Chapter 1
Grounded Theory Methods

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Abstract The essential methods of grounded theory research, beginning with Glaser and Strauss's seminal work in 1967, are described. These methods include concurrent data collection and analysis, coding of data into concepts and categories, the use of interpretative frameworks, theoretical sampling, memoing, and the integration of categories into grounded theory. Variations in methods developed by second-generation grounded theory researchers are presented in the contexts of their methodological perspectives.

Keywords Grounded theory

1.1 The Development of "Grounded Theory"

Sociologists Barney Glaser and Anselm Strauss set out in their book *The Discovery of Grounded Theory* (1967) to describe a set of research methods that grew out of the authors' collaborative, qualitative study of the interactions between hospital staff and dying patients. Their particular research approach ran counter to the then prevailing social science techniques that focused on theory verification. Instead of using theory at the beginning of research to direct data collection, Glaser and Strauss's method begins with joint data collection and analysis in order to generate theory that "emerges" and is grounded in empirical data; theory that will "fit the situation being researched, and work when put into use" (Glaser and Strauss 1967, p. 3). Bryant (2009, para. 2) notes that the *Discovery* book "was first and foremost a manifesto, seeking to present a genuine alternative to the dominant quantitative agenda of the time."

The study of dying patients utilized a method of comparative analysis that was a standard tool in qualitative social science research in the 1960s. However, Glaser and Strauss (1967) developed this method further. Their purpose in using the technique went beyond creating rich descriptions *of* data to that of generating theory

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from data. The end result was a systematic set of techniques labeled the "constant comparative method" (Glaser 1965). Only later did their approach become known as "grounded theory" (Strauss 1991).

The publication of *The Discovery of Grounded Theory* represented the authors' first attempt at articulating their method. As Glaser (1998, p. 14) explains, "It took a lot of thought for Anselm [Strauss] and myself to figure out the 'Discovery' book." However, their book, while it introduced the techniques, did not provide extensive details on how to actually conduct similar research in the field.

Glaser and Strauss did not collaborate again after completing the study on dying and writing a set of four books related to this research. Throughout the years, as Glaser and Strauss continued to refine specific aspects of their methods through their work mentoring doctoral students, they developed separate variations of the procedures. The first book to clarify and further explain the methods of grounded theory was Glaser's 1978 book *Theoretical Sensitivity*. Strauss, in collaboration with Juliet Corbin, outlined his version of grounded theory in the textbook *Basics of Qualitative Research* (1990), which has since been revised through a third edition (Corbin and Strauss 2008). Anselm Strauss died in 1996, while Barney Glaser continues to put out books and readers on grounded theory through his publishing company, Sociology Press.

Anselm Strauss and Barney Glaser constitute the first generation of grounded theorists. Through their mentoring of a cadre of doctoral students, they laid the foundation for a second generation of researchers, who have subsequently gone on to refine, extend, and develop variations of the method that reflect changes in the qualitative research paradigm over the last 40 years (Morse 2009).

There are presently four seminal forms of the grounded theory method (Birks and Mills 2011); that espoused by Glaser and articulated through his writings from *Theoretical Sensitivity* forwards; the methods outlined by Strauss and Corbin in their 1990 through 2008 editions of *Basics of Qualitative Research*, a Constructivist perspective associated with Chamaz's work (2000, 2006, 2009), and an approach based on Situational Analysis (Clarke 2005). Further discussions of the different theoretical perspectives taken by these researchers are presented in Sect. 1.8 at the end of the chapter.

It is recommended that this chapter be read in parallel with Maike Vollstedt's chapter (Chap. 2) that details the use of grounded theory methods in an empirical interview study. Throughout the chapter references will be made to specific sections described by Vollstedt that illustrate the topic under discussion.

1.1.1 Overview of Research Processes

Within the variations in grounded theory research that exist today, there is a set of *essential methods* that characterizes all such research (Birks and Mills 2011). This set includes constant comparative analysis, open and intermediate coding, theoretical sampling and saturation, theoretical integration of codes and categories, and memoing. Additionally, a crucial aspect of this research is the concurrent and continuous nature of data generation and analysis.

Initially, data, such as interviews or field notes, are conceptually coded through constant comparison. As codes are generated, categories are also created to express commonalities among groups of codes. As the analysis continues, decisions of where to select more data (theoretical sampling) are directed by key ideas about the data that emerge through the constant comparison of codes and categories. Coding of new data into codes and categories continues towards the goal of identifying a core category that can account for the majority of the participants' behavior in the substantive area. At this stage, more abstract categories that express connections between the lower-level, substantive categories begin to emerge. These higher-level categories lead to the development of grounded hypotheses that explain relations among observed aspects of the area of study. Throughout the analytic process, memos are constantly being written to capture ideas and thoughts about codes and categories, relationships among concepts, emerging theory, and potential directions for further sampling.

The processes of coding data, abstracting concepts into categories, and theoretical sampling are on-going and interactive as the researcher continues to cycle through these steps towards the goal of developing theory grounded in the data. Constant comparison uses inductive reasoning to abstract concepts and categories from patterns identified in the data, and hypotheses are deduced from these patterns that suggest explanations about what is going on in the substantive area. The cycle continues as further data collection and analysis test the validity of the emerging themes.

Theoretical saturation is reached when no new data or coding produce any additional useful material. At this point, the process begins to integrate the categories and their properties into grounded theory. The memos, which have been continually recording the conceptualizations of the research process, are compared and sorted (either manually or by computer) according to how they relate to each other. The writing of the final product is aided by the information derived from the sorted memos; and the particular grounded theory that is developed is legitimized by how well it fits the substantive area, works to explain observed behavior, and has relevance to practitioners in the field. (See Chap. 2, Sects. 2.1 and 2.2, for a discussion of her decisions to use grounded theory methods to investigate a particular area of interest.)

1.2 Place of Literature Review in Grounded Theory

In contrast to research designed to verify theory derived from the literature, grounded theory studies do not begin with a formal literature review. Glaser (1998) stresses that reading other studies beforehand about the substantive area may lead the researcher to "see" what is not there rather than what actually is. Also, once data generation begins, the researcher may find that the categories created about the substantive area are different from what might have been postulated from any preconceived body of literature, and, therefore, an extensive preview may not be relevant to the final focus of the research.

However, it is impossible for the researcher to enter the field with an empty mind. He or she always brings a set of experiences and professional knowledge to the endeavor. In fact, it is this background that forms the basis for the researcher's sensitivity or "ability to see what is in the data" (Bryant 2009, para. 96). Birks and Mills (2011) suggest a "limited and purposive preliminary review" that can help orient the researcher to the general area of study, as well as provide some initial sensitivity towards conceptualizing the data.

As the research progresses, a literature search can provide an additional source of data for locating similarities and differences with the study's grounded categories. Such comparisons can enlarge the scope of the emerging theory, increasing its relevance to a larger set of conditions. A literature review conducted during the final stages of the research can be used to indicate how one's emerging theory fits into what has already been published in the field. The literature may confirm the researcher's developed theory or his or her theory may extend or go beyond that previously published.

1.3 Data Analysis: Open Coding

Grounded theory analysis uses the technique of constant comparison to render the data into codes and categories that reflect layers of abstraction based on phenomena and relations observed in the data. During initial coding, incidents, events and items of interest are identified and labeled with code names that reflect a particular conceptual aspect of each of these phenomena. As analysis continues, codes having similar attributes are grouped together into categories representing a higher level of conceptual abstraction. A second phase of analysis, sometimes identified as "intermediate coding" (Birks and Mills 2011), focuses on linking categories and subcategories together and articulating the relations among them. Section 1.3 discusses the first level of open coding. Intermediate coding, and the use of a coding paradigm within this level of analysis, are addressed in detail in Sect. 1.4.

Open coding starts as soon as the first set of data has been generated. This coding process consists of two analytic, meaning-making procedures, (1) asking questions of the data and (2) constantly comparing incidents. The goal of this process is to conceptualize the data into a collection of codified phenomena, or "substantive codes" that abstractly identify particular aspects of the empirical area study.

The field notes, observations, or documents, etc. are "fractured" into identifiable fragments, or *incidents*. These discrete parts, which may consist of a word or phrase, a complete sentence, or possibly a whole paragraph, are labeled or *coded* by asking *sensitizing questions* such as "What is going on here?" or "What are the actors doing?" in order to identify concepts that stand for particular incidents.

The researcher codes as many incidents as he or she can, using *constant comparison* (in addition to asking questions) to classify data on the basis of similarities and differences. Each newly identified fragment is compared to those already coded. Similar phenomena are given the same code name and new names are developed for previously unidentified aspects of the data. New incidents are also compared to those previously coded as the same concept to check for conflicts in the conceptualization of the represented phenomenon. Similar codes are grouped together to form *categories* that abstract properties common to the collected codes. In addition, *memos*, written during the coding process, note the original data on which each code was based and record researcher thoughts about salient properties linked to the conceptualization of that particular piece of data. (See Chap. 2, Sect. 2.5.3 for examples of open coding.)

1.4 Memoing

Memos are continually written during the on-going data collection and analysis cycles in order to record ideas and insights, *as they are triggered* by particular aspects of data, or by comparisons or "conflicts" in the developing line of thought. Memos provide "moment capture" (Glaser 1998), enabling the researcher to concretize a fleeting idea as it occurs. They are also "the running logs of analytic thinking" (Corbin and Strauss 2008). "Memos are not so much about specific incidents or events, but about the conceptual ideas derived from these. It is the denoting of concepts and their relationships that moves the research from raw data to findings" (Corbin and Strauss 2008, p. 123).

Throughout the research process, memos create an *audit trail* of the development of the analyst's thinking and the direction of theoretical sampling. They provide transparency to the research process; from initial concepts identified during open coding; through the growth of categories, their properties, dimensions, and relations that are generated during intermediate coding; to the final integration of ideas into theory. (See Chap. 2, Sects. 2.5 and 2.5.3, for examples of the type of information noted in her memos.)

Birks and Mills (2011, p. 55) emphasize the importance of memo writing as a method for keeping "accountable for your actions and decisions as the researcher facilitating" the research process. Memos provide opportunities to note instances where personal bias enters the analytic process (Corbin and Strauss 2008). Such circumstances may arise when the researcher becomes aware of an inconsistency or incongruence between the participants' and his or her interpretations of particular phenomena or events. Memoing about these contradictions brings the bias to the fore and promotes conceptualization that is more accurately grounded in the data.

1.4.1 Writing Memos and Using Diagrams

Glaser (1998) advocates the use of unstructured memos. Writing in correct English or with proper grammar is not important; the researcher should feel free to express his or her ideas in whatever form is comfortable and promotes the outpouring of ideas. A lack of restrictive rules and attention to form helps writers overcome any writer's block that may impede this essential analytic process.

At the same time, there are organizational precepts that help researchers manage and retrieve the ever-growing number of memos that accumulate as analysis progresses (Corbin and Strauss 2008). At the very least, the researcher should date each memo, create a heading, and indicate the document and raw data upon which the memo is based. It is also useful to include short quotes from an interview or segment of the original field note to remind the researcher of the data that generated the idea behind the memo. These data can be used later to illustrate aspects of the grounded theory in the final written product.

Besides memos, diagrams can also be used to support the on-going analysis (Corbin and Strauss 2008). Diagrams, which are visual, are naturally more abstract than raw data and, as such, they promote thinking at a conceptual, rather than at an empirical level. Diagrams are particularly useful in showing relationships between concepts. (See Chap. 2, Figs. 2.3 and 2.4, for examples of diagrams used to display relations between categories.)

Glaser (1998), however, cautions researchers about an over-reliance on diagrams as a way to explicate grounded theory. While the diagram may visualize relationships, it is in the write-up, or text, where the meaning of the relationship is made explicit. A diagram is "an aid to comprehending the meaning of the written theory. It is not a theory in and of itself" (p. 169).

1.4.2 Using Computer Programs

Various software programs have been designed to help *manage* qualitative data – allowing the researcher to store, search for, retrieve, and organize research artifacts such as interview data, codes, categories, and memos. However, these programs should be regarded as tools that facilitate, rather than replace the researcher's analytic thinking processes (Corbin and Strauss 2008; Birks and Mills 2011). It is the researcher that must decide how data are to be coded and creatively determine the meanings that emerge from the constant comparison of data to codes and categories.

In the third edition of *Basics of Qualitative Research* (Corbin and Strauss 2008), Corbin presents examples of data management and analysis that were generated using a particular computer program. These data and analyses are also available online to enable the reader to "work live" with the data and practice coding techniques. (See Chap. 2, Sect. 2.5.3, for examples of computer-assisted coding using the same program.)

Computer programs also facilitate the creation of an audit trail to help keep track of the researcher's analytic progress. The software makes it possible to organize, reorganize and diagram connections between codes and categories in many different ways as theoretical sampling and constant comparison continue. Memos, linked to these actions, help trace the researcher's reasoning during the continuous and concurrent analytic and conceptualization processes. In addition, the software program's ability to quickly access memos, codes, and raw data greatly enhance the write-up phase of the research. The writer can easily call up particular incidents from the raw data to use as illustrations and access memos and diagrams that describe specific relationships among categories.

1.5 Intermediate Coding and the Use of a Coding Paradigm

Since Glaser and Strauss first wrote *The Discovery of Grounded Theory* (1967), these authors, as well as the next generation of grounded theory researchers, have more fully articulated, described, and refined the basic grounded theory methods (Birks and Mills 2011). While the essential stages and processes have remained constant, different authors have, in some instances, employed different names to identify similar methods or to distinguish particular techniques. In the following discussions that outline essential aspects of ground theory, variations in techniques and terminology will be noted to clarify similarities and differences among these different authors.

Intermediate coding is the second coding phase. During this stage, coding becomes more focused as the researcher identifies a particular analytic direction. Categories are integrated as relationships among categories and sub categories are identified and the properties of categories become more fully developed. Data that were originally fractured into substantive codes are now put back together at a more abstract conceptual level in order to begin to synthesize and explain phenomena identified in the data (Birks and Mills 2011).

Various authors recommend different methods to focus the researcher's attention during this phase of coding. Glaser and Holton (2004, para. 55), using the term, "selective coding," suggest the researcher restrict coding comparisons to those "variables that relate to the core variable" in significant ways that can lead to the development of a grounded theory. Charmaz (2006, p. 58) also emphasizes a more selective approach to coding at this stage. Her "focused coding" describes using those "initial codes [that] make the most analytic sense to categorize your data incisively and completely." Once such codes have been selected, both authors emphasize the use of constant comparison to develop significant analytic categories and relations.

Strauss (1987, p. 32) describes a technique of more focused coding that operates in conjunction with a particular *coding paradigm. Axial coding* "consists of intense analysis done around [the 'axis' of] one category at a time, in terms of the paradigm items (conditions, consequences, and so forth)." In contrast to the other procedures described above, the inclusion of a coding paradigm that directs the researcher's analytic focus provides a more structured approach designed to develop analytic categories aligned explicitly within a particular social science perspective. While the term "axial coding" is used in Strauss and Corbin's 1990 and 1998 texts, the third edition (Corbin and Strauss 2008) places decreased emphasis on using this label to identify the processes of intermediate coding directed by a particular coding paradigm.

1.5.1 Heuristic Concepts

In this section the nature of the kinds of questions that might be asked of the data and the types of interpretations drawn from comparisons of codes and categories are examined more closely by considering the role that *coding paradigms* or "heuristic concepts" play in "the interpretation, description and explanation of the empirical world under study" (Kelle 2005, para. 31). A coding paradigm, while perhaps implicitly invoked during open coding, provides a particular theoretical perspective and set of heuristic concepts that structurally guide researchers as they begin to code for specific categories and identify relationships among categories.

As Kelle (2005, para. 39) notes, a crucial characteristic of a particular set of heuristic concepts is that it has "limited empirical content." That is, "heuristic categories cannot be used to construct empirically contentful propositions without additional information about empirical phenomena. This makes them rather useless in the context of [developing hypotheses in verification studies], but it is their *strength in the context of exploratory, interpretative research*" (emphasis added). Importantly, the use of low empirical content heuristic concepts makes it more difficult for a researcher to force data to fit pre-specified categories. The heuristic concepts, rather, provide "a theoretical axis or a skeleton" (Kelle 2005, para. 40) around which substantive data are coded to create categories and grounded theory. Blumer (1969, pp. 147–148; quoted in Clarke 2005, p. 77) also notes the value of what he terms *sensitizing concepts* in framing the direction of analysis: "Whereas definitive concepts provide prescriptions of what to see, sensitizing concepts merely suggest directions along which to look." At the same time, the researcher must also be aware that the structure that a particular heuristic "lens" provides may preclude the researcher from noticing other relevant phenomena.

Being able to identify for oneself an appropriate set of heuristic concepts may be problematic, however. Glaser (1998) recommends "reading vociferously" in other substantive areas within the professional domain of the research study in order to build *theoretical sensitivity* and accumulate a repertoire of *theoretical codes*. Yet the novice researcher remains at a disadvantage and may need a more ready-made coding paradigm with an explicit structure and set of procedural rules to move beyond the initial steps of coding and category construction in order to build grounded theory (Birks and Mills 2011). (See Chap. 2, Sect. 2.3 for her discussion on theoretical sensitivity and the identification of sensitizing concepts that were appropriate to her research question; also Sect. 2.5.3.)

1.5.2 Coding for Process

This section uses the coding paradigm developed by Anselm Strauss and Juliet Corbin (Strauss and Corbin 1990, 1998; Corbin and Strauss 2008) to illustrate how a set of heuristic concepts, framed within a specific theoretical tradition, provides analytic structure during intermediate coding. The example highlights the ways in which this structure uses a particular disciplined perspective to guide the construction of grounded theory.

Corbin and Strauss (2008, pp. 98–100) focus their coding procedures, intended to investigate complex social behavior, around the theoretical construct of *process* – defined as "a sequence or a series of actions/interactions/emotions taken in response to situations or problems, or for the purpose of reaching a goal as persons attempt to carry out tasks, solve certain problems, or manage events in their lives." This notion of process, when framed in terms of *relational* categories, also provides a heuristic coding device. That is, individuals (or groups, etc.) *respond*, in a goal-oriented way, to particular contexts or events *with* actions, interactions, and/or emotions *that result* in specific consequences. Thus, analyzing data for process is a way to "capture the dynamic quality of inter/action and emotions" (Corbin and Strauss 2008, p. 98).

Additional heuristic concepts that identify and deal with complex social process are operationalized through the structure given in the Conditional/Consequential Matrix (Corbin and Strauss 2008, pp. 93–95). The Matrix consists of a set of concentric circles, each representing a level of social interaction, moving from the outer-most macro level (representing international or global conditions) through intermediate levels (such as organizational or institutional) to the micro level where the action/interaction/emotional responses are located. Conditions at any level may affect participants or organizations at any other level, moving both inwards and outwards across the Matrix. Importantly, the specific entities that constitute the conditions and consequences at each level of the Matrix are not pre-determined, but must "emerge" from the area of investigation. In addition, the levels considered for analysis are determined by the "type and scope of the phenomenon being studied" (p. 94). Thus, while providing structure, the Matrix and its constituting concepts focus analysis within the particular paradigm in ways that allow the researcher to construct empirically grounded theory that explains the phenomena under study.

To actualize the coding paradigm, Corbin and Strauss (2008, p. 10) suggest some of the following prompts when analyzing for process; "What is going on here? What are the problems or situations as defined by participants? What are the structural conditions that give rise to those situations? How are persons responding to these though inter/action and emotional response?" Answers to these questions focus the direction of intermediate coding. Particular incidents or pre-coded concepts become abstracted and further categorized as conditions, others as consequences, etc., and the specificity of the categorizations reflects the particular *meaning* that participants assign to experiences (either reported on or observed) in the substantive area.

Although the procedural steps outlined above appear to be highly prescriptive, Corbin and Strauss (2008) stress that they are not intended to be "a recipe for doing qualitative research." Individual analysts must always adapt particular methods to fit the realities of their own work. Equally important, a researcher should carefully consider how any given coding paradigm aligns with his or her research goals before considering its application as a viable research technique. (See Chap. 2, Sect. 2.5.2, for her description of the creation of a research-specific coding paradigm, and Sects. 2.5.2 and 2.5.3 for examples of "axial coding.")

1.6 Delimiting the Study

As ongoing data collection, and open and intermediate coding progress in parallel, the researcher begins to identify key categories, deepen descriptions of their properties and identify relations among these categories. Instead of continuing to collect *all* data available in the field of study, the researcher can now begin to purposively seek out only those data that have the potential to further inform the development of these salient categories and their properties. The researcher begins to direct and delimit the work through *theoretical sampling* and the development of a *core category* until the coding process yields category *saturation.*

1.6.1 Theoretical Sampling and Saturation

Having a research purpose of theory generation, rather than that of theory verification or rich description, establishes a different set of criteria for the type of data that are collected. It is not necessary to collect *all* available data, or those that are considered *representative* of a general population in terms of certain properties. Rather, the initial groups or situations from which data are to be collected are chosen, not on the basis of existing theory, but because of their potential to generate theory about the substantive area under study. Once categories begin to develop through ongoing data generation and analysis, further data collection, through *theoretical sampling*, is directed by a search to learn more about these categories. (Chapter 2, Sect. 2.4 uses the term "chronological parallelism" to describe this ongoing, concurrent process of data collection, analysis and the development of theory.)

Theoretical sampling can be directed by questions such as, "*What* groups or subgroups does one turn to *next* in data collection? And for *what* theoretical purpose?" (Glaser and Strauss 1967, p. 47, their emphasis). Corbin and Strauss (2008) characterize theoretical sampling as "concept driven." For theory building, further data collection is not about persons; decisions of what and where to sample next relate to *concepts*. (See Chap. 2, Sect. 2.4, for her criteria for theoretical sampling.)

On-going, simultaneous data collection, coding and category analysis lead to refinements in existing categories and their properties and to further formulation of the emerging theory. This process, in turn, informs the direction for further theoretical sampling. "Data collection never gets too far ahead of analysis because … the questions to be asked in the next interview or observation are based on what was discovered during the previous analysis" (Corbin and Strauss 2008, p. 145).

Theoretical sampling should also seek for *variability* in data. Comparisons for similarities and differences across sites, as well as persons, promote density and depth in a concept's dimensions, properties, and its relations to other concepts. Glaser and Strauss (1967) suggest explicitly sampling for different kinds of data or using different techniques of data collection, creating *slices of data*. The variety offered by different slices of data provides analysts "different views or vantage points from which to understand a category and develop its properties" (p. 65).

Qualitative data may be collected from many different sources. Field evidence may, for example, consist of observations or interviews. Another fruitful source is written material and documentary data, such as letters, biographies and autobiographies, speeches, etc. The library provides an excellent source of documentary material and may be theoretically sampled for concepts derived from analysis, just as with any other research site. Secondary analysis can also be carried out on interviews or field notes previously collected by another researcher. Additionally, theoretical sampling may point the researcher back to previously collected and analyzed data in order to reexamine old data in light of further insights developed through later analyses.

Theoretical sampling ends when categories have reached *saturation*. At this point, no new data will yield additional useful information about the properties of any of the categories. Evidence of saturation of particular categories is also indicated by the presence of "interchangeable indicators" that refer to particular incidents all coded for the same category (Glaser 1998). In such cases, the particular evidence may be changed without affecting the conceptualization of the category.

1.6.2 Core Category

As theoretical sampling and analysis continue, one or more of the developing categories will emerge as a key representative of important aspects of the phenomena under study. These categories form the nucleus of the emerging theory, guide further data collection, and become the most saturated categories under additional theoretical sampling. At this point a *core category* is identified that "appears to have the greatest explanatory relevance and highest potential for linking all the other categories together. … [and to] convey theoretically what the research is all about" (Corbin and Strauss 2008, p. 104). (See Chap. 2, Sect. 2.5.4 for an example of core category selection.)

1.7 Theoretical Integration

Grounded theory does not consist of a set of dense descriptions of the phenomena under study, nor is it merely a list of well-developed categories or findings. "It is the overall unifying explanatory scheme that raises findings to the level of theory" (Corbin and Strauss 2008, p. 104). The scheme provides the "cohesiveness of [grounded] theory" in terms of an "overarching explanatory concept … that, taken together with other concepts, explains the what, how, when, where, and why of something" (ibid., p. 55).

The final phase of analysis that leads to the development of grounded theory involves processes of theoretical integration. Central to these processes are the identification of a core category, the achievement of theoretical saturation of this and other important categories, and the set of analytic memos that have been continuously generated throughout all phases of the research (Birks and Mills 2011). Strategies that can be used to facilitate theoretical integration include using theoretical codes (Glaser 1998), selective coding (Strauss and Corbin 1990), writing a story line (Birks and Mills 2011; Strauss and Corbin 1990), and sorting memos (Glaser 1998; Corbin and Strauss 2008). These techniques help the researcher identify and articulate the nature of the abstract relationships that connect the core category with other important categories; and, ultimately, integrate the categories and relationships into a coherent conceptual explanation of a particular aspect of the substantive area of study. It is time now to integrate the pieces. "You have fractured a story descriptively and are now putting it back together conceptually" (Glaser 1998, p. 194).

Glaser (1998) describes the final theory-building phase in terms of the identification of "theoretical codes." In contrast to "substantive codes," which consist of the categories and properties abstracted from the substantive data, theoretical codes "conceptualize how the substantive codes may relate to each other as hypotheses to be integrated into the theory" (Glaser and Holton 2004). Theoretical codes are formal concepts drawn from existing theory related to or tangential to the researcher's field of study. To be appropriate for use in the integrative phase of grounded theory-building, these theoretical codes must be at an appropriate low-content level, and must earn their way into the analysis as having "emerged" from the data "as much as substantive codes" (Glaser 1998).

Strauss and Corbin (1990) use the term "selective coding" to identify a set of processes leading to theoretical integration. Central to these processes are the identification of a core category and the orderly development of relationships to other categories. (See Chap. 2, Sect. 2.5.4, for an example of selective coding leading to the identification of a core category.)

Corbin and Strauss (2008), while no longer using the term "selective coding," continue to place the selection of a core category within the theory building phase of the research. As with their earlier text, they also suggest that authors write a story line as a way to start thinking about the integration process. This story usually consists of a few sentences that describe "what the research is all about." The authors suggest the question, "what seems to be going on here?" as a useful prompt to facilitate the flow of ideas (Corbin and Strauss 2008, p. 107).

1.7.1 Sorting Memos

The collection of memos that has been accumulating since the beginning phase of open coding provides an important resource for theoretical integration. While early memos may be merely informal descriptions, later memos will reflect a more mature perspective, "generally becoming more summary-like, abstract, and integrative"

(Corbin and Strauss 2008, p. 108). Thus, when it is time to begin writing up the theory, the "discussions in the memos" provide a summarization and suggest "major themes" for the writing process (Glaser and Strauss 1967).

The process of *sorting memos* can facilitate the organization and structuring of the final integrated theory. Glaser (1998, p. 189) describes this process as a form of comparative analysis in which memos are sorted into piles on the basis of how they relate "theoretically and substantively to other memos" (p. 189). As integration begins to emerge, it may take several iterations of sorting, comparing, and resorting before all the memos fit into an emergent theory. Corbin and Strauss (2008, p. 108) note that, if memos have been written within a computer program, they can be retrieved and sorted electronically in many different ways "until a logical theoretical structure is constructed." The sorted memo piles then form the outline for the final written product, where piles may represent separate chapters, sections of a chapter, or paragraphs of a book or paper.

1.7.2 Validating the Theory

At the end of the research process, it is important to validate the emergent grounded theory. Corbin and Strauss (2008, p. 113) note that, while "theory is constructed from data, … by the time of integration, it represents an abstract rendition" of these data. Therefore, the researcher must be sure to compare this "abstraction" against the raw data to ensure it fits and is able "to explain most of the cases." Alternatively, the researcher may ask participants in the field to read what has been written and give their perceptions of the fit.

Glaser (1998, pp. 18–19) defines the criteria for judging grounded theory in terms of fit, workability, relevance, and modifiability. *Fit* addresses the need for a concept to "adequately express the pattern in the data" for which it was created. *Workability* refers to the theory's ability to "sufficiently account for how the main concern of the participants in a substantive area is continually resolved." *Relevance* indicates that the theory does indeed deal "with the main concern of the participants involved." *Modifiability* reflects the fact that grounded theory is "never right or wrong;" it has the ability to be continually modified as new data are introduced. "New data never provides a disproof, just an analytic challenge."

1.8 Interpretive Frameworks

This section briefly examines the variations in essential grounded theory methods that have been developed over two generations of active researchers in terms of how these variations reflect different interpretative frameworks or sets of philosophical assumptions. Such an examination is informative for the beginning researcher since "the methodology subscribed to influences the analysis of the data" (Birks and Mills

2011, p. 4). Being able to ground a study within a particular theoretical framework also enables the researcher to justify claims about the nature of the data, articulate his or her position as a researcher in the field, and defend the legitimacy of the knowledge produced in the form of grounded theory (Bryant 2009).

To begin at the beginning, the description of grounded theory research, as laid out by Glaser and Strauss (1967), in *The Discovery of Grounded Theory* should be considered as a set of *methods* rather than as a *methodology* based on a particular philosophical or theoretical perspective. That is, while the book describes the procedures used to carry out the research, the authors did not explicitly situate these processes within a set of principles that determine the ways in which the methods are to be used and interpreted (Bryant 2009). Questions of ontology (the study of the nature of reality) and epistemology (the nature of justifiable knowledge) were not openly addressed.

Glaser and Strauss conducted their investigation within the prevailing post-positive research paradigm, at a time when the predominate perspective in qualitative research was that, while reality was assumed to exist, it could only be imperfectly perceived, and that the researcher was expected to be a passive, objective observer. Reflecting this perspective, Glaser and Strauss (1967) viewed data as something to be "collected," stressed the importance of open-mindedness in not engaging with relevant literature before entering the field, and characterized concepts and theory as being "discovered" or as "emerging" from the data.

Since then, the second generation of grounded theorists has endeavored to position the essential methods of grounded theory within the more recent post-modern turn. For example, Charmaz (2006) bases her version of grounded theory research within the constructivist perspective, which takes a relativist position. That is, reality is locally constructed and the researcher is seen as an active participant in the joint construction of data with those in the research site. Analyses are viewed "as interpretative renderings not as objective reports or the only viewpoint on the topic" (Charmaz 2009, p. 131).

Glaser, however, has continued in his writings to avoid espousing a particular theoretical paradigm in the belief that doing so restricts the broad potential of grounded theory. His use of a language of "emergence" in the processes of data collection and analysis has led others to situate him "as a critical realist researching within the post-positive paradigm" (Birks and Mills 2011, p. 5).

1.8.1 Pragmatism

Bryant (2009), noting the lack of theoretical grounding in the early writings of Glaser and Strauss, has proposed re-interpreting their methods within the pragmatist tradition, particularly that expressed by the contemporary pragmatist John Dewey (1859–1952) and the neopragmatist Richard Rorty (1931–2007). By doing so, "clear and concise criteria for developing and evaluating" the research techniques can be addressed (ibid., para. 60), including epistemological issues, such as "where codes, categories, concepts and theories come from, and the processes involved in their derivation and articulation" (ibid., para. 68).

For the pragmatist, knowledge is viewed as instrumental; a "tool" that is judged not in terms of "its universal validity, but [in] its usefulness in a specific context" (Bryant 2009, para. 72). Thus, grounded theory that has *fit*, *grab*, or *works* can be seen as meeting the pragmatist's criteria of a systematically generated, explanatory hypothesis. Theories are also regarded as provisional and can be altered upon further inquiry (Hookway 2008).

Pragmatists consider that, "our ability to think about external things and to steadily improve our understanding of them rests upon our experience" (Hookway 2008, p. 16). This view supports the idea of the grounded theory researcher as being an active participant, rather than an objective receiver of external stimuli. In addition, such a perspective supports the notion of *theoretical sensitivity*, or the way in which we "see the data."

The pragmatist tradition is especially appealing for grounded theory methods employed in practice-led disciplines in its emphasis on the relationship between theory and practice. Because theories are judged in terms of their utility within specific contexts, they have direct relevance to those affected by the situations under study. Here, Glaser's (1998) criterion of *workability* and *relevance* are particularly apt.

1.8.2 Corbin and Strauss Circa 2008: Pragmatism and Symbolic Interactionism

Corbin and Strauss did not locate their grounded theory procedures within a particular interpretative framework until the publication of the third edition of *The Basics of Qualitative Research*. Corbin and Strauss (2008) note that while much of the philosophical position described in the Introduction to this book reflects the position taken by Strauss in his book *Continual Permutations of Action* (1993), in the time that has passed since then, Corbin has also left her stamp on this exposition.

The basic assumptions of Corbin and Strauss's methodological foundation are derived from pragmatism and symbolic interactionism. Symbolic interactionism, as articulated by Blumer, states that "people act toward things based on the meaning those things have for them, and these meanings are derived from social interaction and modified through interpretation" (Society for the Study of Symbolic Interaction 2011). Further foundation for Corbin and Strauss's (2008, p. 2) perspective is drawn from Dewey's and Mead's assumption that "knowledge is created through action and interaction." Action and interaction also occur within social complexity. As Dewey states, "Neither inquiry nor the most abstractly formal set of symbols can escape from the cultural matrix in which they live, move and have their being" (as cited by Corbin and Strauss 2008, p. 3).

Corbin also recognizes the influences on her own theoretical perspective of contemporary feminists, constructivists and postmodernists; in particular, the relativist position of constructivists in which meaning and knowledge are co-constructed by the researcher and the participants. Related to feminist thinking, Corbin notes that "we must be self-reflexive about how we influence the research process and, in turn, how it influences us" (Corbin and Strauss 2008, p. 11).

1.8.3 Constructivist Grounded Theory

Methodologically, constructivist grounded theory takes the position that individuals' perceptions of reality and the meanings they ascribe to their experiences are constructed through human activity within particular contexts and social environments. This perspective affects the nature of the relationship between the researcher and the participants in his or her study, how data are perceived and the methods by which they are generated, and emphasizes the importance of a self-reflexive stance for the researcher throughout the research process.

The interview is considered an important method in constructivist research. It is a situation in which data are not "collected" but "generated," and facts are not "discovered" but, rather, meaning is co-constructed between the researcher and the informant. "Interviews are not neutral, context-free tools; rather, they provide a site for the interplay between two people that leads to data that is negotiated and contextual" (Birks and Mills 2011, p. 56).

It is impossible for the researcher to maintain the role of an unbiased, objective observer in any part of the research process, not just during data generation. The researcher's biases and subjectivity enter into all phases of analysis. Reflexive memoing can help the researcher understand "the multiple perspectives of multiple participants" including that of him or herself (Charmaz 2009, p. 132). Such self-reflection is necessary since we are "part of our constructed theory and this theory reflects the vantage points inherent in our varied experiences, whether or not we are aware of them" (Charmaz 2006, p. 149).

1.8.4 Situational Analysis

The variations in grounded theory methods presented above focus on social science research that investigates processes involving "'the knowing subject' as centered decision maker" (Clarke 2005, p. xxix). However, such analytic approaches do not fully meet the needs of mathematics education research, in which *mathematics*, the subject matter, should be an integral part of any research study. *Situational analysis*, developed by Adele Clarke (2005), offers a promising perspective and set of analytic tools for researching the messiness and complexity of mathematics classroom teaching and learning, in relation to a particular topic of study.

Adele Clarke (a doctoral student under Anselm Strauss) developed, beginning in the mid 1990s, her methodological approach as a way to extend and go beyond the analytic heuristics of traditional grounded theory (Clarke 2005). Situational analysis reflects the postmodern assumptions that all knowledge is socially and culturally situated and that situations are complex, messy, and interrelated. Further, inquiry is directed towards examining the "relations of knowledges to the sites of their production and consumption practices" (Clarke 2005, pp. xxxv, xxxiv), and that there can be "simultaneous 'truths' of multiple knowledges" (p. 19). Her methodology draws on social interactionism and constructionism, and also incorporates aspects of Foucault's notions of discursive fields, and ideas developed in action-network theory.

Situational analysis recognizes "the analytic importance of the nonhuman" (Clarke 2005, p. xxxiv). Within situations, nonhuman and human elements are involved in processes of "co-construction and co-constitution," and the nonhuman elements "structurally condition the interactions … through their specific material properties and requirements" (Clarke 2009, p. 203).

Foucault's emphasis on "how discourses are produced and how we are constituted through them" forms an integral part of Clarke's (2005, p. 147) approach. She draws on Foucault's concept of "discursive practice," which describes processes of action and change in terms of how "ways of framing and representing linguistic conventions of meanings and habits of usage together constitute specific discursive fields" (p. 54). Discourses also include disciplinary elements that, as formulated by Foucault, represent a "series of organizing practices that produce the rules through which individuals … make themselves up as subjects" (p. 56).

Clark's methodology is designed to address "the situation" as the basic unit of analysis and to consider the complexity inherent in such a unit.

> The fundamental assumptions are that everything *in* the situation *both constitutes and affects* most everything else in the situation in some way(s). … People and things, humans and nonhumans, fields of practice, discourses, disciplinary and other regimes/formations, symbols, technologies, controversies, organizations and institutions–each and all can be present and mutually consequential (Clarke 2009, pp. 209–210).

As a way to "empirically" construct the situation of inquiry from "multiple angles of perception" and understand "its elements and their relations," Clarke (2005, pp. xxii, 72) developed a form of "cartographic situational analysis," or set of mapping strategies. Briefly, the three types of maps and analyses are (p. 86):

1. *Situational maps* as strategies for articulating the elements in the situation and examining relations among them
2. *Social worlds/arenas maps* as cartographies of collective commitments, relations, and sites of action
3. *Positional maps* as simplification strategies for plotting positions articulated and not articulated in discourses.

Situational and relational maps should not be considered theory as such. Rather they provide "a systematic, coherent, and potentially provocative way to enter and memo the considerable complexities of a project" (Clarke 2005, p. 103). These maps spark deeper analyses, raising questions to be addressed and suggesting areas for further theoretical sampling. Over the course of the study, the researcher may construct many different situational maps and consider different sets of relations as the focus of the study is identified and particular elements are considered for closer scrutiny.

1.9 End Comment

The information presented in this chapter represents a cursory introduction to grounded theory methods. It is recommended that readers interested in using this approach to research find and work with an experienced grounded theory mentor. However, for those in a "minus-mentoring" situation (Glaser 1998), a good place to start is to deeply mine the original sources from which the material in this chapter was derived. Many of the authors cited, such as Clarke (2005), Charmaz (2006), Corbin and Strauss (2008), and Birks and Mills (2011) include extensive examples from actual grounded theory studies to illustrate particular techniques. See also Chap. 2 by Maike Vollsted in this volume.

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Chapter 2
To See the Wood for the Trees: The Development of Theory from Empirical Interview Data Using Grounded Theory

Maike Vollstedt

Abstract The way from empirical interview data to the development of theory is illustrated with reference to an intercultural study. This study was located in the field of mathematics education and focused on the development of a theory of personal meaning. Starting from only a rough understanding of what personal meaning might be, interviews were conducted with students from lower secondary level in Germany and Hong Kong. Due to the setting of the study in two cultures, a pragmatic interpretation of theoretical sampling had to be taken so that as much data as possible was collected to choose from throughout the analytical process. Data analysis followed grounded theory according to Strauss and Corbin (Basics of qualitative research: Grounded theory procedures and techniques . Newbury Park: Sage, Grounded theory: Grundlagen qualitativer Sozialforschung [Basics of qualitative research: Grounded theory procedures and techniques]. Weinheim: Beltz; see also Chap. 1). Therefore, different types of codes (in-vivo, empirically developed, and conceptual) as well as different types of coding (open, axial, and selected) were the result of constant comparison and writing memos. By comparing codes and using a coding paradigm, categories and concepts were developed so that the theory of personal meaning started to evolve from the data. The results of the analyzing process were an empirically grounded theory of personal meaning consisting of 17 different kinds of personal meaning on the one hand and an underlying theoretical framework that describes the surrounding conditions of the construction of personal meaning on the other hand.

Keywords Grounded theory • Personal meaning

In the previous chapter, Teppo gives an introduction to grounded theory and its development into different specifications of the grounded theory methods. In the first section she especially focuses on the four different lines of development of the

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theory of grounded theory in the different schools following the two founders Strauss and Glaser respectively. The prevalent form of grounded theory used in Germany is the one elaborated by Strauss and his disciple Corbin as presented in their 1990 book *Basics of Qualitative Research*. Hence, I also followed their approach in my study so, accordingly, this article provides an example of the application of grounded theory to mathematics educational research following Strauss and Corbin (1990). As I actually worked with the German translation from 1996 of their 1990 book, I will always give both references throughout this text.

The empirical interview study presented here was carried out in Germany and Hong Kong (see Vollstedt 2011b). The aim was to find out and describe what is personally meaningful for the students when they learn mathematics or engage in mathematical problems in a school context and, thus, develop a theory of personal meaning (German: *Sinnkonstruktion*). The resulting theory about personal meaning was supposed to be laid out by different kinds of personal meaning. In the process of data analysis, I followed grounded theory methods according to Strauss and Corbin (1990, 1996). Hence, I also adopted their guidelines for the research process as well as their terminology.

When starting an empirical (interview) study, data often look very confusing and seemingly unrelated. One usually cannot see the wood for the trees at the beginning of data analysis. Therefore, we need a tool to detect a structure in the data that can be further worked out. Following grounded theory is a good possibility to finally see the wood for the trees—i.e. to develop an empirically grounded theory—as it combines methodological as well as methodical aspects (see Chap. 1) that provide guidelines throughout the research process.

This article may in some places diverge from Teppo's (see Chap. 1) description and terminology as she gives a review of the different streams of grounded theory in its different seminal forms. In contrast, I concentrate on one specific line of grounded theory. Nonetheless, it is recommended to read this illustrative chapter of the part alongside the previous chapter of this book as I will often draw back on the methodological basis laid out by Teppo.

2.1 Background and Focus of the Study

The study presented here was embedded in the Graduate Research Group on Educational Experience and Learner Development (German: *Bildungsgangforschung*) at the University of Hamburg, financed by the German Research Foundation DFG. The group's research focused on the question how children, adolescents and young adults act in situations of learning and instruction, how they interpret their learning tasks, and what can be done to encourage their educational development. Hence, in a school context, research on Educational Experience and Learner Development is primarily (empirical) research in teaching and instruction. The emphasis is placed on the perspective of the learners and their development. At the time I was member of the Graduate Research Group, we were especially investigating the role of meaning for learning and educational development.

Vinner (2007, p. 6) points out that humans have a "need for meaning" and that meaningful life and meaningful learning might have the same origin although they seem to be different concepts. If meaningful learning is a special case of "man's search for meaning" (ibid.), this specific human attitude does not disappear before entering the classroom. Meaning is also sought inside the classroom when students engage in learning and dealing with subject contents. Therefore, the question of meaning is posed time and again by students when they are learning mathematics. The demand for meaning in (mathematics) education has been detected for many years. Hence, meaningful learning has been identified as one of the major goals of education (ibid.). Consequently, one of the challenges posed also—if not especially—for mathematics education is to find convincing answers to the questions of meaning. In addition, if the aim is to make the learning of mathematics meaningful for the students, we need to ask what is meaningful to them rather than to impose some kind of meaning on them, which might be meaningful from a normative perspective but does not prove to be personally meaningful.

There is no commonly accepted interpretation of the term *meaning* in the field of mathematics education. The diversity of concepts is due to a mixture of philosophical and non-philosophical interpretations as the collection of articles of the BACOMET-group shows (Kilpatrick et al. 2005). Howson (2005, p. 18) convincingly distinguishes between two different aspects of meaning, "namely, those relating to relevance and personal significance (e.g., 'What is the point of this for me?') and those referring to the objective sense intended (i.e., signification and referents)". Hence, "[e]ven if students have constructed a certain meaning of a concept, that concept may still not yet be 'meaningful' for him or her in the sense of relevance to his/her life in general" (Kilpatrick et al. 2005, p. 14). Here, the mathematical meaning is obviously not interchangeable with the philosophical kind of meaning the student relates to his/her life.

As my study was embedded in the Graduate Research Group, I focused on the student's perspective. I therefore concentrated on Howson's first aspect of meaning and asked for the kinds of meaning that relate to the individual's relevance in the context of learning mathematics. To emphasize the focus of the learner's perspective over the, as Howson terms it, objective sense, I picked the term "personal meaning" instead of "sense-making" to denote the concept. By doing so I am also aware that subject-inherent sense-making sometimes also may be personally meaningful for the students. Accordingly, I did not look at what might be meaningful from a normative or domain-specific perspective, but—on the contrary—I investigated the aspects the students judge to be meaningful for them. As Kilpatrick, Hoyles and Skovsmose pointed out (see above), these do not necessarily have to (but may) be the same.

2.2 Realization of the Study

At the beginning of a study following grounded theory, there is no completed theory but—on the contrary—an open field of study whose relevant aspects become clearer and clearer throughout the research process. This was similar in my study. Prior to it, there was neither a developed theory about what personal meaning in a school context is, nor any empirical results about how personal meaning is constructed in a school context, nor any different kinds or types of personal meaning. The field of research was untilled except for a very rough understanding of personal meaning as described above. Therefore, the decision for reconstructive methods was reasonable—especially as the concerns of reconstructive studies are to understand a certain phenomenon better and to generate new theory that is empirically grounded (Jungwirth 2003).

To get a clearer glance at what is meaningful for the students in their learning processes, I conducted my study in two different learning cultures, Germany and Hong Kong. This decision offered the possibility of getting a sharper view on my own learning culture by being contrasted with a different setting I was not acquainted with. Stigler and Perry (1988, p. 199) describe this with respect to teaching practices as follows:

> Cross cultural comparison […] leads researchers and educators to a more explicit understanding of their own implicit theories about how children learn mathematics. Without comparison, we tend not to question our own traditional teaching practices and we may not even be aware of the choices we have made in constructing the educational process.

Similar to the teaching practices, we do not question our own beliefs and about teaching and learning when we do not reflect them against the background of another culture. Looking at another teaching and learning culture, thus, offers the possibility to reflect aspects that have been taken for granted beforehand and so to get a clearer picture of one's own culture, too. Hence, conducting a comparative study in two different cultures gives us a deeper understanding of our own teaching and learning culture (Jablonka 2006; Kaiser et al. 2006). Accordingly, it is a methodological tool to see the characteristics of both cultures more clearly. My study was conducted in Germany and Hong Kong being representatives of the Western and the Confucian Heritage Culture.[1]

One aim of the study was to develop a theory of personal meaning from empirical interview data. The theory is elaborated by means of the reconstruction of different kinds of personal meaning in the context of academic learning of mathematics.

The study is based on 34 guided interviews conducted in Germany and Hong Kong with students from lower secondary level. At the time they were interviewed, the students were 15 or 16 years old respectively. Seventeen students from each country participated in the study; all attended the highest school type in the respective educational system. In Hong Kong, I collaborated with schools that use English as medium of instruction. It was, thus, possible to conduct the interviews in English. The guided interviews lasted for about 35–45 min and began with a sequence of stimulated recall (Gass and Mackey 2000). This means that the students watched a five- to ten-minute video sequence of the last lesson they attended. Their task was

[1] I also investigated the role of the students' cultural background for the construction of personal meaning by comparing the results of the students from Germany and Hong Kong. As this part of the project is not related to the application of grounded theory, it will not be reported in this chapter in detail (for further information see Vollstedt 2011b).

to reflect on and verbalize the thoughts they had during the lesson. The subsequent interviews then tackled various topics that were assumed to be related to our understanding of personal meaning (see below). This understanding was at that time quite broad and not yet focused. The intention was to come as close as possible to the aspects related to learning mathematics which are personally meaningful for the students in a school context. Students were for instance asked about their associations of the words *mathematics* and *mathematics lessons* and about the characteristics of a good lesson. They were interrogated about their beliefs with relation to mathematics, mathematics lessons and their learning of mathematics as well as about their feelings, their learning strategies, their goals etc. In addition, they were asked about their preferred learning conditions and the reasons why they learn mathematics, whether they see a relation between mathematics and their lives, and whether they might need mathematics for their dream job. All these questions were supposed to give information about aspects that might be relevant for the construction of personal meaning.

The decision to analyze the data in a coding process is made for methodological reasons as well as for reasons of content. From the methodological perspective, coding is a core element for the development of a theory which is grounded in empirical data. To break up and to continuously compare the data is equally constitutional for the development of a grounded theory as well as for the development of codes throughout the analytical process. Thus, relations between phenomena can be detected in the data; phenomena can be distinguished and sharpened. Thereby, the aim of this comparative analysis is to use descriptive categories to come to analytical concepts so that the relations between phenomena can be explored and clarified (Tiefel 2005; see Chap. 1).

Additionally, in my study, there was also a content argument for the coding analysis as personal meaning can be understood as an individual psychological construct. It can be revealed by character traits and individual attitudes from which one can draw conclusions on the kinds of personal meaning preferred by the interviewed students. Thereby, it is of no importance at which time in the interview the utterance was made as long as the incidents mentioned were considered to be relevant for the development of the theory. Therefore, the sequentiality of the interviews can be neglected so that I chose a coding procedure instead of a sequential analysis method for this study. Coding thereby is characterized as a process of continuous comparison of phenomena, codes and categories with the aim of reaching analytical concepts which explore and clarify relationships between phenomena via descriptive categories (Tiefel 2005; see Chap. 1).

As the data of this study were collected to develop an empirically grounded theory, I decided to use grounded theory following Strauss and Corbin (1990, 1996). I chose their approach because they offer the most concrete guide to the grounded theory method that was available in Germany at the time the study was carried out. The authors point out that their outline of this method is not to be adhered to rigidly but it can be used rather as guidance for the research process (ibid.). Yet, this may not be understood as the permission for undirected interpretations. The guidelines given are more than just an enumeration of recommendations as they mark some operations as obligatory. A coding procedure and the writing of analytical memos for instance are among these (Strauss 1987; Strübing 2004; see also Chap. 1).

The following passages give a more detailed introduction to the different decisions made throughout the research process with concrete examples from my study. The main focus thereby lies on the different ways of coding.

2.3 Theoretical Sensitivity and Sensitizing Concepts

In a study following grounded theory, there are no hypotheses to be tested nor is there a fully developed theory of the research field. In return, grounded theory postulates a high level of theoretical sensitivity of the researcher. According to Strauss and Corbin (1990, p. 42), only this "attribute of having insight, the ability to give meaning to data, the capacity to understand, and capability to separate the pertinent from that which isn't […] allows one to develop a theory that is grounded, conceptually dense, and well integrated". To come nearer to our object of research, we need sensitizing concepts (Flick 2005) which are influenced by theoretical prior knowledge. Hence, researchers do not enter the field of study as *tabula rasa* as the approach of grounded theory is often misunderstood (Strübing 2004; see also Chap. 1, Sects. 1.2 and 1.5.1, for the place of literature review in grounded theory).

Strauss and Corbin (1990, 1996) explicitly mention literature, particularly technical literature, as one source of theoretical sensitivity. Other sources are professional and personal experience as well as the intensive interaction with the data throughout the analytical process. In my case, it seemed reasonable that personal meaning is somehow related to or influenced by concepts from educational psychology like the basic needs for autonomy, competence and social relatedness (Ryan and Deci 2002), personal or situational interest (Krapp 2002), concepts from mathematics education like mathematical beliefs (Op't Eynde et al. 2002) or mathematical thinking styles (Borromeo Ferri 2004), and concepts from educational experience and learner development like developmental tasks (Havighurst 1972; Trautmann 2004). These concepts therefore were taken as sensitizing concepts into the analytical process. As Teppo (Chap. 1) points out, a review of related literature can also provide links to which the newly developed theory can be adhered.

2.4 Interdependence of Data Collection, Analysis, and Development of Theory

According to Strauss and Corbin (1990, 1996), a grounded theory is developed from the study of phenomena occurring in the respective field of research. The data collected need to be analyzed systematically to discover, develop, and verify the theory.

> Therefore, data collection, analysis, and theory stand in reciprocal relationship with each other. One does not begin with a theory, then prove it. Rather, one begins with an area of study and what is relevant to that area is allowed to emerge. (Strauss and Corbin 1990, p. 23)

Strübing (2004) describes this close interdependence of data collection and analysis as functionally dependent and chronologically parallel. None of these processes is thereby understood as final; even the theory developed at the end of the researching process is characterized by tentativeness as it can be further developed in future research projects. The research process in the course of developing an empirically grounded theory then is iterative and circular (Strübing 2004; see Chap. 1). Please note that the procedure is repetitive and circular—but not the theory which is developed in this process.

This close interaction of data collection, analysis, and development of theory is also reflected in the procedure of data collection and selection of cases that are to be analyzed. The strategy used in grounded theory for this procedure is called *theoretical sampling* (see Chap. 1, Sects. 1.4 and 1.6.1). This term should not be confused with representative sampling as it is used in studies with large sample sizes opting to test hypotheses. According to Strauss and Corbin (1990, p. 177), theoretical sampling is "sampling on the basis of concepts that have proven theoretical relevance to the evolving theory". This means that the concepts are relevant with respect to the developing theory as they repeatedly occur in the data, or, on the contrary, are notably absent when comparing the incidents (ibid). In order to note which concepts are relevant, theoretical sensitivity is needed, i.e. sensitivity to recognize relevant indicators in the data. As sensitivity increases over time, it is possible that previously analyzed data must be recoded with the additional knowledge gathered in the analytical process (ibid.; Chap. 1, Sect. 1.6.1). Therefore, two aspects characterize theoretical sampling: chronological parallelism of data collection, analysis, and development of theory on the one hand, and a certain influence of the developing theory on the data collection on the other hand.

Chronological parallelism of data collection, analysis, and development of theory is difficult to realize in a study that is carried out in two cultures. If the demand for chronological parallelism is, however, applied not to the collection of new data but to the choice of which cases are to be analyzed from an assorted pool of data, it still can be satisfied. This is also in line with the argumentation of Strauss and Corbin (1990, p. 181, original emphasis), who argue that "*one can sample from previously collected data, as well as from data yet to be gathered*". Following this interpretation of theoretical sampling, I collected as much data as possible in both countries by having interviewed every student who volunteered. By this means, I generated a data set of 17 interviews per country. In addition, I kept the videotapes of all lessons I attended as well as the teaching materials used. Although I was interested in the personal view of the students on their learning process of mathematics, I wanted to be able to draw back on these materials if necessary throughout the analytical process. Further, at the time of data collection, I took field notes. The field notes concentrated on my experiences within the foreign culture, kept track of my understanding of the Hong Kong school system as well as the information I got about the teachers, and noted down

Example 2.1 Field note taken on April 4, 2006 in Hong Kong

Wah Yan College, class 4D/4C, Mr. Ng (approx. mid-thirties)
- 12 years of teaching experience
- School is in fact CMI (Chinese as Medium of Instruction), but from Secondary level on, 3 subjects are taught in English → all are natural sciences!
- Headmaster is one of the authors of the schoolbook that is used in class
- Filmed lesson
- Immediately, several students volunteered for the interviews! (It probably helped that I had my fingers crossed?!)
- School was founded in 1999, hence everything is quite new
- Class is better performing than average
- Today directly interview with Camryn (she was addressed by Mr. Ng before class; he said she does not like his way of teaching so talking to her might be interesting for my study. She denies this. We'll see.
- Sequence of stimulated recall: Introduction to direct variations (more or less ex-cathedra teaching)
- Got a copy of the teacher's version of the book together with a seating plan
- The teacher's version of the book could theoretically be read out in class exactly the way it is; Mr. Ng does not do this
- Solutions are printed in red next to the question (lighter shade of grey in the copy)
- The students' version of the book is similar to the teacher's but with solutions at the end of the book

some experiences from the interviews. Example 2.1 above gives an idea about what these notes looked like. As the analysis proceeded, it turned out to be not necessary to come back to the additional material as the interviews proved to be a very rich source with respect to the focus of my study.

After having collected so much data, one might be overwhelmed by it and it is a challenge to decide where to start the analysis. What should I begin with to find a way through the material? Or, with reference to the title of this chapter: I see a large conglomerate of bigger and smaller plants in front of me that I'd like to explore. But I can't walk through them to understand them—there is too much thicket, bushes and fern. Where and how should I start to find a way through them?

I chose to start with the analysis of interviews according to certain considerations. When listening to the mp3-files after the data collection, I wrote recapitulatory memos that summed up the topics that were talked about in the interviews. I always tried to keep the formulations as close as possible to the ones used by the interviewees. These memos were the first step towards a detailed transcription and also served as its basis. Therefore, I also stuck to the grammatical mistakes. As a whole recapitulatory memo is too long to be presented here, Example 2.2 below gives an excerpt from the interview with William, a student from Hong Kong to

Example 2.2 Excerpt from the recapitulatory memo of William's interview

Time	Main aspects
[…]	[…]
27:12	*Anything of special interest in lesson?* Not much, only doing the exercises. It's quite fun, solving the formula. Discuss with my classmate, knowing what is [quarter].[a]
29:58	*Anything interesting in topic?* Drawing a graph to find the median is quite fun. Because drawing a graph, although it's complicated, but the graph is very beautiful and it's very easy to find some information. So, it's very interesting and attracts me.
31:53	*Associations math?* - Receipts: I like to calculate whether it's correct. It's very interesting. - Sudoku: It's about numbers and logical thinking. - Triangles: Calculating angles is fun and interesting. - Economy: It's always about math. - Computers: Are a calculator. - Time: When I listen to music, it's counting the time; when I sleep I calculate whether I can sleep how long; prepare my timetable. - Volume: Bathing—I like to turn on the tub and to […] the volume, although it's very difficult.
35:31	*Like math?* Most certainly. It's interesting; the logical thinking lets me feel excited. I feel happy after having finished calculating a formula. I like math lessons very much because it's the place, the time I can interact with the math very much. The knowledge of math is very wide. Sometimes it's difficult, but I'm keen on that. Because if I understand that, I get more things in the mind and brain and I feel great at that time. I don't like using a calculator. Using a calculator is fast, but there isn't a feeling of success, so I like calculating by myself. *Do you also do it in class?* Yes, I try. If there're too many numbers, I use the calculator. But if there are less numbers, I do it by myself.
38:52	*Associations math lessons?* Math teacher: She is funny, enjoyable because everything is new. Happy: We can freely talk: In some other lessons teachers don't like us to talk, but in math we can discuss. Interesting, enjoyable: No need to remember things, not like history, geography: just calculating, observation of the graph. It's easier, interesting. If you listen clearly, you can do your exercises easily. You only need to remember the formula. Most of math lessons is recess. After I go out of math lessons, I feel very happy and have […] confidence, maybe because of the logical thinking I do for the questions.
42:50	*Like math lessons?* Yes, I like it very much. One reason is: Ms. Ting is very funny, interesting. Her talking to us is sometimes some jokes. Imagine, I solve a formula, I can […] confidence, increase myself.
[…]	[…]

[a]Expressions in square brackets were not perfectly understandable

illustrate what these memos looked like. The sequence is taken from the beginning of the guided interview following the stimulated recall. We shall have a more detailed look at the mid part of this excerpt below.

The interviews were selected for analysis with reference to these recapitulatory memos. The first interview was chosen due to the personal characteristics of the student; the successive interviews then were chosen either in minimal or maximal contrast to the students analyzed beforehand with respect to the characteristic under consideration. To be more precise, I started the analytical process with William, a very high-performing student from Hong Kong, who wanted to be challenged in his mathematics lessons (see above). The interview with William was exceptional as it was very long compared to the other interviews and, judging from the first impression deduced from the recapitulatory memo, it was very detailed and provided lots of examples William used to undermine his thoughts. Due to this richness, I felt confident that it was a good interview to start with.

William's classmate Vincent was similar with respect to his wish to be challenged in a mathematics lesson so that I analyzed his interview secondly. By this minimal contrast, it was possible to sharpen the concepts that were developed so far and get some more ideas about how they are conceptualized. In addition, new concepts that were not present in William's interview could be developed.

The third analysis dealt with Alban's interview, a low-performing student from Hong Kong who was afraid to fail and to lose his face. This case formed a maximal contrast to the first two with respect to the level of the students' achievement. Hence, the concepts could be deepened again concerning their scope and new concepts were developed. Following this procedure, I first analyzed all interviews from Hong Kong before I proceeded with the German interviews. By this means, I could guarantee utmost sensitivity to the data as I did not apply concepts that were developed from a person with Western cultural background in the context of Western lessons to ways of learning in a Confucian heritage culture. Rather, the concepts were developed from Confucian heritage data and later refined with Western data.

Throughout the analytical process, the sensitivity towards the concepts under consideration grows as more and more concepts are developed (see Chap. 1, Sect. 1.3). To ensure that also concepts could be applied to interviews that were analyzed at the beginning of the analytical process, some of the interviews were coded again. By doing so I was able to tag codes to phenomena that otherwise would have been overlooked, as I was not sensitive enough for them in the first coding cycle.

Finally, theoretical saturation was reached (see Chap. 1, Sect. 1.6.1): In the course of the analytical process of the last two interviews, no new categories were developed and the relationship between the categories seemed well established and validated (Strauss and Corbin 1990, 1996). Hence, I did not collect more data but decided to write down the theory as it was developed up to this point. As mentioned above, this does not mean that the theory is unchangeable—on the contrary: Although the theory of personal meaning may be corroborated by future research, it may well be the case that it can also be elaborated or extended further.

2.5 Data Analysis

When we think about our data as the thick and indistinguishable conglomerate of trees, thicket and bushes again, the coding procedure in grounded theory is our tool to bushwhack deeper and deeper into it. To be more precise, we can distinguish between different kinds of coding steps. Teppo (Chap. 1, Sects. 1.3 and 1.5, with reference to Birks and Mills 2011) differentiates between open and intermediate coding. Strauss and Corbin (1990, 1996) on the other hand discriminate three different types of coding: open, axial, and selective coding.[2] They also state that the decision for different types of coding is artificial and can hardly be made transparent in a coding process. Due to the circular design of the research process (ibid), coding is not necessarily linear. It alternates in particular between open and axial coding (ibid). Accordingly, the analytical process is marked by inductive and deductive thinking: The continuous interplay between deductive assumptions concerning the relationship between phenomena and the attempt to verify it with reference to the data is constitutive for the groundedness of the theory in empirical data (ibid).

This oscillating process is supported by analytical memos and diagrams. They reflect the analytical process and the relationships between the concepts in written analysis protocols or graphical representations respectively (ibid). Abstract thoughts about concrete data can be recorded so that they are prepared for verification or falsification respectively in relation to the material. In line with constant comparison of passages and concepts or categories while coding the data, the production of memos and diagrams is another essential element for the development of an empirically grounded theory (see Corbin and Strauss 1990; see Chap. 1, Sects. 1.1.1 and 1.4). In this study, I wrote recapitulatory memos for every person to keep a synopsis of every interview (see above) and analytical memos for every code to refine the description more and more over time (see below). In addition, I attached memos to certain passages from the interviews that brought up questions that I thought might be answered later on in the coding process. Diagrams were developed to graphically represent the relationships between different levels of codes in the process of axial coding (see below).

Several people were involved in the coding process. Primarily, I worked together with research students. Thus, we were able to develop codes consensually as well as independently. The codes that were developed individually or collaboratively could therefore be discussed intensively. At the beginning of the coding process, there was no code system that could have been applied. Therefore, the first codes were generated consensually. To achieve this, some interviews were analyzed collaboratively so that the developed concepts could intensively be discussed in little sections. We started in very great detail so that soon a great number of concepts was developed. Subsequently, the following interviews were analyzed independently so that the results were compared afterwards. The findings showed that basically we tagged the same contents with codes so that the same phenomena were labeled as categories.

[2] Teppo (see Chap. 1, Sect. 5) groups axial and selective coding under the term intermediate coding.

However, differences occurred whether the respective phenomenon rather belonged to the realm of personal meaning or whether it described a precondition that influences the construction of a personal meaning. This discussion led to a more precise description of the categories as well as a stronger awareness that we have to make the distinction between personal meaning in contrast to its preliminaries. Please note that categories were developed with respect to several interviews, i.e. categories do not describe phenomena that are special for a certain student.

Due to reasons of efficiency and scarce resources, I had to code the majority of the interviews on my own. However, when I came to sections in the interviews that seemed to be not straight forward, I sought the discussion with people who have been involved in the project for some time. Also, the progress of the analytical process was discussed time and again with my colleagues in research colloquia where the whole working group attended, or smaller meetings with my supervisor or just a few colleagues.

From the technical side, the study was carried out with the help of the software MAXQDA (1989–2013). The program can be downloaded from http://www.maxqda.com/. The full version is subject to licensing, the demo version can be tried out for 30 days for free. MAXQDA has been developed specifically to analyze qualitative data and offers a wide range of methods for analysis. Among other features, codes can be organized into a hierarchy and complex inquiries can be made about the coded data to work out connections and differences between the codes.

2.5.1 Open Coding

The data that were analyzed in this study consisted of two different groups of texts: the transcribed interviews with students from Germany and from Hong Kong. I started the analysis with the interviews from the Hong Kong data set to encounter them as unbiased as possible and with a great theoretical sensitivity (see above). Hence, the category system was developed with reference to the Hong Kong interviews and it was adapted and further developed with the help of the German data. I tried to keep the influence of the Western perspective on the Hong Kong data as little as possible.

Although the three different types of coding do not occur sequentially (see above), open coding usually is the first approach to the data. Sensitizing questions and constant comparison are core elements of this coding step (See Chap. 1, Sect. 1.3, for a detailed description of open coding). Strauss and Corbin (1990, 1996) use the terms *concept* and *category* to denote a phenomenon that is categorized and conceptualized by assigning it to one code on the one hand and, on the other hand, concepts of higher order, i.e. concepts that are subsequently compared again so that they can be grouped to more abstract concepts.

The name of codes, concepts, and categories can be derived in different ways. Firstly, there are codes that are developed *in vivo* (Strauss and Corbin 1990, 1996). These codes get their names directly or with only little variation from the data.

The concepts are directly mentioned and named by the interviewee. Secondly, there are codes which are also developed from the data and which are named by the researcher in the course of the analytical process. Thirdly, codes can be related to technical literature applied to enhance theoretical sensitivity (ibid). In this case, theoretical concepts that are relevant for the research question and, hence, that are part of the theoretical background of the study are assigned to the data. Their names are taken over; these names mark the relevance of the theoretical concept for the theory. These codes are called *conceptual codes*. The denomination of codes, concepts, and categories is preliminary at first and may be changed in the course or further analyses. Examples of the three different kinds of coding are presented in the illustrative part of this section below.

With reference to our forest metaphor, open coding helps us to name the different kinds of plants and maybe animals we come across on our way through the conglomerate of trees and thicket. The result is that they are not so indistinguishable anymore. We begin to understand what we are exploring.

2.5.2 Axial Coding

In her overview on intermediate coding, Teppo (see Chap. 1, Sect. 1.5) gives some introduction to axial coding as well as the use of a coding paradigm. She also describes selective coding according to Glaser (2004) in this subsection as a way to focus the researcher's attention on this part of intermediate coding. Strauss and Corbin (1990, 1996), on the other hand, differentiate more strongly between axial and selective coding as separate steps in the analytical process. Therefore, this section will discuss the application of axial coding, whereas selective coding is presented below.

Following Strauss and Corbin (1990, 1996), axial coding is the second step in the coding process. They suggest investigating the following elements to work out the relations between the categories with the help of a coding paradigm (see Chap. 1, Sect. 1.5): causal conditions, context, intervening conditions, action/interaction strategies, and consequences. Strauss and Corbin perceive the coding paradigm as obligatory element of a grounded theory in contrast to the elements used. Therefore, Tiefel (2005) for instance adapted the coding paradigm to her study with respect to a theoretical framework of learning and education. Both versions, i.e. the one by Strauss and Corbin as well as the one by Tiefel, however, seemed of little use for my study so that I also adapted the coding paradigm to come to one that matches my study better. I assumed that there are certain personal preliminaries like the student's personal traits or his/her personal background that might influence the construction of personal meaning. In addition, the kind of personal meaning constructed by the student might influence the student's actions or judgments. Therefore, I analyzed the phenomena with respect to their preliminaries and consequences in the course of axial coding. The results were recorded in theoretical memos and diagrams. Thus, the different kinds of personal meaning, which were developed as main categories, could be theoretically refined and contextually condensed.

The development of main categories from categories works differently than the development of categories from concepts in the course of open coding. In open coding, concepts were related with reference to their content. Similar phenomena were collected in categories of different levels of abstraction. In axial coding, we look for relations between categories and concepts that are proposed by the interviewees themselves. Hence, relations are established between a category (the main category) and other categories or concepts (the subcategories). The differentiation between main categories and subcategories therefore lies on another analytical level than the relation between categories and concepts.

When thinking about our trees metaphor, with axial coding we now begin to understand the relationship between the different plants and trees. Anemones, for instance, are little flowers that widely grow in the undergrowth and underneath trees. They only blossom in springtime when the trees do not yet have strong leaves as they are in the need of much light. The "structure" of the trees and other plants becomes clearer and clearer—especially concerning their relations.

2.5.3 Exemplary Illustration of Open and Axial Coding Using Memos and Diagrams

Before I continue with selective coding, I illustrate the open and axial coding processes with the help of an extract from the interview with William, the student from Hong Kong we already met above in the illustration of the recapitulatory memo. I also show how memos and diagrams can help in the analytical process and how they were used in the course of the analysis. Please note that my interpretation is just one possible interpretation and that other interpretations may also be valid. Especially with a focus on another research question, one might come up with quite different concepts and categories.

To understand the section chosen a bit more easily, consider the following information: The extract quoted below was preceded by the stimulated recall about a section of his last mathematics lesson in which the class learned about the median. In the part of the interview from which the section was taken, the questions dealt with the student's attitude towards mathematics and mathematics lessons. In the interview with William, I started with the question about his associations with the word "mathematics", which was followed by the section below. Questions about his associations with the word "mathematics lesson" and whether he liked mathematics lessons then succeeded (see above). It could be reconstructed from these and other parts of the interview that William liked mathematics lessons very much and he was eager for mathematical knowledge. He therefore wanted his teacher, Ms. Ting, to arrive more quickly at the classroom after the bell rang so that the lesson could start earlier and that they could learn more in a lesson.

1. Interviewer: Do you like mathematics?
2. William: Oh, certainly.
3. Interviewer: Ya?

4. William: Because … I say it's interesting, the logical thinking is … let me feel … exciting
5. … becau- … I feel successful after I finish … calculating a … formula … also feel … (3 sec)
6. happy, happy because it's quite … (5 sec) I feel successful also … (2 sec) when I'm
7. … (3 sec) I like the mathematics lesson very much because … this the … the place, the
8. time I can interact with the mathematics very much (2 sec) becau- I don't know … the
9. … knowledge of the mathematics is very wide so … learning it is … although is, maybe
10. sometimes is difficult but … I'm keen on that because … if I understand that … what is
11. that thing about … (14 sec) I get … I get more more more things in the mind and in the
12. brain, so … (3 sec) I don't know that word is in English but … maybe I try to use another
13. word to explain to you, … the knowledge come into your brain and you feel more, you
14. get more information and get more knowledge and feel great at that time … (3 sec) I
15. don't know that word, sorry.

The excerpt presented starts with the question whether William likes mathematics. He confirms this question and stresses it explicitly with "certainly" (1–2[3]). From this utterance, we can reconstruct a positive attitude towards mathematics. Therefore we can generate the code *positive attitude towards mathematics* and so develop our first concept. To remember later on in the coding process which incidents we wanted to denote with this code, we should write a code memo containing a description of the phenomenon labeled with this code and possibly give an example of an utterance which might stand exemplarily for this code. Although it often seemed straightforward what the code was about judging by its name, it later on frequently turned out wrong in my study. One day I was really sure about what concept I wanted to denote with a certain code and thought that writing a memo would take too much time. Then, a couple of days later I was cross with myself for not having written a memo. It is often difficult to draw the lines between two codes when in doubt whether to add a new interview line to an existing code or whether to create a new one. When you cannot refer back to a definition in a memo, things turn out even worse.

[3] In the original interview, the transcript lines were numbered differently. There, every speech act was labeled with one number, i.e. this section was enumerated with 132–135. To make it as easy as possible to follow the coding process, I chose here to number every line as presented above in order to find the different bits labeled with codes more easily.

Code memos should be kept up to date. They will become more and more explicit over time when we come across similar incidents, which also belong to a certain concept, or—even more precisely—when we detect utterances in the data that just do not belong to the code. It is also helpful to expand the information collected in the code memo and make notes about these concepts that are close to the one explained. Therefore, memos get more and more detailed over time. With reference to the code developed above (*positive attitude towards mathematics*), at first, I just noted down that the interviewee mentions something positive about his or her attitude towards mathematics. The illustrative line taken from the interview helps to get a better understanding of the code when referred back to later on in the analytical process. When more and more passages were coded, the information was enriched, and more illustrative examples were added. For instance, students did not only generally talk about liking mathematics or certain fields of mathematics (e.g. geometry) but they also like mathematics for its difficulty and because they are challenged by it. I also noted down that the concepts labeled with this code referred to mathematics and not to the activity of doing mathematics (like problem solving) or to mathematics lessons. These instances belonged to other codes.

After William's short answer, the interviewer replies with a confirmative "Ya?" (3) and William elaborates more on his attitude towards mathematics. He relates it at first to his interest in mathematics: "I say it's interesting" (4). Here, we can use a code from our sensitizing concepts that we read about in technical literature: We can link this utterance to the concept of personal interest (e.g. Krapp 2002). Again, we develop a code (*personal interest in mathematics*) and write a code memo as explained above. Due to the succeeding utterance ("the logical thinking is … let me feel exciting", 4), one can argue whether William's interest results at least partly from his excitement to think logically. Therefore, in the code memo of *personal interest in mathematics* we can add this idea so that later on in the coding process, we can check whether this relation is made more explicit by other interviewees or whether we can find other incidents which suggest this relation. In addition, we can attach an analytical memo directly to this incident in the interview (i.e. next to the transcript line) with the idea that there might be a relation between William's personal interest in mathematics and his excitement about logical thinking. These ideas and codes about a relation between personal interest of the student and a positive attitude towards mathematics are very first ideas of axial coding as we think about the relation of two concepts that lie apart from the grouping of similar concepts in one bigger category. Thus, we can see that the discrimination of the three different types of coding is artificial as at least open and axial coding interact to quite some extent.

William's excitement about logical thinking, however, seems to be another phenomenon. It shows that William enjoys when he can think logically. We can develop a new code *enjoyment of logical thinking* and write a code memo respectively. The name of the code is partly inspired by the interviewee's formulation, i.e. it is partly coded *in vivo*. William then links the enjoyment of logical thinking to the feeling of success after having finished his calculation and the application of a formula (5). At this instance, again, we can generate a code (and write a corresponding memo) that comes from a sensitizing concept, i.e. the experience of competence as formulated in self-determination theory by Deci and Ryan (2002). We call our code *experience of competence by successful calculation*. Then, William tells the interviewer that he also feels happy when he is successful with the calculation (5–6). Hence, William also links the experience of competence due to his successful calculation with enjoyment so that we get another code: *enjoyment of experience of competence*. Now we realize that we had a similar code beforehand, the *enjoyment of logical thinking*. Thus, we can now generate a broader code that embraces two codes: the category *enjoyment* with the two subcategories or concepts *enjoyment of successful calculation* and *enjoyment of logical thinking*.

After some stammering containing half sentences which cannot be clearly linked or interpreted ("… (5 sec) I feel successful also … (2 sec) when I'm … (3 sec)" (6–7), William further elaborates on his attitude towards mathematics lessons. He explains that he likes his mathematics lessons very much as they provide the time when and the place where to interact with mathematical contents (7–8). William therefore shows a *positive attitude towards mathematics lessons*. Again, we can combine two concepts in a category: *positive attitude towards mathematics lessons* and *positive attitude towards mathematics* can be interpreted as two subcategories of *positive attitude*. In addition, William seems to enjoy interacting with the mathematics (8), i.e. we have our third subcategory of *enjoyment*: *enjoyment of active engagement with tasks*.

Then, William goes on and states that "the knowledge of the mathematics is very wide so … learning it is … although is, maybe sometimes is difficult but … I'm keen on that" (8–9). So, although it is sometimes difficult to understand, William likes to learn more about mathematics. Hence, he does not shy away from difficult topics; on the contrary, it seems that he likes to be challenged by mathematics ("I'm keen on that", 10). Thus, we can develop a new code together with its memo: *enjoyment of challenge by difficult mathematics*.

In William's last longer utterance he obviously has problems in formulating his thoughts. We can tell this from the long pause of 14 seconds in line 11, as well as the fact that he addresses his formulation problems. Still, his thoughts are understandable so that we can interpret them. In this section he makes a connection between understanding and knowledge: "if I understand that … what is that thing about … (14 sec) I get … I get more more more things in the mind and in the brain, so […] the knowledge come into your brain and […] you get more information and get more knowledge and feel great at that time" (10–14). In William's opinion, understanding of the topics seems to be a precondition for education and for knowing more, probably even for becoming more intelligent. He seems to value the broadness of the mathematical body of knowledge and it is his aim to get more knowledge. In addition, he also feels great when he learns more (13–14). Therefore we can generate the codes *eagerness for knowledge* and *enjoyment of knowledge* (again as a subcategory of *enjoyment*) together with their memos.

Another instance of *enjoyment of knowledge* can be reconstructed from William's utterance that he feels great when he gets more information and when "the knowledge come into your brain" (13). William's eagerness to know more combined with

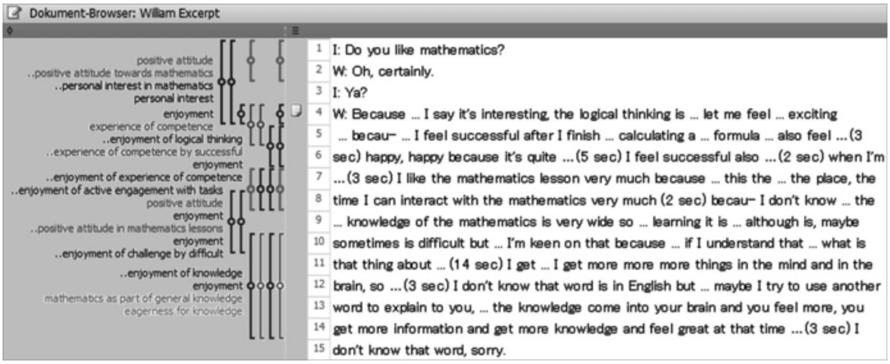

Fig. 2.1 Coded excerpt from William's interview (Screenshot taken from MAXQDA)

his emphasis of the broadness of mathematics suggests that he values mathematics as a part of general knowledge that is to be aspired. Thus, a new code can be *mathematics as part of general knowledge*.

When applying these codes and the analytical memo about the connection between logical thinking and personal interest in mathematics to this section using the software MAXQDA the coded passage looks as presented in Fig. 2.1 above.

To recapitulate, in this interview excerpt we learn something about William's personal attitudes as well as instances that are important for him in the context of learning mathematics. He shows the belief that mathematics may sometimes be difficult and that mathematics lessons provide the conditions in which he can actively engage with mathematical contents. He has a positive attitude towards mathematics and he is interested in the subject as well as the contents. He likes to think logically and to be challenged by difficult topics. Finally, he is eager to learn and wants to develop himself.

Correspondingly, when we subsume our findings from this interview excerpt, we come up with the following (preliminary) list of codes as presented in Fig. 2.2 (given in alphabetical order).

For axial coding we now need to relate categories and concepts on a different level. As described above, I made changes in the coding paradigm, as the elements proposed by Strauss and Corbin (1990, 1996) did not match my research question. To elaborate the different kinds of personal meaning, we need to relate those aspects that are personally meaningful with those which are preconditions and consequences.

When we have a closer look at the categories developed so far in the course of the analytical process, we realize that *eagerness for knowledge*, *personal interest in mathematics*, as well as *positive attitude towards mathematics* or *mathematics lessons* denote elements of William's character. They signify features belonging to his personal traits. Therefore, they are elements of the preliminaries William brings to the process of constructing personal meaning. On the other hand, a closer look to the categories grouped beneath *enjoyment* shows us that we need to distinguish

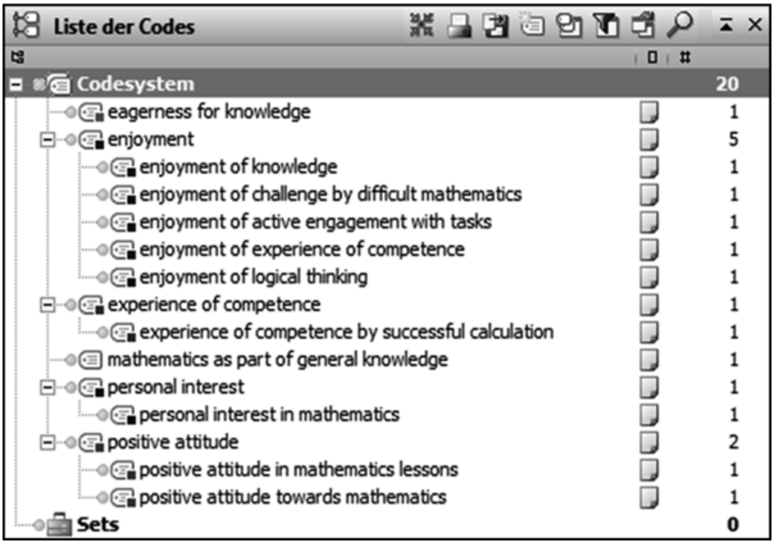

Fig. 2.2 List of codes in alphabetical order (Screenshot taken from MAXQDA)

between the enjoyment itself and the source from which the enjoyment origins. Consequently, the sources are manifold, but they all share the same consequence: the experience of enjoyment. In other words: The phenomena described by the source of enjoyment are personally meaningful for William—provided that he is able to realize them. He then enjoys the learning of mathematics or dealing with mathematical contents.

We can deduce two main statements from these findings: The first one is that the theoretical framework, which relates personal meaning to the surrounding conditions of its construction, becomes clearer and clearer. We now know that we need to distinguish between preliminaries, elements that relate to personal relevance, and consequences. In the course of the analytical process, this model was again refined until the theoretical framework as presented in Fig. 2.3 was developed. With respect to preliminaries, we distinguish between personal background (e.g. cultural and socio-economic background, age, and gender) and personal traits. The latter can be specified in more detail with the help of concepts that are determined in educational psychology (e.g. interest, motivation, and self-efficacy), mathematics education (e.g. mathematical beliefs and thinking styles) or concepts from the didactics of Educational Experience and Learner Development (denoted as *Bildungsgang-didactics* in Fig. 2.3) like developmental tasks.

The second statement is that the sources of enjoyment detected seem to play a decisive role for the development of a theory of personal meaning, as they are elements that are meaningful to William. Hence, they are the first elements that give us an idea about different kinds of personal meaning. In the course of the further analytical process, the different sources of enjoyment show varying degrees of

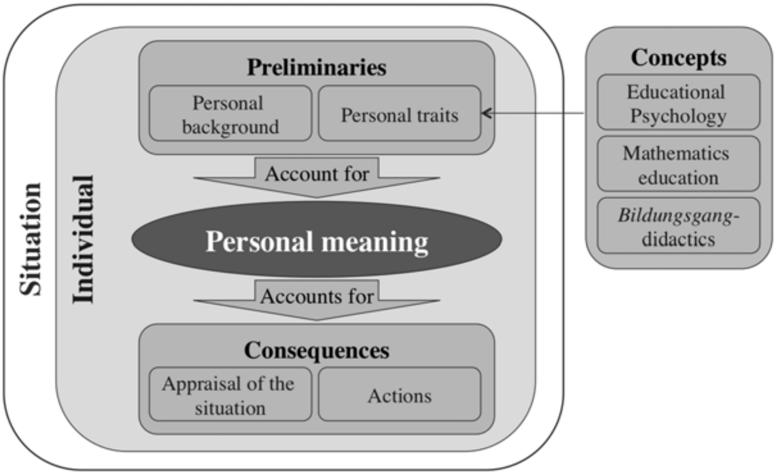

Fig. 2.3 Theoretical framework of personal meaning as developed in the course of the analytical process

relevance for different kinds of personal meaning. One source thereby might be decisive for one kind of personal meaning and also relevant but not central for other kinds. To illustrate this with a more concrete example, let us investigate the idea of *challenge by difficult mathematics* in more detail: At the end of the analyses, this phenomenon that students want to be challenged by difficult topics or tasks proves to be important for the kind of personal meaning *experience of competence* in which it is relevant for the students to experience themselves as competent and successful (see also the need for competence as described in Self-Determination Theory according to Deci and Ryan 2002). One of the personal traits considered as relevant for the construction of this kind of personal meaning is that the student likes to be challenged by difficult mathematics as these contents especially bear the possibility of experiencing competence after they have been successfully solved. The second kind of personal meaning to which *challenge by difficult mathematics* was central is *cognitive challenge*, for which it is the defining element. The final coding paradigm is shown in Fig. 2.4 below. Relevant preliminaries for this kind of personal meaning were a wish for cognitive challenge and that difficult tasks were provided in the lesson so that it was possible for the student to engage with them. Some of the students also are very ambitious and they like competitions with their classmates. Consequences that derive from *cognitive challenge* are for instance that the student can improve his/her achievement and that he/she enjoys the challenge. Hence, the student can experience competence and success. Here, again, the close relationship between some kinds of personal meaning becomes evident.

As only a short excerpt could be shown, it is difficult to clarify the steps of constant comparison in the latter coding process. Hence, from this article it hardly becomes clear how categories become more and more complex and how the 'big idea' of every category arises while the analytical process is proceeding. To cushion this, let me add some general ideas about working with grounded theory. When we

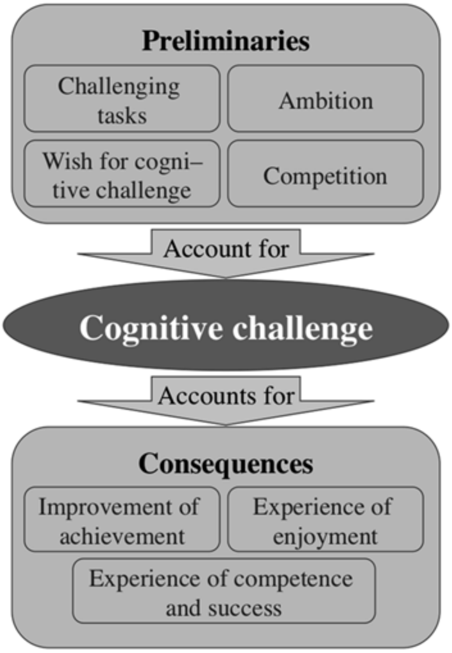

Fig. 2.4 Completed coding paradigm for Cognitive challenge

use the grounded theory method to develop theory from empirical data, our general aim is to discover elements of a theory about our research question in these data. The difficulty is to decide which elements are relevant and how to combine them in such a way that a consistent theory arises. The first thing is that we constantly have to ask ourselves about the more general idea behind what the interviewees say. This means that we have to generalize from the concrete expressions to deduce the more general idea that is relevant for our research question. So, what is behind what the interviewee (or the data in general) tells me? Throughout the research process, these ideas can be linked with each other or—equally or even more interesting—not linked. On the one hand, concepts can be grouped as they denote similar phenomena (subcategories in a category of higher order). On the other hand, concepts can be linked although they do not denote a similar idea. Then, the connection is usually suggested by the interviewees, who combine them in their expressions (axial coding). Here we have to pay attention to the links that can be developed in the analysis and those that cannot be established. Lots of questions arise: Why is that so? Do the categories describe different 'big ideas'? Or do my categories denote facets of an overarching 'bigger idea'? Why can't I put them in one main category? What is missing? And why is it missing? Do I need more (other?) data to answer this question? So here, again, we have to look for the more general idea on category level.

On this level of analysis, we usually keep writing memos over memos to remember all our ideas about combinations of categories and also about links between categories that are not possible and why they are not possible. We formulate hypotheses about them and try to find more evidence or counterevidence with the help of new data or sometimes even data that have been analyzed beforehand. After some time and after the analysis of more data, some links between categories become more and more established as they occur time and again in the data; other links cannot be verified with new data so that we have to dismiss them. You can see that, slowly, a closely-knit net of combinations of categories arises from the data.

2.5.4 Selective Coding

Selective coding describes a procedure similar to axial coding but it is carried out on a more abstract level. The aim is theoretical integration of the developed categories into a consistent overarching theory (see Chap. 1, Sect. 1.7). This means that we are looking for a core category, which is related to all other main categories that were established in axial coding.

Following Strauss and Corbin (1990, 1996), selective coding is the third step in the coding procedure. As Teppo (Chap. 1, Sect. 1.7, with reference to Corbin and Strauss 2008) points out, the questions that have to be answered are "what is the research all about" and "what seems to be going on here". The aim in this analytic step is to find the common thread that runs through the study. Or—in our trees and anemones metaphor—to detect paths that lead the way through all the trees and plants. We finally get to the point of realizing that we are investigating a complex conglomerate of trees, which finally turns out to be a beautiful forest.

When the analytical process in my study came to an end, 17 main categories were developed, that could be described with reference to several subcategories. The main categories cover a broad range from the fulfillment of duty and the wish for cognitive challenge when dealing with mathematics to the experience of social relatedness. So what is their combining element? All these instances are in some way or another important for the students when they are dealing with mathematics. In other words: All phenomena describe aspects or phenomena in the context of learning mathematics at school that are personally relevant for the individual. This relevance makes the phenomena personally meaningful for the students. Hence, when asking the sensitizing questions of selective coding, I decided in favor of the core category *personal relevance*. The different kinds of personal meaning can be characterized as those incidents that are dealt with in the context of learning and dealing with mathematics at school which are personally relevant for the students. With reference to the codes that were developed in the course of the analytical process of the study, this means that the main categories worked out in axial coding describe the different kinds of personal meaning.

Strauss and Corbin (1990, p. 116) define the core category, which is to be developed in this step, as the "central phenomenon around which all the other categories are integrated". It might have been developed in the course of axial coding or it might as well arise in selective coding. The phenomenon being central for selective coding may in some research even be contained in the formulation of the research question (Böhm 2005).

Personal relevance fulfills the assessment factors for a core category suggested by Strauss (1987[4]). The core category *personal relevance* is the central element of the developed theory and can easily be interwoven with the main categories in a close network. This is due to the fact that every main category developed in axial coding describes another kind of personal meaning. Each of these categories therefore categorizes another specification of personal relevance. Every main category, i.e. the different kinds of personal meaning, together with its subcategories describes indicators for the core phenomenon, which frequently occur in the data and form a pattern.

2.6 Going Beyond Grounded Theory

Having reached this point, I came up with a dense grounded theory about personal meaning based on the construction of 15- to 16-year-old students from Germany and Hong Kong when they learn mathematics. I was able to describe 17 different kinds in rich detail. I could have stopped here—and actually the application of grounded theory methods ends here. Moreover, I was interested in the relationship between the different kinds of personal meaning, i.e. the main categories of my theory. Is there some axis they all refer to and according to which they can be ordered? Is there a basic underlying, subject-independent dimension which can be used to work out guidelines or more general criteria to think about personal meaning across different subjects? To answer these questions, I had to think about the different kinds of personal meaning I had worked out from a more general perspective. By doing so, I followed the methods laid out by Kelle and Kluge (1999). The two dimensions I finally came up with were the relatedness towards the individual and the relatedness towards subject contents, i.e. mathematics. I was able to arrange all kinds of personal meaning with reference to these two dimensions. Then, seven different types of personal meaning could be deduced from the arrangement (see ibid). As the typology is not reported here in detail, see Vollstedt 2011a or 2011b for more detail.

The analytical elaboration of the categories finally resulted in a decisive advancement of the theory, which gained more explicitness and density. Furthermore, it is possible to integrate maximum variation of the specifications of the core category *personal relevance* into the theory as can be seen in the development of the typology. By writing down the theory that has been developed from our interview data, we give other people the possibility of also understanding and referring to the theory we worked out.

[4]At the time of writing his introduction to *Qualitative analysis for social sciences*, Strauss (1987) used the term *key category* instead of *core category*. They denote, however, the same kind of category.

2.7 Conclusion

The aim of this chapter was to trace the analytical process of an empirical interview study using grounded theory. To achieve this, an excerpt from one interview with a student from Hong Kong was analyzed and the analytical process was shown in as much detail as possible. It is, of course, not possible to illustrate every little step of the highly complex analytical process with such a short excerpt. Still, I tried to give insight into the different levels of coding as well as to provide examples for the decisions that have to be made throughout the analysis.

To conclude, the basic idea of the development of theory using grounded theory is to get the main ideas behind what the interviewees say (or our data provide), to formulate hypotheses about links between these ideas, and to try to establish or dismiss these links. To finally come to a dense theory that is empirically grounded, a very detailed analysis of the data is necessary. The ideas discovered have to be knit together tightly with the help of empirical evidence. Eventually, we see in the data not only manifold expressions or phenomena but concepts and categories that are strongly interwoven to form a theory about our research question in focus.

In other words: We started our journey with an indistinctive conglomerate of plants, began with a categorization of trees, bushes and animals and finally reached a good understanding of our forest with all its paths, bigger ways and shortcuts through the undergrowth. Having laid out the theory now also puts up signposts to enable other people to enjoy a day in the forest without being lost, and to come back once in a while. Thus, in the end, it is possible to see the wood despite—or precisely because of—all the trees.

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