Chapter 2
Epistemological Developmental Theories

This chapter provides an overview of current epistemological developmental theories. It starts with a conceptualization of personal epistemology, i.e., asking where personal epistemology is situated in a bigger picture of cognition or the cognitive process. Next, it reviews current cognitive developmental theories in personal epistemology, including Perry's theory and its extensions over the past 40 years. A synthesis of these theories leads to modifications of Perry's theory, which is used in this work.

2.1 Conceptualization of Personal Epistemology

Personal epistemology can trace its origin back to Piaget (1950, 1972) when he described his theory of intellectual development of children (referred to as *generic epistemology*). His theory on intellectual development initiated the interest of psychologists and educators in cognitive developmental theories. A central theme in his theory is a developmental progress through different stages throughout childhood and early adolescence. This central theme of a developmental progress in relation to knowing and knowledge is followed by many of the current models of epistemological development (Hofer and Pintrich 1997).

Before I review current models and theories in personal epistemology, I would like to first situate the development that will be discussed in this work within the broader territory of cognition. As shown in Table 2.1, Kitchener (1983) and Kuhn (2000) both distinguished different levels of cognitive processing.

Personal epistemology refers to what Kitchener (1983) defined as the third level of cognition, epistemic cognition (the first two levels are cognition and metacognition). It refers to reflections on "the limits of knowledge," "the certainty of knowledge," and "the criteria for knowing" (Kitchener 1983, p. 222).

In Kitchener's discussion about cognitive processing and dealing with ill-structured problems, he proposed a three-level model including *Cognition*,

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Table 2.1 Locating epistemological thinking in cognitive processing (Hofer 2001, p. 364)

3-level model of cognitive processing (Kitchener 1983)	3-level model of meta-knowing (Kuhn 2000)
Cognition	
Metacognition	Metacognitive knowing Metastrategic knowing Metatask knowledge Metastrategic knowledge
Epistemic cognition	Epistemological knowing

Metacognition, and *Epistemic Cognition*. At the first level, *Cognition* refers to an individual's ability to read, memorize, compute, etc. *Metacognition* has to do with the monitoring of the first level processes; *Epistemic Cognition* is related to reflections on "the limits of knowledge," "the certainty of knowledge," and "the criteria for knowing" (Kitchener 1983, p. 222). Prior findings (Flavell 1979; Kitchener 1983) suggest that cognitive and metacognitive processes emerge in young children and remain active throughout their lifespans, whereas *Epistemic Cognition* begins to develop in late adolescence and continues to shift in the adult years. In the context of solving ill-structured problems, Kitchener (1983) stated that, while *Metacognition* allowed one to choose different cognitive strategies for the purpose of tackling a specific task, *Epistemic Cognition* allows one to "interpret the nature of a problem and to define the limits of any strategy to solving it" (p. 226). *Epistemic Cognition* provides the foundation for adults by which they may deal with conflicting ideas in issues like logic, ethical choice, or career choice.

Besides the first level cognition, Kuhn (1999, 2000) introduced two sub-categories under the second level *Metacognition* (*Metacognitive Knowing* and *Metastrategic Knowing*) and a third level that parallels Kitchener's term, *Epistemic Cognition*, called *Epistemological Knowing*. *Metacognitive Knowing* refers to declarative knowing (knowing that), whereas *Metastrategic Knowing* refers to procedural knowing (knowing how). *Epistemological Knowing* develops when there is a transition from "simply knowing something is true to evaluating whether it might be" (Kuhn 1999, p. 22). As Hofer (2001) pointed out, the changes of criteria that we use to evaluate whether "something is true" are key areas of epistemological development.

Thus far, I have described the conceptualization of personal epistemology. In the rest of this document, cognitive development is only used to refer to epistemological development unless otherwise specified. Specifically, in the rest of this chapter, different frameworks related to epistemological development for young adults will be described. Although these researchers have used different names to refer to epistemological development, for example, "intellectual and ethical development" (Perry 1970) or "ways of knowing" (Belenky et al. 1986), their conceptualizations still fall within the scope of epistemological knowing itself. Therefore, terms like "intellectual development," if used separately (i.e., not in the case of "intellectual development and ethical development"), can be understood as

interchangeable with epistemological development in most cases unless otherwise specified. The original terms of the authors are retained in this literature review to help understand their original ideas.

2.2 Perry's Theory

It has been four decades since the first issue of William Perry's work, "*Forms of Intellectual and Ethical Development: In the College Years*" (1970). Perry's theory delineates the cross sections of nine different "positions" along which development takes place. Following the conventions of the ongoing refinement of Perry's model over the past four decades (Knefelkamp 1974; Knefelkamp and Slepitza 1978; Moore 1991, 1994, 2002), the sequences of the nine positions proposed by Perry can be grouped into four major categories: *Dualism* (Positions 1 and 2), *Multiplicity* (Positions 3 and 4), *Relativism* (Positions 5 and 6), and *Commitment (within Relativism)* (Positions 7 through 9), as shown in Fig. 2.1. From Positions 1 and 2 to Positions 3 and 4, a person modifies a view of dualistic absolutism (right-wrong) to make room for simple pluralism, or so-called *Multiplicity*. From Positions 3 and 4 to Position 5, a person changes from the "simple pluralism of Multiplicity" into "Contextual Relativism," and then comes to Position 6, in which that person foresees the necessity of positioning him- or herself with some form of personal *Commitment* (as opposed to unquestioned commitment to simple belief) to in a relativistic world. In positions 7, 8, and 9, a person experiences a development of personal commitment. Positions 1 and 9 were extrapolations from Positions 2–8. They were added to make a full picture of intellectual and ethical development as noted by Perry (1970), although they were not observed in the original data.

Overview of Positions

Dualism

Position 1 Basic Duality. A person in this position perceives any knowledge, act, or value to be either "right" or "wrong." The world is divided into Authority[1]-right-we and Illegitimate-wrong-other. Any knowledge, act, or value that differs from Authority's world will be associated with error or evil, leaving the person with no alternative or vantage point to observe differently. Authorities cannot be separated from the Absolute.[2] Authorities are mediators of the right answers to any question related to knowledge, act or value.

[1]According to Perry's original description, Authority was defined as, "The possessors of the right answers in the Absolute" or "Pretenders to the right answers in the Absolute" (1970, Glossary page).

[2]Absolute was defined by Perry as, "The established Order; The Truth, conceived to be the creation and possession of the Deity, or simply to exist, as in a Platonic world of its own; The ultimate Criterion, in respect to which all propositions and acts are either right or wrong" (1970, Glossary page).

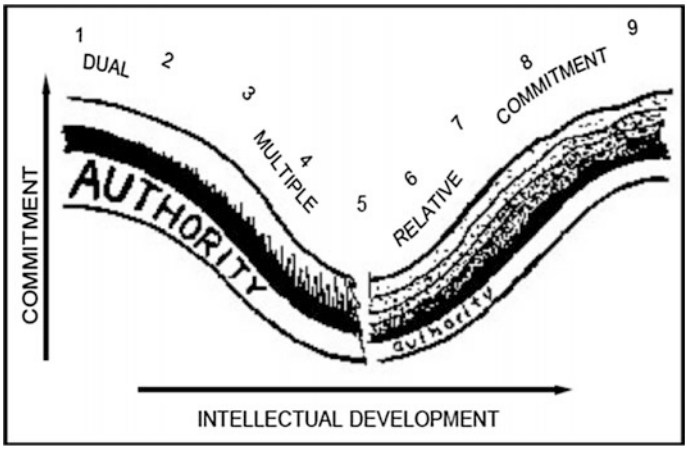


Fig. 2.1 Perry's model of intellectual development (Culver and Hackos 1982, p. 223)

Position 2 Multiplicity[3] *Pre-legitimate*. In this position, diversity in opinion and uncertainty has been given a place. They are viewed as an unwarranted impediment by "poor qualified Authorities" (Perry 1970, p. 9) to the right answer or a narrow area of freedom set by the Authority for student's own exploration. *Multiplicity* has not yet gained legitimacy in the Absolute.

Multiplicity

Position 3 Multiplicity Subordinate. A person in this position accepts uncertainty and diversity as unavoidable and legitimate but only in areas where Authority hasn't attained the right answers. Coupled with this accepted uncertainty is the student's puzzling about the standards against which Authority grades one's work in an educational setting when Authority has no correct answers him- or herself. In this position, he or she supposes that Authority grades based on nothing but "good expression."

Position 4. In developing the structure of this position, two alternative views have emerged from the students that Perry considered equivalent because they each represent an "ultimate extension or accommodation" of the old dualism system. (1) *Multiplicity Correlate.* In this position, *Multiplicity* is raised from a subordinate to a legitimate status, which is separate and equal to that of the Authority. An unstructured epistemological law with equal absolutism—"Everyone has a right to his own opinion" (p. 97) dominates the *Multiplicity* realm, while in the Authority's

[3]Multiplicity: "A plurality of 'answers,' points of view, or evaluations with respect to similar topics…with the implication that no judgments among opinions can be made" (Perry 1970, Glossary page). Compare Relativism.

domain there remains a right-wrong dualism. (2) *Relativism*[4] *Subordinate.* A person in this position perceives relativistic reasoning as what Authority wants. The weighing of different approaches to one problem and developing of one's own thoughts occur in the context of Authority's realm out of a desire to confirm to Authority's demand. In Chap. 3, I will further discuss the difficulties in the measurement in terms of differentiating Position 4b from the next position, Position 5. The difficulties are in part due to the similarities in the behavioral patterns of individuals in these positions. Because of possible similarities between Positions 4b and 5, the boundaries between Positions 4 and 5 are not as clear in actuality.

Relativism

Position 5 Relativism Correlate, Competing, or Diffuse. In this position, all knowledge and values, including the ones of authorities (note here, Authorities become authorities), are perceived as relativistic. *Relativism* is the common characteristic whereas the right-wrong dualism becomes the special case in the new context. The revolution here is "the most violent accommodation of structure in the entire development" in that it involves a "complete transposition between part and whole, figure and ground…" (Perry 1970, p. 111). "*Relativism Correlate*" and "*Relativism Competing*" in the subtitle speak of some unresolved issues in the full transition, which is denoted as "*Relativism Diffuse.*" Accompanying this revolution are new implications, such as the breakdown of old "guidelines and identity" and a new horizontal relation with authorities.

Position 6 Commitment[5] *Foreseen.* This position describes a realization of a necessity to commit oneself in a relativistic world. A relativistic world provides plenty of opportunities for one to exercise reason, but there is a limit in that "reason itself remains reflexively relativistic" (Perry 1970, p. 135). Acknowledging that reason itself cannot fully justify or assure her, she must commit herself through her own faith assuming at the same time the responsibility associated with the choice.

Commitment (within Relativism)

Position 7 Initial Commitment. A person in this position has undertaken his own responsibilities in some major area of his life, e.g., career and decision making about who he is or who he will be. Along with the decision, he also experiences a settled relief internally because of the initial commitment.

Position 8 Orientation in Implications of Commitment. A person in this position has begun to experience the implications of commitment. She also starts to explore the "subjective and stylistic issues" that are related with the implications of commitment; for example, while a person may find that decisions on who he is in a

[4]Relativism: "A plurality of points of view, interpretations… in which the structural properties of contexts and forms allow of various sorts of analysis, comparison and evaluation in Multiplicity" (Perry 1970, Glossary page). Compare Multiplicity.

[5]Commitment: "A conscious act", "An affirmation of personal values or choices in Relativism", "as distinct from commitment to an unquestioned, or unexamined belief, plan or value" (Perry 1970, Glossary page).

career choice actually turn out to be only a first step, there are many ongoing ways to approach this goal and the rest of other choices throughout life.

Position 9 Developing Commitment. A person in this position has developed a maturity in which his identity was affirmed in his commitment and the associated responsibilities. He is aware that commitment is an on-going activity "to a degree that is partly his own to determine and partly in the hands of fate, he is to be forever on the move" (Perry 1970, p. 154).

Perry's theory has been recognized as a piloting work in the understanding of epistemological knowing of college students (Hofer and Pintrich 1997; Moore 2002). This theory was originally developed based on a series of qualitative studies among Harvard college students in the 1950s and 1960s by Perry and his colleagues. The piloting studies that were performed in the 1950s with 31 students resulted in 98 longitudinal interviews with 17 complete four-year records. The enlarged studies in the 1960s included 109 students, resulting in 366 longitudinal interviews with 67 complete four-year reports. After this piloting study, several theories have been proposed. Each of these theories extended the original developmental theory by Perry from different perspectives.

The first half of the development described in Perry's theory is focused on intellectual development, and the second half is focused on ethical, moral, and identity development (Moore 2002). From the measurement and instrumental perspective, it can be difficult to separate these different stages. Most research done in instrumentation development focused on measuring the first five positions because the most dramatic change happens between *Multiplicity* and *Relativism* according to Perry's theory (Perry 1970). The difficulty in the measurement will be discussed in more details later in 2.5 Measurement of Epistemological Development.

2.3 Extension of Epistemological Development Frameworks After Perry's Theory

After the pioneering work by Perry on the intellectual and ethical development of college students, four other major models have emerged from empirical research in the literature body of personal epistemological development, as summarized by Hofer and Pintrich (1997) and Felder and Brent (2004). These include: (1) Belenky et al.'s work on "women's way of knowing" based on women from diverse backgrounds (1986), (2) Baxter Magolda's epistemological Reflection Model (1992), (3) King and Kitchener's Reflective Judgment model (1994), and (4) Kuhn's Argumentative Thinking (1991). The five models, including Perry's theory, each presents distinct points in the number and the naming of different positions/stages/perspectives. In the following section, each model will be reviewed in the order of time when a complete model was published. The discussions will include their main positions/stages/perspectives, their methods, and the implications and limitation of each model. Also later in the discussion, each model will be compared to the original Perry theory and other models in regards to the details of

stages/positions/perspectives in each model. Based upon these review and discussions, and comparison across frameworks, a synthesis of different theoretical frameworks will be presented in the next section.

Women's Way of Knowing (Belenky et al. 1986)
One of the criticisms about Perry's work was that it was based on mainly white, elite college students. Belenky et al. were interested in women's knowing and learning. Using interview questions specifically related to gender, relationships, moral decisions, education, and knowledge, Belenky et al. interviewed 135 women—where 90 of these participants came from 6 diverse academic institutions and the additional 45 were participating in services provided by human service agencies on parenting. Using the metaphor of "Voice," Belenky et al. grouped women's ways of knowing into five categories:

1. *Silence*. A position in which women experience themselves as a voice-less, mind-less, and passive being and subject to external authority. They view themselves as "deaf and dumb" and as not being able to learn from others' words.
2. *Received Knowledge*. Women with this perspective perceive themselves as being able to listen to other's voices. They can receive knowledge from external authority and even reproduce knowledge. However, they believe that all knowledge originates from external authority; they themselves are not constructors of knowledge. Women who adhere to the perspective of received knowledge also believe an either-or dualism. There is no gray area to truth; it is either right or wrong.
3. *Subjective Knowledge*. Women with this perspective see truth as subjective, intuited, and personal. Truth is a private issue and cannot be forced on others. Belenky et al. (1986) noted that *Subjectivism* or (*Subjective Knowing*) is interchangeable with Perry's *Multiplicity* because of the emphasis on personal truth in both positions. The difference is that a woman with subjective knowing holds an anti-rationalist attitude and bases her knowing on intuition or personal experiences.
4. *Procedural Knowledge*. In this position, women start to realize that they cannot know everything by intuition or experiences. Knowing requires careful observation and reasoning. They are learning and applying procedures, techniques or skills of acquiring and communicating knowledge. Within *Procedural Knowledge*, two ways of knowing—*Separate Knowing* and *Connected Knowing*—were identified. The separate knower learns through excluding personal feelings and beliefs and adopting a different lens through explicit formal instruction, while the connected knower learns through being empathetic with the object (e.g., a poem)/person and adopting the lens of another person (in the case of a poem, the lens is that of the poet). Separate and connected knowers both learn to take off their own lenses and take up different ones. Although Hofer and Pintrich (1997) enlisted *Procedural Knowing* as parallel to Perry's *Relativism*, there are only a few indications showing that some parallel characteristics exist between *Procedural Knowing* and Perry's *Relativism*; for

example, in both positions, the knower starts to abandon the either-or thinking and takes into consideration alternative perspectives. However, *Procedural Knowing* cares only about the form of knowing, whereas Perry's *Relativism* is concerned to a greater extent with the certainty of knowing or knowledge.

5. *Constructed Knowledge*. Constructed knowing refers to an effort in which women try to reclaim the self by integrating intuitive knowledge and the knowledge that they learned from others. A constructed knower abandons either-or thinking completely and demonstrates a high tolerance of ambiguity and conflict. Their thought aligns with the basic thought of constructivism: "all knowledge is constructed, and the knower is an intimate part of the known" (p. 137).

The work by Belenky et al. extended the work of Perry by including women's ways of knowing, thereby providing a unique perspective for gender-related study. They also acknowledged that similar categories can be found in the original Perry model except the *Silence* position. However, researchers have noted a serious concern in Belenky et al.'s methodology in the study (Hofer and Pintrich 1997). On one hand, in the interview protocol by Belenky et al. a section on "Gender" and a section on "Relationships" were placed before sections on "Real Life Moral Dilemma," "Education," and "Ways of Knowing." On the other hand, their main findings focus on women's self-knowledge, the relation between self-knowledge and knowing, inner and outer voices, and the connected characteristics of women's way of knowing. Considering the methodology and findings, it is hard to tell the degree to which the interview questions have affected these main findings. Also, different from Perry's theory, which focuses more on the certainty or limits of knowledge, Belenky et al.'s women's way of knowing emphasizes more the source of knowledge, especially in relation to the self (Hofer and Pintrich 1997). Last but not least, Belenky et al. chose to study only women participants, which itself can be both an advantage to draw conclusions about women and a drawback open to criticism about the claims. Although they claim that some of the ways of knowing are not limited to women, e.g., connected knowing, no substantial evidence was provided to support these claims.

Epistemological Reflection (Baxter Magolda 1992)

Continuing on the same main line of epistemological development, Baxter Magolda based her research regarding epistemological development on Perry's model. Also, when combining the concerns raised by Belenky et al. (1986) about women's role and gender dimensions in epistemological development, she explored a gender-inclusive model of epistemological development for young adults from 18 to 30 years.

Using both interviews and the Measure of Epistemological Reflection (MER), which she developed via a series of studies (Baxter Magolda 1985, 1987, 1992; Baxter Mogolda and Porterfield 1988), she conducted a longitudinal study following 101 participants (51 men, 50 women) through their college years. She was able to continue following 70 out of the 101 participants in their post-collegiate phase. She was even following 39 of 70 participants by year 12. Out of these 39

participants, 16 were involved in advanced education (11 with a master's degree, 1 with a PhD degree, and 4 with other degrees, e.g., JD). The eight years' of research data regarding the post-collegiate participants extended Perry's original work to the post-collegiate population.

Using grounded theory, Baxter Magolda (1992) named the following four perspectives in her Epistemological Reflection Model: *Absolute Knowing*, *Transitional Knowing*, *Independent Knowing*, and *Contextual Knowing*. Gender-related patterns were identified within all but the last perspective. Gender-related patterns convey that each gender uses one pattern more than the other. However, these gender-related patterns are not exclusive to one gender.

Absolute Knowing: Receiving or Mastering Knowledge Learners who employ this perspective regard knowledge as absolute and certain. They learn the knowledge from authorities who know the truth. More women than men used the pattern of *Receiving Knowledge*. This pattern is parallel to *Received Knowledge* in Belenky et al.'s women's ways of knowing, in which learning takes place via listening and acquiring information. More men use the *Mastering Knowledge* pattern, which is similar to the experiences of male participants in Perry's study, where learners actively engaged in activities, debating, and quizzing of peers.

Transitional Knowing: *Impersonal and Interpersonal Pattern* Learners maintain the either-or thinking about knowledge in some disciplines, like mathematics and physics, as satisfactory, yet view knowledge in some other disciplines, like the humanities or social sciences, as uncertain. Within this perspective, these learners then focus on developing an understanding instead of acquiring knowing in these areas where knowledge is perceived as uncertain. *Impersonal and Interpersonal Patterns* were identified as gender-related patterns. More men use the *Impersonal Pattern*; more women use the *Interpersonal Patterns*.

Independent Knowing: Individual and Interindividual Pattern Learners with *Independent Knowing* believe that knowledge in itself is uncertain. Every individual thinker has his or her own viewpoints. Peers are encouraged to share views. Peers are also viewed as a source of knowledge along with authorities who are no longer viewed as the only resource for knowledge. Again, *Individual and Interindividual patterns* were identified from Baxter Magolda's findings to capture the gender-related patterns. Felder and Brent (2004) suggested that these two patterns are comparable to Belenky et al.'s *Separate Knowing* and *Connected Knowing* under the *Procedural knowledge* in women's ways of knowing.

Contextual Knowing: Learners with this perspective are able to judge the nature of knowledge based on evidence existent within different contexts. Learners both exercise thinking and compare different perspectives and ideas. Learners with this perspective believe that "some ideas are more valid than others" based on reasoning through available evidence (Baxter Magolda 1992, p. 170). Contextual knowers "think through problems," "integrating knowledge," and "apply it in a context" (Baxter Magolda 1992, p. 170). This perspective is very similar to the last positions of Perry's model (starting from Position 5 up to Position 9). It also parallels Belenky et al.'s *Constructed Knowledge*. No gender-related patterns were identified here because of the small number of participants. Baxter Magolda commented that

it was possible that gender-related patterns converged at this position, in part because contextual knowing exhibits characteristics of both "connecting to others," which is the focus of the interindividual pattern, and "thinking independently," which is the focus of the individual approach.

Baxter Magolda's Epistemological Reflection model continued along the same main thread that was laid out by Perry. Built upon Perry and Belenky et al.'s former work, Baxter Magolda proposed a gender-inclusive model as a possible model of an epistemological development trajectory based upon a longitudinal study. Differing from Perry's male, elite college student population or Belenky's et al.'s female-only participants with a diverse educational background, Baxter Magolda focused on both the college-educated male and female participants. In this sense, Baxter Magolda extended the original Perry model and combined this with the gender perspective proposed by Belenky et al. and proposed a more gender-inclusive model.

However, it should be noted that participants of this study came from the same Midwestern university. The members of the population were mainly white (97 %) and mostly from middle-class families. Therefore, the extent to which this trajectory can be applicable to other races or ethnicities remains unclear.

Baxter Magolda extended the population into the body of post-collegiate young adults. Some of these individuals received advanced degrees, although only one of the participants obtained a PhD degree. This study may render some useful implication, yet still, the extent to which the epistemological developmental patterns can be similarly considered applicable to the doctoral-level students is unclear.

Finally, Perry's model focused on students from a liberal art college. Belenky et al.'s female participants came from a variety of educational levels and backgrounds. Baxter Magolda's participants were from a university with a liberal arts focus. None of these original studies focus on students with an engineering education background. The implications and applications of these epistemological models in engineering education will be discussed in Sect. 4.1.

Reflective Judgment Model (King and Kitchener 1994)
King and Kitchener focused on the epistemological assumptions and the reasoning processes of older adolescents and adults specifically when they face ill-structured problems. They also identified a trend in the development of reasoning skills that is similar, to a certain degree, with the above-mentioned cognitive developmental frameworks.

They conducted interviews centered on four ill-structured problems on topics such as the objectivity of news reporting. Also, they asked participants to justify their point of view in six follow-up questions. Based on their findings, they proposed their Reflective Judgment Model, which includes seven stages that are organized into three types of thinking: *Pre-reflective Thinking, Quasi-Reflective Thinking*, and *Reflective Thinking*. In each stage, they also defined the "view of knowledge" and "concept of justification" to best describe the characteristics of these stages and the specific type of thinking.

Pre-reflective Thinking includes three stages (Stages 1, 2, and 3). In Stage 1, knowledge is absolute and needs no justification. This type of thinking typically exists in young children but is not observed in King and Kitchener's studies. Stage 2 is similar to Perry's *Dualism* in which knowledge is assumed to be absolutely certain and is possessed by authority or to be temporarily unavailable. In Stage 3, beside the certainty of knowledge, there is a component of knowledge that is temporarily uncertain, and judgment itself is based on personal opinion.

Quasi-Reflective Thinking includes two stages (Stages 4 and 5). In Stage 4, knowledge is uncertain and knowing always involves ambiguity. Arguments and evidence that support this knowledge are idiosyncratic. Stage 5 features the subjectivity and context specificity of knowledge. "Other theories could be as true as my own, but based on different evidence" (King and Kitchener 2002, p. 42). Hofer and Pintrich (1997) stated that this stage resembles some characteristics of relativism by Perry (1970). However, King and Kitchener stated that individuals in Stage 5 "frequently appear to be giving a balanced picture of an issue or problem rather than offering a justification for their own beliefs," i.e., that "individuals are able to relate and compare evidence and arguments in several contexts" while however, they still cannot "coordinate evidence and arguments across context into a simple system." This is different from Perry's *Relativism*, *Constructed knowledge* (Belenky 1986), or *Contextual knowing* (Baxter Magolda 1992).

Reflective Thinking (Stages 6 and 7) parallels *Relativism* (Perry 1970), *Constructed knowledge* (Belenky 1986), and *Contextual knowing* (Baxter Magolda 1992) because, in this state, knowledge is an outcome of a process in which different solutions or evidence and perspectives are evaluated.

In King and Kitchener's 20 years of longitudinal study, they studied participants ranging in age from their teenage years to middle adulthood. Their studies with early level graduate students showed mean scores between Stage 4 and Stage 5. Their studies with an advanced level of graduate students showed mean scores between Stage 5 and Stage 6. Stage 6 reasoning has only been typically observed among advanced doctoral students.

Again, King and Kitchener's framework focused more on the application of knowledge beliefs in making justifications in the process of solving ill-structured problems. Their study focus is more on the thinking and justification process instead of on the applicants' beliefs about knowledge. Therefore, it may not be directly comparable to the first three models although it did suggest a similar epistemological developmental trend.

Argumentative Reasoning (Kuhn 1991)

The primary purpose of Kuhn's study was to understand argumentative thinking, but the process of trying to understand argumentative thinking or reasoning has also offered insights into epistemological perspectives. In Kuhn's study, she included a broad sample of participants ranging in age group from the teens, 20s, 40s, and up to 60s with 40 subjects in each division. Participants were interviewed regarding their reasoning process concerning three ill-structured, real-life social problems such as unemployment. Several sections of her interviews asked questions that were

related to epistemological perspectives about expertise, multiple viewpoints, and certainty of knowledge, such as, "Do experts know for sure what causes…?"

Kuhn reported epistemological thoughts observed among participants along the same line laid out by Perry (1970), Belenky et al. (1986), Baxter Magolda (1992), and King and Kitchener (1994). She presented her theory as three categories of epistemological views: *Absolutist*, *Multiplist*, and *Evaluatist*.

The Absolutist viewpoint resembles that of *Dualism* taken by Perry, in which knowledge is certain and absolute. The *Multiplist* viewpoint features a radical subjectivity, which resembles that of *Subjective Knowledge* proposed by Belenky (1986), in which more weight is given to subjective knowledge and emotions rather than to facts. In essence, a *multiplist* believes that all individuals' views have equal legitimacy as that of an expert. An individual taking the *evaluative* viewpoint believes that different views need to be compared and evaluated concerning their merits.

These three positions have again mapped the main line of the epistemological developmental trend from a dualistic view to a more sophisticated way of evaluating evidence and views. This pattern, which has been repeatedly validated by multiple researchers throughout the years (Perry 1970; Belenky et al. 1986; Baxter Magolda 1992; King and Kitchener 1994; Kuhn 1991), will be summarized in the next section and used as the theoretical framework for this work.

2.4 Synthesis of Theoretical Frameworks

The major themes and findings of each model demonstrate that they are each focused on different landscapes of epistemological development. For example, Perry and his colleagues (1970) initially derived their theory from a predominantly male model, whereas, Belenky et al. (1986) focused on an exclusively female sample and described women's way of knowing using the metaphor of "voice." As another example, the first three models centered on mapping a more or less developmental and structural sequence and the last two models focused on the influences of epistemological assumptions on the thinking processes. Despite these distinct points, however, the parallel positions/stages/perspectives were evident across five models in that they all suggested *a movement from a dualistic view of knowledge to a contextual, constructivist perspective*. This movement, which was originally depicted in Perry's model, remains the main thread across the four additional models. They each presented significant extensions to the intellectual development of "the same fundamental journey" (Moore 2002, p. 23).

Therefore, I shall keep primarily the naming from Perry's theory for the theoretical framework for this work. An ongoing refinement of Perry's model grouped Perry's nine positions into four major categories: *Dualism* (Positions 1 and 2), *Multiplicity* (Positions 3 and 4), *Relativism* (Positions 5 and 6), and *Commitment (within Relativism)* (Positions 7 through 9) (Culver and Hackos 1982; Knefelkamp 1974; Knefelkamp and Slepitza 1978; Moore 1991, 1994, 2002). Each category in

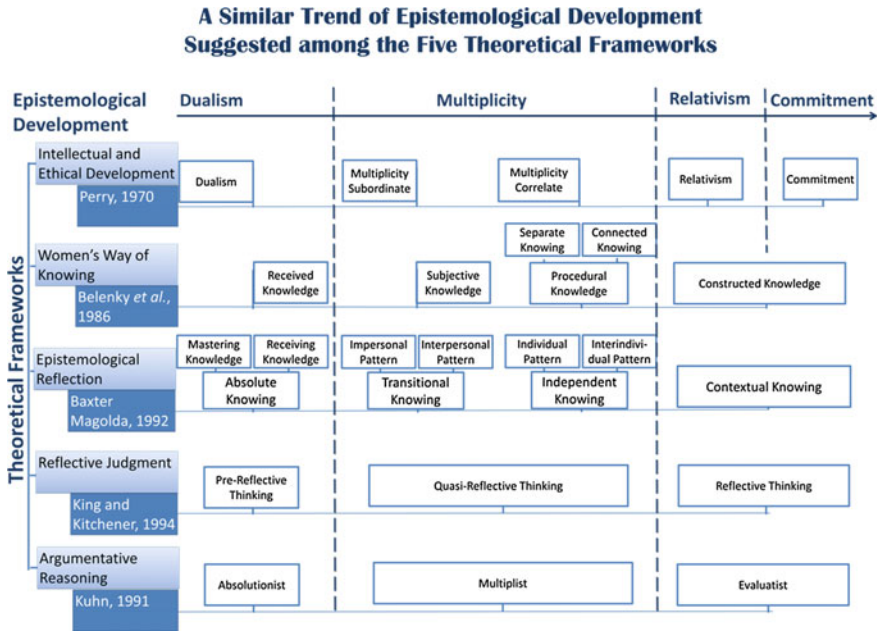


Fig. 2.2 Overview of five current epistemological development frameworks for late adolescents and adults (Zhu and Cox 2015; modified from Hofer and Pintrich 1997, p. 92 and Felder and Brent 2004, p. 5)

this theory corresponds to different stages/positions/perspectives of other cognitive developmental theories, including Belenky et al.'s Women's ways of thinking (1986), Baxter Magolda's Epistemological reflection (1992), King and Kitchener's Reflective Judgment Model (1994), and Kuhn's Argumentative Reasoning (1991).

An alignment of the five models was modified and refined from former literature review works (Hofer and Pintrich 1997; Felder and Brent 2004). Hofer and Pintrich (1997) provided an overview as to the alignment of stages/positions/perspectives across the five models. Felder and Brent (2004) also attempted to establish such an alignment in greater detail by taking into consideration the gender-related patterns. Based on prior works, a diagram (Fig. 2.2) was created to demonstrate the alignment of the five theoretical frameworks to provide an overview of the aligning across these different theories (Zhu and Cox 2015). It should be noted that the representations and comparisons of different stages/positions/perspectives across five frameworks are just illustrations to facilitate understanding. In actuality, there are various overlaps or intertwining among stages/positions/perspectives. They are not to be viewed as precisely confined, separated stages/positions/perspectives as they may appear in the diagram.

The theoretical framework used in this research is refined based on these models using mainly the naming from the original Perry's theory and also definitions of other models in regards to the details of stages/positions/perspectives in each

model. As mentioned above and illustrated in Fig. 2.2, the ongoing refinement of Perry's model suggests the grouping of Perry's nine positions into four major categories: *Dualism* (Positions 1 and 2), *Multiplicity* (Positions 3 and 4), *Relativism* (Positions 5 and 6), and *Commitment* (*within Relativism*) (Positions 7 through 9) (Culver and Hackos 1982; Knefelkamp 1974; Knefelkamp and Slepitza 1978; Moore 1991, 1994, 2002). Considering the similarities and potential gender-related patterns, the process of epistemological development is laid out as follows. It should be noted that gender-related patterns will be taken into consideration in the theoretical framework and data analysis in the later stage of the research, although they are not specified in the framework or in the diagram.

Across the five current models, only Belenky et al.'s (1986) Women's ways of knowing observed the "silence" stage found among underprivileged women. Considering the Chinese engineering doctoral students, the participants in this work, this particular position may not be as relevant for these students who did possess a certain level of academic achievement when compared to the underprivileged women in Belenky et al.'s study. Therefore, this stage is omitted in the theoretical framework used in this research.

Dualism

In the first stage of epistemological development, all five of the cognitive developmental theories found a dualistic way of knowing or thinking among their participants. Belenky et al. (1986) noted that their *Received knowledge* is similar to Perry's *Dualism*. However, in Perry's *Dualism*, a person identifies "We" with "Authority-right" and "They" with "Illegitimate-wrong;" for women with a *Received Knowledge* perspective, they do not align themselves as close to the authorities. Also, "We" and "They" are intertwined. *Received Knowledge* in Belenky et al.'s Women's ways of knowing is paralleled to *Absolute Knowing: Receiving Knowledge* in Epistemological reflection (Baxter Magolda 1992), in which learning takes place via listening and acquiring information. On the other hand, more men used the mastering pattern, which is similar to the experiences of male participants in Perry's study, where learners actively engaged in activities, and the debating and quizzing of peers. Therefore, Perry's *Dualism* is viewed as parallel to *Absolute Knowing: Mastering Knowledge* (Felder and Brent 2004). To summarize, this stage of thinking parallels Baxter Magolda's *Absolute Knowing*. Despite the gender-related patterns, all of these frameworks emphasized the dualistic thinking of a person at this stage. Therefore, the first stage is named *Dualism*.

Multiplicity

The position of *Multiplicity* by Perry (1970) is listed in Fig. 2.2 as *Multiplicity Subordinate* and *Multiplicity Correlate* because the characteristics of these two positions are comparable to stages in other models (Felder and Brent 2004). Perry's *Multiplicity Subordinate* is comparable to the *Impersonal Pattern* of *Transitional Knowing* (Baxter Magolda 1992) and *Subjective Knowledge* (Belenky et al. 1986) is comparable to the *Interpersonal Patterns* of *Transitional Knowing* (Baxter Magolda 1992) (refers to Felder and Brent 2004, p. 5, Table 1). The view of Felder

and Brent (2004) takes into account the gender-related pattern and presents a reasonable comparison across the first three models.

Felder and Brent then paralleled Perry's *Multiplicity* to the male-related patterns within *Procedural Knowledge* (Belenky et al. 1986) and *Independent Knowing* (Baxter Magolda 1992). Hofer and Pintrich (1997) presented a different idea by paralleling *Independent Knowing* (Baxter Magolda 1992) to Perry's next stage—*Relativism*. Although *Independent Knowing* indeed does have some overlaps with Perry's *Relativism* in that they both suggest the legitimacy of students, and not just the authorities, may be viewed as a source of knowledge, nevertheless, *Independent Thinking* is still considered as parallel to *Multiplicity.* According to a later reflection by Baxter Magolda about her own model (Baxter Magolda 2002, p. 100), she suggested that the core of *Relativism* or relativistic thinking was much closer in conceptualization to *Contextual Knowing* than *Independent Thinking*.

It should be noted here that Perry's *Relativism Subordinate*, which was originally defined as part of *Multiplicity*, is not included here because of some complexities in measurement that will be further discussed in Chap. 3. *Relativism Subordinate* is not listed in the diagram although it should be part of *Multiplicity* conceptually.

To summarize, I use the term *Multiplicity* as the naming of this stage. It covers *Multiplicity Subordinate* and *Multiplicity Correlate* defined by Perry (1970), *Subjective* and *Procedural Knowledge* by Belenky et al. (1986), and *Transitional* and *Independent Thinking* by Baxter Magolda (1992) (as shown in Fig. 2.2). It is comparable to King and Kitchner's (1994) *Quasi-Reflective Thinking* and Kuhn's (1991) *Multiplist* in that it emphasizes an equal absolutism the understanding of knowledge—"Everyone has a right to his own opinion" (Perry 1970, p. 97).

Contextual Relativism

After *Multiplicity,* there shall follow the most important transition to the critical stage of the relativistic type of thinking, one that resembles *Constructed Knowledge* (Belenky et al. 1986), *Contextual Knowing* (Baxter Magolda 1992), *Reflective Thinking* (King and Kitchener 1994), or *Evaluatist* (Kuhn 1991). To capture the essence of this stage of thinking, the term "*Contextual Relativism*" is used here to emphasize that a person in this position views knowledge as "contextual and relativistic" (Perry 1970, p. 109), i.e., the concept that knowledge claims become the outcome of a constructed process by comparing and weighing different contexts and evidence. Justifications come from comparing different contexts, evidence, solutions, possible consequences, and so on. This stage will still be called *Relativism* in the other sections of this document.

Commitment (within Contextual Relativism)

Last but not least, *Commitment (within Contextual Relativism)* may be seen as parallel to *Commitment (within Relativism)* by Perry. This stage is not clearly defined in other models. In Perry's original model, it is also the one least understood or elaborated upon by Perry (Baxter Magloda 1985). *Commitment (within Contextual Relativism)* is so far the least explored stage in the literature, partly because of the lack of intense research in more advanced adult populations with

higher degrees, education, or life experiences, for example, the doctoral student population (Moore 2002). This stage will still be called *Commitment within Relativism* in the other sections of this document.

As a final note to this synthesis of theoretical framework section, besides the above-mentioned theoretical frameworks, an additional framework was hypothesized by Schommer (1990, 1993), named *Epistemological Beliefs*. *Epistemological Beliefs* include a set of beliefs about knowledge and knowing, specifically, structure, certainty, source of knowledge, and control and speed of knowledge acquisition. Different from the epistemological developmental frameworks described above, the five dimensions are not organized in an overall developmental order. Therefore, this view was not listed in Fig. 2.2. The first three dimensions originated from Perry's work; the last two originated from Dweck and Leggett's nature of intelligence (1988) and Schoenfeld's beliefs about mathematics (1983, 1985, 1988). This view has encountered methodological and theoretical difficulties. The methodological difficulties will be discussed in the next section. For the theoretical concerns, Hofer and Pintrich (1997) and others (Debacker et al. 2008) have raised questions about the validity of this theoretical hypothesis. Although some dimensions, e.g., the structure and certainty of knowledge, appear to be epistemic, other dimensions, e.g., control and speed of knowledge acquisition, fall outside the conceptualization of epistemological beliefs (see 2.1 Conceptualization of Personal Epistemology). Factor analysis in their studies has also shown that some dimensions appear not to be following the patterns of other dimensions (Schommer 1990). This may be interpreted as "evidence that the dimensions operate independently," but it may be an indication of lacking relations between these two factors with other dimensions (Hofer and Pintrich 1997, p. 108). Given these unsettled issues in *Epistemological* Beliefs, it is not considered in this work as a theoretical framework.

To summarize, Perry's theory and its extensions over the past four decades have repeatedly revealed a similar epistemological developmental trend despite some distinct points and emphases in each model. They all have suggested "movements from a dualistic, objectivist view of knowledge to a more subjective, relativistic stance and ultimately to a contextual, constructivist perspective of knowing" (Hofer 2002, p. 7). Also, there is no compelling evidence that these frameworks present distinct theories (Moore 2002). As Moore commented in his review about the impact of Perry's model 30 plus years after its first publication, "Even after thirty years of extensive and varied scholarship, the Perry's theory continues to reflect the most critical dimension to educators' understanding of learning and students' approaches to learning" (Moore 2002, p. 18).

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