organized the ideas to further distill the authors' opinions about the process of developing theories and their constituent parts.

In a member-check phase, the authors then went through the summary document to verify that it accurately reflected their thinking, and some summaries were revised to reflect their comments. The authors were then asked to indicate the degree to which they agreed with the ideas put forward by other contributors and to briefly expand on those aspects with which they disagreed, as well as reflect on the extent to which they thought a consensus view might be achieved in certain areas. It should be noted that to avoid overloading the authors, they were asked to read only the summaries provided, not entire chapters.

A Delphi method study typically consists of several rounds of structured communication with summaries and responses (cf. Linstone & Turoff, 1975), however for logistical reasons the authors in this book were asked to engage in only one round. We feel that even this single opportunity for the contributors to consider each other's answers to the questions posed and reflect on all of the ideas presented in the volume is very illuminating and can pave the way for more similar systematic interactions in the future.

2 Comparing and Contrasting Authors' Points of View

Sections 2.1 to 2.3 present the contributors' answers to the three questions. The questions can be found in the boxes at the beginning of each section. We present the authors' answers in text and/or tables, depending on the kind of information given. We provide a general commentary in the following sections but reserve a more detailed analysis for the next chapter.

2.1 Existence of Theories of Teaching

One question answered by all of you pertained to the existence of theories of teaching: "*Do we already have a theory/theories of teaching? If so, what are they?*"

As shown in Appendix A, answers to this question divide with respect to:

- The existence of theories of teaching (with some authors arguing that such theories definitely exist and providing examples of them, and others being more cautious about their existence);
- Their degree of development (with some authors arguing that they are already developed, others suggesting that we are at the very beginning of developing theories, and still others opining that theories should be thought of as constantly evolving); and
- Their grain size (with authors discussing small theories, partial theories, mid-range theories, general theories, or meta theories).

One could argue that this variation is to be expected given that scholars focus on different aspects of the complex phenomenon of teaching, using different lenses and approaches. However, one could counter that consensus needs to be reached on key issues in order to accumulate knowledge in the field. Therefore, we ask that you briefly (in 400 words max) address the following question:

Could and should consensus be reached in terms of the existence, degree of development, and grain size of theories of teaching? If so, why and how? If not, why?

2.1.1 Consensus Could and Should Be Reached Within Certain Programs and for Certain Purposes (Hiebert & Stigler)

Should consensus be reached on these elements of teaching theories? It depends on their ultimate purpose. If, as we believe, the purpose is to accumulate knowledge and steadily increase the community's understanding (and practice) of teaching, then we believe consensus is necessary on aspects of theories that enable researchers to build on the work of others and accumulate knowledge. This would require consensus on hypotheses that are important to test and revise. Consensus on hypotheses worth testing would require, in turn, consensus on the most pressing problems of teaching along with a common language to facilitate clear communication among researchers.

We are not arguing for consensus across the entire research community. We could imagine multiple productive programs of research progressing simultaneously. However, we are arguing that knowledge will accumulate only within programs, so the number of such programs must be relatively small (smaller than the number that exist now) for the field, as a whole, to show steady progress.

If the immediate purpose of theories is to explain and predict important phenomena, then similar points of consensus are needed. Research programs grow in richness and scope as theories are able to explain more fully and predict more accurately. We believe this happens when researchers pursue solutions to shared problems and can use the findings of others to improve their predictions and explanations. In many ways, we are arguing for the gradual but steady movement toward "normal science," in Kuhn's (1962) terms. Without such movement, the field can appear, from a big-picture perspective, to be accumulating random facts and unverified observations.

Accumulation of knowledge occurs, in part, through replications. Addressing questions of teaching effectiveness will always require sorting out effects that are constrained by context vs. those that have broader application. Replications are among researchers' best strategies for building knowledge that accounts for these constraints. And, replications require consensus among a community of researchers on the big problems of teaching and the hypotheses (local theories) that stand the best chance of addressing these problems.

2.1.2 Clarifying Underlying Assumptions Instead of Aiming to Reach Universal Consensus (Vieluf & Klieme)

Regarding the existence of theories, we believe that the very existence of this book project is proof that researchers have long started theorizing about teaching. Nobody shall deny the existence of THEORY as long as (a) there is ongoing, rigorous scientific debate on characteristics of teaching using general conceptual notions (which can be considered elements of a language of teaching theory), and (b) there are researchers claiming that their discourse on, reflection of or conceptualization of teaching is theoretical in nature. Second, we believe that there is no clear-cut, authoritative rule for deciding when the process of theorizing (or "doing theory", as we prefer to call it) has led to some (intermediate) results that qualify as "a theory". Setting up a demarcation line between "doing theory" and "establishing a theory" is a scholastic endeavor that does not lead to much scientific progress – at least if you were ready to accept philosophy of science beyond logical empiricism.

What is at stake, however, is the type and quality (or degree of development) of theoretical work on teaching. We think that there can be no universal answer to this question. Definitions of the term "theory" are multiple, so are quality criteria for theories and classification systems differentiating between types of theories. They depend on epistemological and ontological perspectives (see e.g., Abend, 2008; Zima, 2017). Therefore, it seems inevitable that conclusions concerning the status and the degree of development of existing theories of teaching differ depending on these perspectives. We further agree with Abend (2008) who argued that the evaluation of paradigms[1] should be left to the field of philosophy and, as long as there is no definite decision for the superiority of one or the other in the field of philosophy (which may never be the case), theories should be evaluated from within each co-existing paradigm. When researchers have largely similar perspectives and criteria, they should come to similar conclusions. Yet, researchers representing different paradigms are likely to disagree and then it is difficult to decide who is right, because this implies the philosophical question about the "right" epistemological and ontological perspective, which is – at present – not resolved, and possibly cannot ever be resolved. Rather, each perspective has strengths and limitations, so that they may be seen as complementing each other. So we argue against an attempt to reach a universal consensus on what a theory is and how it should look like. However, our argument underlines the importance of always making the own epistemological and ontological perspective and the own criteria for evaluating theories explicit when writing about theories and reflecting about them with the aim of realizing the limitedness of the own claims.

2.1.3 Reaching Consensus on a General Theory of Teaching Is Desirable (Scheerens)

I think that it would be helpful if consensus could be reached on what we mean by "theory". I was inspired by Snow's contribution by distinguishing meta-theory, theory, and grades of theory development. Then, prompted by the way the editors

[1] With the term *paradigm* we refer to a unique combination of ontology, epistemology, and methodology or to "a whole way of doing science, in some particular field" (Godfrey-Smith, 2003, p. 76). This understanding is inspired by Kuhn (1962). Yet, it should be noted that this is not the only meaning of the term discussed by Kuhn and also that we do not fully agree with Kuhn's perspective. In particular, we disagree with his idea that within a field only one research paradigm dominates during times of "normal science". Instead we think that different paradigms co-exist over long periods of time, for example within the field of education. Nevertheless we find the term "paradigm" useful for making the argument that understandings of and normative expectations towards "theories" are likely to depend on (possibly implicit) ideas of researchers about the nature, origin, and limits of human knowledge, on perspectives on the nature and relations of being, and on the preferred research methodology. For this reason we think that consensus on the questions raised by the editors can, at most, be reached among researchers who agree on those more fundamental questions.

framed the theme for this book, I made a distinction between **a** general substantive theory on teaching, and partial theories. A general theory of teaching could be conceived as comprising of a possibly exhaustive set of "building blocks", "sub-theories of teaching (Gage) or "dimensions". Two examples of such building blocks are structure and independence in teaching and classroom management. Partial theories refer to explanatory mechanisms associated with more specific aspects of teaching, like "direct instruction". Models in the sense of conceptual maps of variables in teaching might have less developed explanatory rationales, but just what Snow calls "formative hypotheses" about empirical associations.

The general answer to the question why consensus on a definitional framework on teaching theory is helpful is that it facilitates communication and exchange.

By reflecting on the meaning of a general theory on teaching and seeing this as the union of "building blocks", "sub-theories" or "dimensions", this opens an area of interesting comparison with comparable contributions, some of which also represented in this volume.

The distinction of partial theories and the way they might be connected to formative hypotheses linked with empirical models, points at a level where theorizing and empirical research could be brought together. As such this is probably the most productive level for progress, in both theory formation and empirical research.

2.1.4 Agreeing on Defining Theory Is Prerequisite for Reaching Consensus (Kyriakides et al.)

It is difficult to reach consensus on this question and this is due to the fact that each of us understands the term "theory" differently. So, we believe that it is necessary to provide and reach consensus firstly, on what we define as a theory of teaching. In our view, a theory could not only explain the complex nature of teaching but should also allow researchers to investigate its impact on learning and make predictions and suggestions of what they should observe in order to provide suggestions for improvement. Therefore, it is important to stress that a theory of teaching should be practical and testable. In this perspective, we argue that reaching consensus could be beneficial, but practically it could be very difficult to achieve. This is because, a theory may consist of both generic and contextual aspects which may vary depending on the educational context. Also, different researchers may have different research agendas and make use of their agenda in responding to this question accordingly. We also believe, that to reach a consensus a theory must be parsimonious and clear to the practitioners. To this end, we agree with McIntyre (1995), when he argues about the need for "practical theorizing" in teaching. This could be achieved, at least by focusing on the generic aspects of teaching, which could apply to different educational contexts and backgrounds. Therefore, we believe that it would be beneficial to agree on a more explicit and precise definition of a theory, to avoid receiving replies that do not necessarily reveal disagreement among the researchers but show that each researcher refers to theories of teaching having in mind his/her own research interests and specific research area.

2.1.5 Agreeing on Defining Teaching is Prerequisite for Moderate Consensus (Schoenfeld)

To elaborate on some of the themes in my chapter: where we don't have consensus is on the very definition of "teaching." Until that is clarified, people will be talking past each other. It may be that we need multiple definitions, and that the questions above should be asked for each of the definitions.

Specifically: If you define "teaching" as "the decision-making and actions taken by someone in the act of instruction," then the question is, do we have a theory of decision-making, and how well developed is it? I have argued that we do have such a theory – in my (Schoenfeld's) book *How We Think.* Such a theory is "value free," in that it does not say what a teacher *should do*; it says that if a teacher has certain resources (including knowledge), beliefs and orientations, and goals, then the teacher is likely to act in certain ways. Specifying the theory more completely in any particular context means knowing a particular teacher's resources, beliefs, and goals; that can never be done completely, but it can be done at a level of grain size that supports predictions consistent with teachers' behavior. The theoretical problem has been solved; the practical problems are something else entirely.

Many of the chapters, at least tacitly, take teaching to be a value-laden enterprise: we want teaching to result in specific kinds of student outcomes. First, I believe the focus should be on the learning environment, not simply the actions of the teacher. (This is elaborated on in my chapter.) Second, once one considers desired outcomes, the question has to be: "what outcomes, under what conditions?" There will never be complete consensus, in that different groups value different things; and because concepts such as "understand" can be illustrated but never completely specified. That said, for any particular set of values, one can specify classes of actions that support those values-in-action, and those that are problematic. The grain size has to be fine enough to enable reflection on the question "what will the impact of this particular action be?" along dimensions that count – but that's as much as one can do. Prescriptions don't work, because of the context-specificity of teaching.

2.1.6 Reaching Consensus through Intellectual Competition of Diverse Perspectives (Herbst & Chazan)

We think that the development of a scientific consensus will hinge on our capacity to reconcile community inclusiveness with intellectual competition based on fair and ambitious expectations, such as endurance and productivity.

We are reframing the question as "Will consensus be reached…? " and discuss what we think are the conditions of possibility for the development of such consensus. It seems unlikely to us that such a consensus will be reached, as it is not clear who is in need of such consensus and what material conditions favor such development. While goodwill may support initial investment in consensus development, the success of such effort requires discipline not only to put academics to work together but also to make their ideas work with and against each other. While inclusiveness and goodwill are needed for initial investment, the development of a scientific consensus cannot rely only on inclusiveness but needs also to aspire to qualities usually obtained through competition, such as parsimony and predictive power. The latter may only come to pass if our voluntaristic, inclusive efforts toward consensus are matched by the constraints imposed through limited resources and expectations of use that a patron, sponsor, or set of stakeholders can control.

These presses for consensus can use help from the policy field. International efforts such as TIMSS or GTI, or national efforts such as NAEP in the US, could become good partners for academics to put theories to work complementing and competing with each other. But that would require from these large studies to request proposals from theorists and establish general expectations for those proposals. It would also require a commitment to support the development of theory of teaching by creating arenas for competition among theories.

Thus, we should aim at establishing an infrastructure for the consensus-development process: Can we agree on a consensus-development process that relies not only on the value to include diverse contributions but also uses the mechanisms of social science to allow the ideas to compete? If so we could collaborate on lobbying large studies to accommodate competing resident theorists that agree on conceptual frameworks that accommodate constructs and instruments from different theories to allow the study of teaching at scale. Such search for consensus in conceptual framing and study design could be followed by parting ways in data analysis when theories might be pit against each other, and a third moment in which the competing theories could look for reconciliation on the basis of their accomplishments in the analysis of study data.

2.1.7 Cultural Embeddedness of Teaching Allows Only for Partial Consensus (Cai et al.)

There are two parts to this question: the "should" part, reflecting the desirability of working towards consensus if it is possible, and the "could" part, reflecting the possibility of reaching consensus. On the one hand, it is desirable to work towards consensus. We agree that there does need to be some consensus about theories of teaching, especially given that the phenomenon of teaching exists across the global community. It would be good if we could communicate about ways to teach students better (that is, to better help them to learn) by leveraging shared aspects of our theories. In this way, theories of teaching can provide us with shared bases to communicate with each other (globally) and also allow us to accumulate knowledge about theories of teaching as they continue to evolve.

On the other hand, even though we agree with the desirability of working towards consensus on a general level, the fact is that teaching is a culturally embedded activity that proceeds from (and is continuously entwined with) premises, conditions, and assumptions that can vary greatly across the globe. So, we believe it is not possible to achieve consensus on every aspect of a theory of teaching. That said, we believe we could reach consensus on the existence of theories of teaching, appropriately defined. However, their degree of development and their grain size are aspects that we believe can only achieve partial consensus at best.

2.1.8 Focusing on Functions and Purposes of Theory to Reach Some Consensus (Biesta)

I think that it would be helpful to reach a degree of consensus. One confusion that probably needs to be cleared up is what the function of theory is (the reference to the distinction between meta-theory and object-theory might be helpful here, but it depends on how meta-theory is understood, that is, whether meta-theory is seen as philosophy of knowledge or as an overarching theory of education). There are at least two rather different functions of theory which relate to different purposes for empirical research. The most important distinction is that between explanation (which in most cases means *causal* explanation) and understanding. If the aim of theory is to explain, then there is still the question what the theory should explain (Should it explain the act of teaching for example? Or should it explain the potential impact of teaching?). If the aim of theory is to understand, then there is again the question what it is that the theory should seek to understand. (Should it understand the decisions and judgements teacher make about their teaching, for example? Should it try to understand the complex network of classroom interaction through the perceptions of teachers and students?) And the 'what' question in both cases suggests that there is also theoretical work needed in order to *conceptualize* the object one wishes to theorize about. After all, in order to develop any theory about teaching, we need to begin with the question how we want to understand teaching *itself*. I see that some authors refer to theory in terms of hypotheses that can be tested in order to generate causal explanations, but that is only one possible role for theory. In addition to all this, theory can also play a heuristic role, that is, that it helps to bring certain phenomena into view. To look at the work of teachers through the lens of effectiveness gives, after all, a completely different picture than looking at it through the lens of affective relationships. My sense is that when some of these issues are clarified (which could be seen as 'meta-theoretical' work), it becomes possible to map different approaches to and engagements with theory around teaching. (For more on this see Biesta et al., 2011; Biesta, 2013, 2020).

2.2 Content of Theories of Teaching

You were also asked to reflect on the following question: "*What should a theory contain and why?*"

Appendix B summarizes the answers given. As can be seen in this appendix, the answers focus on different aspects. Attempting to bring some coherence and structure in a parsimonious way, we selected main ideas from the answers given, slightly rephrased them to enhance consistency, and organized them as shown in Table below.

(continued)

Could you please do the following:

1. Use this table to indicate the degree to which your chapter explicitly discusses the proposed element; for elements not captured, please indicate the degree to which you agree with them using the suggested answering format (entering an 'x' in the column chosen).
2. In a text (of no more than 500 words)

   (a) Please elaborate on 2–3 elements with which you (partly) disagree, explaining the reasons for your disagreement.
   (b) If need be, please:

   - Describe other elements that should be added to the list.
   - Identify any elements which you think are redundant and briefly justify your thinking.
   - Identify any concerns you might have with the proposed structure of the list.

	Included in my chapter	Not included in my chapter		
		Do not agree	Partly agree	Fully agree
A. **Basic assumption:** A theory is informed by or grounded in epistemological preferences, paradigms, methodologies, and ontological considerations.				
B. **Considerations about content and structure:** **A theory should …** Explain basic terms (teaching, learning, and the social)				
Explain what teaching is for				
Explain how teaching takes place				
Contain constructs covering various elements and features of classroom teaching and procedures operationalizing those constructs				
Explicitly provide the rationale for including certain teaching aspects				
Explain how categories of instances of practice form larger systems of practice such as lessons, units, courses, and programs of study				
Contain models linking different constructs with student learning and other constructs which have been a priori defined as desirable outcomes of schooling				
Link teaching to its antecedents				

(continued)

		Included in my chapter	Not included in my chapter		
			Do not agree	Partly agree	Fully agree
	Be specific enough to allow concrete connections among learning goals, teaching aspects, and student outcomes				
	Explain how the intended curriculum can be transformed into learning opportunities for students				
	Concurrently attend to issues of quality and equity				
	Have a multi-level character (taking into consideration the system and school level)				
	Explicitly attend to the conditions under which certain teaching aspects matter for student learning				
	Explicitly attend to the student populations for whom certain teaching aspects matter for student learning				
	Include resources for representing the practice of teaching				
	Include technical language for describing the practice of teaching				
	Include non-technical language for describing the practice of teaching				
	Provide the means to express relationships among different teaching aspects				
	Contain empirically falsifiable propositions				
	Include experimentally falsifiable explanations				
C.	**Considerations regarding the usefulness and usability of theories by practitioners:** **A theory should …** Guide practitioners' cause-effect reasoning that lies at the core of making instructional decisions				
	Be expressible in ways that practitioners can judge its face validity				
	Include a semiotic infrastructure that goes beyond language to support communication about teaching between researchers and practitioners				

Table 10.1 presents the authors' answers and each number represents one chapter. The numbers correspond to the order of the respective chapter in the book (for more information, see the notes for the table). Authors could choose between the two broad categories "included in my chapter" and "not included in my chapter" and were asked to indicate, for the second one, the degree to which they agree with these statements ("do not agree", "partly agree", "fully agree"). The editors included another column ("raising concerns") to list the chapters for which the authors partly agreed with the statement or did not choose any option but raised concerns in comments; the editors put the chapters in that column when the authors stated that the idea was included in their chapter, but they were concerned about some aspects of it or how it was phrased. Concerns were raised for the following reasons (the numbers in parentheses indicate the chapter number according to the table): (a) The ideas presented were considered incomplete (5), (b) the words chosen or the meaning conveyed by some of the statements were deemed inappropriate (5, 7), (c) the applicability of the statement content was limited (2, 5), and (d) authors disagreed with the emphasis implied in the statements about the content and the purpose of a theory (7). In the last column of this table, we also list any applicable authors' agreements and disagreements with these elements as well as their comments thereof. Although the authors listed their (dis)agreements and comments in a continuous text, to support the readability of the text, we decided to present these ideas when outlining each corresponding element, instead of presenting them at the end per author/author group, which would render it difficult for the reader to follow what ideas were expressed for certain elements.

Table 10.1 Attributes of theories of teaching

	Included in own chapter[a]	Not included in own chapter[a]			Raising concerns[a]	Comments[a]
		Fully agree	Partly agree	Do not agree		
A. Basic assumption: A theory is informed by or grounded in epistemological preferences, paradigms, methodologies, and ontological considerations	3, 4, 6	2, 7, 8	5	9		
B. Considerations about content and structure: **A theory should …** Explain basic terms (teaching, learning, and the social)	2, 3, 4, 6, 9	7	5, 8		3, 9	**5 (also applies to other elements, see below):** We don't think that certain aspects are relevant for developing a theory of teaching. For example, we don't see that it is necessary to provide an explanation about the meaning of basic terms such as teaching and learning because then we are losing focus and we are not going to have a parsimonious theory **8:** We only partly agree with the assertion that a theory of teaching should explain basic terms. Theories of teaching may use terms like teaching, learning, and the social, but these are terms from a wider discourse than simply theories of teaching. In mathematics, theorems rest on definitions of terms, but not every theorem needs to be accompanied (in its communication) by the entire collection of relevant definitions. That is, of course there are common terms that are used when discussing theories of teaching, but trying to be comprehensive about them is not really productive or even possible all the time. For some terms, the understanding is tacit (or contextual), whereas it may be helpful to explicitly explain other, more proximal terms, to the theory. For example, it is impossible to clearly and completely define what mathematics is; similarly, it is not necessarily all that helpful to do so when expressing a theory of teaching. To some degree, it must rely on common sense and a certain degree of description. Typically, there is no need for an extensive description of the basic terms **9 (also applies to other elements, see below):** I also see references to learning, and I think first of all that this term is not precise enough (learning to tie one's shoelaces is very different from learning the second law of thermodynamics; so just to refer to 'learning' without specifying what it is about and for, is not very helpful). I also think that not everything that matters in education has to do with learning; learning is only one way in which students can relate to the world, and education should open up other ways of being and relating as well.

(continued)

Table 10.1 (continued)

	Included in own chapter[a]	Not included in own chapter[a]		Raising concerns[a]	Comments[a]
		Fully agree	Partly agree	Do not agree		
Explain what teaching is for	3, 4, 6, 8, 9		2, 7	5	2, 3, 6	**7:** The requirement that a theory should "explain what teaching is for" is vague and there are options for how to make it less vague. We should accept that "what teaching is for" is variable culturally and historically. A theory should support research that seeks to understand how conflicting expectations of what teaching is for are negotiated in the crucible of practice. Our preferred interpretation of the requirement for theory to "explain what teaching is for" is aligned with the recognition that different stakeholders of education systems have different end statements and that those vary over time. The role of research is to understand the world; so, even if scientific understanding is situated historically and geopolitically and eventually should inform how the societies that sponsor it evolve, we seek to maintain a critical distance between scientific practice and social policy making. From this perspective, if we are given a world in which teaching exists, it is reasonable to ask what are the conditions that support that existence and how does variability in those conditions relate to the variability in the phenomenon itself. What are the factors that matter in allowing teaching to be what it is and constraining it from being something else, and how do those factors make teaching be what it ends up being? The answer to those questions emphasizes the irreducibility of teaching, as well as of its ends, as a practice rather than a production function: The ends of teaching are as much of an empirical phenomenon as teaching itself, and to grasp those ends, just as much as to understand teaching, we need a theory of practice. If a theory of practice is to explain what teaching is for, it should try doing so first for teaching that happens in a particular place where the same set of conditions may be operating. Formulating a theory of practice within a twenty-first century advanced post-industrial capitalist democracy that supports the growth of scientific knowledge may be one such way of scoping the enterprise. In that case, it may be feasible to hypothesize the types of stakeholders that matter to the practice of teaching and that may end up playing a role in the theory's capacity to explain what teaching is for. In our case, the four stakeholders knowledge, client, society, and organization added to the teacher's own self seem quite reasonable hypotheses for feeding an effort to explain empirically what teaching is for. The client perspective suggests that teaching is for students' learning, development, or emancipation. The knowledge perspective suggests that teaching is for the reproduction of the conditions of production of knowledge. The society perspective suggests that teaching is for the reproduction and/or progress of society's needs and values. The organization perspective suggests that teaching is for the preservation and growth of the education sector. And the perspective of the self suggests that teaching is for the employment and self-actualization of teachers. A theory of practice would consider how these different ends are present in practice and the explanation of what teaching is for might seek to discover emerging ends of a practice of teaching that emerges in a context where all those forces support and constrain its existence.
Explain how teaching takes place	2, 8, 9		3, 4, 7	5, 6		

Contain constructs covering various elements and features of classroom teaching and procedures operationalizing those constructs	2, 3, 4, 7, 8		6	5	3,9	
Explicitly provide the rationale for including certain aspects of teaching	2, 3, 6, 8, 9		4, 7	5	3, 6	
Explain how categories of instances of practice form larger systems of practice such as lessons, units, courses, and programs of study	3, 7, 8			2, 4, 5, 6	3, 9	**2 (also applies to another element, see below):** In our view, this element does not need to be addressed in a theory of teaching. Building on our response to Question 1, we evaluated the necessity of each element in Table 1 by asking whether a theory needed to contain that element in order to generate important or consequential hypotheses about classroom teaching. We believe that this element is not essential as theories of teaching are developing. In our view, hypotheses have yet to be formulated, tested, and revised that build a picture of the causal mechanisms of teaching that transform the curriculum (with the desired learning goals) into learning opportunities experienced by students and, in turn, into learning outcomes. Initially, this work will need to proceed with units of analysis that are small enough to study in detail and large enough to capture the classroom interactions that yield learning opportunities. As we have argued elsewhere, we believe the daily classroom lesson is the best candidate (Stigler & Hiebert, 2009). We expect that hypotheses regarding student outcomes over longer curriculum units will need to build on what researchers learn from work at the lesson level. Similarly, we believe that hypotheses about causal mechanisms of teaching can be formulated, tested, and revised without prior theorizing on the nested relationships among levels within the larger system of education. Beginning with the level at which teachers work--the classroom--makes most sense to us. However, explanations for student outcomes must consider the conditions under which students (and teachers) are participating. This will likely require appealing to considerations outside the classroom. But, we believe these are best pulled in as they are needed to develop explanations (and better predictions), not as a priori requirements of theories.

(continued)

Table 10.1 (continued)

	Included in own chapter[a]	Not included in own chapter[a]			Raising concerns[a]	Comments[a]
		Fully agree	Partly agree	Do not agree		
Contain models linking different constructs with student learning and other constructs which have been defined a priori as desirable outcomes of schooling	2, 3, 4, 8		6, 7	5	3, 9	**3 (also applies to other elements, see below):** The list includes many important aspects. However, a number of them make sense only within specific paradigms. For example, this element is important within the Educational Effectiveness/Teaching Effectiveness Paradigm (EER/TER), but not relevant, for example, from the perspective of a practice theoretical paradigm. Within the latter it is often explicitly avoided to determine which effects teaching should have from the perspective of the researchers. Instead, the ends and normative ideas included in practices are reconstructed from the empirical material without a priori normative expectations Fritzsche et al. (2010) **9 (also applies to other elements, see below):** The problem with quite a lot of the statements is that they lack context, and particularly the context mentioned above, that is, that it's not clear what kind of function(s) authors see for theory. I see that some statements are about causal explanation as the main (only?) role for theory. In my chapter I make the case that causality doesn't exist in education, and therefore any statement that seems to assume that causality does exist is, in my view, problematic. I also see references to learning, and I think first of all that this term is not precise enough (learning to tie one's shoelaces is very different from learning the second law of thermodynamics; so just to refer to 'learning' without specifying what it is about and for, is not very helpful). I also think that not everything that matters in education has to do with learning; learning is only one way in which students can relate to the world, and education should open up other ways of being and relating as well.
Link teaching to its antecedents	4, 8		2, 3, 5, 7	6	2, 9	**3:** See above under "Contain models linking different constructs with student learning and other constructs which have been defined a priori as desirable outcomes of schooling"
Be specific enough to allow concrete connections among learning goals, teaching aspects, and student outcomes	2, 3, 4, 5, 6, 7, 8				3, 9	**3:** See above under "Contain models linking different constructs with student learning and other constructs which have been defined a priori as desirable outcomes of schooling" **9:** See above under "Contain models linking different constructs with student learning and other constructs which have been defined a priori as desirable outcomes of schooling"
Explain how the intended curriculum can be transformed into learning opportunities for students	2, 7, 8	4	3, 5	6	9	**9:** See above under "A theory should explain basic terms (teaching, learning, and the social)"

Concurrently attend to issues of quality and equity	5, 6, 8	2	3, 7	4, 9	6	**3:** See above under “Contain models linking different constructs with student learning and other constructs which have been defined a priori as desirable outcomes of schooling” **4:** I disagree in the sense that – In my view – a theory of teaching should always address the association with educational outcomes, as a central criterion for judging the prescriptive validity of descriptive measures of teaching or as a measure of teaching effectiveness. Once having established effectiveness, assessing equity is just around the corner by assessing effectiveness for different sub-groups of students. However, explaining why what works for whom (equity) would require additional information and explanation as compared to just assessing effectiveness. The demand that a theory should concurrently attend to issues of quality and equity is therefore too demanding **8:** We were not sure about the element, “concurrently attend to issues of quality and equity.” does this encompass two different elements—Quality and equity—Or does this imply that quality requires equity?
Have a multi-level character (taking into consideration the system and school level)	4, 5, 7, 8, 9		3, 6	2	6	**2:** See above under “Explain how categories of instances of practice form larger systems of practice such as lessons, units, courses, and programs of study “ **3:** Practice theory has a “flat ontology” (Schatzki 2016), which implies that the criterion “have a multi-level character (taking into consideration the system and school level)” also is not relevant within this paradigm.
Explicitly attend to the conditions under which certain teaching aspects matter for student learning	2, 5, 6, 7, 8		3	4	6, 9	**4:** I partly disagree. An instrumental theory on teaching (instrumental to furthering student learning) should preferably generalize across all kinds of conditions. Only if conditions are defined as quite robust and “crude”, e.g., different subject matter areas, or teacher vs. technology transmission, should reference to conditions be attended to. Otherwise, the number of situational conditions soon becomes unmanageable from a research perspective **9:** See above under “A theory should explain basic terms (teaching, learning, and the social)”
Explicitly attend to the student populations for whom certain teaching aspects matter for student learning	5, 6, 8	2	3, 4, 7		9	**9:** See above under “A theory should explain basic terms (teaching, learning, and the social)”
Include resources for representing the practice of teaching	2, 7, 8		3, 6	4, 5	6, 9	**4:** I do not see how a theory is supposed to include resources and I do not see what representing the practice of teaching means in this context **5:** See above under “A theory should explain basic terms (teaching, learning, and the social)”

(continued)

Table 10.1 (continued)

	Included in own chapter[a]	Not included in own chapter[a]			Raising concerns[a]	Comments[a]
		Fully agree	Partly agree	Do not agree		
Include technical language for describing the practice of teaching	2, 6, 7		3, 4, 5	8	2, 6, 9	**5 (also applies to another element, see below):** What we consider important is to elaborate more on the why and how a theory of teaching is related with other relevant theories, and especially with theories of learning. This is important as the two groups of theories should be strongly interrelated. This is especially relevant for the items referring to the use (or not) of technical language. In our view, a theory should make explicit to every stakeholder the main principles and aspects of the theory. In the case when a technical term has to be used this is not a necessarily a problem, since the question is whether not only the research community but also teachers (as professionals) find the theory explicit, clear and useful **8:** We do not agree with the assertion that a theory of teaching should include technical language for describing the practice of teaching (although this depends, perhaps, on what exactly is meant by "technical" language). Fundamentally, we believe a theory of teaching has to be applicable and be able to serve as a guide for teachers to actually enact the principles therein in their classrooms. Technical terms, although they can be helpful in speaking precisely, can easily fall into the trap of obscuring plain meanings. This can prevent teachers from easily being able to make use of theory without an unnecessary additional investment of time and energy to decode language. We strongly believe that the language used in theories of teaching should be made as plain as possible to encourage communication among researchers and teachers. Moreover, the kinds of research that we envision in the two-way street of teaching for theory and theory for teaching are often very "close to the ground," meaning that we are often observing and describing phenomena that should be able to be captured in ordinary language. If a new technical term is truly needed, it should be crafted to help convey its meaning as transparently as possible. It might make sense to move this element to the usefulness and usability category (category C).
Include non-technical language for describing the practice of teaching	7, 8		2, 3, 4, 5	6	2, 9	**5:** See above under "Include technical language for describing the practice of teaching" **8:** It might make sense to move the "technical terms" and "non-technical terms" elements to the usefulness and usability category (category C).
Provide the means to express relationships among different aspects of teaching	2, 4, 5, 7, 8, 9		3, 6		6	

Contain empirically falsifiable propositions	4, 7, 8		3, 5	2	6, 9	**2:** In our view, this element does not need to be addressed in a theory of teaching. We agree with the importance of what we presume to be the motivation for this element--theories grow as propositions are tested and refined. We also appreciate much of what Karl Popper–a primary proponent of making progress through falsifying propositions–said about the development and improvement of scientific theories. However, for theories of teaching, we find more helpful Popper's (1944/1985) discussion of processes for testing and revising hypotheses in the social sciences. Advocating "piecemeal tinkering," Popper saw social scientists as social engineers who achieve their goals through "… small adjustments and re-adjustments which can be continually improved upon. … The piecemeal engineer knows … we can learn only from our mistakes. Accordingly, he will make his way, step by step, carefully comparing the results expected with the results achieved, and always on the look-out for the unavoidable unwanted consequences of any reform; and he will avoid undertaking reforms of a complexity and scope which make it impossible for him to disentangle causes and effects, and to know what he is really doing" (p. 309). Rather than requiring hypotheses that are falsifiable, we suggest requiring hypotheses that can be tested and then refined to increase the precisions of the predictions and the adequacy of explanations. We envision theories of teaching growing incrementally through repeated local tests of targeted predictions rather than through large experiments designed to make possible the falsifying of claims **3 (also applies to another element, see below):** This criterion makes sense only within critical rationalism and is irrelevant from constructivist or poststructuralist epistemological positions **8 (also applies to another element, see below):** We were not sure what the intended difference is between "contain empirically falsifiable propositions" and "include experimentally falsifiable explanations." is the latter meant to be a subset of the former?
Include experimentally falsifiable explanations	4, 7		3, 5, 8	2, 9	6	**3:** See above under "Contain empirically falsifiable propositions" **8:** See above under "Contain empirically falsifiable propositions"

(continued)

Table 10.1 (continued)

	Included in own chapter[a]	Not included in own chapter[a]			Raising concerns[a]	Comments[a]
		Fully agree	Partly agree	Do not agree		
C. Considerations regarding the usefulness and usability of theories by practitioners: **A theory should …** Guide practitioners' cause-effect reasoning that is at the core of making instructional decisions	2, 3, 5, 8			3, 9	6	**3:** One of the two criteria we disagree with more fundamentally is "guide practitioners' cause-effect reasoning that lies at the core of making instructional decisions", because this appears to make a "teaching and learning short-circuit" (Holzkamp, 1993) and suggest to teachers that teaching is a social technology and that they can determine with their behaviour what happens in the classroom and how students develop. Such a view has been contested from many theoretical positions and also based on empirical research (Hartmann et al., 2016) **6 (also applies to other elements, see below):** Again, I find that there is confusion about what a theory is, what should be done to improve instruction, and how to communicate that. The considerations under (C), for example, are important – But they're not part of a theory. The goals of a theory should be to (a) understand something; (b) to, if you wish to work in particular directions, specify what it takes to work in those directions. By way of metaphor: Suppose I wanted to develop a theory of economics. The goal would be to specify how any why an economy works. Then, suppose I wanted to create an economy that eliminated poverty. That's a value statement. I'd be identifying the subset of things, consistent with the general theory, that produced the desired outcomes. Those are (a) and (b). Communicating aspects of these effectively may be necessary to move in the desired directions, but they're not part of the theory. It seems to me that the field needs consensus, first, on what a theory is; second, on desirable goals; third, on the kinds of knowledge and understandings that would enable us to reach those goals. That third point – Which, at some level, is the point of this enterprise – Is a matter of *engineering,* not theory. That's part of the confusion (and beyond any one volume). It's not clear how much the construction of new airplanes over the past decade has added to the theory of aerodynamics – But the engineering knowledge developed has been substantial **9:** See above under "contain models linking different constructs with student learning and other constructs which have been defined a priori as desirable outcomes of schooling"

Be expressible in ways that practitioners can judge its face validity	2, 5, 7, 8	4		3, 9	6	**3:** Another criterion with which we disagree more fundamentally is "be expressible in ways that practitioners can judge its face validity". This criterion implies that theories are generally formulated for practice – An assumption that also can be contested more fundamentally. Given the complexity of the social, limiting theories to what can be formulated in a way that is easily understood by practitioners seems an unnecessary restriction and we argue that the aim of research is more than just informing practice. Science in general needs to support transfer into practice – Yet, this transfer is not part of the theory as such **6:** See above under "A theory should guide practitioners' cause-effect reasoning that is at the core of making instructional decisions"
Include a semiotic infrastructure that goes beyond language to support communication about teaching between researchers and practitioners	2, 7, 8	6	3, 5	4	2, 4, 6, 9	**6:** See above under "A theory should guide practitioners' cause-effect reasoning that is at the core of making instructional decisions" **8:** We were not sure exactly what was meant by "semiotic infrastructure beyond language." for us, going beyond language falls into the category of what we proposed about using artifacts and teaching cases to convey and to store and improve a theory of teaching. If that counts as "semiotic infrastructure beyond language," then we believe the element is at least partly redundant with "include resources for representing the practice of teaching"

[a]*Note*. 2 = Hiebert & Stigler, 3 = Vieluf & Klieme; 4 = Scheerens; 5 = Kyriakides et al.; 6 = Schoenfeld; 7 = Herbst & Chazan; 8 = Cai et al.; 9 = Biesta

Commenting on these elements more generally, some authors also noted the following:

Vieluf & Klieme: The list includes many important aspects. However, a number of them make sense only within specific paradigms. Hence, it appears difficult to argue that theories generally "should" contain these elements. Yet, we do think that they "could", that they can be relevant criteria from a specific epistemological and ontological perspective.
***Kyriakides* et al.**: Table 1 consists of some important aspects but we need to be careful on deciding if those are relevant for developing a theory of teaching. In this perspective, we have used the "partly agree" to stress that we don't think that those aspects of theory of teaching are necessary.
***Cai* et al.**: We would add "A theory should include clear learning goals." Even though some entries in the table involve learning goals, it is important for a theory of teaching to explicitly include clear learning goals (to which the theory is relevant).
Biesta: This list is a further argument that without some kind of map of the different roles/functions/usages of theory, it is difficult to judge individual statements about what theory should include.

2.3 Process of Developing Theories of Teaching

Another question answered by all of the authors pertained to the process of developing (comprehensive) theories: "*In the future, in what ways might it be possible, if at all, to create a (more comprehensive) theory of teaching?*"

We compiled the answers received in Table below to provide a basis for a discussion about what aspects are important for developing theories (for a detailed list, see Appendix C).
Could you please do the following:

1. Please use the table below to indicate the degree to which your book chapter explicitly captures the proposed aspect; for aspects not captured, please indicate the degree to which you agree with them using the suggested answering format (entering an 'x' in the column chosen).
2. In a text (of no more than 400 words)
   (a) Please elaborate on the aspect with which you agree the most and the aspect with which you disagree the most, clearly providing your rationale.
   (b) If need be, please also describe other aspects that should be added to the list.

(continued)

	Included in my chapter	Not included in my chapter		
		Do not agree	Partly agree	Fully agree
1. Making explicit the commitments on which theories are built				
2. Acknowledging the limitations of existing models/theories				
3. Bringing together different perspectives, paradigms, and theories to identify "blind spots" of each and reflect on irreconcilabilities				
4. Reaching consensus on shared rules of engagement (e.g., dealing with tensions among sets of competing values such as ecumenism and consistency, complexity and parsimony)				
5. Developing theories in a way that they provide mechanisms to help teachers move in productive directions				
6. Acknowledging the dynamic and co-evolving character of teaching and theory				
7. Pursuing a piecemeal, bottom-up development of theories, rooted in the analysis and synthesis of empirical research outcomes.				
8. Following a series of steps to develop/enrich theories of teaching (a) Generate concrete hypotheses (drawing on empirical data, if available)				
(b) Continuously test and revise predictions suggested by the hypotheses				
(c) Coordinate the work of teachers and researchers to test predictions and revise hypotheses				
(d) Aggregate findings across classrooms and search for patterns that rise above specific contexts				
(d) Find ways to create sustainable partnerships between teachers and researchers, and build networks of partnerships				
(f) Continue to expand the scope of the theory generated.				

Table 10.2 presents the answers by the contributors where each number represents one chapter (see the notes for the table). The answer categories correspond to the ones for Table 1. Reasons for raising concerns about the statements in Table 2 were: (a) the words chosen for some of the statements were deemed inappropriate (7) or (b) the authors disagreed with how the statements about content and purpose were focused (5, 7). Following a similar approach to that pursued above, instead of listing the authors' comments as a unified text, we preferred to list them in the last column for each aspect under consideration.

Table 10.2 Process of developing theories of teaching

	Included in own chapter[a]	Not included in own chapter[a]			Raising concerns[a]	Comments[a]
		Fully agree	Partly agree	Do not agree		
1. Making explicit the commitments on which theories are built	3, 5, 6, 7, 8, 9	2			4	**3:** We agree in particular with the statement: "Making explicit the commitments on which theories are built". We find it important to be explicit concerning the own stance within the diversity of possible epistemological, ontological and methodological perspectives, because these open up different ways of analysing social phenomena, but also have different blind spots. Positioning oneself within this diversity makes it easier for the reader to critically assess a theory. This necessity becomes especially clear when the theoretical discourse combines different paradigms, as we do in our chapter, which however is rarely done in educational research **4:** I think the term "commitments" in this context is ambiguous. The only "commitment" on which theories are built is to further knowledge. I would rule out commitment to political objectives.
2. Acknowledging the limitations of existing models/theories	2, 3, 4, 5, 6, 7, 8, 9				2, 6	**3:** A second statement we agree with is: "Acknowledging the limitations of existing models/ theories". Because theories can be considered to be necessarily "under-determined by empirical 'facts'" (Reckwitz 2002, p. 257), reflecting limitations of theories appears to be particularly important for their further development, but also to prevent unfounded claims to a singular truth that may not even exist.
3. Bringing together different perspectives, paradigms, and theories to identify "blind spots" of each and reflect on irreconcilabilities	3, 4, 9		5, 6, 7, 8	2	3	**8:** We least agreed with #3 (although we do partly agree with it). Of course, trying to use different paradigms or perspectives may allow us to see things we might not see from a single paradigm or perspective. However, especially if perspectives are irreconcilable, this is really at a high level of abstraction. Within the ongoing back-and-forth of teaching and theory for teaching, we feel that one should at least attempt to choose a perspective or paradigm that is maximally helpful in making progress on the specific problem of practice that is at hand.

4. Reaching consensus on shared rules of engagement (e.g., dealing with tensions among sets of competing values such as ecumenism and consistency, complexity and parsimony)	7, 8	4, 6	5, 9	2, 3	9	**2:** We interpret this strategy to recommend researchers and/or theorists create consensus by talking with each other, comparing "rules of engagement" and "sets of competing values" and moving toward consensus through conversations and debates. Our point of view is somewhat different in two respects. First, although we agree that consensus is useful, we believe the consensus that drives theories forward is consensus on teaching problems and hypotheses that address these problems (see our response to question 1). Second, we believe the most productive path toward consensus is shared observations of potential teaching problems in classrooms. Consensus is more likely when researchers have seen the same phenomena in classrooms and jointly construct hypotheses that should be tested, repeatedly, in multiple settings by multiple researchers. **3:** A statement we disagree with more fundamentally is: "Reaching consensus on shared rules of engagement (e.g., dealing with tensions among sets of competing values such as ecumenism and consistency, complexity and parsimony)". The reason is that searching consensus between different positions is certainly an important part of the process of theory development. Yet, acknowledging and reflecting disaccord also is important. For many issues it appears even questionable whether it is possible to "reach" consensus, because theories always involve assumptions that can hardly be empirically tested – starting with the question whether and how theories need to be empirically tested (see e.g., Kuhn, 1962). Also, in the field of pedagogy some values appear to be fundamentally irreconcilable. Some dilemmas and contradictions inherent in pedagogical practice can only be addressed with reflection, but never be solved (for a more detailed discussion of fields tension within pedagogy see e.g., Helsper et al., 2001). Thus, we think that searching for consensus is an important part of science, but often a process without an end **9:** My concern here is that this statement seems to assume a particular role for theory and, as I have said above, we first need to clarify these different roles and functions before statements such as this one can become meaningful.

(continued)

Table 10.2 (continued)

	Included in own chapter[a]	Not included in own chapter[a]			Raising concerns[a]	Comments[a]
		Fully agree	Partly agree	Do not agree		
5. Developing theories in a way that they provide mechanisms to help teachers move in productive directions	2, 3, 4, 5, 6, 8, 9			7	6, 9	**5 (comment also applies to item 6):** The dynamic character of education as well as its multilevel structure should be considered in establishing a theory of teaching. Moreover, we don't see the point of developing a theory of teaching that cannot be used for improvement purposes. We need to find ways to establish stronger links between research and practice and this should be the ultimate aim of developing a comprehensive theory of teaching. For example, in our chapter we refer to the dynamic approach to school improvement (DASI), which was based on the dynamic model of EER, aims to establish stronger links between the EER and school improvement initiatives. DASI promotes the design of school improvement projects that are based on a theory which has been tested and refers to school factors that need to be considered in introducing a change (Kyriakides, et al., 2021) **6 (comment also applies to item 6):** I find the framing of both questions 5 and 6 to be problematic. The question is, are you talking about a theory of (a) the decision-making a teacher engages in, in the classroom or (b) specific actions that result in desired types of student learning? We have a theory of (a); issues of type (b) implicate a theory of *teaching and learning,* which to me are not the same as a theory of teaching. By way of analogy, consider a theory of human metabolism – The goal being to understand how human environment, intake, and exercise affect one's bodily health. That's a theory that describes the impact of things, for good or for bad – "This is how things work." (the same applies, for example, to a theory of climate change.) That's a theory of type (a): It should explain what happens, no matter what the input. Diet advice is of type (b). What's being confused is what happens when people want to have a theory of "good" or "effective" teaching. That's a matter of applications, of type (b). To continue the analogy, suppose you have a theory of metabolic function. If you want to be healthy, you worry about your intake, your exercise, etc. if you want the earth to survive, you worry about climate change. Clearly then, there's a dialectic between theory and understanding of practice – Analogous to the interaction of teaching and learning. If you want students to emerge from classrooms as knowledgeable, flexible, agentive learners, you study what helps that to happen, and you communicate that to teachers. Communicating useful ideas to teachers is essential for improvement, but it is not part of a theory of teaching, any more than telling people to conserve energy is – While beneficial – a contribution to the theory of climate change. For me, that's why we have to clarify what's entailed in any theory (of teaching, or of teaching and learning) before asking questions of type 5 and 6

						7: In our view, the first order of business is to identify what is the purpose of theory-making. A consensual theory seems a tall order, and it is even taller if we don't even know for what it is that we need a theory. We argue that we (as the research field) need *theory in order to improve research on teaching, and reciprocally, we need research on teaching to contribute to the improvement of theory of teaching*. While the practice field might also need (prescriptive) theories to improve teaching practice, there are many people already doing those things. The existence of different prescriptive theories of teaching is good for our business in that it creates enough variability in teaching that we can justify the need to have general ways of understanding the work of teaching that happens. Furthermore, because change is the currency of policy-making and of the marketplace, we know that those prescriptive theories will continue to emerge. The role of descriptive and explanatory theory then is to provide researchers the means for studying the avowed enactment of those prescriptive theories as well as of intact practice and to be able to compare them as variations in practice (rather than only in terms of their outcomes). We need to ask ourselves what is this moment in our field? At which stage are we? Are we committed to understanding scientifically the world of practice or are we just advocating for a particular vision for practice? If we don't want to be a scientific field, there may be no point in developing a theoretical consensus, as consensus on a prescriptive theory can easily conjure images of colonialism and globalism. But if we think that developing a theoretical consensus is a step toward making *the study* of mathematics teaching more scientific, this consensus needs to be oriented to *empowering research* on teaching. Theory is needed to guide research. The purpose of theory is very practical, it is to enable the development and the confirmation of scholarly knowledge. This may include representing the knowledge we have, but this representation needs to be aimed at knowledge producers, directed to researchers rather than to teachers, and directed to being used in research. If we agree that the need for theory is to empower research, middle range theory can be a mechanism for consensus development. Middle range theory defines conceptually its scope of work and develops its constructs and propositions empirically. Middle range theory helps aggregate and understand results of empirical research as well as direct more empirical research where that research is needed.

(continued)

Table 10.2 (continued)

	Included in own chapter[a]	Not included in own chapter[a]			Raising concerns[a]	Comments[a]
		Fully agree	Partly agree	Do not agree		
6. Acknowledging the dynamic and co-evolving character of teaching and theory	2, 5, 8	3, 7		4	6	**3:** "Acknowledging the dynamic and co-evolving character of teaching and theory" is also in line with the more constructivist understanding of theory building that we lean towards **5:** See comment above in item 5 **6:** See comment above in item 5 **8:** We most agreed with #6, because we believe that progress in increasing the comprehensiveness of a theory of teaching depends on harnessing the two-way street between teaching for theory and theory for teaching. Without an ongoing, explicit, and deliberate interplay between these two, neither can make much useful headway.
7. Pursuing a piecemeal, bottom-up development of theories, rooted in the analysis and synthesis of empirical research outcomes.	2, 3, 4, 6, 8		5	7, 9	9	**2:** Given our responses to the previous questions, it is no surprise that we agree with this approach as a possible way to create more comprehensive theories of teaching. We do not expect useful theories to be fashioned from the heads of theorists. Rather, we assume that hypotheses about teaching effectiveness--about causal relationships between teaching and learning--to emerge from observations of classroom interactions. Hypotheses are then refined as their predictions are tested, empirically, and theories grow as hypotheses build on each other and accumulate over time. We find it interesting that the same process used to create this chapter (a Delphi study) would be especially useful for building on others' work to improve *predictions*. If researchers were addressing the same problems, then comparing predictions and sharing data and rationales could help individual researchers--and the group as a whole, build from empirical outcomes to not only improve their predictions but increase the richness of their explanations or, said another way, their understanding of the problems they are investigating **4:** In my view theories on teaching should not be developed "from the armchair", but, next to obtaining good ideas from any source, be it history or hermeneutics, be strongly tied to empirical research outcomes **9:** My concern is, once more, that much depends on what we see as the roles and functions of theory. In addition, I am not sure that it is possible to build up theory from empirical research outcomes, because such outcomes are generated in particular ways, and thus already contain many assumptions.

8. Following a series of steps to develop/enrich theories of teaching (a) Generate concrete hypotheses (drawing on empirical data, if available)	2, 5, 6, 8	4	3, 7	9		**9:** All these elements (8a-8e) seem to assume that the role of research is to provide causal explanations through hypothesis testing. This is only one role for research and in my view one that is not achievable in education.
(b) Continuously test and revise predictions suggested by the hypotheses	2, 6, 8	4	3, 5, 7	9		**9:** See comment above under (8a)
(c) Coordinate the work of teachers and researchers to test predictions and revise hypotheses	2, 8		3, 4, 5, 6, 7	9		**9:** See comment above under (8a)
(d) Aggregate findings across classrooms and search for patterns that rise above specific contexts	2, 5, 6, 8	7	3, 4	9	9	**9:** See comment above under (8a)
(e) Find ways to create sustainable partnerships between teachers and researchers, and build networks of partnerships	2, 8, 9		3, 5, 7	4, 6		**4:** Anyone is welcome to the process of theory development, particularly also teachers and researchers. "Sustainable partnerships" is a term from organization consultants, who are not needed for obvious cooperation between knowledgeable and interested parties **9:** See comment above under (8a)
(f) Continue to expand the scope of the theory generated.	2, 3, 5, 8, 9	4	6, 7			

[a] *Note*. 2 = Hiebert & Stigler, 3 = Vieluf & Klieme; 4 = Scheerens; 5 = Kyriakides et al.; 6 = Schoenfeld; 7 = Herbst & Chazan; 8 = Cai et al.; 9 = Biesta

In addition to their comments for particular statements, the authors also provided some more general comments:

- ***Vieluf & Klieme*****:** With several criteria we agree only partly, because, again, they appear to make sense from specific epistemological and ontological perspectives only.
- ***Scheerens*****:** Maybe an addition to the list might be: bringing together authors who have addressed theories on teaching from various perspectives and encourage exchange between them. In other words what the editors of this volume have initiated, and which could hopefully continue.
- ***Kyriakides*** **et al.:** We don't agree with those that consider important to refer to the content of teaching. The content of teaching is an area that may be of interest to the field of philosophy of education or to those working in the area of curriculum development. We don't think that we have the right to refer to the content because there are other mechanisms and procedures that need to take place to give answers to questions about the content of a curriculum which have to do with the context and other characteristics of a specific educational system. This is also strongly influenced by cultural factors.
- ***Cai*** **et al.:** We would argue that developing more comprehensive theories of teaching requires an artifact—some kind of embodied object—that serves to store the theory and the ongoing development of knowledge related to the theory. In a sense, the artifact is the theory of teaching made into a thing that can be accessed, shared, modified, and updated as those who are using the theory slowly deepen or widen the theory. In our chapter, we have highlighted teaching cases in China as an example of an artifact and discussed features that this potential artifact must have to successfully embody the dynamic relationship between theory for teaching and teaching for theory (see Cai & Hwang, 2021, for details).

3 Summary

The purpose of this chapter was to offer the scholars participating in this endeavour a venue for an initial exchange of ideas on theorizing teaching, in the form of commenting on a summary of perspectives expressed in the previous chapters. This exercise exposed the huge variance in the contributors' perspectives on (a) reaching consensus about the existence, degree of development, and grain size of theories of teaching (first question), (b) what a theory of teaching should contain (second question), and (c) the process of developing theories of teaching (third question). Below we briefly summarize this variance, reserving a more in-depth discussion for the following chapter.

Comparing the authors' answers to the first question reveals that not only was there no agreement that a consensus could be achieved but it was not even generally accepted that consensus should be a goal. In their responses to the second question, although the authors did not all agree with any one statement, there was more consensus. Most of the contributors agreed that "A theory should explain basic terms" and "A theory should provide the means to express relationships among different teaching aspects", whereas few agreed that "A theory should include experimentally falsifiable explanations" or "A theory should concurrently attend to issues of quality and equity". The third question elicited a similar pattern of responses, although there seems to be more consensus on the process of developing theories (third question) than its content (second question). A notable number of authors seemed to agree with some statements, but once again there was no single statement with which they all agreed. The responses ranged from statements with which a large proportion of the authors agreed (e.g., "Acknowledging the limitations of existing models/ theories" or "Developing theories in a way that they provide mechanisms to help teachers move in productive directions") to statements for which considerable disagreement emerged (e.g., "Reaching consensus on shared rules of engagement" or "find[ing] ways to create sustainable partnerships between teachers and researchers, and build[ing] networks of partnerships").

A thorough discussion of potential reasons for the heterogeneity of author opinions as well as practical options for moving the topic of theorizing teaching forward is presented in the following chapter. Methodological restrictions of the approach taken are also discussed, among others, the challenge that the two levels of reduction in developing the statements for rating and commenting might have caused misinterpretations of each other's intended meanings.

Appendices

Appendix A

Do we already have a theory/theories on teaching? If so, which are they?

Hiebert & Stigler	The authors argue that, "[T]heories of teaching are necessarily so complex that they are only in progress; they are never complete. The status of a theory can be measured by the number of hypotheses that have been formulated, the range of classroom learning events they can predict, and the state of empirical confirmation of these predictions. Using these criteria, we would say the field has theories at the very beginning stages of development. Often, the 'theories' are more like small collections of hypotheses that still need to be fully tested" (pp. 47). The authors also maintain that in the future "small theories" rather than a comprehensive theory of teaching will be useful to teachers (p. 48).

(continued)

Vieluf & Klieme	The authors emphasize that "there is a multitude of theories of teaching (for the German speaking context see e.g., Lüders, 2014)", but not providing further detail (p. 84). They present and further develop the *Three Basic Dimensions* [TBD] as one theory of teaching quality. Their theoretical conceptualizations are based on two distinct paradigms: The paradigm of Teaching Effectiveness Research [TER], which includes the Three Basic Dimensions Theory, and the paradigm of Practice Theories. Each paradigm is believed to include multiple individual theories - some broad and general, some addressing a narrower range of phenomena.
Scheerens	The author makes a distinction between different types of theories in the field of educational effectiveness: – *Meta-theory* (i.e., a theory concerned with the development, investigation or description of theory itself). The author provides the example of "context, input, process, and outcome indicators" as a meta-theory illustrating the logical structure of causal conditions leading from teaching to learning. – *Substantive theories on teaching effectiveness* (i.e., defined in close connection to the state of the art of empirical research). The author distinguishes this category into: • *General theories:* e.g., process structure and independence in teaching; classroom management • *Partial theories*: e.g., direct teaching, social-emotional support in teaching. In concluding the chapter, the author notes, "There is growing consensus on core sub-theories on teaching in the sense Gage refers to these, while others prefer to speak of core dimensions […]. Still some contributions might not be called theories by everyone. In an earlier contribution (Scheerens, 2013) I concluded that conceptual maps and dimensional models reflect the state of the art. Snow's levels of theory development supports calling models, and "summaries" of empirical findings "theories" be it at a low level on his scale. Occasional applications of "eclectic" use of more established theory from basic disciplines is seen as an instance of gradual progress towards a higher level of theory. From the perspective of the educational effectiveness paradigm the key issue is the explanation of the findings by means of a plausible and established causal mechanisms." (p. 126)
Kyriakides et al.	The authors refer to different theories of learning that have been developed mainly from educational psychologists and which had an impact on developing specific theoretical models of teaching and learning. Throughout the chapter, they refer to different such theories (e.g., motivation theories, cognitive load theory, organizational theories). The authors also conclude by pointing out that the *Dynamic Model of Educational Effectiveness* provides a starting point for developing a comprehensive theory in the field.

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Schoenfeld	"I claim that we already have a theory of teaching, which specifies that teachers' in-the-moment classroom decisions can be modeled by attending to three major factors: the resources at their disposal (both their knowledge and material resources), their orientations (beliefs, preferences, values, etc.), and their goals (which exist at multiple levels and change dynamically according to evolving events). Beyond that, the Teaching for Robust Understanding (TRU) framework indicates that five dimensions of learning are consequential and comprehensive – the degree to which the environment: offers affordances for rich engagement with content; operates within the students' zone of proximal development; supports *all* students in engaging with core content; provides opportunities for students to contribute to classroom discourse and develop a sense of agency and disciplinary identity; and, reveals and responds to student thinking. Combining these two theoretical frames yields a theoretical specification of what has been called "ambitious teaching."" (p. 159)
Herbst & Chazan	In their chapter, the authors present *practical rationality of mathematics teaching* as a middle-range theory of teaching. According to Merten's (1949) work, middle-range theories lie in between specific hypotheses (amenable to be tested empirically) and grand theories ("being large sets of ideal constructs designed speculatively to be used to read the world", p. 192). Such theories can be developed through the practice of research. The authors conclude: "There are multiple kinds of theories of teaching. Some theories describe the work of teaching. Herbst & Chazan (2017) reviewed how different theories rely on different conceptualizations of teaching, behavioral, cognitive, social interactionist, sociocultural, and more. Practical rationality aspires to explore complementarities and contrasts with all of those. There also are accounts of teaching that attempt to prescribe what teaching should look like in order for it to achieve some desired ends. While not often called theories, expressions like ambitious instruction, complex instruction, direct instruction, equitable practice, inquiry oriented instruction, student-centered instruction, and others have been used to designate some aspirational kinds of teaching that can have the force of prescriptive theory. Insofar as practical rationality is a fundamental theory of teaching, its goals are to describe and explain all kinds of teaching, not to prescribe a particular kind of teaching." (p. 219)
Cai et al.	The authors maintain that "it seems that there are many different potential theories of teaching, but they span a wide range of grain sizes and attend to many different aspects of teaching" (p. 238). The authors also argue that the theories should be seen as being in constant development ("theory keeps evolving along with teaching, and we do not anticipate there will ever be a be-all, end-all comprehensive theory for teaching", p. 322).
Biesta	The author argues that "[W]e already have theories of teaching and in the theorisation I have presented [in this chapter] I have relied upon theories of teaching that have been developed in the past, going back, to begin with, as far as Plato's account of teaching." (p. 278) [The author clarifies: I am saying that there is a very long tradition of theorizing teaching, though in my chapter I don't provide a comprehensive historical overview of such theories, but do position my observations in this longer tradition. To identify all existing theories of teaching is probably quite a big task. There is also the question whether teaching is only seen in a school context and/or as instruction (in German related to Didaktik) or whether a broader notion of teaching is used (in German related to Erziehung; in English for example the question whether moral education is a form of teaching.]

Appendix B

What should a theory contain? Why?

Hiebert & Stigler	Building on Kurt Lewin's claim "there is nothing as practical as a good theory," the authors begin with the proposition that "it is possible to build theories of teaching–practical theories–that are useful for teachers" (p. 24). The authors describe theories as "an interrelated set of ideas intended to explain something" (p. 46). To be useful for teachers, they argue that: "In a general sense, theories of teaching must account for how the intended curriculum, broadly defined, is transformed into learning opportunities that are experienced by students. This means that, in our view, theories of teaching consist of connected sets of hypotheses that predict how specific instructional activities and tasks will produce learning opportunities experienced by students in particular ways. That is, theories of teaching are capable of guiding the cause-effect reasoning that lies at the core of making instructional decisions about what kinds of tasks and activities will yield what kinds of sustained learning opportunities, and they do so with an eye toward studying and improving these decisions." (p. 46). They also add that theories of teaching that are useful for teachers include hypotheses that are "specific enough to be indexed according to the learning goals or outcomes students are asked to achieve" (p. 47).
Vieluf & Klieme	The authors argue that the response to this question depends on the paradigm followed. For example, in the Teaching Effectiveness Research [TER] paradigm, which is based on critical rationalism, "Theory […] usually consists of constructs covering various elements and features of classroom teaching, procedures operationalizing those constructs, and models linking them with student learning and other constructs which have been a priori defined as desirable outcomes of schooling. Teaching effectiveness theories attempt to explain and predict student outcomes, explicitly modelled as effects of the learning environment." (p. 84). And they continue: "According to Kuhn, general principles such as, in the field of education, (a) the idea of the learning environment having causal impact on students' information processing vs. (b) the idea that the classroom is a social sphere consisting of practices, can hardly be contested empirically, although they have inspired much sound empirical work – mostly quantitative in the first case, qualitative in the second case. These general principles belong to the core assumptions of separate paradigms (Practice Theories and TER, respectively) which are basically incommensurable, since they are framing, if not constituting the field of classroom teaching and learning in different ways" (p. 85). The authors conclude by arguing, "Separate paradigms include not only different basic assumptions about the social, about teaching and learning, but also differ with regard to their understandings of "theory" (Kuhn, 1962, p. 94). (…) Hence, answers to the questions what constitutes a theory and what it should contain depend on the perspective." (p. 85). The authors declare themselves "in favor of recognizing diversity of perspectives – also with reference to epistemology – instead of opting for a single set of criteria for a 'good theory'. Because different perspectives always have different blind spots and can complement each other." (p. 85).

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Scheerens	The author first distinguishes between different levels of theories: – *Meta-theory* (i.e., a theory concerned with the development, investigation or description of theory itself). The author provides the example of "context, input, process, and outcome indicators" as a meta-theory illustrating the logical structure of causal conditions leading from teaching to learning. – *Substantive theories on teaching effectiveness* (i.e., defined in close connection to the state of the art of empirical research). The author distinguishes this category into: • *General theories:* e.g., process structure and independence in teaching; classroom management • *Partial theories*: e.g., direct teaching, social-emotional support in teaching. Based on this distinction, he then remarks: "The […] question on what theory at each level should contain has different answers for each of the levels. At the level of meta-theory 'teaching' was framed in accordance with the educational effectiveness research paradigm. This choice yielded a conceptual ground structure, based on a model from systems theory and reference to the scientific method as the epistemological and methodological background. The level of general theory was conceived as containing a potentially exhaustive limited set of sub-theories of effectiveness enhancing teaching processes. The third level, indicated as "partial theories", refers to more specific explanatory mechanisms intricately linked to empirical research outcomes" (p. 124). He further clarifies that "Meta-theory contains first principles, such as logical ground structures, epistemological preferences, methodologies and ontological considerations (defining characteristics). Substantive theory in relation to the educational effectiveness research paradigm is strongly rooted in empirical evidence, distinguishes descriptive components and relationships between these, as well as explanatory conjectures that explain hypothetical as well as empirically supported relationships." (p. 125).
Kyriakides et al.	The authors list different attributes (rather than components) that theories on teaching need to have (pp. 146–152): – Being multi-level in nature, by considering the impact that school and system level factors may have on teacher factors. – Being explicit about why the factors included are associated with student learning outcomes (therefore, the relevant theories of learning and schooling that are considered in defining each factor should be made explicit) – Being explicit about the conditions under which each factor matters (i.e., the context) and the extent to which specific factors and their measurement dimensions matter more for specific groups of students. – Being informed by the dynamic nature of education Simultaneously addressing issues of quality and equity [i.e., "effective teachers are not only those who manage to contribute to the promotion of learning outcomes for all (quality) but also those that manage to reduce differences in student learning outcomes between groups of students with different background characteristics (equity)] (p. 149)

(continued)

Schoenfeld	Considering that a theory of teaching needs to explain the teacher's in-the-moment decision making in combination with an environment that is successful in producing powerful thinkers and learners, the author identifies the following components and attributes that such a theory needs to include/have: – Decision-making components: • The individual's resources • The individual's orientations • The individual's goals – Components/attributes of an environment that nurtures powerful thinking/learning: • Disciplinarily rich content and practices with which students engage • Opportunities for students to engage in sense making within their zones of proximal development • Provision that *all* students engage with core content and practices • Opportunities for students to contribute to discussions and progress in ways that support the development of agency, ownership over content, and the development of disciplinary identity • Provision that student thinking be made public and the learning environment adjust accordingly.
Herbst & Chazan	The authors argue that a theory of teaching should have an explicit focus on the practice of teaching. They explain, "A theory of teaching should be a theory of the practice in which teachers engage as opposed to a theory of the individuals who do the practice, though it may articulate with ways of describing the individual resources people bring to teaching. It should aim to describe, explain, and predict this practice. As far as description, it should include resources for representing the practice of teaching that permit to draw similarities across some instances of the practice while also sustaining differences across some other instances of the practice, both within and across individual teachers.

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	The authors argue that a theory of teaching should have an explicit focus on the practice of teaching. They explain, "A theory of teaching should be a theory of the practice in which teachers engage as opposed to a theory of the individuals who do the practice, though it may articulate with ways of describing the individual resources people bring to teaching. It should aim to describe, explain, and predict this practice. As far as description, it should include resources for representing the practice of teaching that permit to draw similarities across some instances of the practice while also sustaining differences across some other instances of the practice, both within and across individual teachers. It should contain some technical language and other semiotic tokens whose definitions are provided, some technical uses of language whose definitions are sought through research, and nontechnical uses of language that support reading and writing without calling attention to themselves. As far as explanation, a theory of teaching should provide the means to express relationships that connect instances of practice, not only in terms of similarity or difference, but more generally in terms of how categories of instances of practice form larger systems of practice such as lessons, units, courses, and programs of study. A theory of teaching should identify some sources or dimensions of complexity as ones that will not be reduced but whose texture is to be dissected and understood. A theory should contain connections among constructs of the theory and other phenomena, both possible causes and possible consequences. As far as prediction, a theory of teaching should contain connections among constructs of the theory and sources of empirical evidence or measures of those constructs. It should contain empirically falsifiable propositions and experimentally falsifiable explanations. It should articulate how the interplay of theorization and empirical research enables theorists to manage critically the objectifying and subjectifying tendencies of social research." (p. 218). And they continue, "At the same time, descriptions and predictions should at least be expressible in ways that practitioners can adjudicate their face validity. But, we do not expect that practitioners will come to adopt the language of educational theorists. This raises the question of whether our field might develop a semiotic infrastructure that goes beyond language and permits researchers and teachers to transact practice without having to rely solely on words. Such possibilities suggest the need for mathematics educators to continue to elaborate theoretically the notion of representations of practice" (p. 218).

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Cai et al.	The authors argue that two components are necessary for a theory of teaching: a *framework to support teachers' thinking* and an *operational* side. They elaborate on this idea, explaining that a theory of teaching should provide a framework that teachers can use as they think through principles of the best ways to teach in a given situation. In addition, [a theory of teaching] needs to have "some operational aspects that address the practical translation of principles into actions" (p. 231). As an example, the authors list the framework for examining the effectiveness of mathematics instruction (Cai, 2014). This framework addresses three critical aspects of effective classroom instruction: (1) students' learning goals; (2) instructional tasks (both as set up by teachers and as implemented in the classroom); and (3) classroom discourse. According to this framework, "the role of teachers is to select and develop tasks that are likely to foster students' development of understanding and mastering procedures in a way that also promotes their development of abilities to solve problems, to reason, and to communicate mathematically" (p. 231).
Biesta	The author argues that "a *theory* of teaching needs to start with a *conceptualisation* of teaching, as it is only once we have an account or proposal of what teaching is, that we can begin to ask such questions as what teaching is for or how teaching takes place. […] I have suggested to conceptualise teaching as the art of (re)directing the attention of another human being aimed at what we might term 'attention formation.' Answers to […] questions such as what teaching is *for* and how teaching *takes place* constitute (elements of) a theory of teaching. In this chapter, I have suggested that with regard to the question what teaching is *for* we should always consider three domains of purpose (qualification, socialisation and subjectification [see note below]), whereas with regard to the question how teaching takes place I have suggested a theorisation of teaching that sees education as an open, semiotic and recursive system that operates with the principle of 'complexity reduction,' bearing in mind that if the complexity of the education system is reduced too much, education turns into indoctrination and thus loses its educational 'identity,' so to speak. It becomes, in other words, a different system." (p. 277) *Note*. – Definition of qualification: "Providing students with knowledge, skills and other things they may need – such as attitudes and dispositions – in order to do something. This 'doing' can either be quite specific and precise, such as becoming qualified for a particular job or profession; but it can also be understood more broadly, such as the way in which schools seek to equip children and young people for their life in complex modern societies" (p. 263) – Definition of socialization: "Providing our students with an orientation into existing cultures, traditions and practices, with the invitation – and in some cases the insistence – that they locate themselves within them" (p. 264) – Definition of subjectification: "Refers to the ambition that students end up as subjects of their own life" (p. 265) [The author clarifies: I am suggesting, therefore, that in theorizing teaching we need to [1] conceptualise teaching, [2] articulate the purpose or purposes of teaching, and [3] theorise how teaching 'works' or 'functions.' In my chapter I provide an answer to each of these questions.]

Appendix C

In the future, in what ways might it be possible, if at all, to create a (more comprehensive) theory of teaching?

Hiebert & Stigler	The authors mention: "Our first response to this question is that we have described what Lipsey (1993) calls "small theories attempting to explain treatment processes, not a large theory of general . . . phenomena" (p. 48). In this sense, we have shown, at least implicitly, our bias against "comprehensive" theories of teaching. This is due partly to our belief that "small theories," focused on teaching processes that lead to particular learning opportunities for students, are the kinds of theories that will be useful for teachers. Our interest in "small theories" also is due to our skepticism that, at this point in the history of theory development and research on teaching, developing a comprehensive theory of teaching is likely, or is even the next best step. However, we certainly endorse the goal of creating more comprehensive "small theories." Our answer to the question of creating gradually more comprehensive (small) theories is contained in our descriptions of building theories of creating sustained learning opportunities. We can pull out a few features of this work that seem especially important: begin with documented connections between the kinds of sustained learning opportunities that yield specifiable learning outcomes; identify features of these opportunities and develop hypotheses about how teachers can create them; continuously test and revise predictions suggested by the hypotheses; coordinate the work of teachers and researchers to test predictions and revise hypotheses; aggregate findings across classrooms and search for patterns that rise above specific contexts; [and, to do this work,] find ways to create sustainable partnerships between teachers and researchers, and build networks of these partnerships. As learning theorists and researchers continue to identify the features of sustained learning opportunities that yield particular learning outcomes, researchers and teachers can continue to expand the scope of their theories of teaching. We want to repeat that the processes we have identified for building more comprehensive theories are tailored to our biases and to the kind of theories in which we are most interested. Stepping back, we recognize that the processes for building theories of teaching will result, in large part, from the kinds of theories the community wishes to build." (p. 49)

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Vieluf & Klieme	The authors argue: "From our perspective, creating "A" comprehensive theory of teaching doesn't seem to be a reasonable goal of scientific discourse. (…) The goal of creating "A" comprehensive theory of teaching, only makes sense within the traditional "statement view" of theory from critical rationalism (Popper, 1965/2005), which assumes a theory to be a coherent set of definitions, axioms, derived hypotheses, and empirical statements testing (i.e. potentially falsifying) these hypotheses." And they continue, "Considering the incommensurability of paradigms, we think that it is desirable that the Three Basic Dimensions [TBD], Teaching Effectiveness Research [TER] in general, and Practice Theories alike will grow and become more and more sophisticated, and, instead of converging into one grand theory of teaching, even diversify into separate (sub-)theories. New paradigms, such as neuroscience, may further start to compete with existing strands of social science and the humanities. Nevertheless, we argue (in opposition to Kuhn) that fruitful exchange between paradigms is possible." Finally, they conclude: "Overall, we can conclude that not only teaching, but also educational research itself, is situated in fields of tension. One such field of tension is between the intention to provide educational practice with clear and convertible recommendations and the wish to do justice to the whole complexity, contingency and ambiguity of social interactions. Multiple perspectives address this tension in different ways. By themselves they are necessarily limited and "under-determined by empirical 'facts'" (Reckwitz, 2002, p. 257). Yet, they all contribute substantially to our understanding of the social world. Mannheim (1931/1995) argued that a "true" picture can emerge from integrating different perspectives. Our aim was not finding a synthesized truth in the middle, but we argue that dialogue between paradigms can be inspiring. Accordingly, our paper is the result of an open process of bringing perspectives together and reflecting on irreconcilabilities with the purpose of 'doing theory'." (p. 87)
Scheerens	Reflecting on this question, the author concludes, "I see this as a continuation of a piecemeal, bottom up development, rooted in the analysis and synthesis of empirical research outcomes. Making sense of the enormous quantity of research outcomes by means of meta-analyses and research reviews stimulates reflection on what is generalizable and what is helpful for further research. Last but not least, the answers that policy makers and practitioners want from researchers call for conceptual synthesis and theoretically meaningful interpretation of the evidence. Again: nothing more practical than a good theory." (p. 126)

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Kyriakides et al.	The authors propose that the Dynamic Model of Educational Effectiveness can be the starting point for developing a comprehensive theory of teaching. To facilitate this work, they propose that several steps need to be taken: – By providing answers to questions [such as, "is orientation equally productive in classes with a high variation in terms of student abilities or socioeconomic background?", p. 150] "the impact of teacher factors on promoting both quality and equity could be better realized and factors deriving from different models of effectiveness which are able to promote equity may be used in developing a comprehensive framework of teaching" (p. 150). – "By acknowledging the limitations of existing models (including the ones of the dynamic model), a theory that may be used so as to provide a basis for educational improvement purposes can be developed." (p. 150) – "The possibilities of combining factors deriving from different models should be examined." (p. 150) – Using different models to develop a comprehensive framework of teaching and learning "may provide a better linkage between different approaches to teaching" (p. 151). "It should also be examined whether domain-specific factors could be included in generic models such as the dynamic model and also if these factors can also be grouped into stages of effective teaching. The possibilities of the development of a comprehensive framework for measuring quality of teaching through combining both generic and domain-specific factors should be examined." (p. 151)
Schoenfeld	The author points out, "As indicated above, the issues facing us as a field are not theoretical: the theory of in-the-moment decision making during teaching and the TRU framework, together, provide a comprehensive theoretical framework regarding teaching for robust understanding. The issue before us is: what would be useful to know in order to flesh out the details of that theoretical framework and provide mechanisms to help teachers move in productive directions?" (p. 181).
Herbst & Chazan	The authors maintain, "For our field to make progress toward a theory of teaching, we need theorists to make explicit the commitments on which they build. We need to develop instruments that can gather information on constructs from different theories so that we can use them to develop better understanding of how competing constructs are related and so that we can have a publicly accessible source of data that many people can contribute to steward and mine. We need to pre-register experiments that will allow different theories to compete to explain or predict the outcomes of these experiments. Framing all that, we need a scientific consensus not only on the need to articulate commitments but also on shared rules of engagement (e.g., to recognize our scholarly practice also as complex and demanding us to hold on to the tensions among sets of competing values such as ecumenism and consistency, complexity and parsimony, and so on) in order to make such progress." (p. 220)

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Cai et al.	The authors mention, "Following the characterization we have given of theories of teaching, we take it to mean that a theory of teaching grows in generality to accommodate differences between subject matter, grade levels, and cultural aspects and grows in connection to other theories of teaching. Growing in generality means that although a theory should span these different areas, we have to keep in mind the specific character and requirements of each of them. For example, the level of higher order thinking between elementary and secondary students is not the same, but the theory of using higher order thinking should still be adjusted to fit the needs of the students. Growing in connectedness means that we should strive to find commonalities and parallel ideas across theories of teaching. For example, despite the seeming lack of overlap between Confucian and Western modes of learning, there may be areas of connection. […] Ultimately, although we believe that theory of teaching can become more comprehensive, we continue to stress that there is a two-way street. Thus, theory keeps evolving along with teaching, and we do not anticipate there will ever be a be-all, end-all comprehensive theory for teaching. Rather, as teaching and theory co-evolve, we anticipate continuous improvements in both." (p. 246)
Biesta	The author argues, "whether the field of educational theory, research and practice will converge on conceptualisations and theories of teaching or will diverge, remains to be seen. From my own perspective any contribution that helps to restore the balance between the discourse on teaching and the discourse on learning would definitely be welcome." (p. 278) [The author clarifies: I might add that in Continental educational theory the first two aims are generally seen as dimensions of Bildung, that is, of education as a process in which individuals become 'cultivated' through their interaction with cultural resources, such as language and knowledge, whereas the third ambition is seen as the ambition of Erziehung. Here I rely, for example, on Dietrich Benner's definition of Erziehung as 'Aufforderung zur Selbsttatigkeit.']

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Chapter 11
Theorizing Teaching: Synthesizing Expert Opinion to Identify the Next Steps

Charalambos Y. Charalambous and Anna-Katharina Praetorius

Abstract This chapter is a synthesis of the views on theorizing teaching put forward in Chaps. 2, 3, 4, 5, 6, 7, 8 and 9 and those that emerged from the Delphi study in Chap. 10. In considering these views, we discuss a number of questions: Do theories of teaching exist? If they do, how are they defined, what purpose do they serve, and what attributes do they have? How should theories be generated, and is it possible to develop a comprehensive theory of teaching? What role does content specificity and context sensitivity have in the generation of such theories? What role can teachers play in this process and how can theories of teaching inform practice? The chapter considers how and why the contributors' views on these questions agreed or differed, and identifies pathways to resolving differences. The exercise demonstrates the importance of providing the research community with opportunities for focused and systematic discussion. As the capstone of this book, the chapter also proposes ways in which the field of theorizing teaching can be moved forward.

Keywords Expert opinion synthesis · Theorizing teaching · Theory of teaching

1 Introduction

Theories are a fundamental aspect of scientific research and researchers have been investigating teaching for decades, but to date there has been no concerted effort to discuss whether there are valid theories of teaching, how a theory of teaching should be defined, what purpose it should have, what it should include, or how it should be developed. This book aimed to initiate a discussion of these topics by inviting internationally recognized scholars in the field to contribute their thoughts on the

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theorizing of teaching (see Chaps. 2, 3, 4, 5, 6, 7, 8 and 9). The contributors were asked to focus on a particular set of questions (see Chap. 1) and to participate in a Delphi study where they reflected on some of the other contributors' answers (see Chap. 10). In addition to providing an up-to-date overview of how teaching is theorized, the purpose of this volume was to contribute to the further development of theories so that we better understand teaching.

The literature on the theorizing of teaching is extensive and no single volume could possibly address the whole subject. Bikner-Ahsbahs and Prediger (2010) suggested that a productive way to consider multiple theories of teaching would be to make sure that there is some overlap in the assumptions underlying the theories. Because of our background, we selected authors who had demonstrated an instrumental view of teaching in their work (cf. Herbst & Chazan, 2017) and enriched this view with some other perspectives.[1]

In this chapter we synthesize and identify the patterns in the ideas presented in the contributions and, the implications of their findings; we also consider how the field can proceed to further develop theories of teaching in the future. Although this is a genuine attempt to consider the full contents of the volume, we have had to abridge the contributors' ideas when summarizing, as providing an in-depth discussion of every idea would not have been possible (for a discussion of the limitations of this endeavor, see Sect. 9). The issues discussed in this chapter are: Why do we need theories and how can we define them (Sect. 2)? Do theories of teaching exist and if so, what are their foci (Sect. 3)? What are their key attributes (Sect. 4)? How can we develop theories of teaching and are comprehensive theories possible (Sect. 5)? Do theories of teaching need to account for content and context (Sect. 6)? What is the role of practitioners and practice in theories of teaching (Sect. 7)? What can the thought exercise in this book teach us about theorizing teaching (Sect. 8)? What are the limitations of the approach taken in this book (Sect. 9)? What general conclusions can one draw from this exercise (Sect. 10)? We believe that providing opportunities for discussion among scholars in the field is critical for the advancement of theories of teaching, therefore we discuss this issue throughout the chapter. We would like to stress, however, that the purpose of discussion is not to homogenize the field. Rather, we believe that discussion can help us to better understand each other's perspectives and work and thus develop a better understanding of our own work—a key requirement for bringing together theoretical perspectives (cf. Prediger et al., 2008).

[1] An instrumental understanding of teaching focuses on the idea that teaching is investigated based on its relationship to student learning outcomes. It is the most common approach within the educational effectiveness paradigm. This is opposed to a fundamental understanding of teaching, which focuses on the actual work of teaching (see Herbst & Chazan, 2017). Fenstermacher and Richardson (2005) made a similar distinction, using the terms achievement sense for the former and task sense for the latter.

2 The Purposes and Definitions of Theories of Teaching

In our introduction to the book (see Praetorius & Charalambous, this volume)[2] we reviewed the reasons for which theories are crucial for scientific research on teaching. We noted that discussions about the need for theories of teaching were mostly found in publications dated before 1980 and questioned whether the consensus in the field was that no more work on theorizing teaching was needed. This is clearly not the case; in Chaps. 2, 3, 4, 5, 6, 7, 8 and 9 the contributors provided many important reasons why theories of teaching may be indispensable.

The contributors suggested that theories of teaching were useful for *describing*, *explaining*, and *predicting,* emphasizing the importance of explanation. One kind of explaining is causal explanations, which is inherent to the educational effectiveness approach (see e.g., Scheerens, this volume), but vehemently challenged by authors who focus more on educational theory (Biesta, this volume). A significant point of controversy between contributors was whether theories should be designed to *improve practice* (see also Sect. 7). Some authors stated that they should be (Cai et al., this volume; Hiebert & Stigler, this volume; Kyriakides et al., this volume), while others argued for using theories to *improve research* (Herbst & Chazan, this volume; Schoenfeld, this volume).

Looking at definitions of theories, we can see a similar heterogeneity. In Chap. 1 we provided an overview of definitions of theories of teaching based on a literature review. We showed that all of the definitions emphasized the systematic organization of concepts as a central element of theories of teaching. However, the definitions then each included different elements (listed in Table 11.1), illustrating that there has been little progress since Snow wrote, almost 50 years ago, that there "appear to be almost as many definitions of theory as there are people concerned with theory" (Snow, 1973, p. 78). When the authors were asked to explain their understanding of theories of teaching, their responses ranged from explicit definitions to detailed explanations.

The systematic organization of concepts can be taken to be a key aspect of theories of teaching since it was mentioned in all but one of the contributions (see Table 11.1) and in the definitions reviewed in our introduction.[3] Most contributors stated that theories should explain but fewer advocated that they should describe and predict. Some, but not all, chapters noted that theories should allow for generalizations and explain the relationships between concepts. These differences resulted in an array of views of what counts as a theory. For example, the direct teaching approach is cited by Scheerens (this volume) as an example of what he calls a partial theory whereas Herbst and Chazan (this volume) do not consider it a theory at all.

[2] In this chapter, we refer to each of the chapters in the book in several places, providing the authors' names, followed by "this volume". When reporting on the authors' ideas from the Delphi study, we refer to Chap. 10.

[3] Although Kyriakides et al. (this volume) discuss about theories in their chapter, they do not provide an explicit definition of theory. Therefore, the analysis does not include this chapter.

Table 11.1 Aspects of theory definitions covered by the individual chapters

	Hiebert & Stigler	Vieluf & Klieme	Scheerens	Kyriakides et al.	Schoenfeld	Herbst & Chazan	Cai et al.	Biesta
Common to all definitions in the introductory chapter								
Systematic organization of concepts	x	x	x		x	x	x	
Specific aspects of some definitions in the introductory chapter								
Involve concepts and the relations among them	x		x		x	x		
Describe certain events					x	x		x
Explain certain events	x		x		x	x	x	x
Predict certain events	x				x	x	x	
Allow for the making of generalizations		x	x		x		x	

Vieluf and Klieme (this volume) highlighted two meta-theoretical aspects of theories which were not mentioned in Chap. 1, noting that (1) theories are socially constructed and (2) definitions of the term theory differ depending on epistemological and ontological perspectives.

Comparing the different chapters also revealed that theories have different grain sizes (see Cai et al., this volume), ranging from small (Hiebert & Stigler, this volume), to middle (Herbst & Chazan, this volume) to meta-level theories (Scheerens, this volume), an issue to which we return below. Because the authors understand the terms in different ways, further discussions are necessary to disentangle their specific comparative meanings both within and across paradigms.[4]

Theories of teaching are formulated to serve a variety of purposes and are likely to have differing underlying assumptions so it is hardly surprising that the answers to the other four questions posed to the contributors also varied (see Sects. 3, 4, 5 and 6). Biesta wondered whether the authors' answers to the other questions could be compared at all, as contributors had different views of the role of theories of teaching (see Chap. 10). Although we acknowledge these complexities, we are convinced that the ideas and reflections of the contributors provide a valuable starting point for a discussion on theorizing teaching.

Two related issues enable critical reflection on what the agreements and disagreements can suggest for future steps in theorizing teaching. First, because it forms the basis for all further discussion, researchers should clearly define their understanding of the purpose of a theory. Due to space restrictions and other policies of journals, this may not be possible in every research article, but it is important to include the information in theoretical papers, technical reports, or online materials. Second, because in research on teaching we often discuss many concepts/ statements without being explicit about their interrelations, in the future, we need to become more explicit about their similiarities and differences. In fact, Biesta (personal communication, April 1, 2021) suggested that if some kind of map of these statements could be provided, "apparent differences and perhaps even disagreements between the authors begin to disappear, as it seems that authors may be talking about different issues rather than that they have disagreeing views about the same issue." If we succeed in developing such a map that allows the community to place different theories within it, the similarities and differences between them should be easier to identify.

3 The Existence of Theories of Teaching

As discussed in Chap. 1, since the 1960s opinion has been divided on whether theories of teaching exist. One group of scholars have either directly (e.g., Floden, 2001; Gage, 1963, 2009) or more tacitly (e.g., Snow, 1973) argued that theories of

[4] We use the term paradigm in the same way as Vieluf and Klieme (see Chaps. 3 and 10).

teaching do not exist. Writing in 1963, Gage argued that although there was a strong interest in developing theories of learning, theories of teaching were neglected or even deemed unnecessary on the grounds that "if we have an adequate theory of learning, then the teacher must of necessity act upon that theory, without employing any separate theory of teaching" (p. 133). Echoing this argument decades later, Gage (2009) lamented the fact that teaching was still the "stepchild" of theoretical work on teaching and learning. When he classified theories into different levels Snow (1973) suggested that it was not even possible to generate the highest level for teaching. Along similar lines, Floden (2001) argued that although a worthy goal, "a theory of teaching […] is unlikely to be attained in the near future" (p. 14). On the other hand, there are scholars (e.g., Biesta & Stengel, 2016; Klauer, 1985; Openshaw & Clarke, 1970; Oser & Baeriswyl, 2001; Philips, 2003) who assert that theories of teaching do exist, even though they do not always define them or provide examples.

Contributors were asked to comment on whether theories of teaching existed and to explain their thinking. Most maintained that they did, although, unsurprisingly given the many ways they defined theories (see Sect. 2), there was some disagreement. Biesta (this volume) made reference to a plethora of theories, rendering the identification of all of them a particularly challenging task. Similarly, Vieluf and Klieme (this volume) argued about the existence of multiple theories of teaching even within the same paradigm. Referring to theories of and for teaching in general, Cai and colleagues (this volume) also alluded to the existence of several theories.

Scheerens (this volume) made a distinction between different levels of theories. In his view, there are meta-theories concerned with the development, investigation or description of theory itself and substantive theories which are defined in relation to existing empirical findings. He further distinguished two subtypes of substantive theories, general theories and partial theories, with the first capturing a limited set of substantive teaching dimensions assumed to affect student learning and outcomes and the second corresponding to theories representing particular manifestations of the teaching-learning chain captured by the general theories. Scheerens (this volume) accepted that some of what he considered a theory might not be identified as such by others. Both in their prior work (Chazan et al., 2016; Herbst & Chazan, 2017; Silver & Herbst, 2007) and in this book, Herbst and Chazan (this volume) discussed the existence of multiple theories of teaching. Drawing on Merton (1949), they proposed a different classification of theories which included three types of theories, descending in size and complexity: grand, middle-range, and those based on specific hypotheses. Grand theories are "large sets of ideal constructs designed speculatively to be used to read the world" whereas specific hypotheses are "amenable to be tested empirically." They classified their theory as middle-range, a "theory developed through the practice of research." Linking two lines of his research, found in *How We Think* and his *Teaching for Robust Understanding* framework, Schoenfeld (this volume) argued that his work demonstrated the existence of theories of teaching. Overall, six of the eight chapters argued that theories of teaching exist. In four of those the authors either presented their work as an example of theory (Herbst & Chazan, this volume; Schoenfeld, this volume; Vieluf & Klieme, this volume) or named specific examples of theories of teaching (Scheerens, this volume). In the other two, the contributors referred to theories of teaching in rather broad strokes without naming any examples.

Taking a different stance, Kyriakides and colleagues (this volume) argued that although theories of teaching do not exist now, they could be developed. Presenting their work on the *Dynamic Model of Educational Effectiveness*, they argued that this model could gradually be turned into a comprehensive theory of teaching. Falling in the middle, Hiebert and Stigler (this volume) maintained that theories of teaching exist, but they are at a very nascent level and always in progress. They commented that "theories of teaching are necessarily so complex that they are only in progress; they are never complete" (p. 47).

Clearly, almost six decades of academic study has not managed to resolve the question of whether theories of teaching exist. It was therefore not surprising that in their response to the Delphi study question about the extent to which consensus can be reached in the field of teaching, Cai and colleagues wondered: "Can we at least, reach consensus on whether we have theories of teaching?" (Chap. 10, p. 288). Despite its simplicity, this question seems rather difficult to answer as it requires agreement on several other questions, including what a theory should contain (i.e., attributes of theories) and why.

4 Attributes of Theories of Teaching

In this section, we consider the attributes of theories as identified by the contributors, beginning with those endorsed by most authors and moving on to those about which there was considerable disagreement.

While the contributors were not unanimously in agreement with any one of the 24 statements about the desirable attributes of theories presented in the Delphi study, there were three with which no one disagreed. They were that a theory should "explain basic terms," "be specific enough to allow concrete connections among learning goals, teaching aspects, and student outcomes," and "provide the means for expressing relationships among different aspects of teaching." A fourth statement was disagreed with by only one contributor: A theory [of teaching] is informed by or grounded in epistemological preferences, paradigms, methodologies, and ontological considerations of theories in general" (Chap. 10).

The four statements on the desirable traits of theories echo some of the criteria for evaluating the quality of a theory that were identified in the literature review in Chap. 1. For example, the first statement is essentially what the key sources in the review said 60 years ago, that theories should clearly define terms. The second statement also concurs with two attributes endorsed by two of the review sources - that theories should include quantitative and qualitative relations. The first captures how the sequence of teaching events can lead to student learning, and the second goes further to explore the mechanisms by which goals, teaching aspects, and student outcomes are linked. That both the literature review and the Delphi study converge on these attributes supports their fundamental importance and suggests that these attributes could serve as the basis for developing key features of theories of teaching.

Interestingly, there were some concerns raised by contributors about certain aspects of the statements discussed above. Below we focus on one key example to illustrate how the ensuing discussion can craft opportunities for productive discussions about theorizing teaching. When responding to the first statement, some authors (e.g., Cai et al., this volume; Kyriakides et al., this volume) argued that defining basic terms could result in non-parsimonious theories. While this might be a valid concern, we argue that defining key terms is a prerequisite of theories in general, and of theories of teaching in particular as prior work (Grossman & McDonald, 2008; Praetorius & Charalambous, 2018) suggests that terms in the field of teaching and teaching quality are not always used in a consistent manner.

What should be determined though, is which terms need to be explained. To initiate this discussion, we would argue that teaching and learning should be the first terms to consider, followed by teaching practice (cf. Herbst & Chazan, this volume) and learning opportunities (cf. Hiebert & Stigler, this volume): The term teaching practice is currently used in several different ways (see Lampert, 2010; Vieluf & Klieme, this volume) and warrants careful unpacking. Learning opportunities, on the other hand, can function as the intermediate link between teaching and student learning.

In discussing the importance of defining these terms, we are aware that there are objections to identifying learning as a key part of theories of teaching, since, as Biesta reminds us, not everything that happens in school is directly related to student learning, "learning is only one way in which students can relate to the world, and education should open up other ways of being and relating as well" (Chap. 10, p. 296). Biesta's admonition to avoid referring to learning "without specifying what it is about and for" (Chap. 10, p. 296) resonates with the growing trend for a broader view of learning, moving from a rather restricted consideration of the cognitive and affective dimensions of learning to encompass meta-cognitive and psychomotor dimensions, as well as aspects of students' well-being (physical and mental health), socio-emotional competence, and civic engagement (cf. Cappella et al., 2016; Reynolds et al., 2016). This example illustrates that exploring disagreements about theorizing teaching can also bring into focus how we explore the phenomena under consideration.

Opinions were clearly divided on nearly half of the statements about attributes of theories of teaching in the Delphi study. The divisive statements largely fall into two categories. The first category is statements about the content and function of theories of teaching and includes statements stipulating that a theory should contain empirically falsifiable propositions and experimentally falsifiable explanations, explain how teaching takes place, guide practitioners' cause and effect reasoning in order to inform their instructional decisions, link teaching to its antecedents, and concurrently attend to issues of quality and equity.

Several factors contributed to disagreements about these statements. One was that some, especially those referring to the notions of falsifiable propositions and explanations, were not totally clear to all of the authors. As discussed in the previous chapter, this can partly be considered to be an artifact of the limitations of the Delphi approach as implemented in this book (see also Sect. 9). Since the contributors were not requested to read the other chapters in the book, they sometimes found it difficult to deduce the statements' context. Some scholars from different paradigms or research traditions might also not have been very familiar with the terms we used to summarize and present ideas in the Delphi study. We argue that some of these disagreements might not be very problematic as they do not reflect deeper underlying philosophical assumptions. Offering scholars the opportunity to directly discuss such disagreements can provide insights into whether they are governed by underlying assumptions or if they can be resolved by discussing ambiguities in the terms used across research groups.

Other objections are more substantive since they concern fundamental questions about the purpose of theories. For example, Biesta made a strong case that "causality doesn't exist in education" (Chap. 10, p. 296), and therefore disagreed with any statement that directly or indirectly assumes that causality does exist. Vieluf and Klieme (this volume) were also skeptical about causality based on Luhmann's (1984) theory. This is, of course, in sharp contrast to perspectives entirely based on educational effectiveness research (e.g., Scheerens, this volume; Kyriakides et al., this volume) which are strongly supportive of causality.

Interestingly, in this category there were even disagreements about statements between scholars from the same paradigm. For example, Kyriakides and colleagues proposed that theories of teaching should concurrently attend to issues of quality and equity, but Scheerens disagreed, pointing out that although quality is a necessary concept within theories of teaching, asking for equity as well represents an unnecessary demand (Chap. 10). Such disagreements are interesting for what they might offer for the process of reaching consensus both within and across paradigms, a point to which we return later.

The second category of disagreement includes statements that largely capture how to organize, express, and represent theories. Included in this category are statements that stipulate that a theory of teaching should explain how instances of practice can be organized to form larger systems of practice (e.g., lessons, units, courses, and programs of study), include resources for representing the practice of teaching, include technical and non-technical language for describing the practice of teaching, and be expressed in a way that practitioners can easily evaluate. As in the previous category, there were a variety of reasons for the disagreements. Schoenfeld argued that, although important, such aspects should not be an integral part of theories, since they are concerned with *communicating* rather than *describing* a theory. Using the parallel of developing a theory in economics, Schoenfeld (Chap. 10, p. 300) explained:

> The goals of a theory should be to (a) understand something; (b) to, if you wish to work in particular directions, specify what it takes to work in those directions. By way of metaphor: suppose I wanted to develop a theory of economics. The goal would be to specify how and why an economy works. Then, suppose I wanted to create an economy that eliminated poverty. That's a value statement. I'd be identifying the subset of things, consistent with the general theory, that produced the desired outcomes. Those are (a) and (b). Communicating aspects of these effectively may be necessary to move in the desired directions, but they're not part of the theory.

Cai and colleagues were also skeptical about the value of including technical terms in theories, worrying that doing so could lead to "obscuring plain meanings" and "prevent teachers from "easily being able to make use of theory without an unnecessary additional investment of time and energy to decode language" (Chap. 10, p. 298), a concern also echoed by Kyriakides and colleagues. In contrast, Vieluf and Klieme pointed out that focusing on ensuring that theories are expressed in ways that make them easy for practitioners to evaluate could be limiting given that this presupposes that theories are only developed for informing practice (see Chap. 10). Perspectives on the interplay between theory and practice and teachers' role in understanding and using theories underlie these disagreements, an issue we discuss further in Sect. 7.

What do these disagreements tell us? We argue that identifying and classifying the source of any disagreement is an important first step since different reasons for disagreement require different approaches for a resolution. Disagreements based on deeper philosophical, epistemological, and methodological differences might be harder to address than those related to the clarification of ideas and definitions. The next step is to give scholars more opportunities for focused interactions around the theorizing of teaching. Taking the Delphi study in this book as beginning, we feel that further rounds of exchanges need to occur and that these need to be more interactive than the approach undertaken in this book.

Despite its limitations, the current Delphi study also offers some guidelines for how to improve. For example, the fact that scholars from the same research paradigm still disagreed on fundamental statements suggests that it might be more productive to initially aim for consensus within more homogeneous groups before moving to more heterogeneous groups where disagreements are more likely to arise. The third step would involve carefully analyzing persistent disagreements to understand their origins and examine whether it is realistic or worthwhile to try to resolve them within or across paradigms. In fact, discussions about such disagreements would probably be beneficial even if consensus is not possible, because they could help clarify our perspectives of educational phenomena. Unresolved disagreements need to be carefully codified, along with the reasons causing them.

5 Processes for Developing (Comprehensive) Theories of Teaching

Developing theories of teaching is a very complex activity and requires meta-theoretical work (Snow, 1973). In Chap. 1 we reviewed the literature on what such meta-theoretical processes could and should look like, but concluded that to date, the actual process of generating theories of teaching has not received much attention. Reviewing the ideas in the individual chapters and in the Delphi study, it seems that there is more agreement about the process of developing theories than there is about the attributes of theories (see Sect. 4). This might be because the process of developing theories is less dependent on the purpose and definition of theories of teaching than on its content. However, there are still important differences in how much contributors agree with statements related to the process of generating theories. It is therefore useful to group these into general statements that apply to any theory of teaching, independent of its purpose, definition, and content (first category), statements that reflect prevailing assumptions in certain research areas (second category), and statements that seem to be dependent on other, more specific issues (e.g., specific norms and values shared only within specific research groups; individual differences in the understanding of specific terms) (third category).

The responses to the most general statements, the first category, revealed that most participants agreed that good theory development requires that the underlying principles on which the theory is built be explicitly stated, the limitations of existing models/theories be acknowledged, and the scope of the theory generated be open to expansion. These statements provide a basic structure for developing theories further to a meta-level, as currently not all theories of research on teaching satisfy these conditions (see also Chap. 1).

Several statements in the Delphi study about the process of developing theories of teaching reflect prevailing assumptions in educational effectiveness and mathematics education research (second category). This is especially true of those that focus on hypothesis building and revision ("generate a concrete hypothesis" or "continuously test and revise predictions suggested by the hypothesis"), but also holds for the idea of generalization ("aggregate findings across classrooms and search for patterns that rise above specific contexts"). That the ratings for these statements are again not entirely consistent even for scholars within the same research area [e.g., Cai et al. (this volume) and Herbst and Chazan (this volume) differed on their level of agreement on these statements, something that was also true for Kyriakides et al. (this volume) and Scheerens (this volume), see Chap. 10], may be due to semantics.

The third category largely consists of statements that pertain to the relationship between research and practice (e.g., "find ways to create sustainable partnerships between teachers and researchers and build networks of partnerships") and meta-statements (e.g., "reaching consensus on shared rules of engagement; dealing with tensions among sets of competing values such as ecumenism and consistency, complexity and parsimony"). Whether scholars agree with such statements seems to depend on reasons unrelated to their research specialism (for further analysis, see Sects. 7 and 8).

What the contributors found difficult for reaching an agreement about the process of theory development pertained to which terms were best for describing this process. For example, in his response to the first statement, Scheerens disagreed with the term *commitment* as this might also encompass political objectives which, in his view, would not be appropriate (Chap. 10), but he agreed with a similar statement about the attributes of theories ("A theory is informed by or grounded in epistemological preferences, paradigms, methodologies, and ontological considerations.") that did not contain this term. This makes it clear that such disagreements about terminology could more easily be resolved in a discussion or more discursive exchange of ideas.

Researchers also disagreed with some of the ideas underlying the Delphi statements. For example, Hiebert and Stigler questioned the process of testing and refuting hypotheses (Chap. 10). They held that piecemeal tinkering to gradually refine and improve a theory, as proposed by Karl Popper, was preferable. Biesta meanwhile disagreed with any approach rooted in empirical research outcomes, skeptical that empirical data is suitable for the development of theories (Chap. 10).

Consequently, it would be fruitful to continue the discussion started in this book with further, more detailed, exchanges between research groups. In his contribution to the Delphi study (Chap. 10), Scheerens drew attention to the added-value of exchanges between researchers with different perspectives on teaching, such as the one in this book. Hiebert and Stigler commented that they found the Delphi approach useful for building on one another's work in order to improve theoretical predictions (Chap. 10, p. 308):

> We find it interesting that the same process used to create this chapter (a Delphi Study) would be especially useful for building on others' work to improve *predictions*. If researchers were addressing the same problems, then comparing predictions and sharing data and rationales could help individual researchers—and the group as a whole, build from empirical outcomes to not only improve their predictions but increase the richness of their explanations or, said another way, their understanding of the problems they are investigating.

Such a process might be particularly useful for discussions in rather homogenous groups where sufficient agreement is expected to exist on the purpose of theories and on useful ways of investigating theories scientifically (e.g., different ways of using empirical data).

The contributors were also asked to reflect on whether, and if so, how a (more) comprehensive theory of teaching could be developed in the future. The authors' answers were again divided. Some authors (Kyriakides et al., this volume; Scheerens, this volume; Schoenfeld, this volume) replied in the affirmative, either stating that their own theoretical work could evolve into a comprehensive theory (Kyriakides et al., this volume; Schoenfeld, this volume), or that meta-analyses and research reviews could facilitate the generation of one (Scheerens, this volume). Herbst and Chazan were optimistic that the field could move toward a more comprehensive theory of teaching, once a number of prerequisites were satisfied. Apart from making their commitment to certain underlying assumptions explicit (as discussed above), they also highlighted a set of facilitating conditions: The development of instruments that allow the gathering of information on competing constructs from different theories so that the relations between them can be compared and understood; the pre-registration of experiments that would allow different theories to compete (see a similar discussion in Charalambous et al., 2021); and the development and articulation of shared rules of engagement, such as recognition of the tensions that exist in theorizing teaching (complexity vs. parsimony, see Chap. 10).

Others argued that it is simply not possible to create a grand comprehensive theory of teaching. Cai and colleagues (this volume), for example, believe that although theories of teaching will develop over time because they will be connected to each other and also evolve to accommodate differences in subject matter, grade levels, and culture, a comprehensive theory is not possible. Rather, they maintain that it is reasonable to expect that teaching and theory will co-evolve with each informing and setting the ground for the evolution of the other. Vieluf and Klieme (this volume) anticipate that theories of teaching will move in the direction of diversification. They believe that as the existing theoretical paradigms increase in sophistication, they will further split into multiple theories per paradigm instead of converging into one grand theory Biesta (this volume) was not sure if convergence or divergence would be the pattern in the future, but highlighted the importance of restoring the balance between the discourse on teaching and the discourse on learning—alluding to the need to make teaching the key focus of our work instead of considering it only in conjunction with learning. Hiebert and Stigler (this volume) were also against the development of a grand comprehensive theory of teaching and argued for the importance of expanding on smaller theories.

In conclusion, the contributors to this book predict that theories of teaching will evolve in two possible directions. Either they will become more comprehensive and integrate existing theoretical conceptualizations or they will diversify. The affordances and limitations of both options merit further discussion in the future.

6 The Role of Content and Context in (Generating) Theories of Teaching

The contributors to this book were asked to discuss whether a theory of teaching can accommodate differences across subjects and student populations. We asked this question because although the writings from the 1960s to the 1980s were agnostic on the role of subject (see Chap. 1), strong arguments were made in the mid-1980s about the role of content in teaching (e.g., Romberg & Carpenter, 1986; Shulman, 1986). Chazan et al. (2016) also noted that in the last decades, content has moved from the background to the foreground in the study of teaching. We also considered arguments about the importance of differences in student populations (see, for example, Kennedy, 2010). Although, in hindsight, we recognize that a slightly different wording of this question (i.e., asking whether a theory *should* accommodate considerations of content and student population) could have led to an even a richer set of ideas, the authors' answers to this question helped capture different perspectives about the role of content and context in theories of teaching, which we consider below.

The contributions to this book can be thought of as occupying different positions across a spectrum of the importance and role of content in theories of teaching. Unsurprisingly, these perspectives are consistent with the authors' prior work. At one end of this spectrum is Biesta; Herbst and Chazan and Hiebert and Stigler sit at the other. Clearly articulating that his conceptualization of teaching is subject-matter independent, Biesta (this volume) argued that content should not be a concern in theories of teaching. Attention should be focused on three content-independent domains that capture, according to him, the role of teaching: the qualification, socialization and subjectification of students. Consistent with previous statements they have made, [e.g., in Herbst & Chazan, 2017 they called on the field "to increase the subject specificity of mathematics teaching", p. 119], Herbst and Chazan (this volume) strongly endorsed the role of content. Without ruling out the possibility that the elements they used in their *Practical Rationality* theory (e.g., instructional exchanges, situations, and norms) have applicability beyond mathematics, their theory and body of work argue that content-specificity is an integral part of generating theories of teaching. Along similar lines, although Hiebert and Stigler (this volume) accepted the possibility that a generic theory of teaching that "swap[s] out subject matter" may help teachers "make and test instructional decisions" (p. 47), they argued that these decisions will remain general and vague. For them, the more useful theories are those developed with greater specificity, with content-specificity being one of the defining parameters. These differences in perspective tie in with the scholars' body of work: whereas Biesta's work transcends the borders of different subject matter, Herbst and Chazan as well as Hiebert and Stigler have largely studied teaching within the discipline of mathematics.

While also working in the field of mathematics, Schoenfeld appears to adopt a content-generic stance when it comes to the role of content in theories of teaching. For Schoenfeld (2011), the three building blocks of his theory of how teachers think—resources, goals, and orientations—cut across different subjects. Although indispensable for teaching, content can be considered as adding details to those three blocks. This is not surprising because Schoenfeld's work (e.g., his "*How We Think?*" book and his *Teaching for Robust Understanding* framework), derives from studies in mathematics, but is considered to be applicable beyond the one subject.

For the remaining scholars, content-specificity appears to be a potentially important, but not integral aspect of theory generation. Although coming from a more content-generic perspective, as evidenced by their work on educational effectiveness research, Kyriakides et al. (this volume), Scheerens (this volume), and Vieluf and Klieme (this volume) endorsed looking for universalities/generalizations in their field, while acknowledging that there might be certain differences in teaching between subjects, what in prior work (Campbell et al., 2004; Scheerens, 2015, 2016), the first two author groups labeled differentiated effectiveness. According to this perspective, the "foundational concepts and explanatory mechanism of theories of teaching should be considered as working equally well across subject matter areas" (Scheerens, this volume, p. 124); content represents one of the parameters, alongside others such as the students and the working environment, that might moderate how teaching contributes to student learning. Cai and colleagues (this volume) deemed content-specificity important, although not as much so as Herbst and Chazan (this volume) or Hiebert and Stigler (this volume), accepting that there are conceptualizations of teaching, such as Resnick's work on higher-order thinking, that appear to work well across subjects. Different groups of scholars, therefore, seem willing to embrace either content-generality or content-specificity regardless of their prior work, a point we elaborate upon below.

The authors were also asked to discuss whether theories of teaching can accommodate differences between students. Their responses largely mirrored their stances on the issue of content-specificity. For example, Biesta (this volume) talked about his theorization being student-independent, arguing that considering the student population and how teaching can be shaped to account for differences between students should be left to the "artistry of the teachers" (p. 277). Similarly, Schoenfeld (this volume) argued that although student composition matters since "[t]o be an effective teacher of any group of students, one needs to know those particular students and have a sense of what supports their learning" (p. 180), when developing theories of teaching differences across learners should not [be] prioritized; actually, he deemed such differences second-level elements ("details") compared to the key building blocks of his theory. In contrast, Cai and colleagues (this volume) and Herbst and Chazan (this volume), ascribed a more central role to the student population, claiming that not just student population differences but also other contextual characteristics needed to be considered, a stance that resonates with the perspective of the practice theories paradigm discussed by Vieluf and Klieme (this volume). Specifically, Herbst and Chazan (this volume) asked that cultures and institutions also be considered, claiming that "At some level of theorization, a theory of teaching practice could take all those […] sources of difference and elaborate them theoretically" (p. 218). Similarly, accommodating both the Confucian tradition and Western beliefs about the role of teaching and teachers, Cai and colleagues (this volume) made a strong case for the role of context in theorizing teaching, writing that "teaching is […] shaped by cultural expectations, and, consequently, theories of teaching may naturally end up reflecting the cultural practices of the context in which they are conceived, used, and refined" (p. 238).

One way to resolve these differences with respect to content and context might be to accept that, as suggested by Vieluf and Klieme (this volume), different paradigms often conceptualize educational phenomena differently. For example, when comparing and contrasting the teaching effectiveness research paradigm with the practice theories paradigm, Vieluf and Klieme (this volume) explain that while teaching effectiveness research "aims at explaining achievement test results with teaching, research from a practice theoretical perspective aims at understanding teaching in all its facets" (p. 75). In the first paradigm, the content and composition of the student population are two factors moderating the teaching-learning relation. In the second paradigm, they can play a more prominent role since they can shape how teaching unfolds, especially when teaching is viewed as interactions between the teacher and the students around specific content and situated in specific contexts (see Cohen et al., 2003).

Another way to handle these differences would be to offer scholars more systematic opportunities to discuss these differences in order to better understand why they might hold a more content/context agnostic or supportive perspective. We are convinced that continuing this dialogue can be beneficial, since we see some areas of convergence in the authors' answers, even when their answers seem to be superficially quite different. This is exemplified by the way some content-generic authors accept the possible validity of content specificity and some content-specific authors acknowledging that content-specific attributes might have wider applicability in other subject areas. For example, when discussing the need to advance their work on the *Dynamic Model of Educational Effectiveness* (Creemers & Kyriakides, 2008), a content-generic model, Kyriakides and colleagues (this volume) argued for the importance of incorporating content-specific aspects into their work. Herbst and Chazan (this volume) entertained the idea of exploring the applicability of the building blocks of their content-specific *Practical Rationality* theory (Herbst & Chazan, 2003) in other subject matters. Hence, there seems to be a move toward the integration of the two views. This can couple with current attempts to enhance classroom observation instruments that move between the content generic and the specific, attempting to reap the benefits of each perspective (see, for example, the German special issue on content-specificity in research on teaching quality, Praetorius & Gräsel, 2021).

We do not wish to underplay the fact that most of the contributors to this book were associated with research in mathematics and that several of the authors associated with content-generic approaches have used mathematics as the main subject area in their investigations. Given the increasing heterogeneity in the field of research on teaching, we intentionally chose a homogeneous group of researchers to facilitate a first step in reaching consensus. Moving forward, a more diverse group of researchers, not only in terms of subject but also in terms of culture, language, or disciplinary background, needs to be involved.

7 The Role of Practitioners in Theorizing and Using Theories of Teaching

Although the questions that guided the development of this book did not refer to it explicitly, an important topic repeatedly emerged in the contributors' answers: the role of practitioners in developing and using theories of teaching.

In line with their prior work (see, for example, the 2018 editorial co-authored by Cai, Hiebert, and other colleagues), two groups of contributors called for blending the traditional roles of researchers and teachers when generating theories of teaching. Hiebert and Stigler (this volume) proposed giving teachers a more prominent role in developing and testing hypotheses for teaching and learning. Building on their idea of the importance of creating sustained learning opportunities (SLO) for students, they write (p. 39):

> Imagine teachers and researchers developing teams, or partnerships, to meet the challenge of creating theories of SLOs. The promise of researcher-practitioner partnerships has been realized in professional fields outside of education […] From auto manufacturing to the repair of Xerox machines to clinical medicine to the wind turbine industry, this multiple expertise model has been used effectively to improve practices across a range of professions […] When teachers and researchers form partnerships around shared problems of practice, they can realize similar successes […]

Using the terms "theory for teaching" and "teaching for theories," Cai and colleagues (this volume) also saw researchers as working closely with teachers to co-develop and refine theories needed for the work of teaching. Using the example of creating teaching cases in a Chinese setting, they suggested that the continuous and spiraling opportunities teachers are provided with to create a lesson, implement it, and reflect on it, provide fertile soil for testing "small, local hypotheses about how attributes of tasks or instruction may influence students' learning in the particular context" (p. 243), thus contributing to theory generation (for a similar argument, see Kyriakides et al. on McIntyre's (1995) "practical theorizing", see Chap. 10). And they continue, "the teaching case provides a dynamic, tangible resource that can help store this knowledge gained from teaching for theory and, in turn, allow teachers and researchers to use that knowledge to extend theory for teaching" (p. 243).

Unlike these two groups, who proposed that theories be co-generated through researcher-teacher collaboration, the authors of the remaining chapters do not directly address this issue, which is not surprising given that they were not asked to do so. However, there are some comments in their writing, either in their chapters or in their Delphi study replies, which could be considered indicative of their perspective on teachers' roles in the development of theory.

Perhaps the most telling piece of evidence stems from comparing their responses to the three statements concerning the process of generating theories. The first stipulates that theories should be developed in ways that help teachers inform and improve their practice. All but one of the authors agreed with this, with Kyriakides and colleagues even contending that the ultimate goal of theory development is to inform practice (Chap. 10). The other two statements held that to develop and/or enrich theories of teaching, researchers needed to coordinate with teachers to test predictions and revise hypotheses and to build networks and create sustainable partnerships with practitioners. There was more disagreement with these two statements: in addition to explicit disagreements (one in each case), there were also a number of partial agreements (four to five). The level of disagreement might in part have been caused by issues of terminology (e.g., using terms such as networks and partnerships) that influenced some authors' opinions (e.g., Scheerens). However, the range of responses to these statements compared to those for the first one makes us wonder whether the disagreement is also partly due to the different roles ascribed to teachers, with the first statement characterizing teachers as merely users of theories and the latter two ascribing a more active role to them based on productive teacher-researcher collaborations and partnerships. This conclusion is supported by the fact that, as discussed in Sect. 4, another statement which stipulated that theories need to be expressed in ways in which teachers can easily see their value also divided the contributors.

We see three distinct options for the role of practitioners in developing scientific theories.[5] We will call the first the *consumer* role. In this role it is not the teachers'

[5] In considering these roles, we emphasize the term *scientific* to distinguish it from other theories, for example, those that teachers themselves might generate without collaborating with researchers.

responsibility to develop theories of teaching; it is not even necessary for teachers to understand such theories or to judge their validity. Instead, teachers need to be exposed to any practical implications that certain theories of teaching might have for their work and be able to use those to improve their work and benefit their students. The second is the *informed applicant* role. As in the first role, teachers are not expected to develop theories of teaching however, unlike in their role as a consumer, they are expected to understand theories and consider their implications for their daily practice. The third is a *co-developer* role. In this role teachers are expected to be more active and work closely in collaboration with researchers to develop and refine theories of teaching.

Several statements in the contributions as well as in the Delphi study suggest that each of the three roles is favored by some authors. From their work it is clear that Cai and colleagues, Hiebert and Stigler, and Kyriakides and colleagues subscribe to the co-developer role for teachers (see Chap. 10). However, because this issue was not directly raised by us, we will not assume which option the other contributors preferred. There are arguments for all three options. Opponents of blending the roles of teachers and researchers could point out that teachers are often concerned with more local problems that relate to their daily practice, whereas researchers, when viewed through certain paradigms, are more concerned with producing work that transcends particular situational and historical contexts. Opponents could point out that practitioners themselves also hold theories, which are different from researchers' scientific theories, in terms of theoretical grounding, level of generality, and empirical verification. Therefore, although continuous exchange between scholars and practitioners is desirable, seeking to co-develop theories might be dysfunctional.[6] Proponents of assigning teachers a more active role in the theorizing process might, on the other hand, counter that practitioners are in a better place than researchers to identify problems of daily practice and offer initial ideas for resolving them. These arguments show that the potential role of teachers in the process of theorizing and using theories warrants focused and explicit discussion among scholars. Teachers should also be invited to join the discussion to present their perspective on how they see their role in this process, and what they think it is feasible.

The role of teachers in theorizing teaching raises a number of other related issues. Herbst and Chazan as well as Schoenfeld point out that limiting ourselves to generating theories just for the sake of improving practice might result in producing prescriptive theories that stipulate how teaching should look in order to improve student learning. Producing such theories, Herbst and Chazan (Chap. 10) argue, is both limited and limiting in a field that aspires to be scientific. They wonder, "Are we committed to understanding scientifically the world of practice or are we just advocating for a particular vision for practice?" (p. 307). For them, the answer is the former and therefore we need descriptive and/or explanatory theories to guide research in ways that help develop and validate the existing scholarly knowledge.

[6] We would like to thank Eckhard Klieme for pointing this out when providing feedback on this chapter.

Vieluf and Klieme appear to concur with this stance, when, reflecting on a statement included in the Delphi study ("a theory should be expressible in ways that practitioners can judge its face validity"), they challenge the idea that the goal of developing theories is simply to inform practice. For them, ascribing such a focused role to theories imposes unnecessary restrictions on theorizing teaching (Chap. 10). Schoenfeld raises a related concern: when attempting to communicate theories to teachers, in order to improve practice, we are running the risk of rendering this communication a theory attribute. For him, this should not be the case, as he explains while commenting on a Delphi study statement: "Communicating useful ideas to teachers is essential for improvement, but it is not part of a theory of teaching, any more than telling people to conserve energy is […] a contribution to the theory of climate change" (Chap. 10, p. 306). These points actually raise a set of additional issues about the type of theories generated (prescriptive, descriptive, explanatory), and their attributes.

8 Theorizing Teaching: Looking Back and Looking Forward

In the introduction to this volume (Praetorius & Charalambous, this volume), we noted the significant variation in views on the subject of theorizing teaching among scholars and the apparent scarcity of attempts to initiate discussions that promote the exchange of ideas and consensus. We set out to conduct a directed discussion and improved the odds for a productive dialogue by selecting a relatively homogeneous group of academics. Despite being complex and demanding, we were convinced that this exercise was worthwhile since exchanges are crucial for enhancing our collective understanding of theorizing teaching (see Chap. 1). So have we learned anything new?

One could argue that this volume simply adds to the body of work confirming that there is a huge variation in how researchers view the theorizing teaching. In fact, as a reviewer opined, despite our attempts to establish some common ground, the chapters do not necessarily represent a collective "we"—and we agree. As the reviewer eloquently noted,

> Some [chapters] seem to not agree on the nature of rigorous research. Some chapters seem to suggest that "scientific" research is quantitative and rigorous and empirical [...]. Some chapters seem aligned with a relatively technocratic idea of educational "effectiveness" […] versus a more generous, robust, or ambitious view that would include a range of proxies for measuring whether teachers and students did productive work together [...]. Some authors seem to embrace a view of theorizing the work of teaching as messy and variegated, others as searching for parsimonious lists of discrete, easily measured variables.

When reading the book one can hardly miss the differences in the authors' viewpoints on the existence (or not) of theories of teaching, the process of developing theories, their attributes, and the extent to which they could or should accommodate differences across contexts and subjects.

Yet, we would argue that this volume is much more than a compilation of the wide range of opinions about teaching. To corroborate this argument, in this section, we discuss three lessons learned from this exercise and propose five steps for how to move forward.

The first lesson is that in order to better understand how theories are developing and be able to compare and contrast differing perspectives, the prerequisite is researcher making their work comprehensible to others and being able to understand the work of others (cf. the first two steps in the model of Bikner-Ahsbahs & Prediger, 2010). The importance of this prerequisite was confirmed when the contributors were asked to respond to the five questions that formed the backbone of the project (Chap. 1). They first outlined and then reflected on their own work (Chaps. 2, 3, 4, 5, 6, 7, 8 and 9), which ensured that they explained the underlying assumptions that guided their thinking. The attempt to then engage the contributors in an exchange (Chap. 10) showed both the importance of and the difficulties in understanding others' work. The difficulties ranged from developing a vocabulary of terms—including some one might think were clear—to understanding, but not necessarily embracing, assumptions different from your own. Thus we agree wholeheartedly with Bikner-Ahsbahs and Prediger (2010) that significant effort should be invested in making one own's work as clear and unambiguous as possible. This and the opportunity to interact often with others is necessary for more synergy in the field of theorizing teaching.

The second lesson concerns the issue of whether consensus can be reached on the issues around theorizing teaching which have been discussed in this volume. When we began the project we believed achieving consensus on the many complex aspects of theorizing teaching to be a desirable, important goal. However, the contributors' answers to one question in the Delphi study raised the possibility that reaching consensus may not be optimal. Some authors favored consensus because it facilitates communication and exchanges about teaching (Scheerens, this volume), a common understanding of teaching (Hiebert & Stigler, this volume), and knowledge accumulation (Cai et al., this volume; Hiebert & Stigler, this volume). Others considered reaching complete consensus unlikely (Cai et al., this volume; Schoenfeld, this volume), questioned who might need consensus and for what purposes (Herbst & Chazan, this volume) or pointed out that the cultural embeddedness of teaching precludes the possibility of reaching consensus (Cai et al., this volume). Other obstacles to consensus put forward were that researchers have their own agendas (Kyriakides et al., this volume), that funding for such activities is currently limited (Herbst & Chazan, this volume), and that researchers need to be motivated to do such work (Herbst & Chazan, this volume). Overall, the contributors seemed to view reaching consensus as a worthwhile, if possibly unattainable goal. We accept this view given that we were unable to reach a consensus during an exercise that involved a relatively homogeneous group of researchers and focused on particular aspects of theorizing teaching. At the same time, we embrace some authors' contention that even though it may not be possible to reach consensus across the entire research community, it may be possible within research paradigms (Hiebert & Stigler, this volume; Vieluf & Klieme, this volume). We revisit this idea when discussing the work that needs to be undertaken across and within given paradigms.

The third lesson involves a specific form of consensus—whether it is possible to develop a (more) comprehensive theory of teaching in the future. The contributors responses to this question were divided with some authors suggesting that existing theoretical work could evolve into such theories and others being opposed to the development of a comprehensive theory of teaching. This latter stance is also reflected in Bikner-Ahsbahs and Prediger's (2010) paper which argues that attempts to develop global unified theories run the risk of homogenizing different ideas by regarding their diversity as an obstacle to scientific progress. Such a stance, "risks usurp[ing] the richness of theories by one dominant approach" (p. 491). Therefore, instead of attempting to develop one overarching theory, we believe that the theorizing of teaching would benefit from simultaneously moving in two different directions: diversifying as the existing paradigms grow in sophistication, as suggested by Vieluf and Klieme (this volume), and *local* synthesis and integration, as suggested by Bikner-Ahsbahs and Prediger (2010). According to the latter authors, although developing unified global theories might be neither realistic nor productive, attempting to build more local synergies between theories is a viable and worthwhile goal since it can help to advance a field scientifically. Theories which have compatible underlying philosophical assumptions can be brought together and integrated in ways that can produce new theories that can help to better understand issues in teaching.

Given the lessons learned, we would like to suggest five steps which are important for the future advancement of theorizing teaching. We identify those steps which appeared to work well in this exercise and could possibly be scaled-up in future, and those which need revision, extension or refinement.

Step 1

Selecting the research groups who would be asked to contribute to this book was our starting point. We assumed that inviting researchers who have focused on teaching quality would be a good starting point. We learned, however, that even scholars who apparently subscribe to similar approaches to studying teaching and learning can have significant differences. For example, we originally thought Kyriakides and colleagues and Vieluf and Klieme to be in a cluster since both groups focused on teaching effectiveness research, but their contributions revealed notable differences in their thinking, with Vieluf and Klieme moving a long way beyond ideas of teaching effectiveness. We are still convinced that inviting scholars with similar ideas is important, since otherwise, as Hiebert and Stigler argue "the field can appear, from a big-picture perspective, to be accumulating random facts and unverified observations." Arguing that "knowledge will accumulate only within programs" these scholars call for "a relatively small (smaller than the number that exist now) programs for the field, as a whole, to show steady progress" (Chap. 10, p. 284).

In agreement with Hiebert and Stigler (this volume), and adopting Vieluf and Klieme's (this volume) use of the term paradigm, we propose that another possible starting point would be identifying a small group of paradigms. This might not be easy, especially nowadays, given that the boundaries between different paradigms may not be easy to demarcate. But, mapping the field in terms of the existence of certain paradigms [e.g., by drawing on Shulman's (1986) approach back in 1980s] appears to be a particularly worthwhile first endeavor and one which, to the best of our knowledge, has not been recently attempted. Scholars could also be asked to nominate existing paradigms and then, through consensus, a list of the most important ones could be developed. This should not only facilitate the next steps in theorizing teaching but should also give a clearer structure and organizational framework to the existing literature.

Step 2

Having selected a paradigm to work in, we believe that is of paramount importance to agree, before moving forward, on the value and implications of cumulative work. When we began this project, we assumed that the authors' acceptance of our invitation implied a shared understanding of why such an exercise was important. We later realized that this was not entirely true. In hindsight we recognize that ensuring some common ground about the value and implications of cumulative work is a fundamental prerequisite for making the theorizing of teaching more collaborative.

Step 3

Within paradigms, the process of theorizing teaching can evolve in multiple directions three of which we outline below. The first is having meta-theoretical discussions on the purposes and functions a theory needs to serve. Without such discussions, as Biesta suggests, the existing differences might appear inexplicable and insurmountable. Hill and Lampert also stress the key role that such discussions can have when they present David Cohen in their foreword asking Heather Hill, "*Why* would you want to develop a theory of teaching?" (p. 190). Such meta-theoretical discussions were not planned for this volume because we assumed that contributors generally had similar views on these issues. The Delphi study made us realize the importance of discussing these issues early on.

A second is attempting to reach consensus on the definitions and attributes of theories, as well as on the extent to which theories could or should accommodate different aspects of context and content. This can yield important insights, even when disagreements emerge, since it can reveal issues, ranging from underlying substantive theoretical differences about the purpose of theorizing teaching that need to be discussed to more minor linguistic differences that need to be clarified.

A third and perhaps the most critical direction is identifying the most important theories within each paradigm and exploring how they can be synthesized locally [to use Bikner-Ahsbahs and Prediger's (2010) words] in ways that would help to better describe and explain teaching. During this process, it could be interesting to pursue Herbst and Chazan's idea to have theories openly compete with each other (see more on that in Chap. 10).

Step 4

Regardless of how critical work within any given paradigm can be, it might be limiting and limited if it is not informed by the perspectives of other paradigms. Thus although we propose that work be undertaken within homogeneous groups subscribing to the same paradigm in the third step, we also believe that there is great value in conferring with other paradigms. This volume shows that different perspectives can enrich each other. Notice, for example, how Biesta's objections to causality (see Chap. 10) might problematize and enrich the discussions undertaken within the Teaching Effectiveness Research paradigm, or take Vieluf and Klieme's chapter (this volume) in which they discuss how the latter paradigm and the *Practice Theories* paradigm can inform each other. We would like to propose that after working within paradigms, such heterogeneity be purposefully incorporated into the work of more homogenous groups by inviting critical friends that represent other perspectives. This will not be to reach a consensus, as we learned in this volume, but it can help identify blind spots and limitations, enrich ideas, and point towards next steps that can be undertaken within a given paradigm.

Step 5

A final, yet, equally important, step pertains to communicating all this work, both within and across paradigms, in a clear, useful, and usable way that would contribute toward its development in the future by enticing the next generation of researchers to engage in the cognitively demanding work of theorizing teaching. We recognize that often journal space restrictions are limiting. Edited volumes like this one, as well as other events and organizations (symposia in conferences, forming special interest groups, etc.) might offer additional ways of communicating the results of such work in comprehensible ways and in the level of detail required. We hope that in this volume we have clearly communicated the process and results of this exercise and so can provide an example for others to follow or develop on.

9 Limitations of the Approach Taken

The approach we have taken yields a significant delineation of the current status of theorizing teaching and provides many interesting ideas for future work in this field. It does, however, have several limitations.

The core of the project was the contribution of a group of eminent researchers who were invited to participate. The concrete focus on researchers following an instrumental idea of teaching was based on our own background and expertise. Following the approach suggested by Bikner-Ahsbahs and Prediger (2010), we selected researchers whose work had some areas of overlap and included a few additional perspectives for enrichment. This resulted in certain ideas being highlighted and other important areas of teaching, such as issues raised by critical race theory (e.g., Howard & Navarro, 2016; Ladson-Billings & Tate, 1995; Ledesma & Calderón, 2015), ecological theories (e.g., Bronfenbrenner, 1989), relational and affective teaching (e.g., Grossman et al., 2009; Lampert, 2001; Noddings, 2001), sociocultural (e.g., Banks & Banks, 2004; Gallego et al., 2001; Gay, 2018) and sociopolitical (e.g., Nasir et al., 2016; Nieto, 2005) contexts, as well as historical perspectives (e.g., Kafka, 2016; Sweeting, 2005) not being addressed or addressed only in single chapters. Ideas such as the interdependency of teachers and students and the consideration of the influence of systems and structures on teaching had originally been expected to be better represented in the book based on the chapter by David Cohen; his unexpected passing away resulted in their underrepresentation. It is obvious that no single book can address all of the aspects relevant to theorizing teaching and that our decision to ensure there were sufficient overlaps between chapters to enable a productive exchange between the authors led to a further narrowing of focus. Future research should follow a similar procedure, but with different foci, so that a more complete picture of the field of theorizing teaching could emerge.

To ensure comparability across the chapters, we asked all of the authors to respond to five questions derived from a review of the literature review (Chap. 1). Different, or differently phrased questions could have resulted in different insights into research on teaching. The authors also each chose to concentrate on some questions more than others in their responses.

The structure of the Delphi study is also likely to have had an impact on the results (Chap. 10). The contributions were summarized in a series of statements, and this was followed by a member-check phase to ensure that authors agreed with the summaries of their work. The length of the responses was also limited. The summaries were necessary to ensure a manageable work load, but some misunderstandings may have arisen from the resulting reduced context. Also, to again reduce the work load, we asked the authors to only provide a comment on the statements with which they most agreed or disagreed, which meant we did not have a response to every statement from everyone. We also restricted the exchange between authors to one round, whereas several additional rounds, ideally not only in written form, but also in symposia or a conference environment, would have been very interesting, if also likely too demanding of participants' time.

Despite these limitations, we are convinced that the approach we have used has provided a wealth of important insights into theories of teaching and a great starting point for future discussions in this area.

10 Conclusion

This book was quite an ambitious and complex endeavour. We wanted to provide an up-to-date overview of the theorizing of teaching that included a review of the literature, the views of leading experts in the field, and a directed discussion among the experts on specific aspects of theorizing teaching. We believe that many insightful and thought-provoking ideas are collected in this book and that it provides a unique view on the subject. The key ideas to emerge from the compilation of this endeavour are: The issue of theories of teaching is highly complex; theories and their development, which we tried to separate using five guiding questions, are quite intertwined; the lines between attributes of theories, the process of generating them, and whether and how to develop more comprehensive theories of teaching in the future, are hard to distinguish. It became evident that the purpose and definition of theories of teaching provide essential basis for the other issues. Because the authors differed in their definitions and the purposes that they ascribed to theories of teaching, they were often not focusing on the same aspects of the complex phenomenon of teaching.

Despite these challenges, many important issues were raised and addressed such as the question of how to define theory as well as teaching, the necessity of reflecting on the purpose of theories, what to include in a theory and what not, the different levels at which theories can be developed, the role of content specificity and context sensitivity in developing such theories, the embeddedness of theories in different paradigms, the role of teachers with respect to theories of teaching and related to that the link between research and practice, and how to come up with a useful consensus-development process.

So where are we in terms of theorizing teaching? There has been considerable progress in theorizing teaching since the publication of the work in our literature review (Chap. 1); however, this volume demonstrates that there is still much work to be done. The big disagreements between the authors highlighted the complexity in research on teaching and revealed that we need more close collaborations in order to clarify these issues, taking an explicitly stronger meta-level stance in discussions about theorizing teaching, along the lines of those in this book. More specifically, each research group needs to be more explicit in their own work with respect to terminology and the paradigm they follow, including its underlying assumptions. It would be very useful to continue comparing different approaches and theories in order to identify similarities and differences. Based on such work, a meta-framework could be developed that helps to organize different theories into an overarching picture to see how existing theories of teaching relate to each other and on which levels they are located. This would also give us better ways to discuss whether and to what degree consensus could and should be reached about certain aspects of theories. Such a meta-framework could be started within paradigms before being extended to discussions across paradigms.

We have learnt a great deal about the opportunities and constraints of such a complex endeavour and have used the exercise to develop several ideas on how to continue and optimize such exchanges in the future. Fortunately, there is already some interest from the contributors for continuing these fruitful discussions. We are looking forward to it, hoping that the readers of this book will also be interested in joining such efforts. For now, we want to conclude with an adapted version of the quote that has been ascribed to Kurt Lewin: There is nothing as practical as theory—but also nothing as complex as theory and theorizing.

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