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Challenges in exploring individual's conceptions of knowledge and knowing: Examples of research on university students

Abstract

This chapter analyses challenges in exploring conceptions of knowledge and knowing. It firstly introduces empirical methods that have been applied to investigate individuals' conceptions of knowledge. After that, the chapter elaborates methodological and theoretical challenges related to this issue based on current research. Finally, conclusions and recommendations for developing research methods for further studies are presented. Although the chapter especially focuses on research on university students, our broader aim is to demonstrate the methodological and theoretical challenges from the perspective of developmental and educational psychology more generally.

Introduction

Individual's conceptions of knowledge and knowing are considered to be complex and multidimensional phenomena. As noted in chapters by Seppälä, Lindblom and Kallio, and Pirttilä-Backman, Ahola and Sakki, these conceptions have been investigated in the context of different disciplines, such as philosophy, psychology and education. Because of the complexity and multidisciplinary nature of the phenomena they are also challenging research topics. Although previous research on education and psychology has frequently applied self-report measures, their reliability and adequacy have recently been questioned, and it has been suggested that they do not capture the complexity of phenomena. The present chapter extends the discussion on epistemological development by introducing and evaluating empirical methods that have been applied to investigate individuals' conceptions of knowledge, focusing on the methodological and theoretical challenges related to them. The chapter presents alternatives for developing research methods for future research, and highlights the need for dialogue between theoretical, methodological and empirical perspectives to further develop research on epistemic conceptions. The chapter particularly focuses on research on university students' conceptions of knowledge from the perspective of developmental and educational psychology.

A short history of investigating individuals' conceptions of knowledge and knowing

A variety of research methods and materials have been applied when investigating epistemic conceptions within developmental and educational psychology (see Seppälä et al., Chapter x, this volume). From the 1950s onward William Perry used open-ended interviews, questionnaires and problem-solving tasks to examine epistemological beliefs – or in Perry's own words "forms of intellectual and ethical development" (Perry, 1970). However, the next generation of researchers has quite systematically applied different questionnaires, and it was not until the turn of this millennium that qualitative methods became increasingly common.

In his research project, Perry investigated college students at Harvard University and followed their intellectual and ethical development during their four college years by interviewing them at the end of each academic year. Participants were randomly selected white male students who had answered a questionnaire developed by Perry and his colleagues entitled *A Checklist of Educational View* (Perry, 1970; Schommer-Aikins, 2004). Interviewing was the main research method because, according to Perry, the use of open-ended interviews enabled the examination of individual development paths during college years. The research group detected a nine-phase development process during which the students' conceptions of the nature of knowledge changed and deepened and their worldviews and self-conceptions changed (Perry, 1970; Schommer-Aikins, 2004).

From interviews to questionnaires and problem-solving tasks

After Perry, research has expanded to include female students (e.g., Belenky, Clinchy, Goldberger & Tarule, 1986) and the different societal and cultural backgrounds of students (Helsing et al., 2001). Like Perry, Mary Belenky and colleagues also used open-ended interviews in the Women's Ways of Knowing research project (Belenky et al., 1986). On the basis of interviews they described the process of cognitive development comprising of five knowledge positions, from reliance on authorities to constructed knowledge by integrating voices. These five positions follow quite closely Perry's development model, though his model is more detailed at the more developed end.

To conclude, both Perry and Belenky created their development models on the basis of open-ended interview data, focusing on students' experiences, evaluations, and narratives. Both research groups used several raters in analysing the data, and were aware of the limitations of their research method, in particular the possibility of subjective bias during the analysis process. Furthermore, both groups

were aware of restricted generalizability of their findings (Baxter Magolda, 2001; Belenky et al., 1986; Perry, 1970).

Many researchers were concerned about the use of interviews as the main data collection method and began to apply quantitative research methods to explore epistemic conceptions. Interviews were considered slow and expensive, and both data collection and analysis required high expertise compared to questionnaires, which were much faster and cheaper to use, and expertise was not required in scoring students' answers. Moreover, teachers, tutors and counsellors were all able to use the questionnaires.

Ryan (1984, p. 250) developed the Dualism Scale on the basis of Perry's model. The scale consisted of seven items, such as "*For most questions there is only one right answer once a person is able to get all the facts*" and "*If professors would stick more to the facts and do less theorizing one could get more out of college*". These items were designed to measure the level of students' epistemological development in the "dualism-relativism continuum". A five-point Likert scale was used. An average score lower than 3.0 reflected a relativist conception of knowledge, whereas an average score above 3.0 was judged to reflect a dualist conception of knowledge.

Schommer-Aikins presented a theoretical model (Schommer, 1990) which suggests that epistemological beliefs consist of several more or less independent beliefs which form the individual's epistemological belief system. This broadened view of epistemological beliefs led to a more systematic use of questionnaires in this research field. Schommer-Aikins (2004) has, however, emphasised the difficulties and challenges in measuring epistemological beliefs by using questionnaires. These difficulties were also apparent in her Epistemological Questionnaire (EQ; Schommer, 1998). Researchers using this questionnaire reported various factor solutions, because in different datasets, the original scales failed to appear. Therefore, Schommer-Aikins shortened the Epistemological Questionnaire from 63 items first to a 34-item and later to a 28-item questionnaire. However, the scale reliabilities remained quite low. Indeed, the key challenge in the use of questionnaires has been to find a way to capture the complex nature of the phenomenon in questionnaire items (e.g., Baxter Magolda, 2001; Schommer-Aikins, 2004).

Besides questionnaires and interviews, additional methods have also been applied in examining individuals' conceptions of knowledge and knowing. Ryan (1984, p. 251) developed a

Comprehension Monitoring Probe, in which the students were given 15 minutes to answer the following questions:

1) How do you determine (when you have completed a reading assignment or when you are reviewing the material) whether you have understood the material well enough?
2) What specific information do you use to assess the degree to which you have understood the material you have read in a chapter?
3) On what basis would you decide that you need to go over the chapter again or to seek help in figuring it out?

Ryan analysed each student's response to the comprehension-monitoring probe to determine the specific comprehension criteria employed. An effort was made to score each response for as many different comprehension criteria as possible in order to capture the full range of each student's comprehension monitoring capabilities. The comprehension monitoring criteria (Ryan, 1984) were classified as knowledge criteria or comprehension/application criteria. Ryan showed that it was possible to statistically analyse epistemic conceptions and to demonstrate a correlation between students' conceptions of knowledge and the comprehension criteria they used.

Baxter Magolda and Porterfield developed the *Measure of Epistemological Reflection (MER*) (Baxter Magolda, 2001) on the basis of Perry's model. MER contains six short open-ended tasks on the basis of which it is possible to evaluate different areas of epistemological development. These tasks measure students' skills in drawing conclusions, their perceptions of the roles of themselves, teachers and peers in learning, their views of how learning should be evaluated, and how students make decisions about what to believe. The tasks are open-ended to avoid leading students' answers, and follow-up questions are made to clarify students' perspectives. Because of the use of open-ended tasks, evaluation of students' answers is a demanding process. After the development of MER, Baxter Magolda developed *the MER constructivist interpretation process* on the basis of which it is possible to analyse open-ended interviews on students' epistemological development. The aim of this method is not to evaluate the development phase of individual students, but instead to steer and support the researcher's analysis process.

Based on an extensive review of contemporary research findings and theoretical frameworks, Hofer and Pintrich (1997) proposed that although the number and nature of dimensions of individuals' conceptions of knowledge vary across different theoretical frameworks, they all include some common commonalities, such as certainty of knowledge (i.e. an absolutist versus a relativist view),

simplicity of knowledge (i.e. simple and concrete versus complex and context-dependent) , source of knowledge (from external authorities versus from personal construction) and justification for knowing (criteria for making knowledge claims, use of evidence and reasoning (Hofer & Pintrich, 1997; see also Seppälä et al., Chapter x, this volume). Around these theoretical findings, Hofer (2000) built the *Discipline-focused Epistemological Belief Questionnaire* (DEBQ), which has become one of the most widely used quantitative measures (Muis, Trevors, Duffy, Ranellucci & Foy, 2016). Hofer's DEBQ questionnaire is designed to focus on these four common commonalities of conceptions of knowledge (Hofer, 2000).

Mixed-method approaches, e.g. combining questionnaire and interview data, have recently become increasingly common in exploring personal epistemology (e.g., Hofer & Sinatra, 2010; King & Kitchener, 2004; Muis et al., 2016; Hyytinen, Clancy, Teviotdale & Postareff, 2016). For example, King and Kitchener (2004) created the *Reflective Judgment Model* (see also Pirttilä-Backman et al., in Chapter X). To evaluate the level of the students' cognitive development, King and Kitchener used problem-solving tasks. They developed the *Reflective Judgment Interview* in which trained interviewers ask open-ended questions to evaluate the students' cognitive development, the quality of argumentation and their conceptions of knowledge and knowing. The results of the Reflective Judgment Interviews can further be analysed statistically. Kuhn and her colleagues (e.g., Kuhn, Cheney & Weinstock, 2000; Kuhn, Katz & Dean, 2004) have also used different problem-solving tasks combined with questionnaires to examine cognitive development from childhood to adulthood. Thus, the methodological approach is similar to that of King and Kitchener (2004).

Addressing concerns about self-report measures

Self-report measures, such as questionnaires and surveys, are often easily implemented to gather a large dataset. Another reason for the preference for self-reports is that they provide a time- and cost-effective way to collect data (DeBacker, Crowson, Beesley, Thoma & Hestevold, 2008). Therefore, it is not surprising that self-reports have been a dominant data collection regime in the field of research on individuals' conceptions of knowledge. Although self-reports methods are widely used, many researchers nevertheless criticize this method. Among other thing, researchers have found that individuals' conceptions of the nature of knowledge and knowing are extremely difficult to measure with self-report assessments (DeBacker et al., 2008; Karabenick et al., 2007; Muis, Duffy, Trevors, Ranellucci & Foy, 2014; Muis et al., 2016; Schraw, 2013).

One challenge in investigating an individual's conception of knowledge and knowing is that this kind of phenomenon is not directly observable. The interpretations of an individual's conceptions of knowledge are thus for the most part indirect. Furthermore, epistemic conceptions are characterised as an abstract construct. Therefore, reporting these kinds of conceptions requires considerable self-reflection and abstraction from respondents and it is cognitively extremely challenging (Karabenick et al., 2007). The most important drawback to self-report assessments is that to some extent individuals are unable to introspectively assess themselves (Bowman, 2010). Previous research has also shown that students' belief in themselves as knowers is not necessarily equivalent to how they perform and assess knowledge in real life (e.g., Hyytinen, Holma, Toom, Shavelson, & Lindblom-Ylänne, 2014). Moreover, individuals are not necessarily aware of their own conceptions and thus they are not competent to describe their perceptions (Bowman, 2010). Therefore, self-report measures may provide incorrect information despite respondents' best efforts to be honest and accurate in the data collection situation. It is suggested that self-reports alone cannot adequately assess complex phenomena (Greene & Yu, 2014).

In addition, stronger critiques have questioned the reliability and validity of present self-report assessments (Karabenick et al., 2007; DeBacker et al., 2008; Muis et al, 2014; Bowman, 2010). Previous studies have identified several problematic issues with questionnaires assessing individuals' conceptions of knowledge (e.g., Buehl & Alexander, 2005;: Muis et al., 2006; DeBacker et al., 2008; Muis et al., 2014; Hyytinen et al., 2016). One concern relates to tests and how the phenomenon is operationalised and conceptualised. Students' interpretations of present self-report items have been found to be inconsistent with researchers' assumptions and intended meanings (Greene et al., 2010; Muis et al., 2014). Previous research has shown that there is clear variation not only between but also within student groups in how students understood, interpreted and responded to items concerning epistemic conceptions (Muis et al., 2014).

Several reasons for these conceptual shortcomings can be given. Firstly, one reason for inconstancies is that self-report items often include complex concepts (i.e. 'truth', 'expert', 'first-hand knowledge'), which need to be interpreted and combined with relevant contexts and experiences when responding (see Karabenick et al., 2007; Muis et al., 2014). Secondly, some items have been found to include multiple or ambiguous meanings and interpretations (Greene et al., 2010; Muis et al., 2014; Hyytinen et al., 2016) as the following extract from a focus group interview of Finnish students in educational sciences shows:

> Hofer's DEBQ questionnaire item "*Truth is unchanging in this subject*" (see Hofer, 2000, 390)

Student 8: *"For me truth is a matter that is considered correct"*

Student 7 : *"Yeah, research tells us what is generally accepted in a specific moment within a particular context."*

Student 6: "*But I considered here that* [the meaning of 'truth'] *was a philosophical view, not a verified fact or something"*

Student 7: *"I thought this* [truth] *referred to the construction of knowledge"*

Student 6: *"So. What is actually meant* [by this item]*? This question is really paralysing! For me nothing holds absolute truth but some aspects can be accepted as truthful at a particular moment in a specific context."*

Hyytinen et al. (2016) found that similar challenges with the questionnaire items in the DEBQ resulted in a high number of missing values. In addition, the problematic items included several 'unsure' responses (response alternative 3 on a 5-point Likert scale). Furthermore, factor analysis resulted in an unclear factor solution, including low communalities with some items. In a similar vein, DeBacker et al. (2008) analysed data from three self-report questionnaires, namely the Epistemological Questionnaire (EQ; Schommer, 1990), the Epistemic Beliefs Inventory (EBI; Schraw, Bendixen, & Dunkle, 2002), and the Epistemological Beliefs Survey (EBS; Wood & Kardash, 2002). Their results indicated psychometric problems with all three. The results demonstrated, among other things, consistent failure of factor analyses (exploratory and confirmatory) to support the hypothesised factor structures. In addition, the reliability of the scales remained rather low, and the scales functioned differently in different contexts. The use of a Likert scale to measure has also been debated elsewhere (e.g., Greene et al. 2010; Muis, Bendixen & Haerle, 2006; Muis et al., 2014). Muis and her colleagues (2014) found that students chose option 3 when conflicting items occurred. In contrast, Greene et al. (2010) has reported that students opt for "3" as a neutral response when they were unfamiliar with the question.

A Need for the multiple methods approach

In recent years, the multiple methods approach has been proposed to overcome the above-mentioned challenges of self-report assessments (Hofer, 2004; Muis et al., 2016). Epistemic conceptions literature contains several variants for the term multi-methodology, such as triangulate, multi-method, and mixed-method. Sometimes these terms have been used as synonyms, sometimes

not. Among researchers there is not an all-encompassing agreement about the meanings and definitions of these terms (Teddlie & Tashakkori, 2010). One alternative is to consider the term 'multi-method' as research in which multiple qualitative or quantitative methods in data collection and analysing are involved. While 'mixed-method' can be used to refer to research in which both quantitative and qualitative methods are combined in the same study or in a series of studies (see also Leech and Onwuegbuzie, 2009; Creswell, 2010). The present discussion pertains to this definition.

As mentioned before, there is a long history of using multiple methods in research on epistemic conceptions (see King & Kitchener, 2004; Kuhn, 2005; Hofer, 2004). In the existing literature, several advantages to the mixed- or multi-method approach have been reported. Firstly, through the use of the mixed- or multi-method approach, it is possible to select and integrate the appropriate methods to gain a more thorough picture of the phenomenon (Ghelbach & Brinkworth, 2011; Muis et al., 2016; Karabenick et al., 2007). Secondly, the use of multiple methods allows a researcher to minimize the weaknesses or complement the strengths of one method or another. Thus, the advantage of combining the different assessment methods by which individuals' conceptions of knowledge are measured is that it offers multiple insights into understanding individuals' conceptions of knowledge and knowing. As Muis et al. (2016) have argued, the mixed-method approach (i.e. combining surveys with interviews) provided much deeper nuances of the nature of students' conceptions. This kind of information could not have possibly been obtained using a sole self-report method. Thirdly, through the use of the mixed- and multi-method approach it is also possible to identify and address new and unexplored aspects of students' conceptions and gain a more complete understanding of the phenomenon (see Onwuegbuzie, Johnson & Collins, 2009). Finally, the mixed- and multi-method approach is provided a way to enhance the *cognitive validity* of surveys which focus on abstract constructs, such as conceptions of knowledge and knowing (Ghelbach & Brinkworth, 2011; Karabenick et al., 2007).

It is important to notice that the mixed- and multi-method approach can be employed in data collection, data analysing and merging interpretations (Creswell, 2010). Epistemic conceptions literature features several variants of multi- and mixed-method research. In essence, these variants can be roughly divided into two main strategies, namely sequential and concurrent strategies (see Figure 1). To our knowledge, most mixed- and multi-method research on individuals' conceptions of knowledge have followed a sequential strategy in which research has been divided into at least two separate phases or sub-studies. The researcher first uses one method to collect and analyse the

data. After that, the results that need additional explanations are identified, and based on that information the researcher selects a second method. The purpose of the second method, i.e. the follow-up phase, is to provide a better understanding of the research problem than using only the first method. As an example, the results of qualitative analyses of interviews are used to extend the findings of quantitative analyses of questionnaire data (e.g., Hofer, 2006; Muis, et al., 2014; Hyytinen et al., 2016). In these cases, a sequential strategy is used to develop and revise quantitative data collection instruments.

A concurrent strategy, by contrast, is used to confirm and cross-validate findings, to seek information at different levels, and address different questions and perspectives (e.g., Barzilai & Zohar, 2012; Hofer, 2004; Hyytinen et al. 2014; Strømsø & Bråten, 2014; Kienhues, Stadtler, & Bromme, 2011). A concurrent strategy refers to situations in which two or more data collection and analytical methods are simultaneously and interactively applied to understand a phenomenon (Leech & Onwuemgbuzie, 2009). In this strategy, the different methods are prioritised as equal. This kind of strategy may help to strengthen the validity and reliability of the study. It is worth noting that mixed- and multi-method research is not limited to a sequential or concurrent strategy. The same study could employ both these strategies. Figure 1 illustrates the main differences between sequential and concurrent strategies.

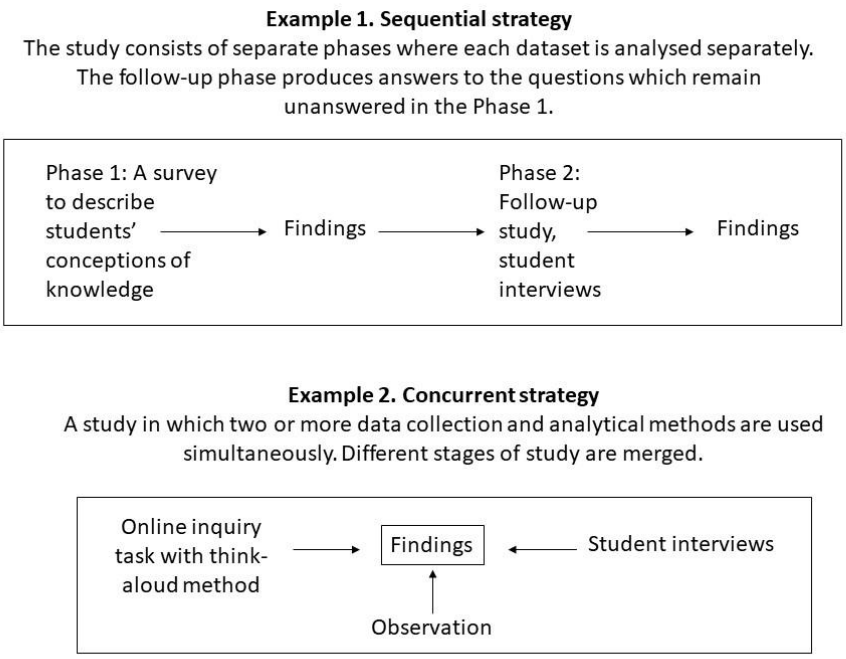

Figure 1. Examples of sequential and concurrent designs in research on individuals' conceptions of knowledge

Measuring the individual's conception of knowledge and knowing in action

To overcome the challenges involved in exploring conceptions of knowledge, researchers have also called for a need for authentic measures (Hofer, 2004; Sandoval, 2009). 'Authentic' here means that individuals' conceptions of knowledge and knowing are explored in real-world situations, for example in classrooms, and in different problem-solving or data-searching situations. The major advantage of authentic assessment is that it enables capturing such aspects, like students' justification of knowledge, that are too complex and multifaceted to lend themselves to mere self-report methods. Authentic measurement may improve the reliability of the study because the findings do not depend on respondents' abilities to describe their conceptions. In addition, authentic measurement makes it possible to consider the characteristics of the context in which epistemic thinking is activated (Mason, Arasi & Boldrin, 2011; Sandoval, 2009). It provides an opportunity to deepen an understanding of the situated nature of thinking (Hofer, 2004; Barzilai & Zohar, 2012; Kuhn et al., 2008).

Recent studies have found that authentic measurements, such as data searching about a controversial topic and problem-solving with open-ended questions, provide an opportunity for students to reflect spontaneously on their beliefs about knowledge and knowing (Barzilai & Zohar, 2012; Ferguson, Bråten & Strømsø, 2012; Mason et al., 2011; Hyytinen et al., 2014). These kinds of measurements are found to be rich sources concerning how students analyse, evaluate, integrate and justify both sources of knowledge and claims. They also show the criteria by which students evaluate not only knowledge but also the evidence that supports the knowledge (Hofer, 2004), as well as the way in which students respond to conflicting sources of knowledge.

Literature on these issues displays several facets as how to explore individuals' conceptions of knowledge and knowing in action. One way is to connect an authentic approach to the concurrent data collection strategy. For example, some researchers have combined online search and knowledge integration with a think-aloud method and video observation (e.g., Hofer, 2004; Brazilai & Zohar, 2012; Strømsø & Bråten 2014), while others have focused on how students acquire, justify, process, and utilize knowledge from various sources in an open-ended problem-solving situation (e.g., Hyytinen et al., 2014). Furthermore, concept maps together with storylines or detailed written explanations have proved to be valuable tools for exploring students' reflection, justification and use of knowledge (Nousiainen & Koponen, 2013a; Nousiainen & Koponen,

2013b). Such maps are also found to provide various insights into analysing the development of students' understanding (Schwendimann, 2014).

Although there are clear advantages to exploring students' conceptions of knowledge and knowing by applying authentic methods, these kinds of methods are not complete. It is very common that data collection situations are video recorded (e.g., Brazilai & Zohar, 2012; Hyytinen et al., 2014; Strømsø & Bråten, 2014). Analysing video-observation data is time consuming: a large amount of time and effort is needed to analyse properly this kind of data. Another challenge is how to combine different kinds of datasets which are produced in the data collection situation, such as video data on students' think-aloud or written explanations (see Strømsø & Bråten, 2014; Hyytinen et al., 2014). Furthermore, authentic methods can be tougher for participants than self-reports, because they really need to use higher-order thinking skills in the data collection situation when they analyse, justify and utilize the sources of knowledge.

Theoretical challenges

One potential cause of inconsistency and ambiguity in results can be theoretical, that is to say, how researchers have specified and conceptualised the models of epistemic conceptions. In the literature, there is no consensus what categories and dimensions of multidimensional phenomena are included in the measures (DeBacker et al. 2008; Scraw, 2013; Muis et al., 2014). Schraw (2013, 1) in summing up the prevailing situation emphasising that it is unclear whether the measurements used in contemporary research on individuals' conceptions of knowledge really measure the same constructs and phenomena. There is also evidence that researchers define the dimensions of individual's conceptions of knowledge in conceptually and theoretically different ways (Hofer & Pintrich, 2002; Kallio, 2011; Chinn, Buckland, & Samarapungavan, 2011; Holma & Hyytinen, 2015). For example, the term 'relativism' is used to refer to at least three different epistemological positions (Holma & Hyytinen, 2015; for another philosophical critique, see also Tuominen & Kallio, Chapter X). The theoretical problems with the concept of relativism have also been highlighted elsewhere. Kallio (2011) and Leadbeater (1986), for example, have demonstrated that the definition of relativism is ambiguous.

It is important to understand that theoretical frameworks play a significant role in how the data is analysed and interpreted. A theoretical framework is the researcher's tool for analysing and interpreting data. If the tool is not adequate, then there is a real risk that the analyses will be

distorted (Holma & Hyytinen, 2015; Hyytinen, 2015). Therefore, we suggest that theoretical analysis of the current theoretical frameworks of epistemic conceptions would provide a bridge between theory and practice. By applying theoretical analyses it is possible to elucidate theoretical background assumptions as well as contradictory statements and inconsistencies in the theoretical framework by analysing the interconnections between the concepts. In summary, theoretical analyses have great relevance in developing research methods in future research (e.g., Leadbeater, 1986; Chinn et al., 2011; Kallio, 2011; Holma & Hyytinen, 2015).

Conclusions and recommendations for further studies

To conclude, the challenges in exploring conceptions of knowledge are both methodological and theoretical in nature. The methodological challenges include heavy reliance on self-report measures which have not, however, been able to capture the complexity of the phenomenon in a reliable and valid manner (DeBacker et al., 2008; Buehl & Alexander, 2005; Hyytinen et al., 2016: Muis et al., 2006; Muis et al., 2014). It seems obvious that research on epistemic conceptions benefits from mixed- and multi-method research, which enable researchers to identify unexplored aspects of students' conceptions of knowledge and knowing as well as gain a more complete understanding of the phenomenon at hand. Especially the concurrent strategy, where two or more methods are simultaneously applied, can provide information from different levels and address new perspectives, as well as cross-validate findings obtained through different methods (see Hyytinen et al., 2014; Strømsø & Bråten, 2014). Although there has been an increasing use of multi- and mixed-method approaches (e.g., Barzilai & Zohar, 2012; Hofer, 2004; Hyytinen et al., 2014; Muis, et al., 2014; Strømsø & Bråten, 2014; Kienhues et al., 2011), it does not solve the underlying challenge related to self-reports when solely different self-report measures are combined. Therefore, there is an urgent need for more authentic measures. Authentic measures seem to capture aspects, such as students' justification of knowledge and contextual perspectives in which epistemic thinking is activated, that are too complex and multifaceted to yield results using different self-report methods.

The challenges related to using self-report measures in research on epistemic conceptions are also related to the theoretical challenges in the research field (e.g., Chinn et al., 2011: Kallio, 2011; Holma & Hyytinen, 2015). The main challenges concern the inconsistent use and complexity of the concepts commonly used to measure conceptions of knowledge and knowing. This causes inconsistency concerning which categories and dimensions should be included in the measures. Furthermore, if research focuses on measuring conceptions of knowledge in a specific context or

discipline, it does not necessarily reflect more general conceptions of knowledge. Thus, awareness of what actually is being measured is important.

The use of the concurrent strategy in mixed-method research, as well as authentic measures in exploring individuals' conceptions of knowledge, can serve as a means to further develop the theory of the phenomenon. A more solid theoretical basis, on the other hand, is needed to further develop self-report instruments for measuring conceptions of knowledge. The instruments should be able to capture the elements of this phenomenon and reflect students' conceptions of knowledge clearly and accurately. To ensure valid and reliable research on individual's conceptions of knowledge, it is essential to enhance the dialogue between theoretical, methodological, and empirical perspectives to extend and enhance previous work in the field. Previous chapters in this book – by Pirttilä-Backman colleagues and also Seppälä and colleagues – provide innovative examples of how research on epistemic conceptions can be combined with new theoretical insights.

In the following we summarise the main tactics for enhancing the quality of measurements of individuals' conceptions of knowledge:

- One assessment or analysis method is not enough to evaluate and capture complex and multifaceted phenomena. A mixed- and multi-method approach is needed.
- Authentic methods are found to be rich sources how students analyse, evaluate, integrate, and justify knowledge. They also provide an opportunity to deepen the understanding of the situated and contextual nature of thinking.
- Instead of a sole focus on empirical, methodological, or theoretical elements, more communication between the theoretical, empirical and methodological perspectives is required to deepen our understanding of epistemic conceptions (cf. Hyytinen, 2015).

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