Chapter 3
Building and Using Theoretical Frameworks

Part I. What Are Theoretical Frameworks?

As the name implies, a theoretical framework is a type of theory. We will define it as the *custom-made theory* that focuses specifically on the hypotheses you want to test and the research questions you want to answer. It is custom-made for your study because it explains why your predictions are plausible. It does no more and no less. Building directly on Chap. 2, as you develop more complete rationales for your predictions, you are actually building a theory to support your predictions. Our goal in this chapter is for you to become comfortable with what theoretical frameworks are, with how they relate to the general concept of theory, with what role they play in scientific inquiry, and with why and how to create one for your study.

As you build a more complete rationale for your predictions, you are actually building a theory to support your predictions.

As you read this chapter, it will be helpful to remember that our definitions of terms in this book, such as theoretical framework, are based on our view of scientific inquiry as formulating, testing, and revising hypotheses. We define theoretical framework in ways that continue the coherent story we lay out across all phases of scientific inquiry and all the chapters this book. You are likely to find descriptions of theoretical frameworks in other sources that differ in some ways from our description. In addition, you are likely to see other terms that we would include as synonyms for theoretical framework, including conceptual framework. We suggest that when you encounter these special terms, make sure you understand how the authors are defining them.

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TIP

Although we treat terms like "theoretical framework" and "conceptual framework" as synonyms, some authors use these terms to mean different things. In this book, we encourage you to focus less on the exact terminology and more on what should be in a theoretical framework.

Definitions of Theories

We begin by stepping back and considering how theoretical frameworks fit within the concept of theory, as usually defined. There are many definitions of theory; you can find a huge number simply by googling "theory." Educational researchers and theorists often propose their own definitions but many of these are quite similar. Praetorius and Charalambous (2022) reviewed a number of definitions to set the stage for examining theories of teaching. Here are a few, beginning with a dictionary definition:

- Lexico.com Dictionary (Oxford University Press, 2021): "A supposition or a system of ideas intended to explain something, especially one based on general principles independent of the thing to be explained."
- Biddle and 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).
- Kerlinger (1964): "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" (p. 11).
- Colquitt and Zapata-Phelan (2007): The authors say that theories allow researchers to *understand* and *predict* outcomes of interest, *describe* and *explain* a process or sequence of events, *raise consciousness* about a specific set of concepts as well as *prevent* scholars from "being dazzled by the complexity of the empirical world by providing a linguistic tool for organizing it" (p. 1281).

For our purposes, it is important to notice two things that most definitions of theories share: They are descriptions of a connected set of facts and concepts, and they are created to predict and/or explain observed events. You can connect these ideas to Chaps. 1 and 2 by noticing that the language for the descriptors of scientific inquiry we suggested in Chap. 1 are reflected in the definitions of theories. In particular, notice in the definitions two of the descriptors: "Observing something and trying to explain why it is the way it is" and "Updating everyone's thinking in response to more and better information." Notice also in the definitions the emphasis on the

elements of a theory similar to the elements of a rationale described in Chap. 2: definitions, variables, and mechanisms that explain relationships.

Exercise 3.1
Before you continue reading, in your own words, write down a definition for "theoretical framework."

Theoretical Frameworks Are Local Theories

There are strong similarities between building theories and doing scientific inquiry (formulating, testing, and revising hypotheses). In both cases, the researcher (or theorist) develops explanations for phenomena of interest. Building theories involves describing the concepts and conjectures that predict and later explain the events, and specifying the predictions by identifying the variables that will be measured. Doing scientific inquiry involves many of the same activities: formulating predictions for answers to questions about the research problem and building rationales to explain why the predictions are appropriate and reasonable.

As you move through the cycles described in Chap. 2—cycles of asking questions, making predictions, writing out the reasons for these predictions, imagining how you would test the predictions, reading more about what scholars know and have hypothesized, revising your predictions (and maybe your questions), and so on—your theoretical rationales will become both more complete and more precise. They will become more complete as you find new arguments and new data in the literature and through talking with others, and they will become sharper as you remove parts of the rationales that originally seemed relevant but now create mostly distractions and noise. They will become increasingly customized local theories that support your predictions.

In the end, your framework should be as clean and frugal as possible without missing arguments or data that are directly relevant. In the language of mathematics, you should use an idea *if and only if* it makes your framework stronger, more convincing. On the one hand, including more than you need becomes a distraction and can confuse both you, as you try to conceptualize and conduct your research, and others, as they read your reports of your research. On the other hand, including less than you need means your rationale is not yet as convincing as it could be.

The set of rationales, blended together, constitute a precisely targeted custom-made theory that supports *your* predictions. Custom designing your rationales for your specific predictions means you probably will be drawing ideas from lots of sources and combining them in new ways. You are likely to end up with a unique local theory, a theoretical framework that has not been proposed in exactly the same way before.

A common misconception among beginning researchers is that they should borrow a theoretical framework from somewhere else, especially from well-known

scholars who have theories named after them or well-known general theories of learning or teaching. You are likely to use ideas from these theories (e.g., Vygotsky's theory of learning, Maslow's theory of motivation, constructivist theories of learning), but you will combine specific ideas from multiple sources to create your own framework. When someone asks, "What theoretical framework are you using?" you would not say, "A Vygotskian framework." Rather, you would say something like, "I created my framework by combining ideas from different sources so it explains why I am making these predictions."

Your set of custom-designed rationales for your predictions is your theoretical framework.

You should think of your theoretical framework as a potential contribution to the field, all on its own. Although it is unique to your study, there are elements of your framework that other researchers could draw from to construct theoretical frameworks for their studies, just as you drew from others' frameworks. In rare cases, other researchers could use your framework as is. This might happen if they want to replicate your study or extend it in very specific ways. Usually, however, researchers borrow parts of frameworks or modify them in ways that better fit their own studies. And, just as you are doing with your own theoretical framework, those researchers will need to justify why borrowing or modifying parts of your framework will help them explain the predictions they are making.

Considering your theoretical framework as a contribution to the field means you should treat it as a central part of scientific inquiry, not just as a required step that must be completed before moving to the next phase. To be useful, the theoretical framework should be constructed as a critical part of conceptualizing and carrying out the research (Cai et al., 2019c). This also means you should write out your framework as you are developing it. This will be a key part of your evolving research paper. Because your framework will be adjusted multiple times, your written document will go through many drafts.

If you are a graduate student, do not think of the potential audience for your written framework as only your advisor and committee members. Rather, consider your audience to be the larger community of education researchers. You will need to be sure all the key terms are defined and each part of your argument is clear, even to those who are not familiar with your study. This is one place where writing out your framework can benefit your study—it is easy to assume key terms are clear, but then you find out they are not so clear, even to you, when trying to communicate them. Failing to notice this lack of clarity can create lots of problems down the road.

HELPFUL

TIP

When you write up your theoretical framework, consider your audience to be the larger community of education researchers. Define all of the key terms and make sure each part of your argument is clear.

Exercise 3.2
Researchers have used a number of different metaphors to describe theoretical frameworks. Maxwell (2005) referred to a theoretical framework as a "coat closet" that provides "places to 'hang' data, showing their relationship to other data," although he cautioned that "a theory that neatly organizes some data will leave other data disheveled and lying on the floor, with no place to put them" (p. 49). Lester (2005) referred to a framework as a "scaffold" (p. 458), and others have called it a "blueprint" (Grant & Osanloo, 2014). Eisenhart (1991) described the framework as a "skeletal structure of justification" (p. 209). Spangler and Williams (2019) drew an analogy to the role that a house frame provides in preventing the house from collapsing in on itself. What aspects of a theoretical framework does each of these metaphors capture? What aspects does each fail to capture? Which metaphor do you find best fits your definition of a theoretical framework? Why? Can you think of another metaphor to describe a theoretical framework?

Part II. Why Do You Need Theoretical Frameworks?

Theoretical frameworks do lots of work for you. They have four primary purposes. They ensure (1) you have sound reasons to expect your predictions will be accurate, (2) you will craft appropriate methods to test your predictions, (3) you can interpret appropriately what you find, and (4) your interpretations will contribute to the accumulation of a knowledge base that can improve education. How do they do this?

Supporting Your Predictions

In previous chapters and earlier in this chapter, we described how theoretical frameworks are built *along* with your predictions. In fact, the rationales you develop for convincing others (and yourself) that your predictions are accurate are used to refine your predictions, and vice versa. So, it is not surprising that your refined framework

provides a rationale that is fully aligned with your predictions. In fact, you could think of your theoretical framework as your best explanation, at any given moment during scientific inquiry, for why you will find what you think you will find.

Throughout this book, we are using "explanation" in a broad sense. As we noted earlier, an explanation for why your predictions are accurate includes all the concepts and definitions about mechanisms (Kerlinger's, 1964 definition of "theory") that help you describe why you think the predictions you are making are the best predictions possible. The explanation also identifies and describes all the variables that make up your predictions, variables that will be measured to test your predictions.

Crafting Appropriate Methods

Critical decisions you make to test your hypotheses form the methods for your scientific inquiry. As we have noted, imagining how you will test your hypotheses helps you decide whether the empirical observations you make can be compared with your predictions or whether you need to revise the methods (or your predictions). Remember, the theoretical framework is the coherent argument built from the rationales you develop as part of each hypothesis you formulate. Because each rationale explains why you make that prediction, it contains helpful cues for which methods would provide the fairest and most complete test of that prediction. In fact, your theoretical framework provides a logic against which you can check every aspect of the methods you imagine using.

You might find it helpful to ask yourself two questions as you think about which methods are best aligned with your theoretical framework. One is, "After reading my theoretical framework, will anyone be surprised by the methods I use?" If so, you should look back at your framework and make sure the predictions are clear and the rationales include all the reasons for your predictions. Your framework should telegraph the methods that make the most sense. The other question is, "Are there some predictions for which I can't imagine appropriate methods?" If so, we recommend you return to your hypotheses—to your predictions and rationales (theoretical framework)—to make sure the predictions are phrased as precisely as possible and your framework is fully developed. In most cases, this will help you imagine methods that could be used. If not, you might need to revise your hypotheses.

Exercise 3.3
Kerlinger (1964) stated, "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" (p. 11). What role do definitions play in a theoretical framework and how do they help in crafting appropriate methods?

Exercise 3.4
Sarah is in the beginning stages of developing a study. Her initial prediction is: There is a relationship between pedagogical content knowledge and ambitious teaching. She realizes that in order to craft appropriate measures, she needs to develop definitions of these constructs. Sarah's original definitions are: Pedagogical content knowledge is knowledge about subject matter that is relevant to teaching. Ambitious teaching is teaching that is responsive to students' thinking and develops a deep knowledge of content. Sarah recognizes that her prediction and her definitions are too broad and too general to work with. She wants to refine the definitions so they can guide the refinement of her prediction and the design of the study. Develop definitions of these two constructs that have clearer implications for the design and that would help Sarah to refine her prediction. (tip: Sarah may need to reduce the scope of her prediction by choosing to focus only on one aspect of pedagogical content knowledge and one aspect of ambitious teaching. Then, she can more precisely define those aspects.)

Guiding Interpretations of the Data

By providing rationales for your predictions, your theoretical framework explains why you think your predictions will be accurate. In education, researchers almost always find that if they make *specific* predictions (which they should), the predictions are not entirely accurate. This is a consequence of the fact that theoretical frameworks are never complete. Recall the definition of theories from Biddle and Anderson (1986): A theory "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). If you have created your best developed and clearly stated theoretical framework that explains why you expected certain results, you can focus your interpretation on the ways in which your theoretical framework should be revised.

Focusing on realigning your theoretical framework with the data you collected produces the richest interpretation of your results. And it prevents you from making one of the most common errors of beginning researchers (and veteran researchers, as well): claiming that your results say more than they really do. Without this anchor to ground your interpretation of the data, it is easy to overgeneralize and make claims that go beyond the evidence.

In one of the definitions of theory presented earlier, Colquitt and Zapata-Phelan (2007) say that theories prevent scholars from "being dazzled by the complexity of

the empirical world" (p. 1281). Theoretical frameworks keep researchers grounded by setting parameters within which the empirical world can be interpreted.

Exercise 3.5
Find two published articles that explicitly present theoretical frameworks (not all articles do). Where do you see evidence of the researchers using their theoretical frameworks to inform, shape, and connect other parts of their articles?

Showing the Contribution of Your Study

Theoretical frameworks contain the arguments that define the contribution of research studies. They do this in two ways, by showing how your study extends what is known and by setting the parameters for your contribution.

Showing How Your Study Extends What Is Known

Because your theoretical framework is built from what is already known or has been proposed, it situates your study in work that has occurred before. A clearly written framework shows readers how your study will take advantage of what is known to extend it further. It reveals what is new about what you are studying. The predictions that are generated from your framework are predictions that have never been made in quite the same way. They predict you will find something that has not been found previously in exactly this way. Your theoretical framework allows others to see the contributions that your study is likely to make even before the study has been conducted.

Setting the Parameters for Your Contribution

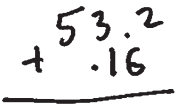
Earlier we noted that theoretical frameworks keep researchers grounded by setting parameters within which they should interpret their data. They do this by providing an initial explanation for why researchers expect to find particular results. The explanation is custom-built for each study. This means it uniquely explains the expected results. The results will almost surely turn out somewhat differently than predicted. Interpreting the data includes revising the initial explanation. So, you will end up with two versions of your theoretical framework, one that explains what you expected to find plus a second, updated framework that explains what you actually found.

The two frameworks—the initial version and the updated version—define the parameters of your study's contribution. The difference between the two frameworks is what can be learned from your study. The first framework is a claim about

what is known before you conduct your study about the phenomenon you are studying; the updated framework is a claim about how what is known has changed based on your results. It is the new aspects of the updated framework that capture the important contribution of your work.

Here is a brief example. Suppose you study the errors fourth graders make after receiving ordinary instruction on adding and subtracting decimal fractions. Based on empirical findings from past research, on theories of student learning, and on your own experience, you develop a rationale which predicts that a common error on "ragged" addition problems will be adding the wrong numerals. One of the reasons for this prediction is that students are likely to ignore the values of the digit positions and "line up" the numerals as they do with whole numbers. For instance, if they are asked to add 53.2 + .16, they are likely to answer either 5.48 or 54.8.

When you conduct your study, you present problems, handwritten, in both horizontal and vertical form. The horizontal form presents the numbers using the format shown above. The vertical form places one numeral over the other but not carefully aligned:



You find the predicted error occurs, but only for problems written in vertical form. To interpret these data, you look back at your theoretical framework and realize that students might ignore the value of the digits if the format reminded them of the way they lined up digits for whole number addition but might consider the value of the digits if they are forced to align the digits themselves, either by rewriting the problem or by just adding in their heads. A measure of what you (and others) learned from this study is the change in possible explanations (your theoretical frameworks). This does not mean your updated theoretical framework is "correct" or will make perfectly accurate predictions next time. But, it does mean that you are very likely moving toward more accurate predictions *and* toward a deeper understanding of how students think about adding decimal fractions.

Anchoring the Coherence of Your Study (and Your Evolving Research Paper)

Your theoretical framework serves as the anchor or center point around which all other aspects of your study should be aligned. This does not mean it is created first or that all other aspects are changed to align with the framework after it is created. The framework also changes as other aspects are considered. However, it is useful to always check alignment by beginning with the framework and asking whether other aspects are aligned and, if not, adjusting one or the other. This process of

checking alignment is equally true when writing your evolving research paper as when planning and conducting your study.

Part III. How Do You Construct a Theoretical Framework for Your Study?

How do you start the process? Because constructing a theoretical framework is a natural extension of constructing rationales for your predictions, you already started as soon as you began formulating hypotheses: making predictions for what you will find and writing down reasons for why you are making these predictions. In Chap. 2, we talked about beginning this process. In this section, we will explore how you can continue building out your rationales into a full-fledged theoretical framework.

Building a Theoretical Framework in Phases

Building your framework will occur in phases and proceed through cycles of clarifying your questions, making more precise and explicit your predictions, articulating reasons for making *these* predictions, and imagining ways of testing the predictions. The major source for ideas that will shape the framework is the research literature. That said, conversations with colleagues and other experts can help clarify your predictions and the rationales you develop to justify the predictions.

As you read relevant literature, you can ask: What have researchers found that help me predict what I will find? How have they explained their findings, and how might those explanations help me develop reasons for my predictions? Are there new ways to interpret past results so they better inform my predictions? Are there ways to look across previous results (and claims) and see new patterns that I can use to refine my predictions and enrich my rationales? How can theories that have credibility in the research community help me understand what I might find and help me explain why this is the case? As we have said, this process will go back and forth between clarifying your predictions, adjusting your rationales, reading, clarifying more, adjusting, reading, and so on.

One Researcher's Experience Constructing a Theoretical Framework: The Continuing Case of Martha

In Chap. 2, we followed Martha, a doctoral student in mathematics education, as she was working out the topic for her study, asking questions she wanted to answer, predicting the answers, and developing rationales for these predictions. Our story

concluded with a research question, a sample set of predictions, and some reasons for Martha's predictions. The question was: "Under what conditions do middle school teachers who lack conceptual knowledge of linear functions benefit from five 2-hour learning opportunity (LO) sessions that engage them in conceptual learning of linear functions as assessed by changes in their teaching toward a more conceptual emphasis of linear functions?" Her predictions focused on particular conditions that would affect the outcomes in particular ways. She was beginning to build rationales for these predictions by returning to the literature and identifying previous research and theory that were relevant. We continue the story here.

Imagine Martha continuing to read as she develops her theoretical framework—the rationales for her predictions. She tweaks some of her predictions based on what other researchers have already found. As she continues reading, she comes across some related literature on learning opportunities for teachers. A number of articles describe the potential of another form of LOs that might help teachers teach mathematics more conceptually—analyzing videos of mathematics lessons.

The data suggested that teachers can improve their teaching by analyzing videos of other teachers' lessons as well as their own. However, the results were mixed so researchers did not seem to know exactly what makes the difference. Martha also read that teachers who *already* can analyze videos of lessons and spontaneously describe the mathematics that students are struggling with and offer useful suggestions for how to improve learning opportunities for students teach toward more conceptual learning goals, and their students learn more (Kersting et al., 2010, 2012). These findings caught Martha's attention because it is unusual to find correlates with conceptual teaching *and* better achievement. What is not known, realized Martha, is whether teachers who learn to analyze videos in this way, through specially designed LOs, would look like the teachers who already could analyze them. Would teachers who *learned* to analyze videos teach more conceptually?

It occurred to Martha she could bring these lines of research together by extending what is known along both lines. Recall our earlier suggestion of looking across the literature and noticing new patterns that can inform your work. Martha thought about studying how, exactly, these two skills are related: analyzing videos in particular ways and teaching conceptually. Would the relationships reported in the literature hold up for teachers who *learn* to describe the mathematics students are struggling with and make useful suggestions for improving students' LOs?

Martha was now conflicted. She was well on her way to developing a testable hypothesis about the effects of learning about linear functions, but she was really intrigued by the work on analyzing videos of teaching. In addition, she saw several advantages of switching to this new topic:

- The research question could be formulated quite easily. It would be something like: "What are the relationships between learning to analyze videos of mathematics teaching in particular ways (specified from prior research) and teaching for conceptual understanding?"
- She could imagine predicting the answers to this question based directly on previous research. She would predict connections between particular kinds of analy-

sis skills and levels of conceptual teaching of mathematics in ways that employed these skills.

- The level of conceptual teaching, a challenging construct to define with her previous topic (the effects of professional development on the teaching of linear functions), was already defined in the work on analyzing videos of mathematics teaching, so that would solve a big problem. The definition foregrounded particular sets of behaviors and skills such as identifying key learning moments in a lesson and focusing on students' thinking about the key mathematical idea during these moments. In other words, Martha saw ways to adapt a definition that had already been used and tested.
- The issue of transfer—another challenging issue in her original hypothesis—was addressed more directly in this setting because the learning environment—analyzing videos of classroom teaching—is quite close to the classroom environment in which participants' conceptual teaching would be observed.
- Finally, the nature of learning opportunities, an aspect of her original idea she still needed to work through, had been explored in previous studies on this new topic, and connections were found between studying videos and changes in teaching.

Given all these advantages, Martha decided to change her topic and her research question. We applaud this decision for two major reasons. First, Martha's interest grew as she explored this new topic. She became excited about conducting a study that might answer the research question she posed. It is always good to be passionate about what you study. Second, Martha was more likely to contribute important new insights if she could extend what is already known rather than explore a new area. Exploring something quite new requires lots of effort defining terms, creating measures, making new predictions, developing reasons for the predictions, and so on. Sometimes, exploring a new area has payoffs. But, as a beginning researcher, we suggest you take advantage of work that has already been done and extend it in creative ways.

Although Martha's idea of extending previous work came with real advantages, she still faced a number of challenges. A first, major challenge was to decide whether she could build a rationale that would predict learning to analyze videos *caused* more conceptual teaching. Or, could she only build a rationale that would predict that there was a relationship between changes in analyzing videos and level of conceptual teaching? Perhaps a cause-effect relationship existed but in the opposite direction: If teachers learned to teach more conceptually, their analysis of teaching videos would improve. Although most of the literature described learning to analyze videos as the potential cause of teaching conceptually, Martha did not believe there was sufficient evidence to build a rationale for this prediction. Instead, she decided to first determine if a relationship existed and, if so, to *understand* the relationship. Then, if warranted, she could develop and test a hypothesis of causation in a future study. In fact, the direction of the causation might become clearer when she understood the relationship more clearly.

A second major challenge was whether to study the relationship as it existed or as one (or both) of the constructs was changing. Past research had explored the relationship as it existed, without inducing changes in either analyzing videos or teaching conceptually. So, Martha decided she could learn more about the relationship if one of the constructs was changing in a planned way. Because researchers had argued that teachers' analysis of video could be changed with appropriate LOs, and because changing teachers' teaching practices has resisted simple interventions, Martha decided to study the relationship as she facilitated changes in teachers' analysis of videos. This would require gathering data on the relationship at more than one point in time.

Even after resolving these thorny issues, Martha faced many additional challenges. Should she predict a closer relationship between learning to analyze video and teaching for conceptual understanding before teachers began learning to analyze videos or after? Perhaps the relationship increases over time because conceptual teaching often changes slowly. Should she predict a closer relationship if the content of the videos teachers analyzed was the same as the content they would be teaching? Should she predict the relationship will be similar across pairs of similar topics? Should she predict that some analysis skills will show closer relationships to levels of conceptual teaching than others? These questions and others occurred to Martha as she was formulating her predictions, developing justifications for her predictions, and considering how she would test the predictions.

Based on her reading and discussions with colleagues, Martha phrased her initial predictions as follows:

1. There will be a significant positive correlation between teachers' performance on analysis of videos and the extent to which they create conceptual learning opportunities for their students both before and after proposed learning experiences.
2. The relationship will be stronger:
   (a) Before the proposed opportunities to learn to analyze videos of teaching;
   (b) When the videos and the instruction are about similar mathematical topics; and,
   (c) When the videos analyzed display conceptual misunderstandings among students.
3. Of the video analysis skills that will be assessed, the two that will show the strongest relationship are spontaneously describing (1) the mathematics that students are struggling with and (2) useful suggestions for how to improve the conceptual learning opportunities for students.

Martha's rationales for these predictions—her theoretical framework—evolved along with her predictions. We will not detail the framework here, but we will note that the rationale for the first prediction was based on findings from past research. In particular, the prediction is generated by reasoning that if there has been no special intervention, the tendency to analyze videos in particular ways and to teach conceptually develop together. This might explain Kersting's findings described

earlier. The second and third predictions were based on the literature on teachers' learning, especially their learning from analyzing videos of teaching.

Before leaving Martha at this point in her journey, we want to make an important point about the change she made to her research topic. Changes like this occur quite often as researchers do the hard intellectual work of developing testable hypotheses that guide research studies. When this happens to you, it can feel like you have lost ground. You might feel like you wasted your time on the original topic. In Chap. 1, we described inevitable "failure" when engaged in scientific inquiry. Failure is often associated with realizing the data you collected do not come close to supporting your predictions. But a common kind of failure occurs when researchers realize the direction they have been pursuing should change before they collect data. This happened in Martha's case because she came across a topic that was more intriguing to her and because it helped solve some problems she was facing with the previous topic. This is an example of "failing productively" (see Chap. 1). Martha did not succeed in pursuing her original idea, but while she was recognizing the problems, she was also seeing new possibilities.

Constantly Improving Your Framework

We will use Martha's experience to be more specific about the back-and-forth process in which you will engage as you flesh out your framework. We mentioned earlier your review of the literature as a major source of ideas and evidence that will affect your framework.

Reviewing Published Empirical Evidence

One of the best sources for helping you specify your predictions are studies that have been conducted on related topics. The closer to your topic, the more helpful will be the evidence for anticipating what you will find. Many beginning researchers worry they will locate a study just like the one they are planning. This (almost) never happens. Your study will be different in some ways, and a study that is very similar to yours can be extraordinarily helpful in specifying your predictions. Be excited instead of terrified when you come across a study with a title similar to yours.

Try to locate all the published research that has been conducted on your topic. What does "on your topic" mean? How widely should you cast your net? There are no rules here; you will need to use your professional judgment. However, here is a general guide: If the study does not help you clarify your predictions, change your confidence in them, or strengthen your rationale, then it falls outside your net.

In addition to helping specify your predictions, prior research studies can be a goldmine for developing and strengthening your theoretical framework. How did researchers justify their predictions or explain why they found what they did? How can you use these ideas to support (or change) your own predictions?

By reading research on similar topics, you might also imagine ways of testing your predictions. Maybe you learn of ways you could design your study, measures you could use to collect data, or strategies you could use to analyze your data. As you find helpful ideas, you will want to keep track of where you found these ideas so you can cite the appropriate sources as you write drafts of your evolving research paper.

Examining Theories

You will read a wide range of theories that provide insights into why things might work like they do. When the phenomena addressed by the theory are similar to those you will study, the associated theories can help you think through your own predictions and why you are making them. Returning to Martha's situation, she could benefit from reading theories on adult learning, especially teacher learning, on transferring knowledge from one setting to another, on professional development for teachers, on the role of videos in learning, on the knowledge needed to teach conceptually, and so on.

Focusing on Variables and Mechanisms

As you review the literature and search for evidence and ideas that could strengthen your predictions and rationales, it is useful to keep your eyes on two components: the variables you will attend to and the mechanisms that might explain the relationships between the variables. Predictions could be considered statements about expected behaviors of the variables. The theoretical framework could be thought of as a description of all the variables that will be deliberately attended to plus the mechanisms conjectured to account for these relationships.

In Martha's case, the most obvious variables are the responses teachers give to questions about their analysis of the videos and the features observed in their teaching practices. The mechanism of primary interest is the (mental and social) process that transforms the skills, knowledge, and attention involved in analyzing videos into particular kinds of teaching practices—or vice versa. The definition of conceptual teaching she adopted from previous studies gave her a clue about the mechanisms—about how and why learning to analyze videos might affect classroom teaching. The definition included attending to key learning moments in a lesson and tracking students' thinking during these moments. Martha predicted that if teachers learned to attend to these aspects of teaching when viewing videos, they might attend to them when planning and implementing their own teaching.

As Martha reviewed the literature, she identified a number of variables that might affect the likelihood and extent of this translation. Here are some examples: how well teachers understand the mathematics in the videos and the mathematics they will teach; the nature of the videos themselves; the number of opportunities teachers have to analyze videos and the ways in which these opportunities are structured;

teachers' analysis of videos and their teaching practices before the learning opportunities begin; and how much time they have to apply what they learn to their own teaching.

Martha identified these additional variables because she learned they might have a direct influence on the mechanisms that could explain the relationship between analyzing videos and teaching. Some variables might support these mechanisms, and some might interfere. Martha's task at this point in her work is to identify and describe all the variables that could play a meaningful role in the outcome of her study. This means to identify each variable for which it is possible to establish a clear and direct connection between the variable and the relationship she planned to investigate. Using the outcome of this task, Martha then needs to update her description of the mechanisms that could account for the relationships she expects to see and review her predictions and theoretical framework with these variables and mechanisms in mind.

Exercise 3.6
Review the predictions that Martha made and identify the variables that play a role in these predictions. Even though you might not be immersed in this literature, think about the alignment between the variables included in the predictions and those that could impact the relationships in which Martha is interested. Are there other missing variables that should be included in her predictions?

How Do You Know When You Have Finished Building Your Theoretical Framework?

The question of when your theoretical framework is finished could be answered in several ways. First, it is never really finished. As you continue to write your evolving research paper, you will continue strengthening your framework. You might even refine the framework as you write the final draft of your paper, *after* you have collected and analyzed your data. Furthermore, if you do follow-up studies, you will continue to build your framework.

A second answer is that you should invest the time and effort to build a theoretical framework that is as finished as possible at each point in the research process. As you write each draft of your evolving research paper, you should feel as if you have the strongest, most robust rationale you can have for your current predictions. In other words, you should feel that with each succeeding draft you have finished building your framework, even though you are quite sure you have not.

A third answer addresses a common, related question: "How do I know when I have included enough ideas and borrowed from enough sources? Would including another idea or citing another source be useful?" The answer is that you should include *only* those ideas that contribute to building a stronger framework. When you

wonder whether you should include another idea or reference, ask yourself whether doing so would make your framework stronger in all the ways we described earlier.

Exercise 3.7
In 2–3 pages (single spaced), write out the plan for your study. The plan should include your research questions, your predictions of the answers, your rationale for the predictions (i.e., your theoretical framework), and your imagined plan for testing the predictions. Be as explicit and precise as you can. Be sure you have identified the critical variables and described the mechanism(s) that could explain the phenomena, the relationships, and/or the changes you predict. Look back to see if the logic connecting the parts is obvious. Ask yourself whether the tests you plan are what anyone familiar with your framework would expect (i.e., there should be no surprises).

Part IV. Refining a Theoretical Framework: A Scholarly Dialogue

As we noted above, conversations with colleagues and other experts can help you refine your theoretical framework by clarifying your predictions and digging into the details of the rationales you develop to justify those predictions. This is as true for experienced researchers as it is for beginning researchers. The dialogue below is an example of how two colleagues, Adrian (A) and Corin (C), work together to gradually formulate a testable hypothesis. Some of their conversation will look familiar as they refine their prediction through multiple steps of discussion:

- Narrowing the focus of their prediction.
- Making their prediction more testable.
- Being more specific about what they want to study.
- Engaging their prediction in cycles of refinements.
- Determining the appropriate level/grainsize of their prediction (zoom in, zoom out).
- Adding more predictions.
- Thinking about underlying mechanisms (i.e., what explains the relationships between their variables).
- Putting their predictions on a continuum (going from black and white to grey).

In addition, they construct their theoretical framework to match their hypotheses through multiple steps:

- Defining and rationalizing their variables.
- Re-evaluating their initial rationales in response to changes in their initial predictions.
- Asking themselves “why” questions about predictions and rationales.

- Finding empirical evidence and theory that better supports their evolving predictions.
- Keeping in mind what they are going to be measuring.
- Making sure their rationales support each link in their chain of reasoning.
- Identifying underlying mechanisms.
- Making sure that statements are included in their rationale if and only if they directly support their predictions and are essential to the argument.

They begin with the following hypothesis:

- **Prediction:** Students will exhibit more persistence in mathematical course taking in high school if they work in groups.
- **Brief Description of Rationale:** When people work in groups, they feel more competent and learn better (Cohen & Lotan, 2014; Jansen, 2012). When people feel more competent, they persist in additional mathematical course taking (Bandura & Schunk, 1981; Dweck, 1986).

A: So, do we think this hypothesis is testable?

C: Well actually, who these students are is probably something we need to be more specific about.

A: Good point, and also, since Algebra 2 is the bridge to additional course taking (i.e., the first course students don't have to take), perhaps we should target Algebra 2. How about if we change our prediction to the following: *Algebra 2 students will exhibit more mathematical persistence in mathematical course taking in high school if they work in groups in Algebra 2.*

C: Okay, but another problem is that it would take a long time to collect data that would inform a prediction about the courses students take, and over that amount of time I'm not sure we could even tell if groupwork was responsible. What if we limited our prediction to: *Algebra 2 students will exhibit more mathematical persistence in Algebra 2 if they work in groups.*

A: Good idea! But when we talk about persistence, do we mean students don't quit, or that they don't drop the course, or *productively* struggle during class, or turn in their homework, or is it something else we mean? To me, what would be testable about mathematical persistence would be persistence at the problem level, such as when students get stuck on a problem, but they don't give up.

C: I agree. So, let's predict the following: Algebra 2 students will exhibit more mathematical persistence in Algebra 2 when they get stuck on problems if they work in groups. That's something I think we could test.

A: Yes, but I think we need to be even more specific about what we mean by mathematical persistence when students get stuck on problems.

C: Hmm, what if we focused specifically on mathematical persistence that involves staying engaged in trying to solve a problem for the duration of a

problem-solving session or until the problem gets solved? But that also makes me wonder if we want to be focusing on persistence at the individual level or at the group level?

A: Umm, I think we should focus on persistence at the individual level, because that's more consistent with our original interest in persistence in course taking, which is about individual students, not about groups.

C: Okay, that makes sense. So then how about this for a prediction: If Algebra 2 students work in groups, they will be more likely to stay engaged in trying to solve problems for the duration of a problem-solving session or until they solve the problem.

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To this point in the dialogue, Adrian and Corin are developing a theoretical framework by sharpening what they mean by their prediction and making sure their prediction is testable. In the next part, they return to their original idea to make sure they have not strayed too far by making their prediction more precise. The dialogue illustrates how making predictions should support the goal of understanding the relationship between variables and the mechanisms for change.

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A: Yes, I'm liking the way this prediction is evolving. However, I also feel like our prediction is now so focused that we've lost a bit of our initial idea of competence and learning, which is what we were initially interested in. Could we do something to bring those ideas back? Perhaps we could create more predictions to get at more of those ideas?

C: Great idea! Okay, so to help us see what we are missing now, let's look back at the initial links in our chain of reasoning. We initially said that Working in Groups leads to Feeling Competent & Learning Better leads to Persistence in Math Course Taking. But our chain of reasoning has changed. I think it's more like this: Working in Groups on Problems leads to Staying Engaged in Problem Solving leads to Greater Sense of Competence and Learning Better leads to More Persistence in Course Taking.

A: Okay, so if that's the case, it looks like our new prediction just tests the first link in this chain, the link between Working in Groups on Problems and Staying Engaged in Problem Solving. It looks like there are three other potential predictions we could make; we could make a prediction about the relationship between Staying Engaged in Problem Solving and having a Greater Sense of Competence, between Staying Engaged in Problem Solving and Learning Better, and between having a Greater Sense of Competence/Learning Better and More Persistence in Course Taking.

C: Clearly that's too many predictions for us to tackle in one study and actually I am aware of several studies that already address the third prediction. So, we can use those studies as part of our rationale and don't need to study that link.

A: I agree. Let's just add one prediction, one about the link between Staying Engaged and Sense of Competence. In our initial prediction, we just had a vague connection between Working in Groups and Sense of Competence. But in our new prediction, we were more

specific that working in groups helps students stay engaged until the end of a problem-solving session. So, I guess we could say for a second prediction then that *When Algebra 2 students stay engaged in problem solving until the end of a problem-solving session, they develop a greater sense of competence.*

C: Okay so we will have two predictions to examine with our study: Prediction 1 is: If Algebra 2 students work in groups, they will be more likely to stay engaged in trying to solve problems for the duration of a problem-solving session or until they solve the problem. This prediction deals with the first link in our chain of reasoning. And then Prediction 2 is: If Algebra 2 students try to solve problems for the duration of a problem-solving session or until they solve the problem, they will be more likely to develop a sense of competence. Oh, as soon as I finished stating that prediction, the thought just came to me, "sense of competence about what?"

A: How about if we focused on sense of competence in being able to solve similar problems in the future? Actually, maybe that's too limited. Maybe we should expand our prediction a bit more so we include a sense of competence that's at least somewhat closer to more course taking? Something like sense of competence that involves feeling capable of understanding future Algebra 2 concepts. That's at least bigger than sense of competence at solving similar problems. If students feel they're capable of understanding future Algebra 2 concepts, then they will probably be more likely to persist in course taking too.

C: Okay, that makes sense. So, then our Prediction 2 could be: If Algebra 2 students try to solve problems for the duration of a problem-solving session or until they solve the problem, they will be more likely to feel they will be capable of understanding future Algebra 2 concepts.

A: Oh, I just had an additional idea! What if we changed the two predictions one more time to allow for more or less of the variables? For example, Prediction 1 could be: *The more Algebra 2 students work in groups, the more likely they will stay engaged in trying to solve problems for the duration of a problem-solving session or until they solve the problem.*

C: Yes, great. So, that would mean Prediction 2 could be: The more Algebra 2 students try to solve problems for the duration of a problem-solving session or until they solve the problem, the more likely they will feel they are capable of understanding future Algebra 2 concepts.

A: So, I think we're happy with our predictions for now, but I think we need to work on our rationales for those predictions because they no longer apply very well.

C: Okay, to recap, our original chain of reasoning was Working in Groups leads to Feeling Competent & Learning Better leads to Persistence in Math Course Taking. Our initial rationales were the following: For the link between working in groups and feeling competent, we based that link on Cohen and Lotan's (2014) book on Designing Groupwork, in which they explain why and how all students can feel competent through

their engagement in groupwork. We also based this link on that 2012 Jansen study that found that groupwork helped students enact their competence in math. Then, for the link between competence and persistence, we based that link on the Bandura and Schunk (1981) study and on the work by Carol Dweck (1986) that show that children who feel more competent in arithmetic, tend to persist more.

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Corin and Adrian have looked back at their initial research idea. In doing so, they illustrated how developing a theoretical framework involves developing and refining a chain of reasoning. They continue by working on developing rationales for their predictions.

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A: Okay, so let's think if any of our previous rationales still work. How about Elizabeth Cohen's work? I still think her work applies because it shows that groupwork can affect engagement. But now that I think about it, another part of her work indicates that groupwork needs particular norms in order to be effective. So maybe we should tighten up our predictions to focus just on groupwork that has particular norms?

C. But, on the other hand, what about Jo Boaler's (1998) "Open and Closed Mathematics" article? In that study, students at the Phoenix Park School did not have much structure, and in spite of that, groupwork worked quite well for those students, better than individual work did for students at the Amber Hill School who had highly structured instruction.

A. That's a good point. So maybe we should leave our predictions about groupwork as is (i.e., not focus on particular norms). Also, the ideas in the Boaler article would be good to add to our theoretical framework because it deals with secondary students, which aligns better with the ages of the Algebra 2 students we are planning on studying.

C: Okay, so we're adding the ideas in the Boaler article. I also think we need to find literature that specifies the kind of engagement we want to focus on. Looking at the engagement literature would sharpen our thinking about the engagement we are most interested in. We should consider Brigid Barron's (2003) study, "When Smart Groups Fail." In her study, students produced better products if they engaged with each other and with the content. But that makes me think that we are mostly just focused on the latter, namely on how individuals engage with the content.

A: I agree we're focused on individuals' engagement with the content. Come to think of it, the fact that we're focused on how individuals engage with content rather than how groups engage further justifies why we're not looking at groupwork norms. But let me ask a question we need to answer. Why are we focusing on how individuals engage with content? It's not just a preference. It's because we think individual engagement with content is related to feeling capable. So, our decision to focus on individual engagement aligns with our predictions. And even though we're not including Barron's work in our framework, considering her work helped sharpen our thinking about what we're focusing on.

C: You know, we are kind of in a weird space because we're focusing on individual engagement with content at the same time as we are predicting that groupwork leads to more engagement. In other words, we are and aren't taking a social perspective. But what this reminds me of is how, from the perspective of the theory of constructivism, even though individuals have to make sense of things for themselves, social interactions are what drives sense making. In fact, here's a quote from von Glasersfeld (1995): "Piaget has stressed many times that the most frequent cause of accommodation is the interaction" (p. 66). So, I think we can use constructivism as a theoretical justification for predicting that the social activity of groupwork is what is related to individual engagement with content.

A: Interesting! Yes, makes sense. When you were describing that, I had another insight from constructivism. You know how when someone experiences a perturbation, it also creates a need in them to resolve the perturbation, right? So maybe perturbations are the mechanism explaining why groupwork leads to more individual engagement with content. Groupwork potentially generates perturbations, meaning the person engages more to try to resolve those perturbations.

C: Okay, now that we have brought in the idea of perturbations as potentially being the mechanism that drives how working in groups leads to staying more engaged, perhaps we need to reconsider what we will be measuring in our study. Will it be perturbations, or will it be staying engaged that we should be measuring?

A: I think what we are saying is that the need to resolve perturbations is part of the underlying mechanism, but measuring the need to resolve perturbations would be difficult if not impossible. So, instead, I think we should focus on measuring the variable *staying engaged*, a variable we can measure. And then if we find that more working in groups leads to more staying engaged, that also gives us more evidence that our theoretical framework with perturbations as a mechanism is viable. In other words, mechanisms are part of our framework and by testing our prediction, we are testing our theoretical framework (i.e., our rationales) too.

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This final part of the dialogue illustrates that the rationale for a study continues to develop as the predictions continue to be refined and testability continues to be considered. In other words, the development of the predictions and rationale (i.e., the theoretical framework) should be iterative and ongoing.

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Through their discussion, Adrian and Corin have refined both their predictions and their rationales. In the process, the key ideas they have drawn on contributed to their rationales and thus to constructing their theoretical framework.

Part V. Distinctions Between Rationales, Theoretical Frameworks, and Literature Reviews

We have introduced a number of terms that play critical roles in the scientific inquiry process. Because they refer to related and sometimes overlapping ideas, keeping straight their meanings and uses can be challenging. It might be helpful to revisit each of them briefly to describe how they are similar to, and different from, each other.

To distinguish between rationales, theoretical frameworks, and literature reviews, it is useful to consider the roles they play as you plan and conduct a study compared to the roles they play when you write the report of your study.

Thinking Through a Study

The chronology of the thinking process often moves through many cycles of identifying a research problem or asking a question, and then reading the literature to learn more about the problem, and then refining and narrowing the scope of a question that would add to or extend what is known, and then predicting (guessing) an answer to the question and asking yourself why you predicted this answer and writing a first draft of your rationale, and then reading the literature to improve your rationale, and then realizing you can refine the question further along with specifying a clearer and more targeted prediction, and then reading the literature to further improve your rationale, and then realizing you can refine the question further along with a clearer and more targeted prediction, and so on.

The primary activity that generates more specific and clearer hypotheses is searching and *reviewing literature*. You can return to the literature as often as you need to build your *rationales*. As your rationales develop, they morph into your *theoretical framework*. The theoretical framework is a coherent argument that threads together the individual rationales and explains why your predictions are the best predictions the field can make at this time.

If you have one research question and one prediction you will have one rationale. In this case, your rationale is essentially the same as your theoretical framework. If you have more than one research question, you will have multiple predictions and multiple rationales. As you develop rationales for each prediction, you might find lots of overlap. Maybe the literatures you read to refine each prediction and develop each rationale overlap, and maybe the arguments you piece together include many of the same elements. Your theoretical framework emerges from weaving the rationales together into one coherent argument. Although this process is more complicated than the thinking process for one prediction, it is more common. If you find few connections among the rationales for each prediction, we recommend stepping back and asking whether you are conducting more than one study. It might make more sense to sort the questions into two or more studies because the rationales for the predicted answers are drawing from different literatures.

Writing the Evolving Research Paper

We recommend that you write drafts of the research report as you think through your study and make decisions about how to proceed. Although your thinking will be fluid and evolving, we recommend that you follow the conventions of academic writing as you write drafts. For example, we recommend that you structure the paper using the five typical major sections of a journal article: introduction, theoretical framework, methods, results, and discussion. Each of these sections will go through multiple drafts as you plan your study, collect the data, analyze the data, and interpret the results.

In the introduction, you will present the research problem you are studying. This includes describing the problem, explaining why it is significant, defining the special terms you use, and often presenting the research questions you will address along with the answers you predict. Sometimes the questions and predictions are part of the next section—the theoretical framework.

In the theoretical framework, you will present your best arguments for expecting the predicted answers to the research questions. You will *not* trace the many cycles in which you engaged to get to the best versions of your arguments but rather present the latest and best version. The report of a study does not describe the chronology of the back-and-forth messiness always involved in thinking through all aspects of the study. What you learned from reviewing the literature will be an integral part of your arguments. In other words, the review of research will be included in the presentation of your theoretical framework rather than in a separate section.

The report of a study does not describe the chronology of the back-and-forth messiness always involved in thinking through all aspects of the study.

The literature you choose to include to present your theoretical framework is not all the literature you reviewed for conducting your study. Rather, the literature cited in your paper should be the literature that contributed to building your theoretical framework, and *only* that literature. In other words, the theoretical framework places the boundaries on what you should review in the paper.

Beginning researchers are often tempted to review much of what they read. Researchers put lots of time into reading, and leaving lots of it out when writing the paper can make all that reading feel like a waste of time. It is not a waste of time; it is always part of the research process. But, reviewing more than you need in the paper becomes a distraction and diverts the reader from the main points.

The literature cited in your paper should be the literature that contributed to building your theoretical framework, and only *that literature.*

What should you do if the editor of the journal requires, or recommends, a section titled "review of research"? We recommend you create a somewhat more elaborated review for this section and then show exactly how you used the literature to build your rationale in the theoretical framework section.

Reviewers notice when the theoretical framework and the literature reviewed do not provide sufficient justification for the research questions (or the hypotheses). We found that about 13% of *JRME* reviews noted an especially important gap—the research questions in a paper were not sufficiently motivated. We expect the same would be true for other research journals. Reviewers also note when manuscripts either do not have an explicit theoretical framework or when they seem to be juggling more than one theoretical framework.

Part VI. Moving to Methods

A significant benefit of building rich and precise theoretical frameworks is the guidance they provide for selecting and creating the methods you will use to test your hypotheses. The next phase in the process of scientific inquiry is crafting your methods: choosing your research design, selecting your sample, developing your measures, deciding on your data analysis strategies, and so on. In Chap. 4, we discuss how you can do this in ways that keep your story coherent.