

Epistemic beliefs among upper-secondary students  
in education for sustainable development



# Epistemic beliefs among upper- secondary students in education for sustainable development

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This licentiate thesis has been prepared within the framework of the graduate school in educational science at the Centre for Educational and Teacher Research, University of Gothenburg.

In 2004 the University of Gothenburg established the Centre for Educational Science and Teacher Research (CUL). CUL aims to promote and support research and third-cycle studies linked to the teaching profession and the teacher training programme. The graduate school is an interfaculty initiative carried out jointly by the Faculties involved in the teacher training programme at the University of Gothenburg and in cooperation with municipalities, school governing bodies and university colleges.



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## Abstract

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This research project explores an educational context through two approaches. The first analyses the interpretability and role of the concept of sustainable development according to the writings of four syllabuses in the curriculum for Swedish compulsory school. Close reading of the syllabuses of Geography, History, Religious education and Civics rendered various demands of action-oriented knowledge development. Theoretical perspectives seem to be combined with implications of practical and action-oriented educational methods and goals. This aspect of action responsibility is more explicit in the syllabuses of Geography and Civics. As an analytical tool, *thick* and *thin* concepts understood as *world-guided* and *action-guiding*, were used to address education *for* rather than education *about* sustainable development. A Phronesian strategy is suggested by the authors to move students from a state of awareness to readiness and aptitude for action. Within such a holistic interpretation the development of knowledge is seen as a group process and the individual in balance with the welfare of others.

The second approach is through an empirical study that sets out to answer two research questions. One of them concerns the dimensionality of epistemic beliefs among upper-secondary students involved in a transdisciplinary project called *Food!*, the other the relationship between the students' evaluation of the project experience (outcome) and their epistemic beliefs. Following the tradition of Marlene Schommer a research instrument was constructed consisting of 26 domain-general items and 5 project-contextualized items. However, the current framework proposes only three dimensions: the structure of, the source of and the justification of knowledge. N=208 students from 14 upper-secondary schools and 2 folk high schools participated. Through exploratory factor analysis, support was indicated for five factors:

*transdisciplinary knowledge, certain knowledge, quick knowledge, collaborative knowledge* and *simple knowledge*, followed by multiple regression analysis, in which three factors showed predictive power on the project outcome. For educational practice the awareness of the impact of epistemic beliefs on the outcome of the empirical context might motivate teachers to challenge their students and to discuss the epistemology of their specific school subjects. In addition teachers may rethink and expand their own conceptions of knowledge and knowing.

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## Part One: Dissertation frame



## Preface

The origin of the present research stems from my teaching experience in upper-secondary school. My colleagues and I have worked in transdisciplinary projects about sustainability with our first-year students on the Technical programme in projects about *energy, water and food*. About 90 students a year were involved in those projects, resulting in student-produced exhibitions and books. Two projects were organized externally by Global Forum, a meeting-place in western Sweden initiating dialogues about globalization and its consequences. At Global Forum a number of experts were involved, but also representatives of the political parties, the trade unions and other stakeholders. The themes for the two projects with Global Forum were *Water!* and *Food!* respectively. Both projects resulted in published books.

The education in these projects at the school where I teach, were organized so that several teachers of different school subjects taught together. In addition other professionals, extramural experts were available to the students, some of whom were civic servants related to environmental and energy issues in the municipality. These civic servants were invited to the school and the students also visited other professionals in their work places to acquire new knowledge.

While working together with the students in these projects and teaching and planning together with my colleagues, a few issues gradually surfaced. Some of the issues appeared while talking to teachers not teaching or involved in the projects. A question such as “What do the students really learn or acquire from such an educational model?” were quite frequent. Participating in a transdisciplinary project requires extra planning time, which might not be available within a teacher’s service. Therefore, a major concern for some teachers is that time is never sufficient for all that is included in the particular syllabus of a school subject.

With the intention of finding out what students really learn in transdisciplinary education, the research project has moved towards an empirical concept; epistemic beliefs, concepts of knowledge and knowing. By exploring what these might be and do in such an educational project, I hope

to add some new understanding to share with my colleagues who have put heart and effort into these projects and find new knowledge that could further enhance similar educational contexts for anyone inclined.

This research is carried out within the research school of CUL, [Centrum för utbildningsvetenskap och lärarforskning] Centre for Educational Sciences and Teacher Education at the University of Gothenburg, in cooperation with the municipality of Uddevalla (Uddevalla kommun), where I have been a teacher in upper-secondary school for more than 25 years. Through a governmental grant (Kammarkollegiet) I have been able to undertake PhD-studies towards a licentiate degree in pedagogical work.

Parts of the research project have been presented at the international conferences below:

- NERA 2013 Congress in Reykjavik, in the curriculum network: Paper proposal: Concepts of knowledge and knowledge creation among students and teachers in transdisciplinary education
- NERA 2014 Congress in Lillehammer, in the curriculum network: Paper proposal: Philosophizing with sustainable development and knowledge creation
- ECER 2014 Congress in Porto, in the network for Environmental and Sustainability Education Research: Paper proposal: Epistemic beliefs, sustainable development and knowledge creation in Upper-secondary Education

Finally I wish to express my gratitude to a few people. First of all Olof Franck, main supervisor, you have been a most significant discussion partner. Then Eva Nyberg, co-supervisor, your critical comments have helped my dissertation take shape. Both of you have balanced professional supervising and personal support in an impressive way.

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# 1. Introduction

In educational research students' personal epistemologies have attracted a great deal of attention over the last four decades. Personal epistemology (Hofer & Pintrich, 1997) is here defined as the individual's understanding of what knowledge is and how he or she comes to know. The educational implication is that this understanding is essential in reasoning and critical thinking. For the large part, educational research regarding epistemology has related to college or university students (Perry, 1968, Schommer, 1990). The present dissertation will focus upper-secondary students involved in a transdisciplinary project regarding education for sustainable development. It is assumed that such a transdisciplinary educational project may give rise to issues concerning what it is to know and see depending on various sources of knowledge. Furthermore, within the field of study, sustainable development, assumedly there will be complex dimensions of ethical, philosophical and political character (Peters & Wals, 2013). These dimensions may vary in impact on the processes of learning involved in education for sustainable development depending on students' personal epistemologies.

## 1.1 An epistemological orientation

'*I know*' and '*I see*' are two affirmative responses in knowledge sharing conversation whether it be in school or in another educational situation. The first response, 'I know', confirms that the two people in the conversation already share the same knowledge, whereas in the second case, 'I see', new knowledge has been brought into the mind of somebody. It is related to the moment of insight. '*I know*' is naturally a phrase discussed in epistemology, the branch of philosophy concerned with knowledge and knowing. What does it mean to know? Is it a state of being or does it refer to a mental process? Through his or her senses or mental processes the student might express the phrases '*I know*' and '*I see*', but does that mean that he or she now knows something?

## EPISTEMIC BELIEFS

Ludwig Wittgenstein sees a similarity on a primitive level between ‘*I know*’ and ‘*I see*’:

‘I know’ is supposed to express a relation, not between me and the sense of a proposition (like ‘I believe’) but between me and a fact. So that the fact is taken into my consciousness...This would give us a picture of knowing as the perception of an outer event through visual rays which project it as it is into the eye and the consciousness. Only then the question at once arises whether one can be certain of this projection. And this picture indeed shows how our imagination presents knowledge, but not what lies at the bottom of the presentation. (Wittgenstein, 2012, p 182)

In connection with curriculum and education three types of knowledge are generally referred to: propositional knowledge or *knowing that* which concerns the distinction between knowledge and true belief. It is constantly debated in philosophical literature (Winch, 2013). The other type is *knowledge how*, which seems to concern more practical dimensions of knowledge, although this epistemic capacity will also be said to include some elements of the first and the third type of knowledge. This third type of knowledge is *knowledge by acquaintance*. It is knowledge accessed through one’s senses; seeing, hearing etc. This third category refers to qualities that cannot be understood in any other manner (Winch, 2013). However, ‘*I see*’ as used above will not exclusively refer to knowledge apprehended through the senses. In fact, ‘*I see*’ should also refer to the student’s understanding, a recognition of the fact that he or she now has come into knowing. This inference is practical in the sense that the student almost visualizes himself or herself as knowing something.

The philosophical roots of epistemology trace back to the ancient Greeks. Together with metaphysics, logics and ethics it is a branch of philosophy and its concerns are knowledge and knowing. With its genesis in ancient Greek philosophy the Standard Analysis of knowledge was determined during the Enlightenment with empiricism appearing as the sign of evidence in science (Gerson, 2009). In addition to exploring the nature and source of knowledge, epistemology concerns itself with the nature of justification of knowing something, the justification of truth claims (Muis, Bendixen, & Haerle, 2006). The Standard Analysis of knowledge is that *S knows p if and only if*

- p is true
- S believes p and
- S is justified in her belief (Gerson, 2009)

There have been several other and similar attempts to provide sufficient conditions for what it means to know something. However, Edmund Gettier challenged it in 1966 (Gettier, 2012) by claiming that the truth condition in the Standard Analysis is not sufficient. By attacking the whole complex of propositions in the analysis, an individual could still be wrong (Welbourne, 2001, pp. 50-56). A great deal of attention in epistemology has been devoted to adding propositions in order to amend the Standard Analysis, but that line or research within epistemology does not lie within the scope of this dissertation.

### 1.2 Motivation for research focus

A great deal of focus in this dissertation is oriented towards epistemological issues, namely what does it mean to know, and what are the demarcations of knowledge? Our society in the Western world is sometimes referred to as a knowledge society or even knowledge economy (Russell, Wickson, & Carew, 2008). In several fields of interest the word knowledge appears and is incorporated; in business, economy, and leadership to mention a few (Uggla, 2007). The access of knowledge on the Internet is massive. Weinberger (2011) describes how the Internet with its mash of facts, knowledge, lies and fiction, fundamentally changes the structure of knowledge, which indeed takes on the shape of the internet. Throughout philosophical discussions ever since the time of the ancient Greeks, a few characteristics of knowledge have remained, according to Weinberger. First, knowledge is a subset of belief, and only some are knowledge. Second, through logics or experiments we have good reason for some beliefs and they constitute knowledge. However, third, that knowledge consists of a body of truths, that express the truth of the world, is being erased. The very dimensions of knowledge in society are changing with the internet, Weinberger states (2011). This impact of the internet is also recognized by Uggla, who claims that the revolution of the internet has made globalization possible, which in turn has an enormous transformal capacity (Uggla, 2007) not least on traditional institutions and concepts. Such do the epistemological concerns seem to be in society at large. An inquiry into the concepts of knowledge is an always immanent issue in educational research and practice.

In the Swedish curriculum for the upper-secondary school it is propounded that concepts of knowledge should be under constant review and

discussion. The present dissertation can be seen as an active response to that encouragement.

[S]chool's task of imparting knowledge presupposes an active discussion about concepts of knowledge, about what knowledge is important today, what will be important in the future, and also about how learning and the acquisition of knowledge take place. Different aspects of knowledge are natural starting points for such a discussion. (Skolverket [Swedish National Agency for Education], 2013, p. 4)

The notion that knowledge is changeable is most apparent in the curriculum. There is the notion that knowledge changes over time; knowledge is depicted as complex and multi-faceted.

There seems to be little Swedish research regarding epistemic beliefs among upper-secondary students. This does not mean that similar work does not exist in Sweden, but as Hofer (2004) points out the results have been dispersed and there are several coexisting constructs. Therefore it can be difficult to get an overview of the field and be able to conclude that there is an obvious gap in Swedish research concerning epistemic beliefs.

### 1.3 Research aim

The broad aim of the research project is to foreground epistemic issues in relation to education for sustainable development and transdisciplinarity as a means to organize such education. The assumption is that both the content and the way education is organized will prove complex and offer contradictory knowledge to some extent. A concern is how students will orient themselves in such an educational setting. Inspired by Strømsø, Bråten and Samuelstuen (2008) in their research regarding the influence of students' personal epistemologies on their understanding different texts representing various and somewhat contradictory views on climate change, the empirical construct of epistemic belief was chosen for the present study. Epistemic beliefs are thought to have an impact on the learning process and higher-order thinking.



## 1.4 Structure of the dissertation

Two research articles make up the basis for this dissertation: *A phronesian strategy to education for sustainable development in Swedish school curricula* and *Epistemic beliefs and knowledge creation among upper-secondary students in transdisciplinary education for sustainable development*. The first research article was accepted for publication in January 2014 and published in *The Journal of Education for Sustainable Development* in March 2014. The second was accepted for publication in *Nordidactica – Journal of Humanities and Social Science Education* in June 2014 and published in August 2014. The two papers are part of epistemological research. The aspect of the first article concerns mainly conceptual issues regarding the concepts of knowledge in sustainable development. As the empirical study is embedded in an educational context which is set in the field of sustainable development, it becomes relevant to firstly explore the concept of sustainable development in its own right and to further analyze what it might entail for educational practice. Sustainable development is the object of knowledge with which the students of the second study engaged. It is a complex concept and requires critical analysis for understanding it in this research context. The second article describes the empirical study set within the educational project *Food!* and is mainly an empirical inquiry regarding the epistemic beliefs among 208 upper-secondary students in a transdisciplinary project.

In part one of this dissertation the first chapter, the introduction, consists of background, motivation for and the aim of the research. The second chapter is made up of the theoretical framework in which the empirical concept of epistemic beliefs is presented together with the concepts of transdisciplinarity and education for sustainable development. Chapter three introduces the empirical context, the educational project *Food!* in which the study was carried out. Chapter 4 describes the construction of the research instrument. Chapter 5 contains the statistical analyses and chapter 6 follows suit with the discussion. The dissertation concludes with some practical educational implications of the results in chapter 7. Chapter 8 provides a summary of the dissertation in Swedish. In part two of this dissertation – the two research articles can be found and in the appendix the research instrument, the administered questionnaire is attached.



## 2. Theoretical framework

The research on epistemic beliefs and personal epistemology (Kitchener, 2011) is vast, topical and muddled in several respects. Tensions arise in the demarcations of the construct, even in what to call it; personal epistemology, epistemological beliefs, epistemic beliefs, epistemic dispositions or epistemic cognition, drawing on various theoretical perspectives: philosophical, psychological and educational. Personal epistemology can be seen as a collective name for various nomenclatures (Briell, Elen, Verschaffel, & Clarebout, 2011). It relates to beliefs and theories an individual holds about knowledge and knowing (Hofer., 2004). This theory of knowledge an individual constructs over time (Kitchener, 2011). Some attention in research concerns how epistemic beliefs relate to the cognitive processes of thinking and reasoning (Hofer & Pintrich, 1997).

A somewhat different conceptualization is present in a Swedish study that sets out to be one of personal epistemology (Domert, Airey, Linder, & Lippmann Kung, 2007). It is a phenomenological, cross-sectional, exploratory case study of students' epistemological mindsets. The assumption of the study is that students should not only know when to apply a physics equation but also be able to link it to everyday life situations. Twenty university students from the first year at university through to PhD students were interviewed face-to-face or via email. After a short discussion about physics and mathematics the students were asked:

When you say or feel that you understand an equation, what does that mean? (Domert, et.al. 2007, p. 18)

The most frequent component identified in the construct was “knowing how to use the equation” (Domert, et. al, p. 25). It seems to me that the construct epistemological mindset falls outside the general tendency to define epistemic beliefs as the nature of knowledge and how you come to know. Albeit, interesting, the meaning of deciphering physics equations does not seem to apply to the present field of research.

However, it has been theoretically and empirically propounded that epistemic beliefs play an important role in cognition, motivation and learning (Muis, et. al., 2006). It seems to be a powerful concept, which can inform any instruction or curricular work. Several studies have established a connection between epistemic beliefs and educational outcomes (Buehl, 2008). The construct is also closely related to several other constructs such as *conceptual change* (Winch, 2013; Vosniadou, 2007), and *reflective judgment* (King & Kitchener, 1994). There is increasing literature on the relationship between epistemic beliefs and conceptual change (Franco, Muis, Kendeou, Ranellucci, Sampasivam, Wang, 2012) but also on the role of epistemic beliefs on learning in general. All of these constructs share the fact that they are related to higher-order thinking (skills), which seems to be required by a society which face a large number of challenges such as climate change, poverty, starvation and environmental pollution. The educational implication is that epistemic beliefs are essential in reasoning and critical thinking and therefore relevant to explore in order to understand and develop educational practice (Schommer-Aikins, 2004)

## 2.1 Epistemic beliefs - the concept of knowledge and justified belief

Educational research on personal epistemology takes the influential work of William G. Perry Jr as its starting point although he did not specifically address epistemic beliefs. Perry was interested in students' responses to a changing and pluralistic world (Perry, 1968). In a longitudinal study with college students at Harvard and Radcliffe during the fifties and early sixties, Perry and his team tried to illustrate a variety of responses to a culture of contingent knowledge and relative value. Starting with a measure referred to as A Checklist of Educational Views, CLEV, a sample of students was selected based on their results to cover student profiles ranging from dualistic to contingent thinkers. This sample was used to provide thick descriptions in continual interviews during their years at university. From these interviews the research team created a developmental scheme on the assumption that it is possible to identify a dominant form of structure for each person. The development scheme consists of nine positions, centering on position 5 in which knowledge is seen as contingent and relative. The nine positions were divided into three phases: of modifying dualism, relativism and commitments

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(Perry, 1968, p. 57). In the tradition of Perry several models of epistemological development have been suggested through longitudinal studies (Belenky, et al., 1986; King & Kitchener, 1994; )

Marlene Schommer (1990) further developed Perry's research and introduced a quantitative approach (Schommer-Aikins, 2004). Drawing on Ryan (1984) she introduced a paper-and-pencil, self-completion questionnaire, the Epistemological Questionnaire (EQ) which has played a major role in subsequent research on epistemic beliefs (Hofer & Pintrich, 1997). Whereas Perry had been looking at the development of epistemological beliefs, Schommer looked at the dimensionality of the belief system. According to this belief system the dimensions of knowledge operate independently of each other, so the students might display various degrees of each dimension. The dimensions are believed to develop asynchronously. Schommer identified five epistemic belief dimensions: *The stability of knowledge*, *The structure of knowledge*, *The source of knowledge*, *The speed of knowledge acquisition* and *The control of knowledge acquisition*. Schommer's items were rendered in reviewing the qualitative research by Perry and Schoenfeld (1983)

Hofer and Pintrich (1997) in their review article have questioned whether beliefs about learning and teaching should be considered part of epistemological beliefs as they do not explicitly deal with the nature of knowledge and knowing. Instead they argued that personal epistemology is made up by systems of beliefs regarding the nature of knowledge and the processes of knowing. Consequently they recognize four epistemological dimensions: *The certainty of knowledge*, *The simplicity of knowledge*, *The source of knowledge* and *The justification of knowledge*.

Depending on whether the authors are interested in what epistemic beliefs are, do or how and when epistemic beliefs change, they operationalize their studies differently, thus, methods vary depending on the theoretical orientation. The focus of this dissertation and the current study is what the epistemic beliefs *are* and what they *do*. Broadly speaking there are two dominating frameworks in the field, one more related to psychology, the other more related to philosophy. In the developmental one the unit of analysis frames the individual and in the dimensional one it is the group of students and the dimensions prevalent in this group that are under scrutiny. Methodology follows on the theory and it is in terms of what the epistemic beliefs are supposed to do that a specific research design and method is applied.

In the present study attention was given to the dimensionality of the epistemic beliefs, what they are and what they do among upper-secondary students, 16 to 19 years old, in a transdisciplinary educational context. Furthermore, the epistemic beliefs prevalent among the participants in the current study are contextualized in education for sustainable development. The learning content and the organization of education will be considered when interpreting the rendered dimensions of epistemic beliefs. Although the current study is not set in the developmental framework, the construct epistemic belief has its roots in the psychological field. Furthermore, the dimensional field talks about dimensions consisting of a continuum between naïve and sophisticated, which can be seen as an influence of this framework.

### **2.1.1 Developmental framework – epistemic sophistication**

Some studies are interested in the development of epistemic beliefs, where aspects of naïve and sophisticated beliefs need be looked at in a critical way (Elby & Hammer, 2001, Greene, 2009). There is a stage-thinking in the developmental framework starting with a dualistic view with a clear-cut difference between right and wrong and the element of certainty is also strong. This stage is followed by one at which multiplicity and uncertainty are accepted to finally move on to an evaluatistic stage which can handle competing knowledge claims through justification and evidence (Bråten, 2010).

The developmental perspective with its origin in Perry's studies has it that epistemic beliefs become more constructive and availing, the more educated and cognitively developed the person is (Mason, et al., 2013). The development is also stage-like; between four and nine stages have been presented in the literature (DeBacker, et al., 2008).

William Perry used a mixed method, and with the help of a big research team he could provide thick descriptions of the students' world-views. Perry was interested in how students experienced pluralistic education and presented an approach to the relativity of knowledge. From his research he postulated nine developmental positions, which were close the forming of identity. The main line of development is from position 1 where the student believes in Right Answers and things are seen as black or white, through to position 9 when:

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The student experiences the affirmation of identity among multiple responsibilities and realizes Commitment as an ongoing, unfolding activity through which he expresses his life style (Perry, 1968, p. 10).

Perry's work was influenced by Piaget's theory of childhood development (Wankat & Oreovicz, 1993). Piaget postulated four stages of intellectual development of children up to the age of twelve. At the fourth stage, the child is capable of formal intellectual operations. This intellectual level meant that the child is now capable of metacognition, to thinking about his or her own thinking. Both Perry and Piaget were interested in the way children or university students move from one level or position to another. Piaget's theory of learning postulated that there are mental structures. If the child meets with new data that fit into their present mental structures, new knowledge is acquired through accommodation. By contrast, should the new information deviate considerably from the existing mental structure, it would either be discarded altogether or assimilated or transformed in order to become compatible with the existing mental structure (Wankat & Oreovicz, 1993).

If one were to let Perry's developmental scheme follow on to Piaget's, the highest position according to Perry, No 9, could be denoted ascendance. This is the level when the student has the assumptions that his knowing and values are relative in time and circumstance; when responsibility and commitment to the kind of person he is, is achieved.

### **2.1.2 Dimensional framework – epistemic orientation**

Whereas the developmental paradigm used in-depth interviews, Marlene Schommer introduced quantitative assessment which allowed for group administration and statistical analysis, factor-analytic methodology (Bråten, Gil, Strømsø, & Vidal-Abarca, 2009). In the dimensional or multidimensional framework personal epistemology is seen as made up of systems of beliefs (Greene, Azevedo, & Torney-Purta, 2008). The systems consist of more or less asynchronous dimensions, generally described as continua, which means that they span from one extreme which is labelled as naïve to the other, labelled sophisticated. In this framework the focus is more on what the epistemic beliefs are and what they do, how they predict educational outcomes (Greene, et.al., 2008). Model development is important and issues regarding whether dimensions are domain general or domain specific are

concerned. Schommer presented the first domain-general model in this conceptualization with the following proposed dimensions: simple knowledge, certain knowledge, omniscient authority, fixed ability and quick learning. The proposed Schommer dimensions seem to vary between four and five in the literature (Clarebout, Elen, Luyten, & Bamps, 2001). It has been suggested that the first three dimensions in Schommer's conceptualization belong to the nature of knowledge and the last two to the nature of learning (Bråten, 2010). Indeed Hofer and Pintrich (1997) have argued against the inclusion of dimensions regarding learning under the panoply of personal epistemology. They took a purely epistemological stance with the two general dimensions of the proposed dimensions of the nature of knowledge and the nature of knowing respectively. The former general dimensions captured in Schommer's factor analysis in the factors: simple knowledge and certain knowledge were further specified by Hofer and Pintrich (1997) into certainty of knowledge, simplicity of knowledge and source of knowledge. Given that the definition of epistemic beliefs include the nature of knowledge and the nature of knowing, the clash between conceptualizations seems to rest in the concept of knowing the process by which one comes to know. However interesting this might be, there will not be space within this licentiate dissertation to elaborate on this argument. The number of dimensions seems to attract attention in many studies where Schommer's questionnaire is used. In the two most famous models, Schommer's and Hofer and Pintrich's, they seem to land on four dimensions (Schommer & Walker, 1995), although Schommer initially reported five. In the current study, however, which is exploratory, the attitude to the number of dimensions is open. There are also studies according to which yet further dimensions are explored, such as e.g. epistemic virtues and vices, which, by contrast, concern the disposition of the character to achieve epistemic goals (Chinn, Buckland, & Samarpungavan, 2011). This lack of consensus regarding the construct calls for a clear framing of the construct of one's research.

### **2.1.3 Epistemic beliefs and educational performance**

A recurring notion around the epistemic beliefs is that they follow a developmental curve or continuum from naïve to sophisticated. This notion is sometimes introduced somewhat casually. Spiro, Feltovich and Coulson



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(1996) have looked at prefigurative schemas's<sup>1</sup> impact on the learning experience. They have found that the same factors can lead to either failure or success. It all boils down to the context. The important conclusion to draw from this is that evaluating one epistemic belief over another, or a certain degree of this epistemic belief, should be approached with some care. In instruction, in an introductory course of a new subject, it might be more beneficial to the student if he or she adopts a more naïve attitude when treating well-structured domains, claims Spiro et al. This logic opens up for another hypothesis. This hypothesis is that the sophistication of a person's epistemic beliefs does not rest in the construct itself, but rather in the management of the process, what Maggioni and Parkinson (2008) would refer to as epistemic cognition. To sum up, the most important finding by Spiro et al through their Cognitive Flexibility Inventory instrument, is that this instrument is mainly concerned with the sort of belief that will work for the acquisition of knowledge in ill-structured and complex situations.

Elby & Hammer (2001) have taken a critical attitude to the notion of sophistication in the theory of epistemic beliefs towards scientific knowledge. They claim for instance that it could be quite unsophisticated to adopt a tentative attitude to the scientific fact that the world is round and not flat. Their critical views on the assumption of sophistication in epistemic beliefs' are noteworthy although the space of this dissertation will not allow for the issue to be expanded on.

A number of researchers in this field, however, are concerned that instruction that teaches less sophisticated views, will prove negative for students (Greene, et.al., 2008) and make them less well prepared for academic studies. Schommer claims that there is support for the idea that the student believing in simple knowledge will find comprehension of complex text difficult and is less likely to use integrative study strategies. Believing in fixed ability to learn will make it all the harder to persist in solving complex tasks. Conceptual change research suggests that the epistemic beliefs of more naïve students are resistant to change.

The proposed dimensions in the current study are the *structure of* and the *source of knowledge*, well-established dimensions used by Schommer (1990) influenced by Perry (1968) and the *justification of knowledge*, also used by Hofer

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<sup>1</sup> I interpret the prefigurative schemas as epistemic beliefs as they are defined as "understanding of what knowledge consists of and how it should be acquired" (p S53). Furthermore, in a footnote the previous name of the assessment instrument used is revealed, Epistemic Beliefs and Preferences (EBP)

and Pintrich (1997). They imply a more clearly philosophical stance as they are relating to issues within epistemology: What is the nature of knowledge? How do we come to know? and How do I know that I know? Two of Hofer and Pintrich's dimensions, the *certainty* and the *simplicity* of knowledge can be seen to fall within *the structure of knowledge* in the current study.

## 2.2 Education for sustainable development

Education for sustainable development (ESD) is a concept launched by the UN not the least through the proclamation of the Decade of Education for Sustainable Development 2005-2014. Based on the belief that education holds the key to sustainable development (Ercoskun, 2011), ESD has gained attention. The notion of the common good is prevalent in the conceptualization of sustainable development. Any activity under the panoply of sustainable development and which is performed for no other reason than the common good is what scholastic philosophers would call *bonum commune* (Hittinger, 2012, p. 49). What is common good cannot be distributed among people, but needs be shared or participated. Sustainable development incorporates the aspects of ecology, economy, society and culture in meeting with challenges such as climate change. Research article 1 develops the concepts of sustainable development and education for sustainable development further. In research article 2, education for sustainability is represented through the educational project *Food!*, in which students approached an ill-structured problem - *food* - from a variety of aspects: social, ecological, economical and technical.

### 2.2.1 Vision and normativity in relation to knowledge

In the famous definition of sustainable development – Our common future - (World Commission on Environment and Development (WCED), 1987) there is a vision of a world that includes the opportunities of future generations to thrive. This is important to focus on in the education of sustainable development according to Rauch and Steiner (2013) Furthermore they argue that education should not be separated from society, which means that the empirical context of the transdisciplinary project *Food!* falls well within these interpretations. The vision and hope around sustainable development need be contrasted by critical voices regarding the political implications and that the concept of sustainable development is too value-

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laden for education (Jickling & Wals, 2012). Thus, these dimensions add yet another layer of complexity or ill-structuredness to the concept. The normativity of education for sustainable development needs to be addressed (Wals, 2010) and the contribution of Jickling (1994) is that he has pinpointed the problem of the fact that education for sustainable development is normative and thereby intended to make students think or act in a certain way. In that sense education for sustainable development (ESD) risks turning into indoctrination rather than providing students with the ability to think freely and creatively (Östman, 2010, Öhman, 2008). The risk of indoctrinating students seems to be more apparent in a transmissive view of education (Jickling & Wals, 2008) In teaching for the future, which is the underlying notion of ESD *skills* with instrumental connotations, according to which little understanding is involved, would seem to be counterproductive. Jickling (1994) would like his children to be taught about the concept of sustainable development, to learn that it is a contested concept mainly because of various worldviews, the eco-centric versus the anthropocentric. Jickling argues that his children should be allowed to freely decide whether they want to take action for sustainable development if they find it called for. I interpret this part of his argument as the advocating of another worldview, the individualistic versus the collective. Similar wordings can be found in the Swedish curriculum (Skolverket [Swedish National Agency for Education], 2011):

The task of the school is to encourage all pupils to discover their own uniqueness as individuals and thereby be able to participate in the life of society by giving of their best in responsible freedom. (Skolverket [Swedish National Agency for Education], p. 9)

It is quite an individualistic worldview according to which citizens can decide to or refrain from participating in society. To give of your best in responsible freedom again gives the individual the choice of taking his or her responsibilities or not, as they are supposed to be free. This tension between responsibility and freedom seems to be somewhat contradictory to the intentions of ESD. A challenge for education and democracy is to “make plurality and diversity possible in a shared, local and global community” (Öhman, 2008, p. 28)

Societal problems such as the challenges of sustainable development are seen as complex and interdependent. Therefore transdisciplinary education and real-world problem solving are needed (Dale & Newman, 2005). In the

empirical context of the current study, the interpretability, the normativity and the visionary aspects of education for sustainable development underpin both the knowledge base and the organization of the education in the educational project Food! The concept is further analyzed in article 1.

### 2.3 Trans-, multi- and interdisciplinarity

Transdisciplinarity is used in a broad sense in this dissertation. First, it is used to denote an organizing principle of education. The Latin prefix, *trans-*, means both *across* and *beyond*. In defining *trans-*, *multi-* and *interdisciplinarity*, boundaries and boundary crossing (Klein, 1996) are referred to, but not defined. Nicolescu (2014) has pointed out this gap in the literature and defines disciplinary boundaries as

the totality of the results – past, present and future – obtained by the laws, norms, rules, and practices of a given discipline (Nicolescu, 2014, p. 189)

In the sense that a theme is taught *across* the curriculum, transdisciplinary education is sometimes interchangeable with *interdisciplinary* education, which rather is an attempt to teach *between* school subjects. The prefix, *inter-* refers to the common ground between disciplines (Harris, Brown, & Russell, 2010, p. 4), or school subjects. Another related concept is *multidisciplinarity*, in which various disciplines or school subjects work with the same issue but in a compartmentalized way, without transgressing any disciplinary boundaries. The participating educators or researchers can be referred to as “epistemological silos” (Miller, Baird, Littlefield, Kofinas, Chapin III, Redman, 2008). They all work from the perspective with a shared issue but without meaningful or real integration. Multidisciplinarity can be described as an approach which takes an interest in including other perspectives, as from other disciplines, but without intention of changing the goal of the home discipline (Nicolescu, 2014). In the current educational context a complex socio-scientific, or “wicked” problem (Harris, et.al., 2010) is approached not only in school and across curriculum, but also beyond the curriculum-based school subject, as the project Food! involved extramural experts as co-educators. Wicked problems or ill-structured problems cannot be solved with methods used for structured problems (Ansell, 2011) In terms of education this can be translated as if school cannot solve this problem on its own. School needs to reach out to other co-creators of knowledge.

Transdisciplinarity has been described as a way of collectively understanding an issue (Harris, et.al., 2010, p. 4). It is in this capacity that transdisciplinarity makes possible knowledge creation in educational practice. The notion of new knowledge rests on the assumption that there is knowledge in other sections of the society, which is not yet available in school. In that respect a transdisciplinary project will render new knowledge.

It is assumed in this dissertation that when the students are involved in these projects, they have to grapple with cognitive conflict. In this dialectic process, the individuals express their thoughts and opinions based on various knowledge bases and through a variety of integrative techniques, broad issues are addressed (Klein, 1990) In the current study it is of interest how students orient themselves in such education and how the epistemic beliefs among the participating students relate to such a complex educational context for creating knowledge.

### 2.4 Research questions

The intention of this dissertation is to foreground epistemic issues in relation to upper-secondary student in transdisciplinary education for sustainable development. With a philosophical rather than psychological stance focus is directed to the exploration, description and discussion of the epistemic beliefs among students involved. This research project sets out to answer the following two questions:

- What are the dimensions of epistemic beliefs among upper-secondary students involved in a transdisciplinary project regarding sustainable development?
- Is there a relationship between students' epistemic beliefs and their ratings in the project evaluation?



### 3. Research methodology and design

In this chapter the empirical study as part of the dissertation will be described. The process of developing a questionnaire for gathering information about the epistemic beliefs among the participating upper-secondary students will be described.

#### 3.1 The empirical context

The educational project *Food!* was organized by an extramural organization Global Forum, in Gothenburg . Altogether 351 upper-secondary students from 16 schools were involved in the writing and publication of a book called *Food!*. The subject or theme was global and related to issues of sustainability. In 105 mini-chapters subjects such as food waste, starvation, locally produced food, supermarkets and meat production were covered. The students presented facts and advice on a way forward for a society that is fair and sustainable. The project was transdisciplinary in the fact that the physical boundaries of the school were transgressed. For four months the students worked individually or in small groups together with their teachers, but also with the access of 39 external experts in various fields. One could argue that school was reaching out in order to create new knowledge. The notion of new knowledge rests on the assumption that there is knowledge in other sections of the society, which is not yet available in school. In that respect a transdisciplinary project will render new knowledge. Furthermore, the students also transgressed the traditional boundaries by disseminating knowledge, by reaching out to society with their findings and knowledge through the publication of the book.

When the manuscript of the book was ready, writers and teachers together with an expert panel, met at a conference centre to discuss the theme of the

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<sup>2</sup> Magnusson, Å & Nilsson, B (2013) Mat! 351 västsvenska ungdomar om global matsäkerhet och hållbar utveckling [Food! 351 young people in Western Sweden about global food security and sustainable development]. Göteborg. Tre böcker

project. The questionnaire was group administrated at this conference which 208 students attended to.

### 3.2 Research instrument

In order to address my research questions I developed a self-completion, closed-ended questionnaire: the Survey of Epistemological Beliefs in Transdisciplinary Education (SEBTE). The reason to use a quantitative method was both to cumulate knowledge gained by previous studies and to find dimensions and patterns of epistemic beliefs that could provide the departure for further study and more in-depth research. Another reason was to be able to collect data from a large number of students involved in the transdisciplinary project Food! As it would be rather difficult to find a control group of students who did not have the experience of transdisciplinary education, I decided to solely draw on the students' experience of this particular project. The processes of construction, validation and operationalization will be described in a few steps below.

The questionnaire was influenced by previous research instruments; Epistemological Questionnaire (EQ): (Schommer, 1990); Epistemic Beliefs Inventory (EBI): (G. Schraw, L. E. Bendixen & M.E. Dunkle, 2002), and Epistemological Beliefs Survey (EBS): (Wood & Kardash) 2002. The instruments were all retrieved from DeBacker, Crowson, Beesley, Thoma, & Hestevold (2008). Fourteen items from Schommer's EQ were included, five of which had also been repeated by Schraw et al in EBI. An additional three items from Wood and Kardash's EBS were also used. See table 1 below. All these items had been previously validated. The items were translated into Swedish and only slightly modernized as far as the wording was concerned.



Table 1. SEBTE items, unique items and items repeated from previous measures

Schommer (1990) EQ	Schraw et al (2002) EBI	Wood & Kardash (2002) EBS	Grice (2014) SEBTE
No 1, 3, 9, 11, 13, 14, 15, 16, 17, 18, 19, 23, 25, 26	No 1, 3, 9, 15, 18, 20, 25	No 5, 10, 11, 13, 15, 16, 18, 20, 26	No 2, 4, 6, 7, 8, 12, 21, 22, 24

### 3.2.1 Questionnaire – framework and structure

In the present study, a philosophical stance to the construct is taken, influenced by the theory of Hofer and Pintrich (1997) and Greene et al (2008). Following Hofer and Pintrich (1997) in approaching conceptions of knowledge through purely epistemic beliefs, three out of their four dimensions were included in the framework; the structure of knowledge, the source of knowledge and the justification of knowledge. These proposed dimensions correspond to categories of questions or items in the questionnaire. In order to make an analysis, proposed dimensions or categories are necessary. Although the intention is not to fully explore the relationship with philosophical epistemology as opposed to personal epistemology, the dimensions of the current framework correspond to issues raised in philosophical epistemology, such as: What is knowledge? How do we acquire knowledge? and Why can we claim to know something? The dimensions are epistemological. Consequently, dimensions of learning are not included. Thus the following three dimensions of epistemological beliefs are hypothesized in the Survey of Epistemic Beliefs in Transdisciplinary Education:

1. The structure of knowledge
2. The source of knowledge
3. The justification of knowledge

The structure of knowledge can be seen as a conflation of Hofer and Pintrich's two dimensions, the certainty of and the simplicity of knowledge.

The items in the questionnaire are organized into two parts, A and B. Part A contains 26 domain-general items, part B five evaluative items contextualized in the transdisciplinary project *Food!*. The items in part B will be relevant in the analysis as they will reveal the students attitude to the whole project. The assumption is that the students' evaluation of the project will relate to their epistemic beliefs and consequently their responses in part A. The items are randomly organized so that items relating to a certain

dimension do not appear in a sequence. The reason is to avoid that respondents keep on ticking the same level and stop thinking about the individual item. For similar reasons the type of Lickert scale used comprises an even number of levels. With six levels there is no immediate middle category, which means that the students need to make an active decision (Saris & Gallhofer, 2007) instead of automatically going for the middle level. There are descriptions of the two end points; *Not at all* and *Yes, absolutely* respectively. A not-applicable-box is also provided next to the scale. The wording is kept simple which is particularly important as the responses require a level of metacognition.

### 3.2.2 Pre-pilot, item-casting

By using a rather simplistic pre-test format, which I have called “item casting”, two of the items in SEBTE - 2. *Theoretic knowledge is more valuable than practical*, and 12. *Knowledge has a value in its own right* were tested in a pre-pilot (n=23) through three alternative wordings in Swedish. The item casting was inspired by Saris & Gallhofer (2007) who suggested experiments in which respondents were presented with various survey items in a laboratory setting. In the present pre-pilot, however, “experiments” were carried out in the classrooms.

Each test consisted of two items together with a commentary field. The students were encouraged to comment on the wording or the content of the two items. A fourth item-casting test was also used with an open-ended question. The open-ended question was formulated as a typical composition assignment and the students were asked to suggest a new school subject. The four item-casting tests were distributed randomly within each group of students. The first group was only small (n=11) with students from the Technical Programme. They were previous students of mine. They were relaxed and willing to participate.

For timing reasons the whole questionnaire was also pre-piloted in the second group which was a little larger. Thirteen students filled out the whole questionnaire and needed between 3 and 19 minutes to complete it. For recruiting students for pre-piloting I turned to two colleagues at the upper-secondary school where I am a teacher. The students were from the natural science, the social science and the technical programmes, similar programmes as the target group in the project *Food!* They were all graduating students between 18 and 19 years old.

A few things could be concluded from the pre-pilot test. First, which item in each experiment that was best suited, second; that students are quick respondents, third; that students will only grant a questionnaire a certain amount of time. As an example of the latter, the open-ended item which was to suggest a new school subject was responded to by 21 students. Of these students, 13 had been given the open-ended item as part of the whole questionnaire. They used 243 characters in their responses. This should be contrasted with the 8 students who responded to the open-ended item only. They used 297 characters. My conclusion is that the students are only willing to spend a certain amount of time on such tests, so one has to make the most of that time. The item-casting pre-pilots drew the attention to some words and expressions that were not clear to the students. Based on whether the students expressed confusion or not in their comments, the items with the most appropriate wordings were decided on.

As a result the questionnaire was contextualized in the field and the theoretical framework articulated. After corrections and contextualization SEBTE was ready for a new pilot. A pilot test of the whole questionnaire was conducted with 38 students after the refinement of the instrument and a final attunement of four items was performed with four students in a talk-aloud interview (Krosnick, 1999).

### 3.3 Participants

The demographics of the participants in the study are limited to education program/field of study, age and gender. The 208 students that responded to the questionnaire comprised 76 males and 117 females (15 students excluded that information). The average age was 17 years old. In table 2 below, the distribution of students across the upper-secondary educational programmes is displayed. Two educational programmes are substantially represented in the study, namely; Social sciences (55 percent) and Technology (24 percent).

Table 2. Number of students across educational programme

<b>Educational Programme</b>	<b>Frequency</b>	<b>Percent</b>	<b>Valid Percent</b>
Economics	5	2.4	2.8
Technology	49	23.6	27.2
Social sciences	15	55.3	63.9
Handicraft	1	.5	.6
Natural science	2	1.0	1.1
Natural resource use	8	3.8	4.4
Educational Programme stated	180	86.5	100.0
Educational Programme not stated	28	13.5	
<b>Total</b>	<b>208</b>	<b>100.0</b>	

### 3.4 Methodological considerations and procedures of analysis

In this section I wish to draw attention to a few considerations about the research instrument, and the procedures of analysis, the statistical and the philosophical. The instrument – SEBTE - in the present study is in the category of domain-general, which means that the items relate to concepts of knowledge in general and not to a specific issue or discipline. A general approach was also the notion of Schommer’s instrument (Schommer, 1990). In order to address issues of domain-specificity and topic-specificity some authors (Strømsø, et.al., 2008) have made modifications of Schommer’s instrument. The newly developed instrument of the present project is domain-general, but it seems logical to understand it as to some extent topic-specific as it is embedded in an educational context concerning such a complex issue as sustainable development using a transdisciplinary approach. The educational context assumedly will impact the students’ responses to the items of the questionnaire. Therefore I argue that the results and interpretations should be understood in relation to this specific context.

A Lickert-scale is used in the research instrument SEBTE. This means that student responses to questionnaire items are numeric, degrees of agreement, represented by numbers 1 to 6. The unit of analysis is the group of students’ voices represented by the variables in the data. It is not the individual’s conceptions that I intend to approach in this project, it is more a collection of conceptions that are prevalent within a fairly large group of students involved

in a mutual educational context. Should the research interest be the unique individual voice of the student, should the unit of analysis be the narration of his or her conceptions of knowledge, his or her evaluation of this particular project, other methods would be more useful. Here, the perspective is more distant in the respect that it is the voices of the data that speak to us. Student responses in terms of numeric grading rather than open responses mean that they are more efficiently handled as coding of students' responses is not called for (Saris & Gallhofer, 2007). The interesting thing in this particular project is to examine the dimensions of conceptions of knowledge and see how they relate to both the content and the way education is organized.

The procedure of analysis began by subjecting students' responses to the 26 items of the questionnaire to an exploratory factor analysis (EFA) using the method of principal components analysis (PCA). Each item in the questionnaire makes up an individual variable. In factor analysis the variables are statistically grouped together or set apart. One might argue that a factor consists of a composite variable (Phillips & Lyons, 1990, p. 486). In PCA component is used instead of factors, but as factor analysis is such a widely known method of analysis, the word factor will be used consistently instead of component.

The assumption of factor analysis is that the grouping of variables, the fact that some variables vary together is that, the composite variable will reveal something meaningful, the underlying dimension of in this case students' concepts of knowledge. The relationship between observed variables and factors can be interpreted as causal. The underlying construct of the factor so to speak causes the responses to the observed variables (Henson & Roberts, 2006). Although the responses to individual variables could be very interesting the overall interest in survey data and factor analysis is the generalizability of the conclusions. An aim in factor analysis is to extract as few factors as possible that will explain for or have bearing on the largest part of the total variance (Barmark, 2009). Orthogonal rotation was chosen for the EFA, which means that the factors or components are as distinct as possible. A reason for this is to gain factors with more explanatory power.

In a second stage of statistical analysis, in multiple regression analysis, the correlation of several different variables is possible. A stepwise method was chosen because it is also exploratory in the sense that it inserts one independent variable at a time and builds the model by entering variables that are significant. The five dimensions from the EFA were made into sum

variables and used as independent variables. In addition dummy variables were made of the background information about the students, such as age, sex and field of study.

### 3.4.1 Philosophizing with

In moving in and out of theory, empirical findings and practical implications in the analysis I will be using Dohn's (2011) approach *philosophizing with*. This means that in addition to more conventional applications of philosophy in a priori conceptual clarification and a posteriori empirical interpretation, Dohn (2011) suggests that epistemology should be invited to have an empirically informed but distinct voice. Epistemology should engage in dialogue with the empirical sciences about what knowledge is, how it is acquired, how to investigate it and how to make it possible for others to acquire it. The number of empirical studies of knowledge creation in the field of education is limited and an empirical study of the epistemic beliefs among upper-secondary students involved in project-work regarding sustainable development, could address both the theory of knowledge creation in education as well as the practice of teaching and organizing educational practice.

There is however an obvious risk in using *philosophizing with* and that is that the findings take on different characteristics as they are interpreted or translated into a more philosophical way of thinking about them. The students' responses have been translated in several steps as it is through the statistical analysis and it is worth considering what the advantages and disadvantages are. One of the concerns of this dissertation is on the one hand what the educational content of sustainable development might be or intend to be according to the curriculum and how this content could be related to various dimensions of epistemic beliefs among the students involved in the educational project *Food!* On the other hand, this concern is not only what epistemic beliefs might be and do in relation to this content, but also what they might mean to the individual student, to educational practice. *Philosophizing with* offers an additional stage of analysis, which involves understanding the findings regarding epistemic beliefs. The analysis is taken a step further by the explication of the dimensions of epistemic beliefs and relating them to general issues in epistemology.

### 3.4.2 Limitations of the study

Although transdisciplinarity as well as sustainable development are focused in this research project, the empirical work will provide little evidence beyond the epistemic beliefs manifested among the students participating in such an educational context. Furthermore the students' responses might be more optimistic because of the time and the place for the administration of the questionnaire. It was administrated at a conference, and the students might also be positive because they knew that their mini-chapters would be made public in a book.

Methodological issues are raised regarding the empirical concept or construct, which seems hard to define (Elby, 2009; Hofer., 2000), as well as the pen and paper instruments. Students' concepts of knowledge are theoretic constructs known in the literature as epistemic beliefs. Not only are they hard to fully grasp empirically, there is evidence of discrepancies between what student's say that they do in surveys and what they in fact do. Correlations between general questionnaires responses and students performances on a specific task are often rather low (Baker, 2010). This might apply for students' beliefs too.

Using a questionnaire, as a self-report verbal instrument, has its limitations. Indeed, there has been some criticism of using Lickert-type measurements and a quantitative approach, as they seem to fail to indicate the development and growth of personal epistemology (Kaaritinene- Koutaniemi & Lindblom-Ylänne, 2012). Hofer (2008) claims for instance that interviews have been the most valid and reliable methods of research in epistemic beliefs in the developmental framework. In the dimensional framework, where epistemic issues are focused, questionnaires are frequently used. Consequently, the quantitative design of the present study was chosen because it indeed is successful in establishing what the dimensions of epistemic beliefs are among a group of students rather than how they develop.

The design of the study also has its limitations when it comes to the field of quantitative research as there is no pre- or posttest. Neither is there a control group. Conclusions can only be drawn about the students involved in this particular project. However, this study can contribute to an increased knowledge about the epistemic beliefs of the students in this specific educational context.

### **3.4.3 Ethical concerns**

Swedish legislation, the Ethical Review Act, protects the participants in research from harm and injury. Considering the potential risk of causing infliction on people is part of the high standards there are on research. As the respondents in the present study are sixteen years old or older, and the fact that the items in the questionnaire are not related to sensitive, personal information, the need for an application to the central ethical review board must be considered uncalled for. Participation was voluntary and the questionnaire anonymous.

A general ethical dilemma might be worth commenting on in this section. When an educational researcher uses his or her own school, students or teaching as the object of research, there could be a conflict of interests between the researcher as teacher, who will show due care to the anonymity of his or her respondents, and the teacher as researcher, who needs to be true to her data and analysis. In the present case the questionnaire was launched at a conference, where it could be possible to find the identification of the students present. At the same time, there were more than 200 students present and the questionnaire was anonymous, so it is not probable that a response profile would be connected with a certain student.



## 4. Results and summary of research articles

The two research articles that make up the dissertation may be seen to correspond to both the research aim in a broad sense and to the research questions addressed in the empirical study in a specific sense. The first article is concerned with the field of education for sustainable development and foregrounds epistemic issues in relation to this type of education. The second article reports the results of a study embedded in such an educational context where data were gathered from the participating students. Both articles were published in 2014.

### 4.1 A phronesian strategy to education for sustainable development in Swedish school curricula

By focusing on the concept of sustainable development in the four syllabuses of Geography, History, Religious Education and Civics in the new Swedish curriculum for compulsory school we set out to capture its interpretability. Bernard Williams's notion of thick and thin concepts is applied in this interpretation according to which a thin concept is either purely descriptive or purely evaluative. By contrast a thick concept will be both. Sustainable development would seem to belong to the thick category due to its being theory-laden by various political and ethical theories. Furthermore the distinction between thick and thin concepts can be addressed by using Kotzee's labels world-guidedness and action –guidingness. Sustainable development would seem to convey something true about the world which will justify certain ideas held by the believers. Action-guidingness rather works towards the practical consequences of the world-guidedness. Both dimensions are related to thick concepts.

Two processes are connected to the world-guidedness and the action-guidingness, a justification of belief and a justification of action. With a

holistic perspective these existential dimensions in life, believing and acting, are juxtaposed.

The pluralistic use of the concept of sustainable development in the four syllabuses of social sciences can be related to the definition of the concept as well as to the action required by it. There seems to be a tension between the knowledge base *about* and the development of practical knowledge *for* sustainable development. How explicit the notion of action is in the syllabuses vary. The wordings of the subject of Religion may be interpreted as pointing to an ethical relevance, but demands with reference to an action competence are lacking. In the subject of History nothing is indicated when it comes to the question about how to act practically. In Civics, questions concerning democracy and human rights are foregrounded. The societal perspectives relevant to sustainable development are made visible throughout the content of the syllabus, which nevertheless does not make concepts of action and action competence explicit. In the syllabus of Geography the conditions for life are depicted as changeable and vulnerable. It is stated that it is the responsibility of all to support sustainable development and thereby act in a way to reduce the risk of damage.

Aristotle's notion of phronesis, practical wisdom, can be claimed by anyone who "can see what is good for themselves and what is good for men in general. Bent Flyvbjerg uses the term phronetic social science which concerns how to act and understand in a particular situation with the ultimate end of improving society. Phronesis is so to speak contextualized and true in a particular situation.

A Phronesian strategy to the education for sustainable development would mean that students keep a critical attitude to the justification of belief, which in turn will provide the justification for doing, the so-called action knowledge. As Flyvbjerg points out the end of practical wisdom (phronesis) is to improve society. The action or practical knowledge suggested by the syllabuses of Geography, Religious Education, History and Civics in the Swedish curriculum seem to be mainly of an analytical quality, mainly cognitive. It seems relevant to move the students from a state of awareness to an aptitude for action with action as an intrinsic quality of phronesis.

The authors of article 1 are PhD-student Marie Grice and associate professor Olof Franck. Whereas Franck focused on describing the writings regarding sustainable development in the syllabi, Grice contributed to a large extent by applying the analytical concepts of thick and thin, understood as

world-guided and action-guiding respectively as well as suggesting the Phronesian strategy to the education of sustainable development.

## 4.2. Epistemic beliefs and knowledge creation among upper-secondary students in transdisciplinary education for sustainable development

This study examines the epistemic beliefs of upper-secondary school students (n=208) involved in a transdisciplinary project regarding sustainable development. Specifically the dimensions of knowledge and knowing are explored and interpreted through a questionnaire, the Survey of Epistemological Beliefs in Transdisciplinary Education (SEBTE). A three-dimensional framework underpins the self-report paper-and-pencil questionnaire.

Results from exploratory factor analysis suggest five factors or dimensions: Transdisciplinary knowledge, Quick knowledge, Certain knowledge, Simple knowledge and Collaborative knowledge. In the first factor – transdisciplinary knowledge - knowledge is seen as complex, evolving and even partially contradictory. It speaks of an evaluative epistemology in which expert authority is recognized but looked at in a critical manner. The dimension seems to concern the structure and the source of knowledge. There is a strong individualistic sense in this factor, the capacity of the subject to create knowledge in and out of school.

The second factor – quick knowledge (learning in Schommer) - is a dimension found by previous instruments. Learning quick and the speed of knowledge acquisition concerns how you come to know, quickly or not at all. It could be interpreted as a determiner of knowledge. Quick and effortless learning will bring about knowledge.

The third factor - certain knowledge - was a dimension gained by Schommer (1990). It appears to comprise dimensions concerning the source and justification\_of knowledge. School and research are seen as the basis for what is knowable. There is an answer to all questions and you can find it. Knowledge is static and unchanging. You come to know through transmission. There is a sense of reproduction rather than creation.

## EPISTEMIC BELIEFS

The fourth factor - simple knowledge - was a dimension also established by Schommer (Schommer, 1990). In fact two of Schommer's factors are merged in this factor; simple knowledge and innate ability. Simple knowledge suggests correct choices, right or wrong answers and seems to concern the structure of knowledge. It is related to the innate ability of coming to know. It displays a belief in school as a place to learn stable knowledge.

The fifth factor – collaborative knowledge - associates issues that might be referred to as *collaborative knowledge*, which one might argue could belong to the dimension of the structure of knowledge. Peers play a significant role in the creation of knowledge and integration of knowledge. Knowledge resides outside and between the subjects.

Table 3. Factors from EFA and dependent variable for MRA

<b>Factors rendered in EFA</b>	<b>Item number in SEBTE</b>	<b>Item means</b>	<b>Cronbach's Alpha</b>	<b>Cronbach's Alpha if Item Deleted</b>
TD Knowledge	8, 14, 24, 11, 7, 23, 12, 19	4.905	.766	.730-.753
Quick knowledge	20, 9, 26, 25, 18	2.933	.681	.602-.654
Certain knowledge	5, 10, 17, 2, 1	3.603	.607	.501-.591
Simple knowledge	15, 13, 3, 4, 16	3.886	.552	.430-.525
Collaborative knowledge	21, r22, 6	3.472	.461	.202-.365
Project evaluation-dependent variable (MRA)	B1, B2, B3, B4, B5, B6	4.142	.823	

*The five factors rendered by exploratory factor analysis and project-evaluation as dependent variable for multiple regression analysis. Items from the A-section in SEBTE are reported with numbers only. Items from the B-section are preceded by the letter B.*

The Cronbach's Alphas are satisfactory but not very high. Despite this the inter-item reliability does not increase should any of the items that make up the factors be deleted. The span of Alpha values are if any of the items should be deleted is reported for each factor.

These factors were used in a subsequent stepwise multiple regression analysis. Five index variables were computed out of the standardized variables associated with each factor and used as independent variables together with dummy variables of gender, age and education program. The dependent

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variable was computed of the five context-specific items of the questionnaire, the students' evaluation of the whole project. In a stepwise regression analysis, one independent variable is entered at a time, starting with the most significant one. Three of the factors from the exploratory factor analysis were most significant in a positive way: *collaborative knowledge*, *transdisciplinary knowledge* and *certain knowledge*. The seventh and final model is presented below in table 4.

Table 4 Multiple regression analysis, stepwise, model 7

Independent variables	Standardized B coefficients	Standard error
Collaborative knowledge	.412***	(.300)
Transdisciplinary knowledge	.337***	(.299)
Certain knowledge	.221***	(.300)
Male	-.102	(.669)
Quick knowledge	-.190**	(.305)
Techno-Scientific students	-.191**	(.711)
Simple knowledge	.140*	(.310)

*Dependent variable: Sustainable development project evaluation.\*\*\*=p<.001. \*=p<.05*

*Model 1-model 7: Intercept: 20.712 -- 21.849, Adjusted R<sup>2</sup>: .158 -- .411*

According to this analysis, three dimensions<sup>3</sup> of epistemic beliefs have a positive impact on the students' appreciation of the school project, whereas variables male and techno-scientific students had a negative impact. The significance of male was significant in earlier steps of the model building, but not in the final one. This result might suggest that students who think that knowledge is quick and effortless will not appreciate the educational project. There also seems to be a difference between students on the socioeconomic programmes and students on the techno-scientific programmes. The latter loaded negatively on the dependent variable. However, the dimensions of epistemic beliefs seem to have more significance than the background factors. Finally the transdisciplinary education for sustainable development can be

<sup>3</sup> Throughout the dissertation dimensions, factors and components may seem to be used interchangeably. That is to some extent the case. However, principal component analysis is the correct name of the exploratory factor analysis that is applied in the analysis. As factor analysis is such a well-known concept I occasionally use factor instead of component. A third term is also used in this context, namely dimension. One might argue that factor or component are empirical terms and dimension conceptual as those are the ones referred to in the theoretical frameworks of epistemic beliefs.

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understood in terms of the learning metaphor of knowledge creation and it is suggested that epistemic beliefs interrelate with the educational project and transdisciplinarity. For educational practice, for both in-service and pre-service teachers awareness of epistemic beliefs can be useful to understand students' success and shortcomings. In ESD it could also prove important what epistemic beliefs students have when it comes to organizing the education.

## 5. Discussion

As stated in article 1 sustainable development is a concept which lends itself to pluralistic interpretation, which was supported by the close-reading of four syllabuses in the Swedish national curriculum for compulsory school. Various interpretations were offered by the syllabuses of Geography, Civics, Religious Education and History with varying degrees of references to action, practical knowledge and action competence in the expected outcome. Thus, the syllabuses not only refer to what students should know about sustainable development, they also address what the individual should do and consequently supply reasons why, e. g. expressions about the vulnerability of the planet. One criticism raised in article 1 is that the writings in the syllabuses might benefit from going beyond the focus of the individual. In other words, what the individual should learn about sustainable development, and what he or she needs to do requires a phronesian strategy, according to which the individual develops a competence which could be described as a readiness for action according to the role of responsibility of the individual as part of a group, a community or society. The discussion of the findings is underpinned by a social aspect of sustainable development, as the choice of syllabuses fall within social sciences. Furthermore, knowledge in the field of ESD is looked at as a social aspect. It is the knowledge as process which is at focus. It seems that this particular focus will reject the aspect of the individual and rather fathom the group or the individual as part of the group as the unit of analysis.

One way of understanding the pluralistic interpretability of sustainable development as displayed by the syllabuses is that the concept has a complex character and evades any attempt to pin it down in a set definition. Instead of seeing this as an issue or a problem for education, it could be seen as an expression of the notion of multi- or interdisciplinarity that is propounded in the Swedish curriculum. The four school subjects concern themselves with the same object of knowledge, sustainable development, but approach it differently.

In article 2 an educational context, which is more radically organized and could be denoted transdisciplinary education for sustainable development

made up the setting of the empirical study. In order to investigate how students orient themselves in such a context, their epistemic beliefs were examined through a survey developed within the research project, SEBTE. Although statistical analysis is applied, it is the intention of this dissertation to keep an exploratory attitude. In order to construct the survey, three dimensions of epistemic beliefs were proposed. Five dimensions came out of the exploratory factor analysis (EFA). The number of dimensions corresponds to what was initially reported by Schommer (1990), although she later claimed that there are four dimensions in her model. Finally in 1994, she returns to the five-dimension model (Clarebout, et.al., 2001). With an exploratory attitude to dimensions, a specific number of dimensions are not looked for in the data. The dimensions are rather understood as the voices of the data, which are embedded in a particular educational project. If one looks at the data more qualitatively, an EFA could be seen as a way to find the categories within the data. Of the five dimensions that came out of SEBTE, two are categories that deviate from Schommer and Hofer and Pintrich, namely Transdisciplinary (TD) knowledge and Collaborative knowledge. In the EFA these two dimensions came out as the first, and the last. The first one is manifested through 8 items, four of which are items unique for SEBTE. The last one is manifested through 3 items, all of which are items unique for SEBTE. This might be interpreted as if I found what I set out to look for. However, the manifested dimensions are more than the ones I had proposed, which in turn might be explained for in another manner. It is possible that the proposed dimensions and the manifested dimensions do not operate on the same level of the mind.

The dimensions Collaborative knowledge (CK) and Transdisciplinary knowledge (TDK) proved to be most important in the following stepwise multiple regression analysis. Although CK is the smallest one of the five, it turns out to have the most impact on the result, the evaluation of the school project. At each step of the construction of the regression model another variables is added. In the last model, number 7, it could be interpreted as if the belief that knowledge is quickly developed without any effort, loads negatively on the dependent variable. That is also the case with techno-scientific field of study. From this result it is possible to theorize that the belief quick knowledge will have a negative effect on how students orient themselves in complex educational contexts for sustainable development. The amount of work needed from the student is probably large as the teacher most likely will



adopt a more supervisory role. As far as the field of study is concerned, it might be possible to find that the concept of knowledge within a specific school subject or discipline will favour a belief such as quick knowledge. Two background variables enter the model. Sex, male, has significance through three models but not in the last one. Techno-scientific programme (field of study) is negatively related. Age is a background variable that does not enter the model at all. In the stepwise model building the three dimensions of epistemic beliefs; collaborative knowledge, transdisciplinary knowledge and certain knowledge make up the top. It is interesting to notice that epistemic beliefs seem to have a more powerful effect on the dependent variable in comparison to the background variables. See table 4, page 45.

Regarding competences related to the discourse of sustainability three knowledge clusters surface: strategic, practical and collaborative (Brundiers, Wiek, & Redman, 2010). Should these competences be seen as the expected outcomes of ESD outcomes, it seems to be possible to relate these competences to the dimensions of transdisciplinary knowledge and collaborative knowledge which stood out in the present study. The dimensions transdisciplinary knowledge and collaborative knowledge could be explored through concepts such as, individual agility, flexibility and reflexivity. In both dimensions knowledge is seen as something external, something that can be shared and participated. Transdisciplinary knowledge could moreover be related to as a competence. It seems to be a competence that would make it possible to handle ill-structuredness. It addresses the role of the individual and the group in relation to an ill-defined problem. An interesting distinction between the two dimensions is the individual aspect of transdisciplinary knowledge and the group aspect of collective knowledge.

### 5.1. Knowledge creation - a learning metaphor

In the process of interpreting the educational context, which is the setting of the study, the metaphor of knowledge creation can be explored as a way of addressing both transdisciplinarity and sustainable development. It is assumed that the educational project *Food!* can make knowledge creation possible. Knowledge creation is a metaphor of learning with roots in organizational studies, which draws attention to epistemic issues in educational research and practice. Hakkarainen and Paavola (2005) address this metaphor by comparing it to the learning metaphors of acquisition and participation (Sfard, 1998, p.

5). In a simplified way, one could argue that the acquisition metaphor of learning sees the individual as the unit of knowing. It is the traditional metaphor of learning in which knowledge is transmitted or even given to the individual. The notion of gift is present and apparent in such linguistically set phrases as gifted students. Knowledge is objectified and manageable in a linear and production-type of manner. Despite this, the acquisition metaphor should not be understood as a necessarily passive one. Knowledge can be said to be actively constructed by the individual. It can also be applied and used. In the acquisition model knowledge is looked upon as an outcome of a process and something that is transferable (Paavola, Lipponen, & Hakkarainen, 2004).

By contrast the unit of knowing in the participation metaphor is not the individual but a group or society. Knowing is participating in a social process, becoming a member of a community. The focus is on learning as participation and shared activity. It is the knowing as a process rather than knowledge as a product that is approached. Despite this, participation is not an unproblematic metaphor. For example there is resistance to participation, which is also an activity of participation, although the process is not the one intended in the enactment of education.

In an attempt to breach the gap between the two metaphors, which Hakkarainen and Paavola (2005) find is called for in a knowledge society, they propose a third metaphor of learning, that of knowledge creation. Knowledge creation both combines and surpasses the previous metaphors as the unit of knowing are “[I]ndividuals and groups creating mediating artifacts within cultural settings” (Hakkarainen & Paavola, 2005, p. 541). As a metaphor of learning it opens up for various interpretations, not the least when it comes to the understanding of collective knowledge and action knowledge. The knowledge-creation metaphor is worth exploring for its educational implications. What processes of learning are involved in a sustainable-development project? What processes of learning does our knowledge-based society require? The intention here is not to suggest the answers to these questions. Instead, this metaphor of learning can be seen as the backdrop of a sustainable development project in which students’ epistemic orientations are approached.

The students in the present study produced a mediating artifact, by publishing a book on food, and a conceptual artifact in terms of sustainable development. Sustainable development can be understood as belonging to the epistemic object category (Lund & Hauge, 2011), a theoretical construct,

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which lends itself to the knowledge-creation learning metaphor. An epistemic object typically focuses on issues that are beyond the individual's knowledge and understanding. I interpret this notion of object to follow a centrifugal movement. The object is characterized by a material and an ideational aspect. With reference to Kaptelinin (Lund & Hauge, 2011) the object carries both a material aspect, which projects an external world on the mind and an ideational aspect, predmet in Russian, which seems to refer to how the object is formed by and gives direction to activities. This analysis tallies with the thick and thin concepts as world-guided and action-guiding (Grice & Franck, 2014) used in article 1. In the latter analysis, the unit of analysis is the concept of sustainable development, in the former the mediating object of an activity.

The broad research aim of this dissertation takes an interest in epistemic issues of what is hypothesized and modelled in Figure 1 below.

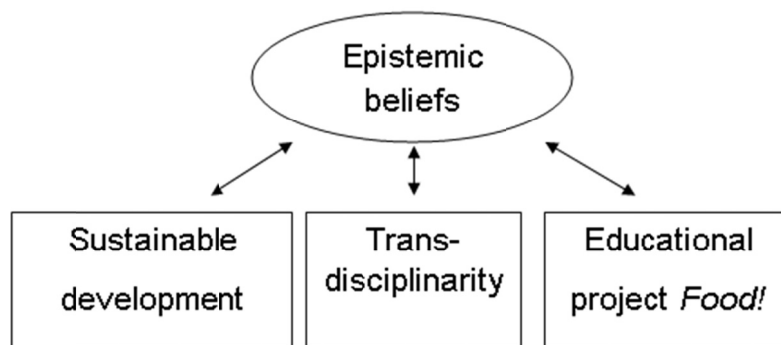


Figure 1: Model of foci in the research project

*A suggested model of how epistemic beliefs may be set in play in relation to the educational context, the educational project Food!, transdisciplinarity as embedded in the organization of the educational project and sustainable development as a field of study for the educational project.*

The model suggests that the epistemic beliefs may on the one hand influence how the students orient themselves in relation to the field of study, sustainable development, in relation to how education is organized, transdisciplinarity and in relation to the more explicit educational project *Food!* with the production of text for a book to be published. In transdisciplinary approaches, boundaries are crossed and multiple disparate discourses and practices are integrated and something new is generated in the interchange of existing discourses and practices due to their differences. This new corresponds to what in the learning metaphor of knowledge creation is

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achieved, which I interpret to be new, in the sense, other than what already exists. The two-way directed arrows indicate that the causal effects could go in either or both ways. However, how epistemic beliefs develop or how they help students approach various complexities of the educational setting cannot be explained by the current study. Given the interpretability of the three components of the present project: epistemic beliefs, sustainable development and transdisciplinarity; an empirical-holistic hermeneutic analysis is called for. The intention is not to stop at the statistical analysis but to move the analysis further by an interpretative approach.

The epistemic beliefs or dimensions that came out of the EFA are clarified through *philosophizing with*, but they can also be understood to some extent to learning theories: constructivist and collaborative. Although the intention of the dissertation is to take a philosophical stance, epistemic dimensions such as those relating to knowing will as a rule relate to the acquisition of knowledge. Therefore the proposed dimensions that in this study belong to the philosophical branch rather than psychological could very well render dimensions that cannot be categorized as relating solely to knowledge. Despite this the overall notion of the study relates to the epistemic and the dimensions of such beliefs.

## 6. Conclusion

In conclusion, what can educational practice do with the knowledge contribution of this dissertation? What do I as a researching teacher now *know*? From the result of the survey, it is not possible to *see* what students know about sustainable development, but it is possible to see what they *believe* knowledge is. That knowledge could be a relevant aspect for educational practice in general and in making knowledge creation possible in particular. As inter- or transdisciplinary project work is a form of education that is encouraged by the Swedish national curriculum, presumably a considerable part of students, teachers and principals throughout Sweden are involved in transdisciplinary education, not the least in the education for sustainable development.

The challenges of education for sustainable development can be on a conceptual level or on a pragmatic level. There is the visionary as well as the risk of indoctrination to consider. A phronesian strategy suggests a way to address these challenges. By introducing the knowledge creation metaphor of learning for understanding the educational practice of sustainable development, teachers may rethink and expand their own conceptions of knowledge and knowing. Further, the awareness of the impact of epistemic beliefs on educational achievement could potentially motivate teachers to challenge their students and to discuss the epistemology of their specific school subject (Kaaritinen- Koutaniemi & Lindblom-Ylänne, 2012). Based on the specific results of SEBTE questionnaire, teachers on the Technical programme might have reason to critically look at how the subject of sustainable development is taught, how students on the programme seem to understand it and how teachers at the programme choose to organize the education. With the knowledge of students' epistemic beliefs, teachers could aim to alter instruction with the intention of making possible a change in students' epistemic beliefs, should they not correspond to the dimensions of knowledge put forward in the national curriculum. Awareness and knowledge about epistemic beliefs could provide the basis needed for teachers' and other educators' action in the classroom.

For curriculum developers and teachers in general it might also be relevant to find out how the epistemic beliefs surfacing in the exploratory factor analysis correspond to the writings regarding knowledge in the national curriculum. For educators, the administration of a reliable and valid instrument based on SEBTE dimensions could yield results that would be beneficial in the tailoring of learning tasks. It could be used both individually and on a group basis.

## 6.1 Suggestions for further research

Repeated studies using the SEBTE questionnaire are suggested to establish its psychometric properties and practical applications. An interesting aspect would be whether the manifested dimensions in the present study are consistent or not among a similar group of respondents who are not involved in transdisciplinary education. This might reveal something about the domain-general property of the instrument. The instrument could also be used with teacher students or in-service teachers, to explore similarities across students and teachers. This result could be the basis for further *philosophizing with* aspects of knowledge.

The data of the empirical study could be further analysed. Initial statistical analysis has suggested five factors in an exploratory factor analysis, three of which correspond to Schommer's dimensions (1990) Confirmatory factor analysis together with Latent cluster analysis could be applied(LPA). See Magidson & Vermunt for a complete description (2004). This would produce clusters or groups that could reveal more about the impact of background variables such as educational programme, gender and age.

For the field of education for sustainable development the SEBTE questionnaire could be used in further empirical studies to investigate the relatedness between sustainability competences and epistemic beliefs.

## 7. Summary in Swedish

Licentiatuppsatsen är en sammanläggning av två forskningsartiklar som fokuserar kunskapsteoretiska dimensioner konceptuellt och empiriskt. I den första artikeln *A Phronesian Strategy to Education for Sustainable Development in Swedish School Curricula* undersöks begreppet hållbar utveckling i fyra ämnesplaner inom samhällsorientering i grundskolans läroplan Lgr 11. Ämnena samhällskunskap, historia, geografi och religion uppvisar en pluralistisk tolkning av begreppet och dess praktiska betydelse i en undervisningskontext. För att analysera begreppet används Bernard Williams *thick and thin concepts* i förhållande till Kotzees *world-guidedness* och *action-guidingness*. Begreppet hållbar utveckling kan förstås som ett tjockt begrepp som såväl förhåller sig till och påverkas av något verkligt i världen samt utövar ett rättsnöre för handling. Ämnesplanerna i de fyra SO-ämnena uppvisar olika grader av praktisk kunskap, men i första hand en mer kognitiv eller analytisk kunskap. Genom att föra in Aristoteles begrepp *fronesis* eller praktisk vishet föreslås en undervisningsstrategi som utgår från kritisk hållning som grund för antagande – *justification of belief*, vilken i sig blir grunden för handling – *justification for doing*. Syftet med fronesis är att förbättra samhället.

Den andra forskningsartikeln *Epistemic beliefs and knowledge creation among upper-secondary students in transdisciplinary education for sustainable development* tar sin utgångspunkt i en undervisningskontext som till sin konstruktion är transdisciplinär och till sitt innehåll handlar om hållbar utveckling. Gymnasieelever (n=208) från 14 gymnasieskolor och 2 folkhögskolor skrev och publicerade en bok om temat Mat. Det kunskapsteoretiska intresset för denna undervisningskontext baseras på antagandet att elevers miniteorier om kunskap och kunnande *epistemic beliefs* sätts i spel på grund av komplexiteten, dels i hur undervisningen är organiserad, dels i själva ämnet, kunskapsobjektets pluralistiska och ibland konfliktartade tolkningsbarhet.

Det finns en rik flora internationella studier kring 'epistemic beliefs' och deras betydelse för motivation samt förståelse av s.k. *ill-structured problem*, komplexa problem som t.ex. hållbar utveckling. Däremot har jag inte funnit några svenska motsvarigheter. Det teoretiska ramverket för den föreliggande

studien närmar sig Hofer & Pintrich (1997) med en mer filosofisk ansats än Schommer (1990) som även hade med undervisnings- och lärandedimensioner i sitt ramverk. För att kunna inhämta kunskap om elevernas miniteorier om kunskap och kunnande har jag tagit fram ett tvådelat enkätinstrument, *Survey of Epistemic Beliefs in Transdisciplinary Education*, SEBTE. Första delen samlar in kunskap om elevernas generella åsikter om kunskaper och kunnande. Andra delen är ett resultat i form av en utvärdering av projektet. Tre epistemologiska dimensioner föreslogs utgöra ramverket för första delen av enkäten; kunskapens struktur, kunskapens ursprung, kunskapens legitimitet. Instrumentet kontextualiserades genom tre tidigare använda instrument och har föregåtts av en serie pilotstudier.

De statistiska analyserna i IBM SPSS version 21 utgjordes av explorativ faktoranalys (EFA) följt av stegvis multipel regressionsanalys (MRA). Den explorativa faktoranalysen handlar i första hand om att identifiera de underliggande dimensionerna eller faktorerna som utgörs av den samvarians som finns mellan de manifesta variablerna. Explorativ faktoranalys stöder en femfaktoriell lösning, varav två stämmer väl överens med Schommers resultat:

- Transdisciplinär kunskap
- Säker kunskap
- Snabb kunskap
- Kollaborativ kunskap
- Enkel kunskap

Namngivandet av dimensionerna knyter an till de teoretiska modellerna Schommer, Hofer och Pintrich m fl.

I en efterföljande multipel regressionsanalys (MRA) undersöktes korrelationen mellan flera olika variabler. De fem faktorerna/dimensionerna gjordes om till summavariabler och matades in som oberoende variabler. Bakgrundsfaktorerna ålder, programtillhörighet och kön lades in som dummyvariabler. Utvärderingsfrågorna i enkäten, del B, gjordes om till en summavariabel som fick utgöra beroendevariabeln. Genom MRA framkom vilka oberoende variabler som hade en signifikant effekt på den beroende variabeln, dvs projektutvärderingen. Det visar sig att kollaborativ kunskap, transdisciplinär kunskap samt säker kunskap hade direkt påverkan på den beroende variabeln som utgörs av elevernas utvärdering av projektet Mat! I den sista modellen, nr 7, visade det sig att elever med uppfattningen att kunskapen kommer till en snabbt eller inte alls, samt elever inom naturvetenskap och teknik laddar negativt på projektutvärderingen. Detta



skulle kunna tyda på att tron på snabb kunskap har en negativ effekt på hur eleverna orienterar sig i en komplex undervisningssituation om hållbar utveckling. Mängden arbete som krävs av eleven är förmodligen större på grund av att läraren handleder elevens egna initiativ och urval av kunskapsstoff. Resultatet skulle också kunna tyda på att det inom de naturvetenskapliga/tekniska programmen förekommer en kunskapssyn som främjar en tro på att du antingen kan eller inte kan ett ämne, t ex matematik. I de tidigare stegen av MRA när inte alla oberoende variabler ingår har könstillhörigheten *man* också signifikans. Den försvinner när ännu fler variabler ingår. Resultatet visar dock att starkast genomslag har miniteorierna om kunskap och inte bakgrundsfaktorerna.

I analysarbetet används även Dohns begrepp *filosofera med*, som förgrund eller bakgrund. Det innebär att filosofi får framkomma med en egen röst i analysarbetet av empirin om kunskapsdimensionerna. Tanken är att filosofera med kan tillföra ett visst förklaringsvärde och få betydelse för en undervisningspraktik. I diskussionen kring både kunskapsobjektet, hållbar utveckling och undervisningens organisation i projektet Mat förs lärande eller snarare kunskapsmetaforen *knowledge creation in*. Metaforen har en bakgrund inom organisationsstudier. Hakkarainen och Paavola (2005) använder sig av denna metafor i en utbildningsvetenskaplig kontext genom att jämföra den med de mer traditionella metaforerna, överföring och deltagande (Sfard 1998).

För att överbrygga gapet mellan dessa två metaforer föreslår Hakkarainen och Paavola kunskapsskapande som en lämplig lärandemetafor i ett kunskapssamhälle. Metaforen förenar och överträffar de båda nämnda metaforerna. Här är kunskapsenheten *individuals and groups creating mediating artefacts within cultural settings* [individer och grupper som skapar medierande artefakter inom kulturella miljöer] (Hakkarainen & Paavola, 2005, p. 541).

Vad kan slutligen en undervisningspraktik göra med den kunskap som producerats av föreliggande licentiatuppsats? Lärare kan få kunskap om betydelsen av miniteorier av kunskap och kunnande för motivation och inläring generellt samt undervisning om hållbar utveckling med ett radikalt interdisciplinärt eller transdisciplinärt undervisningsgrepp. Hur elevers miniteorier påverkas av eller påverkar en komplex undervisning kan inte avgöras av det empiriska arbetet i projektet, men en medvetenhet om möjligheten till denna påverkan och föränderlighet kan ha betydelse för såväl läroplansutveckling som planering och genomförande av liknande undervisning. För forskningen inom utbildningsvetenskap kan instrumentet –

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SEBTE – användas igen för att ytterligare förbättras. Elevers miniteorier om kunskap och kunnande kan ses som kunskap om ett elevperspektiv på undervisningen. Det har betydelse inte bara för lärare och utbildare utan även för eleven själv. Genom en diskussion i undervisningen i enskilda ämnen om kunskapens dimensioner kan såväl ett kritiskt förhållningssätt som en transdisciplinär förmåga utvecklas.

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## **Part Two – Research articles**

Article 1 A Phronesian Strategy to  
Education for Sustainable  
Development in Swedish School  
Curricula

<http://jsd.sagepub.com.ezproxy.ub.gu.se/content/8/1/29.full.pdf+html>

Article 2 Epistemic beliefs and  
knowledge creation among upper-  
secondary students in transdisciplinary  
education for sustainable development

<http://urn.kb.se/resolve?urn=urn:nbn:se:kau:diva-33315>