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LEARNING OF QUANTITATIVE RESEARCH METHODS

– University Students' Views, Motivation, and Difficulties in Learning

by

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MURTONEN, MARI: Learning of quantitative research methods - University students' views, motivation and difficulties in learning

Abstract

The aim of this dissertation was to study the difficulties that some students of education, psychology and social science experience in their quantitative research courses at university. The problem is approached from the perspectives of anxiety studies, studies on conceptions and beliefs, orientations in learning situations and theories of conceptual change.

In Study I, it was found that research, especially quantitative methods and statistics, appeared to be more difficult for education and sociology students to learn than other academic subjects, for example their major subject studies and language studies. The students reported difficulties with superficial teaching, linking theory with practice, unfamiliarity with and difficulty of concepts and content, constituting an integrated picture of the parts of scientific research in order to really understand it, and negative attitude toward these studies

By selecting less and more advanced students with the questionnaires developed on the basis of Study I, it was found in Case Study II that anxious students' concept map of research, drawn in an interview situation, was more fragmented than the concept maps of less anxious students and experts. On the basis of Case Study II, it could be hypothesised that difficulties experienced are connected to students' content knowledge.

It is often assumed that the difficulties experienced in the learning of quantitative methods and statistics could reflect earlier bad experiences with learning of mathematics. Study III revealed that the high school mathematics grade was only partly associated with difficulties experienced. A belief in one's low ability in mathematical subjects was connected to other difficulties experienced in the learning of research, so there is a mathematical factor involved in difficulties in learning of quantitative methods. Difficulties experienced were not related to success in university statistics or research courses, as has also been shown in previous studies.

In Study IV, different views on research methods were found in Finland and USA with regard to students' appreciation of quantitative, qualitative, empirical and theoretical methods. Students could be said to have different research orientations toward methods, meaning a combination of appreciations of, and readiness to use certain methods. Some of the students had a dichotic attitude toward quantitative and qualitative methods; they seemed to "choose their side" between these methods. In both countries, a negative research orientation toward quantitative methods was found which was associated with a positive view on qualitative methods. This qualitative research orientation was connected in some Finnish students with difficulties in learning of quantitative methods. When asked about difficulties experienced in learning of quantitative methods, 58% of the Finnish students and 21% of the US students reported such difficulties

Study V looked at students' views on the need for research skills in their future working life in comparison to their motivational and learning orientations and difficulties experienced in learning of quantitative methods. It was found that in both Finland and the U.S.A., the students who were not convinced that they would need research skills in their future work, were less task- and deep-oriented in their study situations, and experienced more problems with learning than the students who agreed that they would need research skills.

Together, these five studies showed that students' difficulties experienced in quantitative methods courses, research orientations and motivational factors, do constitute an interconnected web that may also have implications for content learning and to students' views of the importance of research skills for their future work.

Keywords: Learning of research methodology, learning of quantitative methods, statistics anxiety

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MURTONEN, MARI: Kvantitatiivisia tutkimusmenetelmiä oppimassa - Yliopisto-opiskelijoiden näkemykset, motivaatio ja vaikeudet oppimisessa

Tiivistelmä

Tässä väitöskirjassa tutkittiin kasvatustieteen, psykologian ja sosiaalitieteiden opiskelijoiden kokemia vaikeuksia yliopistojen kvantitatiivisten menetelmien kursseilla. Ongelmaa lähestyttiin tilastopelkojen, tutkimuskäsitysten ja -uskomusten, oppimisorientaatioiden ja käsitteellisen muutoksen tutkimusten näkökulmista.

Tutkimuksessa I havaittiin, että kasvatustieteen ja sosiologian opiskelijat kokivat tutkimustaitojen opinnot, erityisesti kvantitatiiviset menetelmät ja tilastotieteen, vaikeampina kuin esimerkiksi pääaineopinnot ja kieliopinnot. Ongelmina koettiin opetuksen pinnallisuus, teorian ja käytännön yhdistäminen, käsitteiden ja sisältöjen vieraus ja vaikeus, tutkimuksen kokonaisuuden hahmotus, sekä oma negatiivinen asenne.

Tapaustutkimuksessa II selvitettiin parihaastattelulla opiskelijoiden kokemien vaikeuksien mahdollista yhteyttä sisältöoppimiseen. Haastattelutilanteessa aiheesta 'tutkimus' piirrettyjen käsitekarttojen perusteella kahden vaikeuksia kokeneen noviisiopiskelijan käsitys tutkimuksesta oli paljon hajanaisempi kuin kahden pidemmälle edenneen opiskelijan ja kahden ammattitutkijan.

Tilastopelkojen ja tutkimuskursseilla koettujen vaikeuksien selittäjäksi ehdotetaan usein huonoja kokemuksia aiemmissa matematiikan opinnoissa. Tutkimuksen III perustella lukion matematiikan numero oli vain osittain yhteydessä vaikeuden kokemuksiin yliopiston tutkimusmenetelmäkursseilla. Heikko usko omiin kykyihin matemaattisten aineiden oppijana oli yhteydessä muihin koettuihin vaikeuksiin tutkimustaitojen oppimisessa, joten matemaattisen osatekijä on läsnä vaikeuksien kokemuksessa. Koetut vaikeudet eivät olleet yhteydessä kurssiarvosanoihin yliopistossa.

Tutkimuksessa IV selvitettiin suomalaisten ja yhdysvaltalaisten opiskelijoiden näkemyksiä kvantitatiivisista, kvalitatiivisista, empiirisistä ja teoreettisista tutkimusmenetelmistä, sekä valmiuksia käyttää menetelmiä ja niiden oppimisessa koettuja vaikeuksia. Opiskelijoilta löydettiin erilaisia tutkimusorientaatioita, eli menetelmien arvostusten ja käyttövalmiuksien yhdistelmiä. Molemmista maista löytyi ryhmä opiskelijoita, joilla oli heikko arvostus kvantitatiivisia menetelmiä kohtaan ja matala valmius käyttää niitä. Tämä oli yhteydessä korkeaan kvalitatiivisten menetelmien arvostukseen ja valmiuteen käyttää niitä. Näillä opiskelijoilla voidaan sanoa olleen kvalitatiivinen tutkimusorientaatio. Osalla opiskelijoista se oli yhteydessä vaikeuksiin kvantitatiivisten menetelmien oppimisessa. Suomalaisista 58% ja yhdysvaltalaisista 21% raportoi vaikeuksia tutkimusmenetelmien opinnoissa.

Tutkimuksessa V kysyttiin suomalaisten ja yhdysvaltalaisten opiskelijoiden näkemyksiä tutkimustaitojen tarpeesta heidän tulevassa työelämässään. Noin puolet opiskelijoista oli epävarma näiden taitojen tarpeesta. Nämä opiskelijat kokivat enemmän vaikeuksia tutkimusopinnoissa ja he eivät olleet niin tehtävä- ja syväorientoituneita opiskelutilanteissa kuin ne opiskelijat, jotka uskoivat tutkimustaitoja tarvittavan työelämässä.

Nämä viisi tutkimusta osoittavat, että opiskelijoiden tutkimusmenetelmäkursseilla koetut vaikeudet, tutkimusorientaatiot ja motivationaaliset tekijät ovat yhteydessä toisiinsa ja myös heidän näkemyksiinsä tutkimusmenetelmien tarpeesta tulevassa työssään.

Asiasanat: Tutkimusmetodologian oppiminen, kvantitatiivisten menetelmien oppiminen, tilastopelot

CONTENTS

LIST OF ORIGINAL PUBLICATIONS

This dissertation is based on the following original publications, referred to in the text by their Roman numerals:

I. Murtonen, M., & Lehtinen, E. (2003). Difficulties experienced by education and sociology students in quantitative methods courses. *Studies in Higher Education, 28*(2), 171-185.

II. Murtonen, M., & Merenluoto, K. (2001). Novices' and experts' knowledge on statistics and research methodology. *Proceedings of the 25th Psychology of Mathematics Education conference,* vol 3, pp. 391-398.

III. Murtonen, M., & Titterton, N. (2004). Earlier mathematics achievement and success in university studies in relation to experienced difficulties in quantitative methods courses. *Nordic Studies in Mathematics Education, 9*(4), 3-13.

IV. Murtonen, M. (2005). University students' research orientations - Do negative attitudes exist toward quantitative methods? *Scandinavian Journal of Educational Research, 49*(3), 263-280.

V. Murtonen, M., Olkinuora, E., Tynjälä, P., & Lehtinen, E. (Submitted). "Do I need research skills in working life?" – Students' motivation and difficulties experienced in quantitative methods courses.

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If I think of research as a journey, conducting this dissertation research has been a wonderful and challenging experience. During my master's studies, I became interested in the question of why some things are more difficult to learn than others. I noticed many fellow students saying, and maybe also thought so myself, that quantitative methods are among those things that are hard to learn. When Professor Erno Lehtinen offered me a research topic for my master's thesis about the learning of research, I was immediately interested in it. It sounded challenging, but fascinating. And that is what it still is for me.

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Professor Erno Lehtinen has encouraged and supported me to take part in conferences from the very beginning of my doctoral studies. In the EARLI conference in 1999 in Göteborg, I had a poster on the theme of Study IV in the present dissertation. In the poster session, a little envelope was attached below each poster. At the end of the day, I found a note in my envelope saying, "Please, contact me. Erik Meyer". Since then I have had the opportunity to learn about his interesting studies on conceptions of research. I am grateful to him for introducing me to a great research group, the SCoRI (Students' Conceptions of Research Inventory) group, including Margaret Kiley, and Gerry and Helen Mullins, who invited me to a seminar in Australia and introduced me to the beautiful city of Adelaide. I am also very grateful for Professor Meyer's careful comments on the manuscript of my doctoral dissertation.

When I was finishing my master's education, I studied cognitive science in Helsinki and worked in the Pedagogical Unit of the Faculty of Medicine at the University of Helsinki. That was where I first met Professor Sari Lindblom-Ylänne, the other examiner of my doctoral dissertation. I have learnt to know Sari as a charming and dynamic person who always sees the positive sides of things. Her sharp comments on my dissertation manuscript in the sunny yard of the University of Cyprus, at the EARLI 2005 conference, helped me to see how to improve the manuscript.

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Tammikalliolla, November 2005,

Mari Murtonen

1. INTRODUCTION

Learning of research is one of the most important tasks at the university. It is also one of the most challenging tasks. Students in many disciplines have reported having problems with research courses. Quantitative methods and statistics courses in particular have been noticed to cause problems in many disciplines, such as in education (Lehtinen & Rui, 1995; Onwuegbuzie & Daley, 1998), in psychology (Hauff & Fogarty, 1996; Pretorius & Norman, 1992; Thompson, 1994; Townsend et al., 1998), in sociology (Filinson & Niklas, 1992), in social work (Epstein, 1987; Forte, 1995; Green et al., 2001; Rosenthal & Wilson, 1992), and in social science in general (Zeidner, 1991). Many teachers are aware of the problem, as Wilson and Rosenthal (1992) write: "Social work educators in general, and teachers of research in particular, "know" from their interactions with students that social work students are highly anxious about taking research and statistics courses". The problem is not new; for example, Linn and Greenwald wrote already in 1974 about students' negative attitudes related to knowledge of research and about problems in making research courses relevant to social work students.

The difficulties that students experience in quantitative research courses may result in poor learning and low course grades, but they may also have wider implications. Students with difficulties may not be as eager to take voluntary courses in quantitative methods, the methods used in their course work may be restricted by the difficulties, and they may have difficulties in completing degrees (e.g. Meyer, Shanahan & Laugksch, 2005; Kiley & Mullins, 2005). The difficulties may even be reflected in students' views on their future work and selecting a job (e.g. Onwuegbuzie, 2000). It is also possible that the difficulties experienced during university studies have an impact on how prepared someone is to carry out certain tasks when employed and on the quality of the work done.

Although the problem of difficulties experienced in learning of quantitative methods at university is not new, it has been little explored. There are very few empirical studies in general on the learning of research skills. The most active domain of research about teaching and learning of quantitative methods has been social work education: the Journal of Social Work Education and the Journal of Teaching in Social Work have most frequently published articles on this issue. More research has been published on the domain of statistics teaching and learning. The interest in publishing on these topics seems to be growing, as is the interest in conducting empirical studies on the topic. Becker (1996) has conducted a review of the published literature on statistics teaching. Of the 501 references and 29 dissertations identified, only 3% were dated prior to 1970, while nearly a third were published in 1990 - 1995, indicating the growth of interest in this subject. She found that the literature was largely anecdotal and mainly comprised recommendations; less than 30% of the literature reported results of empirical studies. The non-empirical papers usually provide ideas for developing classroom activities and report the use of computer software.

A more up-to-date bibliography by Hafdahl (2004) on correlates of statistics anxiety shows that of the 538 articles found on the subject, nearly 60% have been published since 1995 and over 30% since 2000. These articles on statistics anxiety have been most frequently published in psychological journals (Hafdahl, 2004).

The increasing interest in the learning of statistics and research skills in general is motivated by the development of western society. Research has become very significant in all fields of a knowledge-based society. Philippe Busquin (2001) states, in his preface to the European Commission publication "Towards a European Research Area", that research and development are seen as a generator of knowledge, growth, employment and social cohesion. Greer (2000) points out that the amount of information based on research and statistical analysis is growing in our society. Technical development and the increasing amount of information produced and made available by computers require the skills to handle this information in many occupations. Because of the various collection and analysis methods, the complexity of the information has also substantially increased. Adequate use of the wealth of information requires that the citizens of a knowledge society develop more advanced and complex knowledge-handling skills (e.g. Bereiter & Scardamalia, 1993; Murtonen & Lehtinen, 2005). The ability to understand and make use of research-based information is becoming one of the key competencies of future expert practices. However, it is not only researchers who are directly dealing with research need these skills. Experts in many other professions also need skills to understand and evaluate research-based information. In Finland, Laukkanen (2001) has emphasised the role of research in policymaking, which includes new and challenging features such as the growing complexity of society, globalisation, social displacement and maintaining welfare. The skills to understand research are thus needed on many levels, even on those that previously were considered to not necessarily need research skills. As Cerrito (1999) puts is, "Statistical literacy is no longer a luxury; it is a necessity". Similarly, it could be said about research skills that they are no longer a luxury or only needed by researchers, but are required in many tasks and occupations.

The goal of research instruction is thus to produce graduates capable of handling research information. Unfortunately, the outcomes of statistics and methodology courses often seem to be only the acquisition of a set of isolated facts and skills without a deeper understanding of research (e.g. Murtonen, Iiskala, Merenluoto & Tähtinen, 2002). Universities are investing considerable resources to teach students research skills, but the learning outcomes of the methodology courses are often not as good as expected, not even after several courses (Lehtinen & Rui, 1995; Garfield & Ahlgren, 1988, Rautopuro, Väisänen & Malin, 2004). The research literature also suggests that students' difficulties do not decrease during education. On the contrary, attitudes toward research become less positive (e.g. Siegel, 1983). There is a need for better approaches to teaching and helping the students learn scientific thinking and research methods in a more effective and deeper way.

The aim of the present study is to explore the problems in the learning of research skills at university. Because very little empirical research exists on education and social science students' difficulties in learning of general research skills and quantitative methods, the present study aims first at exploring the possible difficulties that the students may have in learning of these skills. The focus is especially on learning of quantitative methods, because the earlier research literature, comprising mainly of teachers' views and recommendations for instruction, suggests that this is problematic for many students.

The concepts 'quantitative research', 'quantitative methods' and 'statistics (in the meaning of referring to procedures used as tools in empirical research, not as a separate scientific discipline) are all often used when referring to certain type of difficulties in learning in the literature concerning the teaching and learning of quantitative research. The words "research" and "methodology" have been used as top-level concepts to cover both former concepts. For example, Epstein (1987) writes about the fear of mathematics and statistics, and concludes that they are connected to the anti-research attitudes of social work students. Similarly, in the present study, the terms "research" and also "methodology" are used as top-level concepts that include the narrower "quantitative research methods" and "statistics". It is known on the basis of earlier studies that many social science students have anxiety about statistics (e.g. Onwuegbuzie, 2000), but the present study was not restricted only to studying the anxiety about statistics, because it was assumed that the students' problems are wider. This means that if they have problems with statistics, they probably have problems also on the more general level of learning of quantitative research, and these problems may also influence their other views of research. Thus, the aim in the present study is to examine the learning of quantitative methods that includes both statistics and more general issues of research.

In addition to the exploration of the problems that the students may have with learning of quantitative research, the goal of the present study is to find out what those difficulties may be connected to. Previous bad experiences with mathematics are often claimed to be the reason for anxiety about statistics, and thus also the reason for students' dislike of quantitative methods. It is also often assumed that problems in learning result in low course grades. However, majority of the students pass research courses, but still, many students report difficulties. Could there be some other reasons that influence students' views and experiences about research? Could, for example, the paradigmatic division of social and educational sciences into quantitative and qualitative research be connected to how students orientate themselves to research? In the present study, students' views on quantitative and qualitative methods are examined, as well as their motivational factors in studying quantitative research. The goal of the present study is also to see whether difficulties have an impact on students' content learning of research, evaluated with other instruments than course exams. The goal of teaching of research at university is to prepare students with research skills to be able to conduct research-related tasks in their future work. A question for the present study is that do students understand the relevance of research skills for their future work? Further, are their views about work associated with motivational factors and difficulties in learning?

1.1. Emotional and motivational factors in the learning of quantitative research methods

> *"No other part of the social work curriculum has been so consistently received by students with as much groaning, moaning, eye-rolling, hyperventilation, and waiver strategizing as the research course." (Epstein, 1987,71).*

Emotional and motivational factors are always present in all learning, but in quantitative methods and statistics courses at university they are particularly visible. While teachers try to teach students the contents of the subject area, students having problems with learning may experience a wide range of emotions that impede learning. No matter how well the teacher has prepared the instruction, there may be no way to get the student to concentrate on the task if he or she is mainly focusing on coping with negative feelings.

Until the end of the 1980s, research on motivation made little contribution to research on learning. Problems in behaviour and learning were often seen to be due to information-processing errors and cognitive limitations. Motivation and cognition were in the main studied separately, and the context of learning was not considered. The inseparability of cognition and motivation became acknowledged by the 1990s, and researchers also started to pay attention to context. Motivation is no longer a separate variable or a distinct factor, which can be applied in explanations of an individual readiness to act or learn – but it is reflective of the social and cultural environment. (Järvelä, 2001.)

A similar history can be seen on the area of learning of research and statistics. According to Gal and Ginsburg (1994), while statistics educators have focused on improving the cognitive side of instruction, i.e. the skills and knowledge that students are expected to develop, little regard has been given to non-cognitive issues, such as students' feelings, attitudes, beliefs, interest, expectations, and motivations. There is only one exception to this: studies on anxiety about statistics.

Anxiety about statistics and research

Anxiety about statistics

Negative feelings about statistics are evident in many places, for example, in many textbooks on statistics. The back cover of Hinton's (1995) Statistics Explained, A Guide For Social Science Students asks "Do you hate statistics?" Birenbaum and Eylath (1994, 93) found introductory statistics books from the 70's and 80's named "Statistics without tears" and "Social Statistics without tears", some of them declaring that 'enjoying statistics is rather like eating nettles – it gives you a reputation of being rather odd'. The same types of titles continue to appear in the 90's, for example, when Forte (1995) published his article with the title "Teaching statistics without sadistics".

Statistics anxiety has been characterised by extensive worry, intrusive thoughts, mental disorganisation, tension, and psychological arousal that arise in people when exposed to statistics content, problems, instructional situations or evaluative contexts (Zeidner, 1991). The questions in statistics-anxiety questionnaires usually concern emotional states, such as feeling anxious about using statistical tables, reading a formula, or signing up for a statistics course (e.g. Zeidner, 1991). Statistics anxiety has been shown to be separate from general test anxiety (Benson, 1989; Benson & Bandalos, 1989), i.e. it is not just the test situation that explains anxiety about statistics. Wilson and Rosenthal (1992) differentiate state-anxiety in specific circumstances (e.g. statistics) from trait-anxiety that refers to a more general tendency to be anxious. Trait-anxiety and statistics state-anxiety did not correlate with each other in their study, meaning that these two constructs are separate.

Statistics anxiety has been found to be a serious problem in quantitative methods and statistics courses to many university students, for example in social sciences (e.g. Birenbaum & Eylath, 1994; Forte, 1995; Pretorius & Norman, 1992; Townsend et al., 1998; Zeidner, 1991). In a study by Wilson and Rosenthal (1992), 51% of the social science students reported moderate anxiety about research and statistics, while 27% reported high or very high anxiety, and 22% low anxiety. Statistics anxiety has been also reported in many other disciplines, such as in biology (Kelly, 1992) and in business (Zanakis & Valenzi, 1997), but it is supposed that especially students in the social sciences, education, psychology and other "human sciences" express more anxiety about mathematical and statistical subjects than, for example, students in the natural sciences (e.g. Forte, 1995). Royse and Rompf (1992) found that undergraduate social work students experienced more maths anxiety when compared to students in other disciplines.

Problems in the learning of statistics are often associated with problems in the learning of mathematics. There seems to be a connection between the nature of these domains, and both are considered as hard to learn by many. Mathematics and statistics are not, however, identical domains. Bisgaard (1991, 276) describes statistics as "the art and science of collecting and analyzing data". He continues: "Like physics, it is a science distinct from mathematics. It is true that statistics, like physics, draws heavily on mathematics for developing theory and methods; I would like to emphasize that we should not underestimate the importance of mathematics for statistical theory. But as physics is not just applied differential equations, so is statistics not just applied probability." Statistics, thus, is an independent discipline, but connected closely to mathematics. Both are often referred to when talking about learning of either. For example, in a book on adult numeracy development, edited by Gal (2000b), issues concerning both mathematics and statistics are discussed. Similarly, mathematics professor Paulos, in his book Innumeracy (1991), gives examples in the domains of both mathematics and statistics. Numbers are used in both. For social science, psychology and education students, statistics may be connected to mathematics at first glance because it uses the same symbolic language as mathematics, and also because their prior courses in statistics, for example, in high school might have been taught as a part of the mathematics curriculum.

Students do not necessarily experience statistics and mathematics similarly. For example, in a study by Merenluoto and Murtonen (2004), students reported experiencing statistics as uncertain, unstable and detailed, while mathematics was considered as strict and stable. Although students may experience these differences between mathematics and statistics, their difficulties in these domains may still have a common basis. There might be some common features that evoke the similar type of emotional reactions, such as the use of numbers. According to Gal (2000a), some adults, including highly educated ones, decide that they are not "good with numbers". These types of beliefs may hinder the learning of both mathematics and statistics.

Girls are usually seen as being less interested in "technical" or "hard" subjects, such as mathematics and physics (e.g. Hoffmann, 2002; Näätänen, 2000). It has also been hypothesised that women would experience more statistics and mathematics anxiety than men, but the evidence is not unequivocal in the case of university students. The effect of gender in statistics anxiety has been found to be weak (eg. Benson, 1989). In a study by Zeidner (1991) on behavioural science students, females were observed to have higher statistics test anxiety than males, whereas males were found to have higher statistics content anxiety than females. In a recent Finnish study (Soro, 2002), primary school teachers still saw girls and boys as different kinds of learners of mathematics. Girls were considered to be dutiful and good in routine tasks, and boys to be insightful and good in demanding, inferential thinking. It is probable that some university teachers share these views. It is often hypothesised that, at university, quantitative methods are hard for social science students, because a large part of the students are women. According to Soro (2002, 50), it is possible that by formulating a research question such as "why are girls not as good in mathematics as boys", a self-fulfilling prediction can occur. Thus, the question about difficulties in social sciences with quantitative methods should be formulated as "why is it difficult for these students", regardless of gender.

The studies on statistics anxiety have their roots in mathematics anxiety and mathematical beliefs studies. Anxiety about mathematics has been found to begin at an early age, as over 60% of 9- to 11-year-old pupils reported some degree of mathematical anxiety in Newstead's study (1998). According to Zeidner (1991), statistics anxiety paralleled some known features of mathematics anxiety in the same behavioural science student population. Birenbaum and Eylath (1994) explored different correlates of statistics anxiety among students of the educational sciences and found that mathematics anxiety and statistics anxiety were related.

Negative prior experiences with mathematics, poor prior achievement in mathematics and a low sense of mathematical self-efficacy have been found to be meaningful antecedent correlates of statistics anxiety (Zeidner, 1991). Birenbaum and Eylath (1994) found that a low high school mathematics grade was connected to education students' experience of anxiety about both mathematics and statistics. Earlier mathematics achievement thus seems to be related to statistics anxiety. Experiences with statistics do not seem to be as important; Birenbaum and Eylath (1994) studied the impact of previous experience with statistics on statistics anxiety and concluded that whether or not the student had previously taken courses in statistics for behavioural sciences at university, did not affect statistics anxiety.

Anxiety about research

In the case of learning of research in general, or learning of quantitative methods, almost no research on emotional factors exists. Most of the few research papers just note that the problem exists, and they usually concentrate on proposing a new way of teaching research, or speculate about what contents should be taught (e.g. Epstein, 1987; Filinson & Niklas, 1992; Quinn, Jacobsen & LaBarber, 1992; Morris, 1992). However, there are some studies on the role of statistics anxiety in research methodology courses, or on describing anxiety about research. Wilson and Rosenthal (1992) have studied "anxiety about research and statistics" which they conceptualised as a specific state-anxiety that involves negative emotional reactions, such as tension and nervousness, occurring upon the contemplation of taking a course in research and statistics. Their method was to ask students to "think about taking a course in research and statistics", and to report their feelings about, for example, comfortable, worried, nervous, calm, relaxed and tense (Wilson and Rosenthal, 1992, 78). Their study was thus very similar to statistics anxiety studies, except that they included the word 'research' in their theme of research.

The pioneering work of Onwuegbuzie (1997) studied statistics anxiety (e.g. fear of statistics language, fear of application of statistics knowledge), research process anxiety (e.g. fear of research language, fear of application of research knowledge), composition anxiety in writing (e.g. content anxiety, format and organisational anxiety), and library anxiety (e.g. perceived library competence, perceived comfort with the library). These all were found to be connected to student's inability to undertake and to write an effective research proposal in an introductory research methodology course. This "research proposal writing anxiety" thus appears to involve a complex array of emotional reactions which can inhibit the ability to formulate a research problem, to conduct an extensive review of the literature, to develop a frame of reference, to formulate research questions and hypotheses, to select a research design, to define the population and sample, to develop a plan for data collection and analysis, and to write the research proposal. On the basis of these findings of Onwuegbuzie, we could assume that, in addition to different types of anxieties, difficulties in the learning of research are connected to a wide set of problems involving students' beliefs, fears, views and experiences.

The problem with anxious students is that they may also have other problems connected to their feeling of anxiety, such as failing research courses, achieving low grades, procrastination with studies or avoiding statistics and research in their future decisions. Studies on children have revealed that pupils' sense of their own mathematical ability, their expected mathematical performance and their overall academic performance all correlate strongly with each other Schoenfeld (1989). The situation is, however, not so clear with university students.

Pretorius and Norman (1992) compared anxious and non-anxious psychology students on a research methodology course in terms of passing or failing, and found that the most anxious students did not pass the course. However, a correlation between anxiety and achievement has not been found in many studies involving university students, or it has been weak. A study by Zeidner (1991) on social science and education students suggests that there would be a weak correlation between statistics anxiety and statistics course performance. Similarly, in a study by Benson (1989), university students' statistical test anxiety was found to be weakly connected to achievement. In a study by Wilson and Rosenthal (1992), US social work students' anxiety about research and statistics was not related to performance on the foundation research and statistics course. Also in Rosenthal and Wilson's (1992) study on a social work master students' research course, it was found that confidence in undertaking the research course was not related to performance. In the study of Birenbaum and Eylath (1994), neither statistics nor mathematics anxiety was connected to the statistics-related course grade.

Students' earlier experiences with mathematics tend to explain university statistics course grades more than anxiety. Townsend et al. (1998) found that university psychology students' mathematics backgrounds did become a significant predictor of overall achievement in a statistics course. The students who had taken more mathematics courses had higher statistics grades than the students with fewer mathematics courses. Although the number of courses taken was connected to success, earlier achievement level did not seem to be so clearly related to success at university. Birenbaum and Eylath (1994) found that the earlier high school mathematics grade was only weakly connected to the statistics course grade at university.

In summary, previous research suggests that earlier achievement in mathematics has some correlation with statistics anxiety at university, and is also weakly correlated with achievement in university statistics and methodology courses. However, there seems not to be always a relationship between statistics anxiety and university research and statistics course grades.

Anxiety seems to be a complex concept, and its components appear to be difficult to measure. Moreover, the effects of anxiety on other factors like course performance seem to be hard to establish. Whether or not anxiety has an impact on students' achievement on research courses, anxieties may have other, even more serious, effects on students further actions. Anxieties can be very harmful for learning. Onwuegbuzie (1997) found that even routine problems like parking at the library could increase research proposal writing anxiety levels significantly. In an anxious state, a person cannot concentrate on a cognitive learning task as well as in a non-anxious state. According to Onwuegbuzie (1997), statistics high-anxious students tended to give up research proposal writing more easily than their low-anxious counterparts. They also incorrectly believed that they did not have the ability to learn statistical concepts. Onwuegbuzie also concludes that anxious students tended to engage in procrastination, which is in line with the assumption that problems in the learning of research would result in difficulties in completing degrees (e.g. Meyer, Shanahan & Laugksch, 2005; Kiley & Mullins, 2005).

In a study by Green, Bretzin, Leininger and Stauffer (2001), it was found that social work students who reported higher levels of anxiety about research tended to be less positive about the importance of research to their profession. In a study by Onwuegbuzie (1997), students who displayed the highest levels of statistics anxiety tended to view statistics as irrelevant for their future development, whether academic or career. A conclusion may be drawn from these results that high research or statistics anxiety is connected to not considering research or statistics very important. Thus, it is hypothesised in the present study that difficulties in the learning of quantitative research are connected to not considering research skills very important in working life.

Motivation in situation and approaches to learning

In the case of learning of research, motivation has been seen as one of the major problems causing difficulties in learning. Students have been seen as underestimating the value of research skills for their studies and future work, and thus being non-committed to study. (E.g. Murtonen et al., 2002; Murtonen, 2004.) In addition, feelings of difficulty and anxiety can be thought of as hindering the motivation to study. Research courses are often obligatory for social science students. Thus, they have to take these courses, whether they are motivated or not.

In learning situations students can focus their attention to the task, or they may have task-irrelevant behaviour. Lehtinen, Vauras, Salonen, Olkinuora and Kinnunen (1995) have studied pupils' 'situational orientations'. These situational orientations are concerned with the target of the student's focus at some specific moment. When given a task, some people start to solve the given task, i.e. focus on the task, while others are more interested, for example, in how to please the teacher or just get themselves out of the problem-solving situation. Situational orientations to learning in specific situations have been mostly researched with children. Olkinuora and Salonen (1992) have found that children do have situational orientations to learning that may not foster learning. Some students are not task-oriented, but instead they have an ego-defensive, or a socially motivated orientation, that draws their cognitive activities away from the task. Ego-defensive orientation means that a student is most concerned about the coping of the self when given a task, and her or his self-efficacy is low. The socially oriented student uses her/his energy to please the teacher and does not really try to solve the task. The task-oriented person is eager to solve the task and does not give up even if the solution does not come easily. (Olkinuora & Salonen, 1992; Salonen, Lehtinen & Olkinuora, 1988.) Situational orientations have been seen as established gradually through children's learning and social reward or control histories in family and school contexts (Vauras, Salonen, Lehtinen & Lepola, 1999). Situational orientations to learning among university students have been studied in general learning situations by Mäkinen and Olkinuora (2004). They found that task-orientation and performance orientation were connected to a meaning-oriented and self-regulated learning strategy, while avoiders and socially-oriented students most frequently reported the use of a reproduction-oriented and externally regulated strategy.

Eronen, Nurmi and Salmela-Aro (1998) studied university students' achievement strategies in study situations. They identified four types of strategies: optimistic, defensive-pessimistic, impulsive and self-handicapping. These categories share similarities with the classification of Olkinuora and Salonen (1992) of situational orientations, such as self-handicapping and ego-defensiveness, both of which are associated with potential failure and which may thus lead students to concentrate on task-irrelevant behaviour. Students who are ego-defensive may self-handicap themselves, for example, by giving up or claiming that the task is not important, rather than taking the risk of failing to solve the problem. According to Thompson and Richardson (2001), the benefit of self-handicapping is in sparing individuals from conclusions about their low ability by blurring the link between ability and performance. University research course students may behave ego-defensively, for example, by saying that research skills are not important, thus aiming at avoiding the possibility of working hard for a research course only to achieve a low grade.

In addition to students' motivational orientations in learning situations, their approaches to learning have an effect on the quality of their learning. Students' approached to learning have been found to be mainly deep, surface or strategic; deep approach refers to understanding, surface approach refers to reproducing, and strategic approach refers to achievement or time-management goals (e.g. Marton & Säljö, 1976, Entwistle & Ramsden, 1983). According to Lindblom-Ylänne and Lonka (1999), students' conceptions of learning, approaches to learning and their level of processing may be roughly divided into two categories: surface-level reproduction (or memorizing) versus deep-level transformation (or construction) of knowledge, the latter being associated with qualitatively better learning outcomes.

While approaches to learning are found to be deep or surface (Marton & Säljö, 1976), more general ways to orient oneself towards learning have been called 'learning orientations'. According to Vermunt (1996), learning orientations refer to the whole domain of personal goals, intentions, attitudes, worries and doubts of students in relation to their studies, and they are supposed to influence learning because students mainly use the activities they think are best suited to realize their personal goals. A broader still concept is 'study orientation', referring to students' general ways to orient themselves to studying, including their learning approaches and motivational factors (e.g. Entwistle, Meyer & Tait, 1991). Meyer (1991) introduced the term 'study orchestration' to indicate that the association of constructs that represent approaches to studying at an individual level is a context-specific response, and is affected by the qualitative level of perception of the individual towards certain key elements of the learning context. The notion of context specificity is very important in the case of learning of research skills.

To conclude, effective learning usually follows from good concentration on the task and deep approach to learning. Task-oriented learning focuses cognitively on the given task: attempts are made to solve the task and the effort of the learner or problem solver is directed toward the content features of the task. In the case of learning of quantitative methods at university, some students may not achieve this kind of task-orientation. According to Gal, Ginsburg and Schau (1997), many students are not ready to embrace and function within a problem-solving-oriented learning environment in statistics education. They experience obstacles that hinder their concentration on the task itself.

The goal of the present study is to examine students' orientations in a specific domain; that of learning of quantitative methods, and also in a specific learning situation. There will thus be a focus in students' situational orientations and domain-specific approaches to learning of quantitative research methods.

1.2. Views, beliefs and conceptions of research

Individuals' conceptions of research

Students' conceptions of the learning of research methods might be embedded in more general conceptions of learning and studying. Students are shown to have differing conceptions about what learning and studying are (e.g. Marton & Säljö, 1976; Entwistle & Ramsden, 1983; Lonka & Lindblom-Ylänne, 1996). According to Entwistle, McCune and Walker (2001), conceptions of learning are derived from the cumulative effects of previous educational and other experiences, and so tend to be relatively stable and to influence, to some extent, subsequent ways of thinking and acting. Thus, in the learning of research methods, students' previous experiences influence their way of thinking about the learning tasks, and these influence their ways of learning when attending research methodology courses.

There is a reasonable body of empirical data showing that the conceptions people hold do have implications for their learning outcomes. For example, students' conceptions of learning have been shown to be related to their study orientations, approaches to learning and study outcomes (e.g. Marton & Säljö, 1976; Entwistle & Ramsden, 1983). Lonka and Lindblom-Ylänne (1996) found that conceptions of learning and conceptions of knowledge were related. They also concluded that conceptions of knowledge may guide not only comprehension standards, but also study strategies and orientations. In the study of Lindblom-Ylänne and Lonka (1999), it was found that students' ways of interacting with the learning environment were related to study success. Meaning-oriented independent students succeeded best in their studies, while reproduction-oriented and externally regulated students achieved the lowest grades. Similarly, it could be argued that the conceptions students hold about statistics and research methodology might have an impact on their learning of these subjects.

Ryder, Leach and Driver (1999) examined university natural science students' images of science. According to them, these images are particularly important because students' actions during science learning tasks can be influenced by their ideas about the nature of scientific knowledge and because science graduates may need to carry out tasks which require an understanding of science. Similarly, in social sciences, students' methodological choices in course work, theses etc. might be influenced by their conceptions of research methodology.

Some students may have a conception of science and research that can be classified as mythical. Scientists can be seen as "a special class of people who are particularly endowed with superior mental abilities, exceptional problem solving competence, and well-tuned scientific process skills that they use in an impartial pursuit of truth" (McGinn & Roth, 1999). This view is strengthened by the traditional research textbooks that give abstracted, cookbook-like descriptions of research, and which do not provide students with an understanding of the process of scientific inquiry. McGinn and Roth (1999) wrote that the mythical views of science and scientists have been challenged over the past two decades by research following the traditions of sociology, anthropology, and ethnomethodology. They conclude that "scientific method" is largely a myth and does not describe what scientists actually do. Research and its products are now recognised as situationally contingent achievements involving scientists, technicians, granting agencies, politicians, tools and instruments, local cultures, and so on. That is to say, scientific knowledge emerges from a nexus of interacting people, agencies, materials, instruments, individual and collective goals/interests, and the histories of all these factors. Accordingly, science education needs to look toward new educational aims that reflect the situated, contingent, and contextual nature of science, while also acknowledging the diverse range of communities and locations in which science is created and used.

University students' conceptions of research in general have just recently started to be studied. Meyer, Shanahan and Laugksch (2005) have conducted a study with open-ended questions, such as, 'how you would explain research?' and 'what do you think good research is?' Students' responses were categorised as: information gathering, discovering the truth, insightful exploration and discovery, analytic and systematic enquiry, incompleteness, re-examining existing knowledge, problem-based activity, and a set of misconceptions. An inventory was constituted on the basis of the students' responses, and very similar types of dimensions were found in another sample. Thus, there seems to be variation in students' ways of understanding research.

According to Brew (2001), every conversation about research in universities, every research project, and every discussion in research committees rests on the underlying ideas researchers have concerning what research is and what researchers are doing when they carry it out. It is assumed that researchers mostly agree about what research is, at least within specific disciplines. Further, it is assumed that teachers of research courses know and agree on what research is and know how to teach it. Research students are then assumed to learn what research is without explication of the possible and varying conceptions of research.

Different conceptions of science are not only typical of students but can also be found among professional researchers. Brew (2001) found that there was variation in how research is experienced by researchers. Australian researchers from many different academic fields were interviewed and asked to describe their views on research. Brew identified four categories of conceptions. In *the domino conception*, research is viewed as separate techniques and activities, and the goal is to synthesise these separate elements to solve a problem or answer or open up a question. In *the layer conception*, hidden meanings are sought, and research is interpreted as a process of discovering, uncovering or creating underlying meanings. *The trading conception* emphasises products, end points, publications, grants and social networks. Research is thus understood as a kind of social market place where the exchange of products takes place. In *the journey conception*, the researcher considers personal existential issues and dilemmas. Research is thus interpreted as a personal journey of discovery, possibly leading to a transformation. Academics may of course exhibit evidence of more than one conception. Brew also found that researchers from any one discipline could be represented in any or all categories. These categories are helpful for understanding why, at times, researchers or politicians referring to research do not seem to be discussing the same thing, or are unable to communicate effectively. They may have different conceptions of research. Brew also suggests that this would be an important issue to discuss in the education of postgraduates and early career researchers in order to help them understand the different ways in which research can be conceptualised. From the above-mentioned descriptions of research, analysed from the point of view of sociology of science (e.g. Latour, 1988), we can conclude that many researchers may have rather limited and fragmented ideas about the complex social features of their profession and of the characteristics of research as collaborative practice.

The study by Kiley and Mullins (2005) on supervisors' conceptions of research revealed very similar conceptions of research as those found in the study by Brew (2001) on experienced researchers' conceptions. The question still remains whether a difference between students' and supervisors' conceptions of research are likely to impede students' progress and even completion of their degree.

Students' conceptions of research do not only precede their way of taking a course on research methods at university. The conceptions may have also more longstanding effects, such as directing students when selecting a job, or contributing to how the future work will be undertaken. Students may have unrealistic views of their future job, for example that research skills are not needed in it. Students do not always have a realistic picture of their future work, as shown in a comparison study on experts and novices in the domain of education and computer science, where it was found that professionals rated the need of decision-making skills, problem-solving skills and higher order thinking skills in general higher than students (Tynjälä, Helle & Murtonen, 2002).

Onwuegbuzie (2000, 329) found that education students' perceived job competence was not related to statistics anxiety. He concludes that "this might reflect the fact that many statistics-anxious students tend to select careers that necessitate minimal quantitative techniques. Thus it is possible that, providing individuals who have high levels of anxiety avoid quantitatively based professions, they will not necessarily have negative perceptions about their job competence. Some persons may even have positive perceptions – culminating in a nonrelationship between statistics anxiety and perceived job competence."

Cultural conceptions: The two research paradigms

Students' beliefs are often thought to arise from their own experiences, such as in the hypothesis above about bad previous experiences with mathematics, which refers to students' own situations that create the problems. The sources of beliefs, attitudes and expectations can, however, be various. The educating institution, relatives, friends, or the whole society can create and maintain beliefs that may foster or impede learning.

A common belief in our society is reflected in the division into "technical" and "human" values. In 1959, Snow (1964) gave his famous Rede Lecture at Cambridge about "The two cultures", where he suggested that western society had been divided into two poles, scientific and non-scientific. The theory is still very tenable, and it can be seen at both individual and at societal level. At the individual level, some people may, for example, consider the world in terms of "soft" and "hard" issues or values, of which hard issues are based on the technical and numerical approach and cannot be mastered by a person who behaves and thinks according to the soft, humanistic approach. For example, there may be a conception that skills in mathematics and languages are mutually exclusive and opposite qualifications.

In the social sciences, research is often divided into technical quantitative research and humanistic qualitative methods. Some research books even teach this. In "Beginning Research in Psychology. A practical Guide to Research Methods and Statistics", Dyer (1995, xv) states that "While it is still true that the experimental method is for many researchers the method of first resort, many also do research by other means, including the 'soft' methods such as interviews and participant observational studies". The problem with these two poles of research in the social sciences is not only at the level of individuals' thoughts, but has also been typical of the whole academic discipline since the early 80's (e.g. Smith, 1997).

At the beginning of the 20th century, educational researchers adopted the "scientific" way to study educational questions. Questions of learning were studied in laboratories under strict control, and statistical analyses were applied. Soon, however, some criticism arose and qualitative approaches started to gain advocates (Mc Kenna, 1990). Smith (1997) analyses the fragmentation of the educational research community into the qualitative and quantitative research camps. According to him, this balkanisation is a result of people engaging different vocabularies to tell different stories about research and the work of researchers. The situation has grown into what Snow (1964) describes as them having 'a curious distorted image of each other'.

There are several papers that note that the division into two camps - qualitative and quantitative - is by no means clear. H. Becker (1996) has considered the problem of seeing qualitative epistemology as opposed to quantitative epistemology. Both kinds of research try to see how society works, to describe social reality, to answer specific questions about specific instances of social reality. According to him, both rely on the same epistemology but, to some extent, there has occurred a division of social sciences into two scholarly communities that have constituted worlds of their own, with their own languages, journals, organisations, presidents, prizes, and all the other paraphernalia of a scientific discipline. For these reasons, the two methodologies are also considered somehow intrinsically different.

Töttö (2000) writes about the tendency of the different camps - qualitative and quantitative - to emphasise their own excellence by inveighing against the other. Especially with the rise of the qualitative tradition, the quantitative tradition has been used as an example of bad research, which is not able to produce new theories but only to test the old ones. However, as Töttö (2000) puts it, both qualitative and quantitative research methods are empirical and both can be equally near to or far from theory. Mayer (2000) has pointed out that the division into quantitative and qualitative should not be considered as a division into scientific and non-scientific, but that both quantitative and qualitative can be scientific or non-scientific depending on other requirements.

If scholars tend to divide themselves into two camps, it is also probable that students may make a distinction between the methods. These conceptions of society and the science community may form students' conceptions of what a good scientific method is. The culturally formed conceptions of science and human activity in general should not be omitted when studying adults' conceptions. Cotner et al. (2000) interviewed doctoral students in education about their attitudes toward qualitative research. They found that students described varying degrees of sympathy and interest in qualitative research even before taking their first methodology class in their doctoral programme. Some of the students said that "it never crossed my mind to do anything but a qualitative dissertation" and "I'm a more qualitative person in general" (Cotner et al., 2000, 3). This shows that even students can have widely generalised conceptions about research that may guide their choices and decisions.

According to Johnson and Onwuegbuzie (2004), the quantitative versus qualitative debate has been so divisive that some graduate students who graduate from educational institutions with an aspiration to gain employment in the world of academia or research are left with the impression that they have to pledge allegiance to one research school of thought or the other. The curricular structures and the literature have further emphasised this division by separating these contents into separate courses and books. Only recently has this division been challenged in the literature, when Tashakkori and Teddlie (2003) published the Handbook of Mixed Methods in Social and Behavioral Research. Resting on the groundings of mixed methods methodology, Onwuegbuzie and Leech (2005) have suggested ways to teach qualitative and quantitative methods together by eliminating statistics courses from curricula and replacing these with research methodology courses at different levels that simultaneously teach students both quantitative and qualitative techniques.

If students do "choose their side" between the technical and humanistic views, in this case between quantitative and qualitative, there might also be other sociocultural factors affecting the result apart from just the "formal", publicly expressed division between these views. Students' behaviour in the classroom can be seen as a function of the interplay between who they are (their identity), and the specific classroom context (Op't Eynde, De Corte & Verschaffel, 2001), which, in the case of research methods, would include the polarised view of research methods. Hannover and Kessels (2004) have studied high school students' dislike of mathematics and science from a social psychology perspective. They suggest a prototype theory, according to which people compare themselves and a favourite or a least-liked prototype. These prototypes may also be culturally formed and taught. Hannover and Kessels (2004, 54) give an example of this *self-to-prototype matching approach*: Consider a person who wants to buy a new piece of clothing on the occasion of a dinner party invitation. While he or she is flicking through a fashion magazine and looking at various outfits, he or she may imagine the prototypical buyer for each of the pieces of clothing. The individual's self-definition serves as a reference point against which the features of these prototypical persons can be compared. The person is therefore expected to buy the piece of clothing which most closely reflects the image he or she has of himself or herself, i.e. for which he or she found the strongest similarity or overlap between the prototypical person wearing that outfit and his or her own self-image.

On the basis of their findings, Hannover and Kessels (2004) suggest that high school students do not like mathematics and science because the prototypes they have for people who like these subjects is not what they want to be like themselves. Whereas prototypical maths-liking students were considered socially incompetent, isolated and not creative, prototypical German and English language-liking students were seen in a positive light. This may be the situation in quantitative methods courses too: a student may have a prototypical image of a student who likes quantitative methods or of a worker using these skills in working life, and he or she does not want to be like that. These views may also be connected to some other unrealistic views or conceptions, for example, about the future job. For example, a psychology university student may imagine a favourite prototype of a psychologist whose work is solving peoples' problems by talking with them, as seen in television series, and a least-liked prototype of a psychologist who analyses data with a computer, using statistics.

According to Hannover and Kessels (2004), the prototypes may also result from the script of instruction that guides lessons. If a subject is taught in narrow-focused classwork, like mathematics and science lessons often are, it may feel more dull than, for example, language classes that utilise group work, students' presentations and discussions about different ways of solving a problem.

Another type of theory on the socioconstructive forming of conceptions is presented by Orr (1990), who suggests that people tell stories about their work to build their identity, and to show that they are competent members of the community. In the same way, it could be assumed that people in the field of research set standards for their work by telling stories about it and emphasising the points that they think are relevant. In this way, a general view is created and it is also likely to be taught to the new members of the community. In addition to teachers, older students can also socialise new students the prevailing beliefs. If teachers and older students tell new students stories about how difficult statistics is to learn, the new students are probably more sensitive to similar experiences themselves, and tell the next students the same story. In this way, the dislike of statistics can become as "an accepted secret". Both students and staff know that it is a problem, but nothing is done to solve the situation.

In many areas of human knowledge, people do not want to admit that they do not know or cannot do something. In the domain of statistics, there seems to be no embarrassment about saying that one does not understand anything about statistics. Paulos (1991) writes about the same phenomenon in mathematics in his book called Innumeracy, i.e. that some people are even proud of being ignorant of or bad at mathematics.

1.3. Cognitive processes in the learning of research

The difficulty of learning of statistics and research methodology cannot be explained only by emotional and conceptual factors. There are probably some features in the domain of research that make the learning of it difficult for many people. Research methodology contains elements that make the learning of it cognitively challenging, such as abstractness and complexity. The rules and conventions of research in society have been developed over a long period of time, and these have raised the level of abstractness of research methodology (cf. Lakoff & Núñez, 1997). When more and more concepts become interrelated, knowledge becomes elevated to a higher level of abstraction (Broers, 2002). In learning this takes time and the way is not always easy.

According to Watts (1991), a major difficulty that confounds beginning students and inhibits the learning of statistics is that the important fundamental concepts of statistics are quintessentially abstract. The concepts and principles of statistics, such as probability, are not used in everyday life and they can be hard for some students to understand. Anderson, Pirolli & Farrell (1988) have explored how students learn to programme recursive functions, a task that also has been found to be difficult for university students to learn. They concluded that learning recursive programming is difficult because it is an unfamiliar activity, with hidden complexities, that must be learned in an unfamiliar and difficult domain. Similarly, in the domain of methodology, students face many concepts that they have never heard of, and the process of scientific research may not be familiar. For example, principles of scientific research and statistical inference can be far from students' everyday activities and inference, research activities in certain domains are very complex, and the connection between theory and practice can be difficult to see. The development of statistical knowledge also seems to demand the adoption of rules and ideas that to many are counterintuitive and therefore difficult to master (Broers, 2001).

Research may also appear abstract because of some of the tools it uses. For example, statistical formulas require skills in the formal symbol system and the language of statistics, which can be hard for students to understand. Onwuegbuzie (1997), in a study concerning university students' anxiety in research proposal writing, found that some students had a fear of statistical language. In particular, formulas, symbols, notation, and the terminology increased the levels of statistics anxiety. The students equated learning statistics with 'learning another language'. In addition to the formal symbol system and the language of statistics, the teachers' way of talking about statistics may not be familiar to students. Broers (2002) found that psychology students remembered verbal propositions concerning statistics more easily than abstract facts. He proposes that this is because most psychology students do not tend to think mathematically but in terms of concrete verbal theories of reality. If statistics is taught by a person who thinks mathematically, there might be a problem with mutual understanding. For example, if a statistician tries to teach some statistical concepts by using statistical language, it may be inaccessible to students. In addition to the statistics language, teachers may use a specific type of language typical of the scientific community. According to McGinn and Roth (1999), scientific communities are characterised by their specific forms of discourse and disciplines have their own vocabularies. These specific vocabularies may further widen the gap between students' and teachers' understanding.

The knowledge on research that students read from books and study in courses is not easy to understand or easily transmitted into practice. Methodological expertise requires vast amounts of conceptual knowledge ("knowing what"), although the research process in itself requires procedural knowledge ("knowing how") (e.g. Hiebert & Lefevre, 1986). Students may find it hard to convert the abstract conceptual knowledge into the procedural knowledge needed to conduct research and to truly understand research activity. Broers (2002) found that undergraduate psychology students experienced difficulties in solving a statistical problem, although they possessed the relevant factual knowledge about it. The knowledge of facts, terms and procedures should be integrated into a network of interrelations, i.e. conceptual understanding, before the solving of an abstract problem is possible. (Broers, 2001 & 2002).

According to Sweller and Chandler (1994), some material can be difficult to learn because of the heavy cognitive load. The cognitive load associated with the material to be learned is strongly related to the extent to which the elements of that material interact with each other. The interactions between the various elements may provide the whole point of what must be learned, so the elements of the task cannot be learned in isolation because they interact with each other. Under these circumstances, learning is not just a function of the number of elements that must be learned but also a function of the elements that must be learned simultaneously. In the case of research methodology, the elements interact extensively with each other, and they cannot be learned without understanding the whole system, which burdens the working memory and thus cognitive capacity. In addition to the abstract domain of research methodology, students' prior knowledge may not be at the level that teachers assume it to be. This increases the amount of content to be learned, and further enhances the cognitive load.

Lehtinen and Rui (1995) suggest that problems in the learning of research methodology appear partly because of the complexity of the domain, i.e. methodological knowledge includes several challenging properties for the learner: the sub domains are highly abstract and partly controversial, the links between them are abstract and based partly on structural analogies, and comprehension of the domain requires that the concrete procedures should be understood within the framework of the whole complex system. Onwuegbuzie (1997) found that some students experience statistics anxiety, for example, when attempting to utilize statistical principles in order to understand the results section of a quantitative research article, or to select an appropriate statistical analysis for their research questions or hypotheses. These actions require skills to handle the complex whole of the research process and principles, i.e. the anxiety expressed in these situations may be caused by the complexity of the material.

Skills and knowledge in quantitative methods cannot be learnt without the development of scientific thinking. What, then, is scientific thinking? Klahr (2000, 2) writes that it is a form of human thinking, and the nature of human thinking is one of the "Big Questions" along with the nature of matter, the origin of the universe, and the nature of life, so it cannot be fully answered. However, he does offer some descriptions by which we may differentiate scientific thinking from other forms of thinking, for example, that scientific thinking has enhanced our ability to understand, predict, and control the natural forces that shape our world. The argument of Klahr (2000, 4) is that the processes that support creative scientific discovery are not substantially different from those found in more commonplace thinking; he quotes Einstein who has said that "the whole of science is nothing more than a refinement of everyday thinking".

From the perspective of a university student, scientific thinking requires certain forms of reasoning and problem-solving skills. The knowledge contains both very abstract and very practical elements that set their own challenge to learning. The learner also needs metacognitive skills to fully understand the topic. Kallio (1998) refers to Piaget's developmental theory and concludes that "formal reasoning and reflection on it can be claimed to be the highest developmental levels of scientific reasoning". She studied the training of university students' scientific reasoning skills. She found that causal scientific thinking could be taught to students, and that the performance was sustained at the 16-week delayed post-test. The best results were gained by teaching metastrategies simultaneously with causal thinking. She concludes that it is important to teach metastrategic thinking skills. This can be done, for example, by presenting a structure of the domain with a figure, and by comparing and connecting the similarities and differences of the contents. Metacognitive skills are also emphasised by Kuhn, Amsel and O'Loughlin (1988, 228), who have studied the development of scientific thinking skills among children. They suggest that there is an important difference between thinking *with* theories from thinking *about* theories, the latter enabling awareness and control over the theories.

Learning and becoming skilled in some domain have been largely studied under the concept of expertise. Classical studies on expertise (e.g. Chi, Glaser & Farr, 1988) were conducted mostly on individual skills, i.e. how individuals' knowledge and acting with the task set the grounding for succeeding in the work. Recent theories emphasise the role of the environment and other people. For example, Hakkarainen, Palonen, Paavola and Lehtinen (2004, p. 60) propose a model of growing up to an expert community. First, a novice needs scaffolding, the expert's personal coaching and guidance adjusted to the novice's developing skills. Then, through joint working under the expert's guidance and responsibility the novice gradually becomes a participant in a community of practice and becomes integrated into an expert culture.

On the basis of these models, it does not seem reasonable to introduce the very complex and abstract domain of quantitative research methods to students through giving instruction only in, for example, statistical tests' features, but it is necessary to try to introduce the whole process of research to students. On the other hand, the question should be asked that what kind of skills should university graduates have, and more specifically, what skills should bachelors, masters and doctors have. They will not all be researchers, so they may not necessarily need to be fully grown into the research culture. But, as stated in the introduction, basic research skills are important for all university graduates, and understanding the work of a research community gives students tools for understanding research.

The effects of a group on an individual's performance, as well as on the expertise of the group, have only recently been studied. Hakkarainen, Palonen, Paavola and Lehtinen (2004, 9) describe networked expertise as "higher-level cognitive competencies that arise, in appropriate environments, from sustained collaborative efforts to solve problems and build knowledge together". A new view of expertise is also offered by Engeström and Middleton (1998, 4), who see expertise as an ongoing collaborative and discursive construction of tasks, solutions, visions, breakdowns, and innovations. The research on the development of expertise should thus acknowledge both psychological and sociological factors, and should also take into account the changes generated by the information society (Tynjälä, et al., 2001).

Developing conceptual understanding of research

In the domain of science, Broers (2002) differentiates knowledge of facts, terms and procedures from conceptual understanding, in which the individual concepts and ideas have been integrated into a network of interrelations. Similarly, in the domain of research, conceptual understanding could be said to be wider than just knowledge of the meanings of individual concepts. Conceptual understanding of research, of course, includes knowledge of the individual concepts. We can thus examine the understanding of research concepts at different levels or widths.

The research on the learning of statistical concepts has indicated that a large portion of university students do not understand many of the basic statistical concepts they have been taught (Garfield & Ahlgren, 1988; Marasinghe, 1996; Mevarech, 1983; Séré et al., 1993). According to Garfield and Ahlgren (1988), inadequacies in prerequisite mathematics skills and abstract reasoning are part of the problem of learning of statistics. Moreover, the ability of students to apply statistical procedures has been found to be low, even after several courses (Gardner & Hudson, 1999). It is probable that students have similar problems to those described above also in the whole area of research skills, i.e. with understanding even the basic concepts, and they also have problems in applying their knowledge.

Although many concepts that students face in research courses are new they may still have some conceptions of them, or they may immediately form such conceptions when a concept is introduced to them. The research tradition of conceptual change has shown that the initial or naïve domain-specific preconceptions students bring to the learning situation constrains their attempts to understand new scientific concepts in fields like physics, biology, mathematics and history (eg. Carey 1986 & 1992; Carey & Spelke, 1994; Chi, 1992; Chi, Slotta, & de Leeuw, 1994; Chi & Roscoe, 2002; diSessa, 1988 & 1993; diSessa & Sherin, 1998; Limón & Carretero, 1999; Merenluoto & Lehtinen, 2004; Mikkilä-Erdmann, 2001; Vosniadou, 1992 & 1994; Vosniadou & Brewer, 1987). In addition to the problem of naïve conceptions or misconceptions, theories of conceptual change have emphasised the role of the framework theories, i.e. that individuals' concepts are embedded into larger theoretical structures which constrain them (Vosniadou, 1994). Theories can be seen as complex mental structures consisting of a mentally represented domain of phenomena and explanatory principles that account for them (Carey, 1992). Thus, conceptual change does not take place easily, because if the framework does not fit the new, proposed concept, the new concept is very likely to remain not understood. Misconceptions are students' attempts to interpret scientific information within an existing framework theory that contains information contradictory to the scientific view (Vosniadou, 1994).

A theory of conceptual change by Chi (1992; Chi, Slotta & de Leeuw, 1994) is based on categories which resemble the idea of constraining frameworks presented above. In Chi's theory, individuals' concepts are assigned into categories, which could be thought of as a tree, having branches that stand for categories. The basic ontological categories proposed by Chi, Slotta and de Leeuw (1994) are: matter (or material substances), processes, and mental states. Misplacement of a concept into a wrong category (or branch of a tree) produces a misconception. For example, if electricity is considered to be like water, i.e. flowing from place a to place b, it is placed in the category of matter. This view contradicts the scientific view, according to which electricity is more like a process. Understanding the scientific concept of electricity requires a category shift, i.e. replacing the concept from the matter category to the process category. This would be a radical conceptual change, while a change in the concept's meaning inside a branch of an ontological category would be an easier conceptual change.

There are some difficulties with applying the conceptual change theories to the issue of this thesis, i.e. the learning of research. First of all, when we are talking about research, we are talking about a wide and complex *domain*, and that is not what conceptual change theories were developed for (Tynjälä, Merenluoto & Murtonen, 2002). The conceptual change theories were developed to study the learning of specific science concepts that pupils have difficulties in learning such as electricity (e.g. Chi, 1992). The domain of research compares with, for example, the learning of physics, but not with the learning of some singular concept in the area of physics, which would be more within the scope of conceptual change theories.

Second, even if we take some single *concept* in the domain of research, for example, "research design", there is not necessarily a common definition that is shared by the academic community, and which is applicable to all situations. Theories of conceptual change usually study well-defined science concepts. According to Tennyson (1996), well-defined concepts have characteristics that are constant within any situation or context and can be transferred across situations without changes in their definitions (e.g. mathematical concepts, physical science concepts, etc.), whereas ill-defined concepts have characteristics that are variable according to given situations and are not easily transferable from one context to another without being embedded within the different situation (e.g. humanities concepts, language concepts, etc.). In the domain of learning of statistics, there are well-defined concepts, like probability, but they may also be very complex in their nature. If we consider the concept of "research" itself, we notice that it is very fuzzy, containing complex knowledge on many levels, and understood in many ways, as shown above in the studies by Brew (2001), Meyer et al. (2005), and Kiley and Mullins (2005). Research is a so-called ill-defined domain, where the degree of consensus about the concept is not high, i.e. there is no clear, sharply defined concept (Tynjälä, Merenluoto & Murtonen, 2002).

A third problem in applying conceptual change theories to learning of research is that these theories assume that students have *misconceptions* that should be changed to scientific conceptions. In learning of research, students may not have any conception at all about the concept that is introduced to them. Thus, there may not be a misconception that should be changed to a scientific one. However, it is assumed that people do form some conceptions immediately when a concept is introduced to them. The point of departure can perhaps only be constituted by a common speech genre (Halldén, 1999). Or a conception may be formed, for example, on the basis of the surface structure of the concept. These methods are very likely to produce misconceptions, especially if the issue to be learnt is abstract and complex. Thus, although there might not be initial, longstanding misconceptions about the concepts introduced on research courses, there may still be misconceptions that are formed during instruction. When students hear a new concept, they try to place it to some familiar context, i.e. contextualize it. According to Halldén (1999, 64-65), "Contextualization plays an important role when we are trying to learn something entirely new. This, what we are trying to learn, becomes intelligible when put in context and it is the context that can make the interpretation of the focal event plausible. This line of reasoning suggests that learning is not to be looked upon as a linear process, where we first learn "facts", i.e. about the empirical level or the level of the experimental field of reference, and then try to understand these facts, i.e. relate the empirical level to the conceptual or model level, and then, in turn, to the theoretical level. Rather, learning is to be regarded as a simultaneous processing of these levels where the learner is constantly oscillating between these levels. After all, this is only to say that accommodation and assimilation, in the Piagetian sense, are both constantly in play."

In spite of these problems, conceptual change theories still offer an interesting departure for explaining the learning of research, as long as we acknowledge that we are dealing here with an ill-defined and complex area that was not the original scope of the conceptual change studies. Yukhnovetsky and Hoz (2001) have studied the acquisition of large bodies of knowledge. They separate conceptual change from conceptional change, the former meaning the change in specific entities, and the knowledge validity (i.e. match with the scientific knowledge), and the latter referring to all types of cognitive entities, including attitudes, beliefs, values etc., without focusing on the validity of the knowledge included in the conceptions. The terms conceptual change and conceptional change have also been discussed by White (1994), who defines concepts either as a method of classification (e.g. is an object a dog or not), or as the knowledge that a person has and associates with the concept's name (e.g. all mental images, knowledge and experiences of elephants constitute the person's concept of elephants). He defines conceptions as systems of explanation that are more complex and difficult to define than either of the meanings described above for concept. Thus, he concludes that conceptional change would be more difficult to produce than conceptual change, because conceptions are more complex matters. In the case of learning of research, we should not talk about concepts, but conceptions, and conceptional change would be more appropriate term to describe changes in learning of research.

Category of 'difficult things'- a theory of personal categories

In the present study, I propose a modification of Chi's (e.g. 1992) theory of conceptual change that is presented above. The central idea of the proposed theory is based on Chi's idea of categories. Similar to Chi's theory, I assume that individuals' concepts are assigned into categories, which could be thought of as a tree, having branches that stand for categories. Different to Chi's theory, I do not assume that misplacement of a concept into a wrong category (or branch of a tree) produces a misconception, but that placement of a concept into a category that is not useful for the purpose produces problems in further learning.

The difference mentioned above is motivated by another difference between Chi's theory and the proposed theory, being that I do not assume categories to be ontologically distinct. According to Chi (1992, 130), "Ontology divides our knowledge into categories that are conceptually distinct… I propose there exist a few major categories in the world that are ontologically distinct physically, and should be perceived by adults as ontologically distinct psychologically." In the present proposed theory it is assumed that categories would be formed individually on the basis of our understanding of our environment, cultural involvement, and emotional experiences. This assumption is motivated by the philosophy developed by Lakoff and Johnson (Lakoff, 1987; Lakoff and Johnson, 1999; Johnson 1987) called the 'embodied philosophy' or 'embodiment'. One of central claims of embodiment is that ontology and epistemology cannot be separated. Humans are neural beings who can only form concepts through the body (Lakoff and Johnson, 1999, 555). Thus, we cannot assume an ontology separate from our understanding, i.e. ontology is based on our understanding of our environment. According to Lakoff and Johnson (1999), we are born with a certain body that sets the possibilities and limits for the knowledge that it is possible for us to have. Thus, we cannot know about an ontology that is not within the limits of our understanding. Ontology is the human way to understand the world.

The basic ontological categories proposed by Chi, Slotta and de Leeuw (1994), i.e. matter, processes, and mental states, may well be such that it is obligatory for humans to form categories like this, i.e. we do not have a human way to conceptualize the world if we do not express these categories (for categorisation, see Lakoff & Johnson, 1999). Some of these categories may also be innate (for innate concepts, see e.g. Carey, 1992), and they may be so self-evident for humans that they feel as if to be separate from human cognition, i.e. "in the world". To the question of the possibility of common knowledge, embodied philosophy (Lakoff & Johnson, 1999) would say that we save similar bodies and, thus, we have to understand information from the world in a basically similar way. The objects of understanding are not, however, stable and independent of people. What we see/hear/feel etc. is possible only for people and other nervous systems similar to those of humans in specific cases. For example, a human and a monkey can see a flower, but a tiny bug without eyes cannot 'see a flower' in the same meaning. Communication with others makes the more abstract knowledge common. However, when we assume that the categories are a human way to understand the world, we simultaneously admit that there may be variance among individuals. Categories may also be possessed by a group of people who share some central views on the issue.

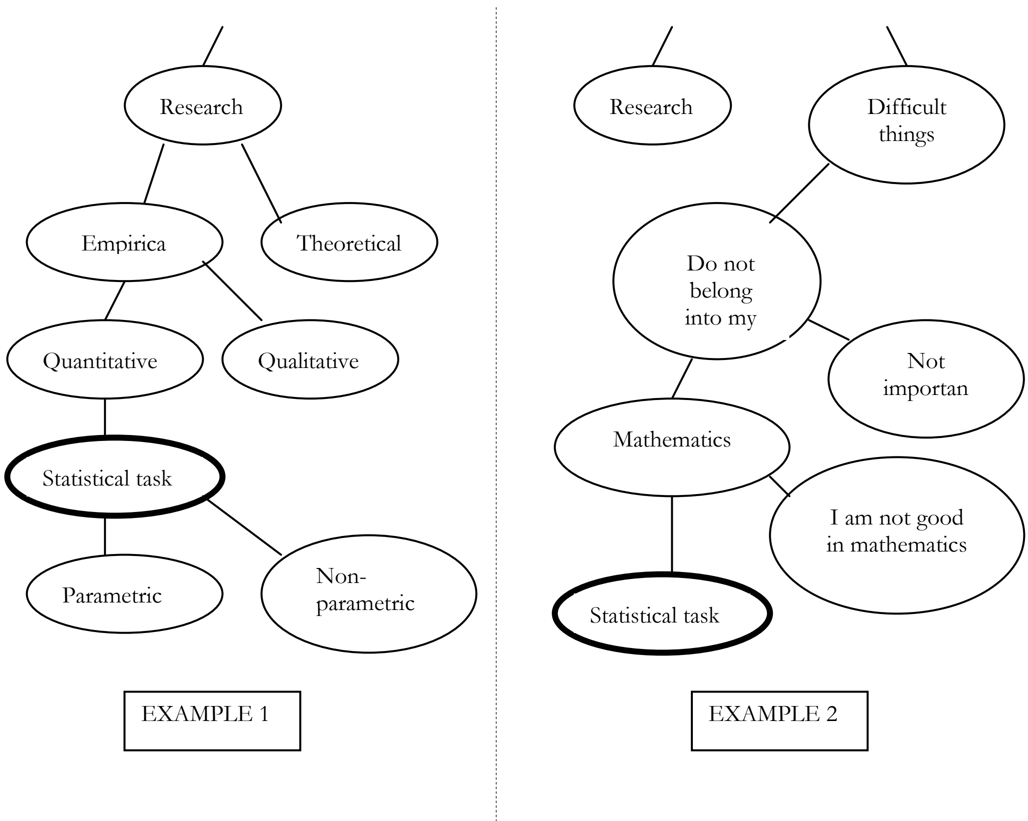

Figure 1. Two examples of placing a 'statistical task' into personal categories that are constrained by individual ways of thinking, previous experiences, culture, and common features of human thinking. The theory is based on Chi's theory of conceptual change (e.g. 1992).

Figure 1 shows a 'theory of personal categories' proposed here that is based on Chi's (e.g. 1992) theory. It is assumed here that these categorical structures vary among individuals. The structure of a person's categorisation is based on individual ways of thinking and previous experiences, and also on common features of human thinking and culture. The theory proposed here is also tied to neuropsychological explanations of learning (e.g. Spitzer, 1999, 225), which assume that activation spreads through certain areas in certain tasks, depending on the previous experiences. Reactions evoked in a situation are thus also a function of the framework theories that are activated simultaneously with the task. Previous experiences determinate which areas are activated while new experiences may change or add connections.

The proposed theory offers an explanation for why people approach certain topics or tasks differently. For example, when given a statistical task at university, one student may consider it a statistical task and start to think about how to solve it, i.e. assigning it to a category of statistical tasks, activating areas in the brain that deal with problem solving, statistical knowledge, knowledge on research, and feeling "at home" with these kinds of tasks. Another student may consider it a difficult task that he or she dislikes and starts to think of ways of getting rid of the task, i.e. he or she is placing it in a category of unpleasant things, and this placement activates areas dealing with anxiety, avoidance behaviour, low self-confidence, mythical science images, and a feeling of doing it as an unpleasant, compulsory task.

The change in the proposed theory could occur inside branches, or between branches, and similarly to Chi's theory, the jumpings between branches are more radical changes than changes inside branches. The changes inside branches may be just small corrections in concepts, such as understanding that *p* means the word probability, or bigger corrections, such as understanding that the importance of a *p*-value is not in the colour of the numbers on the computer screen, but in what it means, for example, that some groups differ statistically significantly from each other. The change may also be jumping between branches, for example, when understanding how a *p*-value can be useful in real life, instead of considering it to be a difficult thing in a statistics course one just wants to avoid. Students having problems should thus be helped to change their conceptions. Unless they can move the issue to a category where solving it is possible, they cannot succeed.

Concepts can change in various ways during learning, but the process of change is often very slow (e.g. Murtonen & Merenluoto, 2002; Tynjälä 1999; Tynjälä, Merenluoto & Murtonen, 2002). The process of developing conceptions and understanding of science and research is slow, as shown in a study by Petersson (2005) with medical and nursing students. The results indicated that students generally held the same conceptions about science after three years' education as they did at the beginning of their undergraduate programme. The conceptions had, however, become increasingly developed and elaborated. In a study by Murtonen (2003), education students' conceptions of research were analysed on the basis of concept maps at the beginning and at the end of the course. The maps remained very similar at the end of the course, i.e. no great changes had occurred during one course lasting one semester. On the basis of the theories and studies on expertise and conceptual change, knowledge about research methodology develops very slowly. Because of its characteristics, abstractness, complexity and specific vocabulary, research methodology demands much from a learner.

To conclude, it is suggested here that people form personal categories in their learning that may vary between individuals and that may hinder their learning in some cases. For example, if a student places ‘quantitative methods’ into his/her category of ‘things that are hard for me to learn’, instead of a category of, for example, ‘things that help me to understand research’, the student is probably experiencing difficulties in learning. A change in this conception is required before learning can occur.

2. AIMS

The goal of the present study is to explore the difficulties that many university education, psychology and social science students may have in their quantitative research courses, and to discuss the possible explanations for this problem in the light of the current theories of learning.

Many research teachers have expressed their concern that many university students continuously have problems with learning of quantitative research. There are, however, no studies showing that quantitative research courses really are more difficult for students than their other studies. Nor do we know how students themselves experience these difficulties. Thus, the first questions to study are:

- Is research more difficult for education and social science students to learn than other academic contents? What kinds of difficulties do students experience in their learning? (*Study I*)

The next question will naturally be that if students have problems, what impact do the problems have? Do they, for example, hinder the learning of research skills? One hypothesis is that students having difficulties in learning of quantitative methods differ in their content knowledge from students not having difficulties. It is also interesting to compare the students' content knowledge to experts' content knowledge.

- Are there differences in content knowledge of the research process between students having problems and students not having problems? Do these differ from experts' content knowledge? (*Study II*)

The impact of difficulties may also be seen in the course success, which is, of course, connected to content knowledge, but a course test is a special type of situation and the students may have special kinds of coping strategies for it. It has often been suggested that students' difficulties are rooted in difficulties with previous mathematics studies. A question would thus be:

- Are difficulties in learning of research methodology connected to previous success in mathematics and success in university research courses? (*Study III*)

Research on conceptions has shown that students' conceptions and views do have an impact on their learning, choices and acting. We asked in the present study:

- Do some students have negative orientations towards either quantitative or qualitative methods? Are these conceptions connected to their readiness to use these methods and to their difficulties experienced in learning of research? (*Study IV*)

Although students' possible struggling with research courses would not necessarily be seen in their course grades, difficulties experienced might have other implications, such as in their readiness to study in research courses or to carry out their future work.

- Do students think they will need research skills in their future work? How are these views of future work related to their difficulties experienced in learning of research, to their motivational orientations in the situation of learning of research, and to their learning approaches? (*Study V*)

3. METHODS

3.1 Participants

The participants of the present study were education, psychology, sociology and social policy students from Finland and the USA (see Table 1). They all participated in a research course in their own discipline. All the Finnish students were from the same university, which is one of the biggest and oldest universities in Finland. The US students were from one of the highest ranked universities in the USA.

Table 1. Participants in studies I – V.

Measurement group & major	*N*	**STUDY I**	**STUDY II**	**STUDY III**	**STUDY IV**	**STUDY V**
Finnish groups						
Education I	19	X				
Sociology I	15	X				
Education II	31		X			
Education III	29			X	X	
Psychology I	26			X	X	
Sociology II	19			X	X	
Education IV	43				X	
Psychology II	11				X	
Social policy	22				X	
Education V	46				X	X
US group						
Psychology	122				X	X
N together	**383**	**34**	**31 / 6 ***	**74**	**318**	**168**

* First phase 31, second phase 6, including two experts

3.2 Materials and procedures

One of the goals of the present study was to examine the difficulties experienced in learning of quantitative methods. Quantitative methods is considered here as a wider area of learning than learning of statistics, and the experience of difficulty is considered as a more holistic experience than anxiety. Many ready-made questionnaires on statistics anxiety are available, such as the Attitudes Toward Statistics, the Statistical Anxiety Rating Scale, Statistical Test Anxiety, the Statistics Anxiety Inventory, the Statistics Anxiety Scale, the Statistics Attitude Survey, the Statistics Readiness Test, and the Survey of Attitudes Toward Statistics (see e.g. Benson, 1989; D'Andrea & Waters, 2002; Gal & Ginsburg, 1994; Gal et al., 1997; Onwuegbuzie, 2000; Pretorius & Norman, 1992; Zeidner, 1991). These anxiety inventories are based mainly on the inventories that have been developed to measure anxiety about mathematics. For example, the Statistical Anxiety Rating Scale (STARS) and the Statistics Anxiety Inventory (SAI) are developed from the Mathematics Anxiety Rating Scale (MARS).

The statistics anxiety inventories have been reported to have some problems. According to Wilson and Rosenthal (1992), the MARS, although its reliability is quite high, has problems of validity: it is multidimensional and reflects, primarily, anxiety about taking tests, and, secondarily, anxiety about arithmetic. This same problem may also occur with the statistics anxiety inventories. A problem for the present study was also that, even if the inventories were able to measure the anxiety about statistics, the aim of the present study was not to measure only anxiety, but a wider range of feelings and experiences.

The domain of the available inventories was also problematic for the present study. The present study aimed to examine the learning of quantitative methods and also the whole of methodology, whereas the statistics anxiety inventories were aimed at the narrower domain of statistics. An inventory on the broader domain has been developed by Green, Bretzin, Leininger and Stauffer (2001), whose Graduate Student Research Anxiety Scale (GRAS) includes statements like "The thought of registering for a research course makes me apprehensive or anxious", "I get anxious reading and interpreting charts and graphs", and "I get uncomfortable or anxious looking through the pages of a research textbook". The problem with this inventory is the same as mentioned above, that the statements are concerned, primarily, with anxiety, and not with other feelings or thoughts.

Because little research on the subject of the present study has been conducted, and no suitable inventories were at hand, the present research commenced asking students about their experiences and feelings with open-ended questions. Suitable questionnaires were developed later, having similarities also with the statistics anxiety inventories. It would be interesting to study the possible connections between the available statistics anxiety scales and difficulties in quantitative methods, but this was not within the scope of the present research.

A research booklet was used in *Study I* consisting of three different tasks and two background questions about students' major subject and age. The booklet was a kind of learning diary, which students filled in during the quantitative methods course whenever they had something to write down about their experience. In the first task, students were asked to place 11 academic subjects within a dimensional field, i.e. a co-ordinate system with two dimensions: easy-difficulty and concrete-abstract. Points in the dimensional field were given values ranging from -5 to +5 and the origin set at 0. The academic subjects included different methodological issues, students' major subject studies and foreign languages. The second task was an open-ended question, in which the students were asked to write down during the course all the difficult things and concepts in their methodology course whenever they faced them. They were also asked to write down how they understood the particular point and why they experienced it as difficult. The third question was also open-ended; the students were asked to consider why the learning of research methodology is difficult. In both questions, the students were also asked to write about their experience if they felt these studies were easy, and to give comments on other areas of learning of methodology, for example, qualitative methods and statistics. We also asked students to note the dates when they wrote their comments. Students were asked to fill in the booklet during their methodology course and quantitative method exercises. The booklet was distributed at the beginning of the courses and collected at the end of them. The researcher handed the booklets to the students, and the teachers were responsible for returning the booklets at the end of the course. The reason for asking the students to write down their thoughts during the course instead of at one specific moment was the assumption that students might not immediately remember the problematic themes or the relevant concepts for describing their methodological problems.

Study II consisted of two phases. In the first phase, two questionnaires were filled in by 31 education students at the beginning of a statistics course. The first one was a test of statistical content knowledge measuring the understanding of, for example, mean, deviation, correlation and statistical inference. Students were also asked to estimate their certainty in each of the tasks. The second questionnaire was aimed at measuring students' difficulties as experienced in learning of quantitative methods, and motivational factors (the questions were formulated with the aid of the results of Study I). On the basis of analysing these questionnaires, four students were selected for further research. Two of the chosen students succeeded well in the statistical test, were confident in performing the tasks, did not experience difficulties in quantitative methods, and had a positive attitude and good motivation to learn methodology. The other two students had considerable problems in the statistics tasks; they were not confident in performing the tasks, they had experienced difficulties in quantitative methods, and they had low motivation in learning of methodology. In the second phase these four students were interviewed after the statistics course. Two experts were also interviewed to be able to compare the students' answers to an expert view. The experts were psychologists who had been working as researchers for many years. All interviewees were female. The interviews were conducted in pairs on each expertise level. Both two researchers were present all the time. The interviews lasted from 1 to 2 hours. The reason for interviewing two students/experts at the same time by two researchers was to encourage a discussion between students and also between students and researchers. The interview was about conceptions of scientific research and statistics. The interviewees were asked to explain what scientific research is and, simultaneously, to draw a concept map of scientific research. During and after drawing a concept map, the students were asked questions concerning their attitudes and conceptions of different domains of scientific research, and especially about statistics. Specific questions about statistics were asked about what they think happens in a *t*-test and do they know what the *p*-value really stands for.

In *Study III*, a questionnaire called Difficulties in Quantitative Methods (DQM) was developed on the basis of the results of Study I's open-ended questions, and comprised 17 statements concerning difficulties experienced in learning of quantitative methods. The statements covered instruction in courses, interest in quantitative methods, superficiality of courses, students' ability in mathematical subjects, and lack of connection between parts in the methodology domain. Students responded to each item on a Likert scale ranging from *strongly disagree* (1) to *strongly agree* (5). The statements were not restricted to a specific course but were more general in nature. Students were asked to give their high school mathematics grade in the questionnaire. University statistics and quantitative methods course grades were taken from the university's student registry, and standardised within the major subject groups. Data collection took place at the beginning of the methods courses. The teacher was responsible for both distributing the questionnaires to the students and collecting them. Students filled in the questionnaires at the beginning of a lecture. The questionnaire began with a short note for the students about the research project and about the importance of their answers for the study.

In S*tudy IV*, a questionnaire was used which consisted of statements in two sections. The first section consisted of 8 statements concerning the appreciation of theoretical-philosophical, empirical, qualitative and quantitative methods, and readiness to use qualitative and quantitative methods. The second section comprised 18 questions of the Difficulties in Quantitative Methods (DQM) instrument, also used in Study III. All statements were measured with a Likert-scale, ranging from strongly disagree (1) to strongly agree (5). The students filled in the questionnaires during the lectures or small-group working at the beginning of the courses. The questionnaires were handed out and collected by the researcher or the teacher. A second measurement at the end of the courses was conducted on two Finnish education student groups, on one Finnish psychology student group, and US psychology students.

In *Study V*, a questionnaire was used consisting of an instrument comprising 21 questions measuring the experience of difficulty in a quantitative methods course (based on the DQM instrument that was used in studies III and IV), 8 questions measuring learning approaches (based partly on the work of Entwistle & Ramsden, 1983; Lonka & Lindblom-Ylänne, 1996; Marton & Säljö, 1976), 12 questions measuring situational orientations (based on the theory of situational orientations by Olkinuora & Salonen, 1992), and a question measuring the view of the need of research skills in working life. The questionnaires were handed out and collected by the teacher or by the researcher at the beginning and at the end for a research methodology course.

3.3 Statistical procedures

In S*tudy I*, the dimensional tasks' values were manually calculated for each academic subject from the students' markings, ranging from -5 to +5. Then means and standard deviations were calculated for each academic subject, and these were placed in the dimensional field. Pearson correlation coefficients were used to calculate correlations among academic subjects. A k-means cluster analysis procedure was used to find groups of students on the basis of their difficulties in academic subjects. Several cluster analyses were performed to find the most stable and theoretically best solution, meaning that the groups differed from each other in a way that was hypothesised.

In S*tudy II*, students' responses to questionnaires were manually evaluated and four suitable students were selected for the interviews.

In S*tudy III*, a principal component analysis was conducted on 17 questions. A five-component varimax solution was chosen. Pearson correlation coefficients were calculated for correlations between the principal components, high school mathematics achievement and university statistics and quantitative methods course grades.

In S*tudy IV*, a k-means clustering by cases procedure was carried out to create groups of students. First, several cluster analyses were performed with a method of maximising between-cluster distances. This gave the researcher a conception of the possible groups of students, i.e. how many groups there were with different profiles. The results of this k-means clustering method depend to some extent on the initial configuration, i.e. the method uses the first N of cases as cluster centres (Statistica, 1995, 3187). This is why the final cluster analysis was conducted with the "Choose the first N (number of clusters) cluster observations" option that gives the user full control over the choice of the initial configuration (Statistica, 1995, 3187). Thus, representatives of the theoretically most interesting and most differing-from-each-other groups were selected manually and moved to the beginning of the data sheet. Those cases were used as the basis for the final clusters. This clustering by sample cases method produced very similar groups to those found by the clustering by maximising the initial between-clusters distances method. The k-means cluster analysis is based on the "ANOVA in reverse" (Statistica, 1995, 3173), and thus these ANOVA results are utilised in the present study. In other between-group comparisons and repeated measurement tests, parametric methods (ANOVA, t-test) were used. Some of the topics were measured by only one item, which is problematic when using parametric methods. The results were confirmed with nonparametric methods (U-test, Wilcoxon test), if there were problems, for example, in the homogeneity of variances. The LSD test was used for post hoc comparisons.

In S*tudy V*, means, standard deviations and Cronbach Alphas were calculated for different scales. Group comparisons were conducted with parametric tests, and for post hoc tests, the Tukey HSD test was used to study differences between groups. All analyses were conducted separately on Finnish and US data.

Statistical software packages Statistica and SPSS were used for analyses by computer. All questionnaires were pre-tested, and inoperative questions were removed.

4. OVERVIEW OF THE EMPIRICAL STUDIES

Study I

Murtonen, M., & Lehtinen, E. (2003). Difficulties experienced by education and sociology students in quantitative methods courses. *Studies in Higher Education, 28*(2), 171-185.

The present study describes difficulties experienced by education and sociology university students (*N* = 34) in their learning of quantitative methods. The two groups did not express different types or amounts of experiences of difficulty.

First, students were asked to rate different academic subjects on the basis of their difficulty within a dimensional field. It was found that statistics and quantitative methods were experienced as more difficult than other domains, such as qualitative methods and the students' main subject. Overall, it seems that students tended to polarise the academic subjects into "easier" language, major and qualitative subjects, and to "harder" mathematical, statistical and quantitative subjects.

Second, the students were asked to answer open-ended questions concerning the most difficult aspects of methodology courses and the reasons for their difficulties. Five main categories of reasons for difficulties were established: 1) Superficial teaching, 2) Linking theory with practice, 3) Unfamiliarity with and difficulty of concepts and content, 4) Constituting an integrated picture of the parts of scientific research in order to really understand it, and 5) Negative attitude toward these studies. Students' spontaneous answers to open-ended questions showed that they had problems with the basic understanding of methodology.

The students who gave high ratings for the difficulty of statistical and quantitative subjects in the dimensional field task cited teaching most frequently as the reason for difficulties. Those students who did not have many problems in statistical and quantitative subjects, but who still had more trouble with them in comparison to major subject studies, mentioned negative attitude as the main reason for difficulties.

The difficulties in methods studies are not necessarily related to overall study difficulties. A group that experienced quantitative methods and related subjects as more difficult than the other groups did not experience qualitative methods, major subject studies or foreign languages as difficult.

Study II

Murtonen, M., & Merenluoto, K. (2001). Novices' and experts' knowledge on statistics and research methodology. *Proceedings of the 25th Psychology of Mathematics Education conference,* vol 3, pp. 391-398.

The goal of this case study was to examine the differences between novices' and experts' content knowledge of statistics and research methodology. Novices (*N* = 2) were here partly defined through their high difficulties experienced in the learning of research, while the more advanced students (*N* = 2) who were selected for the present study did not experience many difficulties. The students were at the same phase of their studies. The experts (*N* = 2) were experienced researchers.

The interviews and the concept maps drawn by the pairs showed remarkable differences in the fragmentation of concept maps and explanations between novices, advanced students and experts. The interview with the novice students about the difficulty of methodology referred to the tendency of some students to create a category of difficult things, a "clump", where they place all the things they think they cannot learn. This kind of categorisation seems to function as an obstacle to further cognitive activities. The novice students also called for more practice, which suggests that they suffer from a lack of operational understanding and helpful representations of the concepts.

The major difference in the concept maps of the interviewees was their state of fragmentation. The map of the novices was a static picture composed of fragmented pieces of external knowledge with hardly any connections between them. The map of the advanced students had more structural elements, connections between the domains and indications of a process like knowledge, even some dynamics. There was, however a noticeable difference between the concept maps of the students and that of the experts. The map of the experts formed an integrated whole of the research, which was clearly structured but simultaneously had the dynamics of the research in action. Besides the formal knowledge of research methodology, there was also a vision of the important informal knowledge reflecting the experience of the experts. The experts also had clear ways of representing the given statistical concepts, while novices had hardly any indications of representations.

The present study gave some preliminary evidence that with a method of interview and drawing simultaneously a concept map of research, it was possible to see differences between novice and more advanced students' content knowledge. On the basis of this case study, a hypothesis could be set that difficulties experienced in the learning of research might have an effect on students' content knowledge.

Study III

Murtonen, M., & Titterton, N. (2004). Earlier mathematics achievement and success in university studies in relation to experienced difficulties in quantitative methods courses. ***Nordic Studies in Mathematics Education, 9*****(4), 3-13.**

The present study explored connections between earlier mathematics achievement in high school, success in university statistics and quantitative methods courses, and difficulties experienced in quantitative methods courses. A questionnaire was used to measure the difficulties experienced (based on the results of Study I), and the high school mathematics grade was asked for. University statistics and quantitative methods course grades were taken from the university's student registry.

The results were in line with previous studies on anxiety and success: almost no correlation was found between difficulties experienced and achievement. Earlier achievement in mathematics correlated with statistics grades in university studies, but not with quantitative methods course grades. Earlier achievement in mathematics was related to the experience of one's own ability in mathematical subjects and quantitative methods, but it was not related to other difficulties experienced. Ability in mathematical subjects and quantitative methods was further connected to other difficulties experienced in quantitative methods. The difficulties experienced and achievement in university courses were not related. On the basis of these results, it seems that the difficulties experienced are not always associated with achievement. The fact that the experience of difficulty was not related to achievement in university courses does not mean that it has no consequences. It is possible that these already highly selected students have developed methods needed for gaining good results in their courses, independently of their motivation, beliefs and attitudes. The real consequences might appear later in further course selections or in working life.

Study IV

Murtonen, M. (2005). University students' research orientations - Do negative attitudes exist toward quantitative methods? *Scandinavian Journal of Educational Research*, *49*(3), 263-280.

This paper examines university social science and education students' views of research methodology, especially asking whether there exist negative views toward quantitative methods. Finnish (N=196) and US (N=122) students answered a questionnaire concerning their views on quantitative, qualitative, empirical and theoretical methods, their readiness to use quantitative and qualitative methods in their own research, and the difficulties they experienced in the learning of quantitative methods. In both countries, the students did think that interesting results are obtained with both quantitative and qualitative methods. Students in both countries were equally interested in conducting a study of their own with quantitative methods, but the Finnish students were more eager to use qualitative methods than the US students. Thus, it may be said that the Finnish students as a group had a more positive orientation toward qualitative than toward quantitative methods. Empirical methods were quite highly appreciated in both countries. Theoretical methods were not so highly appreciated, and especially Finnish students ranked them quite low.

Students were clustered in groups according to their views. Different views on the methods were found between students in both countries with regard to their appreciation of quantitative, qualitative, empirical and theoretical methods, and combinations of the appreciation of these. Students could thus be said to have different *research orientations* toward methods, meaning a combination of views of, appreciations of, and readiness to use certain methods. Some of the students had a dichotic attitude toward quantitative and qualitative methods; they seemed to "choose their side" between these methods. In both countries, a negative research orientation toward quantitative methods was found which was associated with a positive view on qualitative methods. It could be said that these students had a *qualitative research orientation.*

Finnish students' qualitative research orientation was associated with either difficulties experienced in learning of quantitative methods or with a lower appreciation of empirical methods than that of other students. Major subject and study year had no effect, so the views were not discipline-specific and students seemed to possess them on entering university. Views about methods were quite stable during the course.

When asked about difficulties experienced in learning of quantitative methods, 58% of the Finnish students and 21% of the US students reported such difficulties. The difficulties experienced were connected to a negative research orientation toward quantitative methods for part of the students. The Finnish students had a very high appreciation of qualitative methods, named here over-appreciation, and a high readiness to use them. A reduction in difficulties experienced in learning of quantitative methods' was associated to reduced over-appreciation of qualitative methods at the end of the course. Thus, previous over-appreciation of qualitative methods may have been caused by their problems in learning of quantitative methods, and conversely, interest in using qualitative methods increased when students had more difficulties with learning of quantitative methods at the end of the course.

Study V

Murtonen, M., Olkinuora, E., Tynjälä, P., & Lehtinen, E. (Submitted). "Do I need research skills in working life?" – Students' motivation and difficulties experienced in quantitative methods courses.

This study explored students' views of whether they will need research skills in their future work in relation to their approaches to learning, situational orientations, and difficulties experienced in a research methodology course. Education and psychology students in both Finland and the USA (Finnish N=46, US N=122) were given a questionnaire concerning difficulties experienced in quantitative research methodology courses, orientations to studying quantitative research, and situational orientations on a statistics course. These learning factors were compared in different groups of students on the basis of their work views, i.e. whether they thought research skills would be important in their future work or not. About half of the students in both countries thought they would need research methodological skills in their future work, while the other half was not sure if they would need these skills. These groups differed significantly: the groups who considered methodological skills important for their future work were more task-oriented, used a deeper approach to learning, and had fewer difficulties in the learning of research methodology than the other groups. This finding implies that the experiences in learning and the orientations related to it are further related to expectations about the future work. For instruction, this means that if we could somehow change the students' experiences and orientations during formal education, they might be better oriented for their future work.

5. MAIN FINDINGS AND DISCUSSION

Learning and teaching of research is not an easy task. Students are reported to have difficulties and anxieties in research, especially quantitative methods, learning. In the present study, the problem of learning of research was approached from the perspectives of studies about anxiety, studies on conceptions and beliefs as research orientations, motivational orientations in study situations, and conceptual change theories.

In congruence with earlier studies, difficulties experienced and negative attitudes toward quantitative methods were found in the present study. In Study I, issues related to quantitative methods and mathematics were assessed as more difficult than other academic study subjects, such as languages and major studies without research studies. The sources of difficulties were thought to lie both in ones' own interest and lack of abilities, as well as in teaching and course arrangements. The reasons for difficulties that the students gave depended on the amount and quality of their difficulties experienced: the students who experienced mathematical and statistical subjects as most difficult said that problems with teaching caused their experience of difficulty. The students who saw mathematical and statistical subjects as moderately difficult thought that the reason for difficulties lies in attitudinal problems.

One hypothesis in this dissertation was that students' conceptions of research might have an influence on their readiness to use the methods themselves. It has been argued that scholars in behavioural and social sciences tend to divide themselves into two camps, qualitative and quantitative (e.g. Smith, 1997). It was hypothesised that students may also make a similar methodological distinction. These conceptions of society and the science community may form students' conceptions of what a good scientific method is. The culturally formed conceptions of science and human activity in general should not be omitted when studying adults' conceptions. Cotner et al. (2000) interviewed doctoral students in education about their attitudes toward qualitative research, and found that the students described varying degrees of sympathy and interest in qualitative research even before taking their first methodology class in their doctoral programme. Similarly, in Study I, it was found that some master students in social science either described an aversion toward one method, or just said that they experience themselves as a specific kind of person, for example, as a qualitatively oriented person.

Further, in Study IV on Finnish and US students, it was shown that some of the students seemed to have a dichotic attitude toward quantitative and qualitative methods; they seemed to "choose their side" between these methods. It was clearly seen that many students' appreciation of one method was connected to the readiness to use the same method in their own research. In other words, if students did not appreciate, for example, quantitative methods, their readiness to use quantitative methods was also low. Students could thus be said to have different 'research orientations' toward the methods, meaning a combination of views of, appreciations of, and readiness to use certain methods. The Finnish students in particular were more eager to use the qualitative methods. In both countries, a negative orientation toward quantitative methods was found, i.e. students could be said to have a qualitative research orientation. On Finnish students, this qualitative research orientation was associated with either difficulties in learning of quantitative methods or with a lower appreciation of empirical methods than that of other students. This finding indicates that students can have widely generalised conceptions about research that may guide their choices and decisions.

One aim of the present study was to find out how large a proportion of students suffer from difficulties in learning of quantitative research. Wilson and Rosenthal (1992) found, contrary to their hypothesis, that only 27% of the US social work students reported high or very high anxiety in research and statistics, while 51% had moderate anxiety, and 22% low anxiety. They wondered why the formulations based on informal experience are not congruent with the evidence of formal observation. They considered that perhaps the few cases of extreme anxiety are very vivid and stand out for teachers, thus attracting attention, or perhaps social work educators are extremely sensitive to anxiety. In Study IV, 58% of the Finnish students and 21% of the US students reported difficulties experienced in learning of quantitative methods. This finding in respect of the US students is in line with the results of Rosenthal and Wilson. In addition to the considerations that they presented, it may be that there are differences in the style of filling in a questionnaire, and also socially desirable behaviour models may be different in different countries. In the present study, the US students represented one of the highest ranked universities in the U.S.A., and consisted of only one course group, which may have had an effect on the results. The seven Finnish sample groups were selected from different disciplines and courses, which makes the results more generalisable to all Finnish universities. The result of Finnish students' anxiety level is alarming, and should be considered seriously on a national level, i.e. what should be done to reduce the experiences of difficulties in the learning of research.

The problem with students with difficulties in learning is that their difficulties may have some impact on their learning, study success or other factors. In Case Study II, it was shown how the novice students with difficulties experienced were not able to produce a well-elaborated concept map on "research", while other students who did not experience difficulties produced a much better map, although this was still quite different from the map produced by experts. The participants were interviewed at the same time as they drew the maps and it was noticed that the novice students were most anxious, they did not have representations for many central concepts of research, and they talked about their difficulties and anxieties. Thus, while the given task should have evoked thoughts concerning the task, they seemed to just focus on their negative feelings. A theory of personal categories was presented in the introduction to this research, based on Chi's (1992) theory that assumed that some people form categories in their mind based on emotional factors, and that unless they can move the issue to a category where solving it is possible, they cannot succeed. For example, in Study II, the novice students should have re-conceptualised quantitative methods as "an area in which I do have knowledge and I can solve problems concerning it", containing their knowledge of research, instead of the category "I am bad at this, and I cannot do anything about it", containing no knowledge of research, but just negative emotions. In other words, in some peoples' brains, a quantitative task may evoke function in areas that deal with solving the task, while in other persons' brains, the same stimuli may evoke function in structures that cause anxiety, fear and a need to escape from the situation.

The difficulties experienced in learning of quantitative methods, however, are not necessarily visible in students' course grades. In agreement with previous research (e.g.

Birenbaum & Eylath, 1994; Townsend et al., 1998; Wilson and Rosenthal, 1992), the difficulties experienced in learning of quantitative methods by the students in Study III were not associated with research and statistics course grades. However, belief in one's low ability in mathematical subjects was associated with other difficulties experienced in the learning of research, so there is a mathematical factor involved in difficulties in learning of quantitative methods. Townsend et al. (1998) concluded that although the problems are not seen on the level of grades, this does not mean that we should be unconcerned about them, because students' beliefs and attitudes influence not only their enjoyment of the subject but also the likelihood that they will select it for further study. Similarly, in the present research, the fact that the experience of difficulty was not related to achievement in university courses does not mean that there are no consequences. It is possible that these already highly selected students have developed methods needed for gaining good results in their courses, independently of their motivation, beliefs and attitudes.

The consequences of the difficulties might appear later in further course selections or in future working life. This was examined in Study V, and the results indicate that students' difficulties and motivational factors are connected to their conceptions of their future job. The students who had difficulties were more unsure about whether they will need research skills in their future work than the students who did not have so many difficulties. The results showed that the learning approaches, situational orientations, difficulties and views of future work form a connected web. The difficulties and harmful views seem to accumulate for some students, and although we do not know how they will behave in their future work, we know from these results that the students who had difficulties did think they might not need research skills in their future work. This may have an impact on how able and willing they are in their future work to deal with problems that need research skills and statistical understanding. Thus, it is important to consider the students' problems already in research teaching.

5.1. Limitations of the study

Measuring beliefs, conceptions and attitudes is always difficult. In the area of learning of quantitative research, the extra load is imposed by the terms of the domain, such as "quantitative", "empirical", "statistics" and so on. Operationalising these may be difficult, and on the other hand, using them as they are may have an effect on validity and reliability if students do not share the conceptions of these concepts with the researcher. For example, some students may the associate the word "statistics" with basketball statistics, meaning how many scores someone takes. Narrow views regarding life domains where statistics may be used can hinder the understanding of statistics related to research (Gal & Ginsburg, 1994).

Gal and Ginsburg (1994) cite Hegelson (1993) and Germann (1988), according to whom the beginning of research of statistics education probably shares the same problems as the research of assessment of attitudes in science education, for example, that the construct of attitude has been vague, research has often been conducted without a theoretical model of the relationship of attitude with other variables and that the attitude instruments are judged to be immature and inadequate. According to Gal and Ginsburg

(1994), work on assessing statistics attitudes so far has proceeded with little attention to the meaning of the complex constructs being measured, for example, what do "attitudes towards statistics", or "statistics anxiety" mean? In the present study, most of the studied terms, such as "quantitative methods" and "empirical methods" are used as they are, without any more detailed or underlying questions that aim to measure these constructs. The results of the present study thus tell more about students' beliefs and views about these terms than about what they think about the content that, for example, a researcher may think these terms have.

Another question concerning the limitations is whether the measurement instruments used in the present study have succeeded at all in measuring what they aim to measure. For example, in Study III, no correlation was found between the difficulties experienced and study success. Could the questionnaire used have failed to measure the real difficulties experienced? Or do the course tests fail to measure students' real knowledge? These questions are not easy to answer, but it has also emerged in other studies that a correlation between difficulties and success cannot be always found (e.g. Birenbaum & Eylath, 1994; Townsend et al., 1998; Wilson and Rosenthal, 1992). It is concluded in the present study that the missing correlation between difficulties experienced and study success may be due to the situation in which these already highly selected university students may have developed methods needed for gaining good results in their courses, independently of their motivation, beliefs and attitudes. Thus, although they report difficulties when asked, the difficulties do not harm their study success. Concerning the question about course grades as measures of students' knowledge, it is possible, for example, that students are aware of the question types in tests, and thus they are able to fulfil the course requirements although they do not necessarily have a good knowledge of the domain. The Case Study II showed that with a method of interview that was combined with a concept map task, the fragmentation of knowledge was seen in those students' content knowledge, who experienced difficulties in the learning of quantitative methods. Thus, quality of content knowledge may be connected to difficulties experienced in the learning of research. The Study II, however, was a case study conduced only on four students, and no generalisations can be made on that basis. A third problem concerning validity in the present study concerns the participants in the studies. The Finnish samples were quite small due to the small course sizes, but they were selected from different disciplines and courses, which makes the results more generalisable to all Finnish universities. The US sample was selected from one of the highest ranked universities, and consisted of only one course group, which may have had an effect on the results. For example, it is possible that these highly selected students do not have troubles with learning of research skills, or that they tend to produce more socially desirable answers, i.e. not reporting experiencing difficulties, than Finnish students.

5.2 General discussion and challenges for future studies

Research is a rapidly growing activity in our society. Research results are widely utilised and the amount of research that is conducted is increasing. The amount of doctoral students at universities is constantly growing. The Western society is becoming a research society (e.g. Busquin, 2001). Still, there are surprisingly few studies concerning learning and teaching of research. The mostly missing literature about learning of research is even more amazing when we take into account that it is widely known, as was also shown in the present study, that many university students do experience problems in the learning of research. On the basis of the present study it is obvious that the students who experience difficulties in learning have also problems with motivation in the learning of research and they do not see research skills important in their future working life. This is alarming, since we know that research skills are needed in many occupations, including also other than traditional academic careers at university. Students that do not understand the value of research skills are probably not well enough prepared for managing the given tasks in their future work.

In the present study, over half of the Finnish students reported some difficulties in the learning of quantitative methods. It should be questioned on the national level that what are the reasons for this and what can be done to change this situation. The present study suggests that some of the students having difficulties in the learning of quantitative methods have a very negative view about quantitative methods. These students do not appreciate the methods and they are not interested in using these methods in their own studies. It can be questioned, and should be further studied, that what impact does the general division of research in qualitative and quantitative paradigms in behavioural and social sciences have on this problem? The scenario of the division of society into science and art described by Snow (1964) seems to came true also in some students thinking, with the addition of the advocates of each pole having 'a curious distorted image of each other'.

We should also study further students' prototypical images (Hannover and Kessels, 2004) of students and researchers conducting qualitative or quantitative course works or research. Negative prototypical images of, for example, researchers conducting quantitative research, may be one source of low appreciation of these methods. Hannover and Kessels (2004) discussed about the teaching styles of different subjects; it can be, for example that quantitative methods are taught with a very technical and non-creative way, which creates a picture of these methods and people working with them being boring or hard to understand. If a subject is taught in narrow-focused classwork, like mathematics and science lessons often are, it may feel more dull than, for example, language classes that utilise group work, students' presentations and discussions about different ways of solving a problem. Problem-based or inquiry-based learning approaches are thought to be often more beneficial for learning than the old-fashioned, fact-centred lessons (e.g. Hakkarainen, Lonka & Lipponen, 1999). Collaboration and interaction with other students have been found to be beneficial, especially for students who have motivation problems (Tynjälä, Helle, Lonka, Murtonen, Mäkinen & Olkinuora, 2001). Thus, problem-based and collaborative environments might be beneficial also in changing the prototypical images in the domain of research methods.

Another suggestion for trying to reduce students' difficulties experienced in quantitative methods courses would be to 'vanish' the quantitative methods and statistics courses from the curriculum. Onwuegbuzie, Leech, Murtonen & Tähtinen (2005, see also Onwuegbuzie & Leech, 2005) discuss about eliminating statistics courses from the curriculum and combining these with research methodology courses at different levels that simultaneously teach students both quantitative and qualitative techniques within a mixed methodological framework. Teaching based to this mixed methodological framework is supposed to reduce students' statistics anxiety levels. It is also possible that by combining research courses we would be able to reduce the paradigmatic gap between quantitative and qualitative methodologies in students' minds that was found in the present study. These questions should be studied further.

The goals of research methods teaching are not easy to set. Winn (1995) has discussed the dilemmas in research methods teaching, namely, the distinction between providing students with the ability to be critical consumers of research and enabling them to become research practitioners. This is a question at both curriculum level and at the level of individual courses. In the case of statistics instruction, according to Forte (1995), teachers traditionally try to prepare social work students in statistics courses in terms of three outcomes: consumption, production, and integration. Consumption involves the capacity to read and understand social statistics, production is the capacity to appropriately select and correctly use basic statistical procedures, while integration refers to the development of an appreciation for social statistics and the capacity to see its relevance to other areas. We could consider the three goals, consumption, production, and integration, as goals of research methodology courses in general. Research skills include the ability to consume, which comprises the skills to find, read and understand previous research; to produce, i.e. to know how to approach a research problem and which methods are needed to respond to it; and to integrate, i.e. see the problem in a wider context and in connection with other studies and disciplines.

Another important question to ask about curriculum is that are our research courses too packed? Especially with regard to production goal, i.e. students conducting research by themselves, we should ask that what methodological skills students are able to learn during a course? If the answer is that they are introduced a wide range of different methods, but they can hardly understand even some of them as to what the methods can be used for and how, we should seriously think if it is necessary to introduce all these methods to them. It could maybe be better to introduce only some and concentrate on profound understanding of these. It would also be important to teach students to search information by themselves about methods, i.e. what methods can be used for certain purposes and how.

Gal and Ginsburg (1994) stated that in order to make the learning of statistics less frustrating, less frightening, and more effective, further attention should be focused on the beliefs, attitudes, and expectations that students bring into the statistics classroom or develop during their educational experiences. The present study aimed at framing the learning of quantitative research from the perspectives of current learning theories that acknowledge psychological, social and cognitive aspects.

Anxiety about statistics is the one and almost only aspect of emotional problems in learning of statistics that has been studied. Anxiety about statistics, however, is too a narrow viewpoint alone when considering university students' problems with the learning of quantitative methodology and research methodology in general. Anxieties are, of course, to be overcame somehow. In a study by Hannula (2002) with upper level comprehensive school students, anxieties in mathematics were shown to change slowly, but with the help of a constructivistic and supporting learning environment, a positive change in a student's views of themselves as mathematics learner did occur and their grades improved. Similarly it could be assumed that with a supportive environment at university, students' problems in learning of quantitative methods could be reduced. By acknowledging also students' views and conceptions about research methods and about learning of research, teachers can be better prepared to discuss with students about their possible obstacles and anxieties in learning.

Students' anxieties and difficulties are widely acknowledged, but teachers' anxieties are not often discussed. Teachers may also have a fear of quantitative methods. Some teachers may not have wanted to teach, for example, quantitative methods, but they are obliged to do so because of their position. Anxious teachers and students do not contribute to a satisfying or productive educational atmosphere (Forte, 1995). Another problem is that a teacher may be too understanding of students' difficulties or other negative attitudes. According to Epstein (1987), for an effective research instructor, acknowledging students' resistance does not imply "joining" it in such a way that research is a bore that both faculty and students have to endure. Instead, what is needed is an honest, open discussion at the start of the course about negative attitudes towards research, and personal fears and anxieties about its mastery.

Teaching may also be problematic if some parts of the domain are over-emphasised. According to Epstein (1987, 72), some teachers may teach research as though they are "bringing religion to the primitives". In so doing, these teachers emphasize the observance of ontologically meaningless research rituals such as the calculation of Chi-square and other statistical icons. These computational feats have little obvious relevance to the real and appropriate practice concerns of students unless they are consciously linked by teachers. The teachers who emphasize the rituals rarely do this. Instead, they just try to keep the religion alive. Research should thus to be demystified, but not trivialized. (Epstein, 1987.)

There are no available theories to explain the learning of the contents of research methodology. Current theories of learning, such as the conceptual change theory, have been developed for other purposes than learning of research methodology. Conceptual change theories have been developed to explain pupils' understanding of some well-defined science concepts (e.g. Chi, 1992; Vosniadou, 1992). There are studies concerning the learning of specific concepts of statistics, such as sampling distribution and statistical inference (Meletiou-Mavrotheris & Lee, 2005), but, as stated above, the emotional issues about learning of research and statistics should also be studied. Thus, we would need a theory of learning that combines cognitive and emotional issues. A theory is proposed in the present study that involves these two, and is also connected to current neuropsychological views (e.g. Spitzer, 1999) on learning. The theory of "personal categories" proposed in the present study suggests that people form categories that are based on their own experience, and that are not always beneficial for learning. For example, a statistical task can be placed on the category named here as 'difficult things' that hinders the student dealing with the task cognitively. Unless the student in capable to move the conception to a category of, for example, 'things that are possible for me to understand', the student will probably not be able to learn it. The present study thus proposes that to understand learning of research methodology, we should study conceptual change, and, simultaneously, students' emotions related to it.

The theory of personal categories fits well with the results of the studies on conceptions of research (Brew, 2001; Kiley & Mullins, 2005; Meyer, Shanahan & Laugksch, 2005), because different conceptions of research can be understood as being placed in different types of personal categories. For example, someone may have placed the concept of 'research' in a same category with things that involve issues attached to one's personal growth, while someone other may have placed it in a category with technical procedures. These categories may also be associated with emotional factors, such as 'enjoying research' or 'being anxious about research'.

The theory of personal categories proposed in the present study needs to be studied further in more depth. The questions about, for example, how are personal categories constructed and what are the relationships between concepts need clarification. The theory of 'knowledge in pieces' by diSessa (1988) could offer an explanation for possible isolated conceptions that are not connected to the concepts that they should be connected to on the basis of instruction. For example, if a student has a conception of probability as "being hard to learn and having something to do with basketball", the conception has elements of many things that are not introduced on a quantitative methods course and that do not necessarily form a very coherent conception.

An interesting theory to explain difficulties in learning is offered by Meyer and Land (2003, 1) about threshold concepts and troublesome knowledge. They introduce a threshold concept that can be considered as "akin to a portal, opening up a new and previously inaccessible way of thinking about something". They write that these threshold concepts are often "problematic or 'troublesome' for learners" (p. 6), containing, for example, conceptually difficult knowledge, inert knowledge and troublesome language. These all forms of troublesome knowledge are familiar to students who are trying to learn quantitative methods. It should be further studied what would be the central threshold concepts in learning of research that hinder students' learning.

The present study revealed that the students who do not see research skills as important for their future work experienced more difficulties in learning of quantitative methods and expressed lower task and deep orientation in learning than those student who saw that the research skills will be needed in their future work. This finding suggests that students' problems with the learning of research are extensive, and that they should be studied as a whole.

5.3 Practical implications for instruction

Students attending university research courses are usually very diverse in their prior knowledge and experiences with research. Some of the students do not have any problems with research courses. Unfortunately, the number of students having problems seems to be quite large. According to Nicholls (1983), it is simply beyond the resources of a teacher to constantly assess every student's understanding of every topic. According to him, if teachers can create and sustain the right motivation, many other educational problems will solve themselves, for example, students will themselves select material of an appropriate difficulty level and deal with it in a fashion that will most effectively foster intellectual growth. According to Lehtinen (2002), students should face the structural complexity of the task from the very beginning of their study career. This should help them to develop flexible and complex knowledge structures.

It is important that teaching of methods is closely attached to real research problems and practices. In the field of quantitative methods, many teachers have good experiences of improving courses by using real data or linking research method courses to other courses or to real life (e.g. Kelly, 1992; Thompson, 1994; Winn, 1995). According to

Thompson (1994), artificial data sets remove students from the data-collection process, and thus create or reinforce an artificial separation of research and data analysis, two processes that are in practice inseparable. Real data help students to see the link between these two processes. Kelly (1992) calls for creating a link between statistics and everyday life and other parts of the degree programme. Co-operative learning has also been seen as beneficial for students' learning (Townsend et al., 1998; Tynjälä et al., 2001).

The connection that has been made between statistics and mathematics should be reconsidered in terms of whether it is useful in teaching. Perhaps mathematics and statistics cannot be taught in a similar manner. In the case of statistics, the very evident connections to the whole of research methodology should be emphasized more, i.e. teaching just statistics is not a very good idea, unless it is closely tied to other research courses. Or perhaps both domains need a reconsideration of teaching methods. Lakoff and Núñez (1997) write that mathematics should not be considered as objective, being free of human cognition, but as ideas that are embodied and that have developed over time in history. Similarly, it could be assumed, especially if a student also has a mythical conception of science as presented above, that some features in quantitative methods may remain unclear if their history and nature are not known by a student. For example, if a student does not understand that the probability level that social statistics uses is a cultural convention, not a "natural, objective fact", he or she cannot understand the whole meaning of it. The student can then focus his effort on the surface features, for example, with p-levels he can act as if looking for a treasure: you find it if it is red! No matter what it means. No one told him what it means in a way he could understand – why should he be able to say anything else about it than that it is red.

Teaching of research at university is very challenging because of all the difficulties discussed above. The dichotomist situation between the qualitative and quantitative methods sets its own challenge to research instruction. Students should be provided with skills in both methodologies, but they certainly notice the situation of bi-polar methodologies. Snow (1964, 98) wrote about the difficulty of this situation: "It is dangerous to have two cultures which can't or don't communicate. In a time when science is determining much of our destiny, that is, whether we live or die, it is dangerous in most practical terms. Scientists can give bad advice and decision-makers can't know whether it is good or bad." Research instruction should thus acknowledge the importance of a wide and open-minded approach to research.

On the basis of the results of the present study, it could be concluded that dichotic orientation to qualitative and quantitative methods was found among both Finnish and US students (Study IV). Many Finnish students and some US students experienced difficulties in quantitative methods studies (Study IV). The difficulties experienced were connected to weak content knowledge (Study II), to research views and orientations (Study IV), to motivational orientations (Study V), and to students' views about the need for research skills in their future work (Study V). Because these factors are connected, attention should be paid to all of them in instruction. Research teaching and learning and environment should be discussed and, if needed, improved on many levels: on the institutional level, on the curriculum level and, of course, on the level of courses and teaching. On the basis of the results of this dissertation, the following basic principles would be beneficial for the students in quantitative methods and statistics courses:

1. Aims of the course: students should be aware of the goals of the course, i.e. what are the skills and knowledge they should have at the end of the course.
2. Using real data: Students should know where the data come from, how they ended up in the computer and what they consist of. This requirement would be most easily fulfilled if the students collected the data themselves, or answered a questionnaire themselves, and then fed in the data (at least partly) to the file.
3. Vocabulary: Students should be familiar with the vocabulary and knowledge constructs used on a course. On the basis of constructivist and conceptual change theories, there is no use teaching something that is based on information that is not understood.
4. Analyses: Students should understand what they are doing and why, and what the results show, i.e. they should be able to interpret the results.
5. Readiness to use methods: Students on a course should gain confidence and motivation to use their new skills in the future.
6. Problem-based approach: to give students a conception of the real importance of the research methods, tasks used in courses should be real tasks, linked to their area of study, and should show how the methods can be useful in real life. This approach also helps students tie the specific concepts and methods into a larger whole of research, and teaches them the important skill of thinking with a "researching attitude".
7. Discussion about the difficulties in the learning of research methods and about students' and teachers' conceptions of research will help students to understand their own thinking and place their thoughts in the field of conceptions and views about research. The division to qualitative and quantitative research methodologies should also be discussed with students to give them understanding about the history and the current situation in their discipline.

Gal, Ginsburg and Schau (1997, 38) write that "the creation of a problem-solving environment for learning statistics requires teachers to build an emotionally and cognitively supportive atmosphere where students: *feel safe* to explore, conjecture, hypothesize and brainstorm and are *not afraid* to experiment with applying different (statistical) tools and methods, *feel comfortable* with temporary confusion or a state of inconclusive results as well as the uncertainty inherent in statistical and probabilistic situations, *believe in their ability* to navigate or "muddle through" intermediate stages, temporary roadblocks, and the decisions needed to reach certain goal; and are *motivated* to struggle with and keep working on tasks or problems which may require extended investment of energy." [Original emphasis.] The same principles can be applied to the whole domain of learning of research. These would help students to remove the "difficult thing" from the category of difficult things and try to approach the task cognitively.

In a study by Väisänen, Rautopuro and Haapala (2004, 6) on university statistics course students, they conclude that "to be a successful learner of statistics, and of quantitative research methods more generally, a student needs to possess some basic cognitive skills, positive emotions and attitudes, motivation to study forcefully, confidence in one's own abilities and active learning efforts". The present study also emphasises the role of motivation and trust in one's own abilities.

An educational experiment on research teaching has been conducted at the teacher education department at the University of Turku since the late 90's. The "researcher workshop" is based on the principles of linking practice with theory, doing research as an everyday activity, and reducing anxiety and negative attitudes toward research. The guiding pedagogical principles in the workshop include problem-based learning, collaborative learning and the idea of the "teacher as a researcher", meaning not only that the teacher can benefit from research skills in her or his own work, but also that the teacher acts as a model for pupils in how to have a "researching attitude", i.e how to critically evaluate the knowledge, and also how to find and produce it. The researcher workshop begins in the first year and continues throughout the studies. Research is not taught in separate courses like earlier, but linked with other subject courses. Students attend a researcher workshop group, combining 10 to 15 students, which continuously examines the study subjects from the viewpoint of research. (Murtonen, 2002; Murtonen, Iiskala, Merenluoto & Tähtinen, 2002.) The student teachers previously had a low motivation to study research and they could not see the relevance of research studies for their other studies and future work. The students who have participated in the workshop have found research easier and more interesting than they thought it would be. Teachers have also reported that these students have fewer difficulties in their course work and master's theses than the students who did not attend the workshop (Mikkilä-Erdmann, Iiskala & Murtonen, in press).

The problem-based approach challenges the teacher to work as an expert problem solver and thus modelling the researcher for students. In a traditional lecture there is a risk that the teacher just delivers information like in books, i.e. without mistakes, problems or gaps where students might train their own methodological thinking with problems. In problem-based tasks, the students can solve the problem with the teacher and see how the teacher answers difficult questions. This, of course is also challenging for the teacher, but for students it offers a good learning situation.

Computer-based environments offer several tools for presenting information in multiple forms and providing assignments on many levels. Instead of teaching sequences of isolated content units, computer-based learning environments can provide students with complex problems while they are studying the sub-elements of problems (Lehtinen & Rui, 1995). Lehti and Lehtinen (2005) have studied a computer-based learning environment for research methodology learning called 'ALEL' (Artificial Laboratory for Explanatory Learning). It provides students with the whole complexity of experimental research methodology from the very beginning of the learning of research (see also Lehtinen & Rui, 1995). One of the aims of this application is to make it possible for students to start dealing with a complex problem by facilitating their work in different ways. The environment includes a content-related help system and tools that make the whole problem-solving path visible to the collaborating students and to the teacher scaffolding the students' work. Lehti and Lehtinen (2005) compared three different learning modes, a traditional statistics group, a group that learnt methods by reading articles, and an ALEL group. According to the results, the ALEL group outperformed the other groups in tasks that were the learning goals of the course.

In research courses, attention should also be paid to some students' tendency to make a difference between qualitative and quantitative methods and to have a higher appreciation for another. It should be reconsidered whether the traditional way of separating these methods into different courses is the best way to teach them. Making it clear to students that both paradigms are needed, but also discussing with them the differences, similarities and misunderstandings between the views would be valuable. It is possible to teach these methods together (Onwuegbuzie & Leech, 2005; Onwuegbuzie, Leech, Murtonen & Tähtinen, 2005), and also to introduce the paradigms as mixed, i.e. the mixed methods research approach (Johnson & Onwuegbuzie, 2004). The basic idea of the mixed methods approach is to show the similarities and usefulness of both paradigms in the same research settings, and also to formulate a theoretical background for a situation that is common for many researchers, i.e. using both paradigms concurrently. The best way to accomplish this is by eliminating statistics courses from curricula and replacing these with research methodology courses at different levels that simultaneously teach students both techniques within a mixed methodological framework. The courses can be team-taught by different instructors. (Onwuegbuzie & Leech, 2005; Onwuegbuzie, Leech, Murtonen & Tähtinen, submitted) This idea is very close to the researcher workshop idea presented above.

5.4. Epilogue

Snow (1964, 100) ends his "second look" for his famous Rede Lecture about the two cultures by writing that "Changes in education are not going to produce miracles. The division of our culture is making us more obtuse than we need be: we can repair communications to some extent: but, as I have said before, we are not going to turn out men and women who understand as much of our world as Piero della Francesca did of his, or Pascal, or Goethe. With good fortune, however, we can educate a large proportion of our better minds so that they are not ignorant of imaginative experience, both in the arts and in science, nor ignorant either of the endowments of applied science, of the remediable suffering of most of their fellow humans, and of the responsibilities which, once they are seen, cannot be denied." The goal of university research education should be to prepare students with skills to understand and conduct research starting with a research question, not with selecting whether to conduct qualitative or quantitative research. Only by fostering students' trust in themselves and in their skills to understand research without paradigmatic division we can have university graduates with an open mind and wide understanding of research and our society.

Finally, some advice for teachers on how to deal with the situation when a student clearly does not get it. Epstein (1987) writes about the importance of documenting success with students for yourself, for example, by saving a great course work which you can read when you are depressed by not succeeding so well with some other student. Seeking out colleagues' support and ideas is also important, as is constant involvement in research practice yourself. And last but not least, maintain your sense of humour! Epstein writes that amusing students are to be cherished, and how else can a research instructor survive from the following covering note, but with humour?

Dear Professor Epstein:

"I am terribly sorry that I am so late in submitting this corrected paper. I hope it will now meet with your approval. I may be totally wrong but it seems to me that my project somehow doesn't lend itself to a really formal data gathering process as it concerns such a nebulous and subjective thing as behavior." (Epstein 1987, 88)

This total misunderstanding of the meaning of empirical data in research is a good example of a student who sees research as mystified and cannot think his/her own action could be a part of it. Instead, s/he is doing something familiar to him/her, i.e. "researching" the question or object, but not in the way it was intended.

Professor Epstein's tip for using humour in surviving students' ideas is certainly useful advice for teachers, although we do, of course, need to take students' misunderstandings and other weird conceptions seriously. Sometimes, however, we have to wonder where are the limits on what can be taught and what not. At our Department of Education in Turku, a student once presented the following plan, when the task was to present a concrete research design about how to study experimentally (not advised what type of experimental design) the impact of pets on the well-being of families:

"… When you have randomly selected the families, you measure their well-being and divide them into two groups. Then you put a pet into the experiment group families, while the control group families do not get a pet. After a few months you measure the well-being of both groups. Then you take the pets away from the experiment group families and measure the well-being again."

However, I believe learning of research and statistics can be made more interesting and easier for many by reducing the mythical features attributed to them, and by trying to get students to believe that they can learn research, and that it is not as hard as they may think. This can be done by tying elements from real research to courses and concentrating not only on producing results but also on understanding and benefiting from reported research.

REFERENCES

Anderson, J. R., Pirolli, P., & Farrell, R. (1988). Learning to program recursive functions. In M. T. H. Chi, R. Glaser & M. J. Farr, (Eds.), *The nature of expertise* (pp. 153-183). Hillsdale, NJ: Lawrence Erlbaum Associates.

Becker, B. J. (1996). A look at the literature (and other resources) on teaching statistics. *Journal of Educational and Behavioral Statistics, 21*(1), 71-90.

Becker, H. S. (1996). The epistemology of qualitative research. In R. Jessor, A. Colby & R. A. Shweder (Eds.), *Ethnography and human development. Context and meaning in social inquiry* (pp. 53-71). Chicago: The University of Chicago Press.

Benson, J. (1989). Structural components of statistical test anxiety in adults: An exploratory model. *Journal of Experimental Education, 57*, 247-261.

Benson, J., & Bandalos, D. (1989). Structural model of statistical test anxiety in adults. In R. Schwarzer, H. van der Ploeg, & C. D. Spielberg (Eds.), *Advances in Test Anxiety Research* (pp. 137-151). Hillsdale, NJ: Lawrence Erlbaum Associates.

Bereiter, C., & Scardamalia, M. (1993). *Surpassing ourselves. An inquiry into the nature and implications of expertise.* Illinois: Open Court.

Birenbaum, M., & Eylath, S. (1994). Who is afraid of statistics? Correlates of statistics anxiety among students of educational sciences. *Educational Research, 36*, 93-98.

Bisgaard, S. (1991). Teaching statistics to engineers. *American Statistician, 45*(4), 274-283.

Brew, A. (2001). Conceptions of Research: a phenomenographic study. *Studies in Higher Education, 26*(3), 271-285.

Broers, N. J. (2001). Analyzing propositions underlying the theory of statistics. *Journal of Statistics Education, 9*(3). Online: http://www.amstat.org/publications/jse/v9n3/broers.html

Broers, N. J. (2002). Selection and use of propositional knowledge in statistical problem solving. *Learning and Instruction, 12*(3), 323-344.

Busquin, P. (2001). Preface to: Towards a European research area. Key figures 2001. Special edition. Indicators for benchmarking of national research policies. European Commission, Research Directorate General. http://europa.eu.int/comm/research/area/benchmarking2001.pdf

Carey, S. (1986). Cognitive science and science education. *American psychologist, 41*, 1123-1130.

Carey, S. (1992). The origin and evolution of everyday concepts. In R. N. Giere (Ed.), *Cognitive models of science. Minnesota studies in the philosophy of science* (pp. 129-186). Minneapolis, MN: University of Minnesota Press.

Carey, S. & Spelke, E. (1994). Domain-specific knowledge and conceptual change. In L. A. Hirschfeld & S. A. Gelman (Eds.), *Mapping the mind. Domain specifity in cognition and culture* (ss. 169-200). Cambridge, MA: Cambridge University Press.

Cerrito, P, B. (1999). Teaching statistical literacy. *College Teaching, 47*(1), 9-13.

Chi, M. T. H. (1992). Conceptual change within and across ontological categories: Examples from learning and discovery in science. In R. N. Giere (Ed.), *Cognitive models of science. Minnesota studies in the philosophy of science* (pp. 129-186). Minneapolis, MN: University of Minnesota Press.

Chi, M. T. H., Glaser, R., & Farr, M. J. (Eds.). (1988). *The nature of expertise.* Hillsdale, NJ: Erlbabum.

Chi, M. T. H., Slotta, J. D. & de Leeuw, N. (1994). From things to processes: a theory of conceptual change for learning science concepts. *Learning and Instruction*, *4*, 27-43.

Chi, M.T.H., & Roscoe, R.D. (2002). The processes and challenges of conceptual change. In M. Limon and L. Mason (Eds.), *Reconsidering conceptual change: Issues in theory and practice* (pp. 3-27). The Netherlands: Kluwer Academic Publishers.

Cotner, T., Intrator, S., Kelemen, M., & Sato, M. (2000). What graduate students say about their preparation for doing qualitative dissertations: A pilot study. A paper presented at the AERA conference, April 24-28, New Orleans.

D'Andrea, L., & Waters, C. (2002). Teaching statistics using short stories: Reducing anxiety and changing attitudes. A paper presented at the international conference on teaching statistics, July 7-12, Cape Town, South Africa.

diSessa, A. A. (1988). Knowledge in pieces. In G. Forman & P. Pufall (Eds.), *Constructivism in the Computer Age* (pp. 49-70). Hillsdale, NJ: Lawrence Erlbaum.

diSessa, A. A. (1993). Toward an epistemology of physics. *Cognition and Instruction, 10*(2&3), 105-225.

diSessa, A. A., & Sherin, B. (1998). What changes in conceptual change? *International Journal of Science Education, 20*(10), 1155-1191.

Dyer, C. (1995). *Beginning Research in Psychology. A practical Guide to Research Methods and Statistics.* Oxford: Blackwell Publishing Ltd.

Engeström, Y., & Middleton, D. (1998). Introduction: Studying work as mindful practice. In Y. Engeström & D. Middleton (Eds.), *Cognition and communication at work* (pp. 1-14). Cambridge: Cambridge University Press.

Entwistle, N., McCune, V., & Walker, P. (2001). Conceptions, styles, and approaches within higher education: Analytic abstractions and everyday life. In R. J. Sternberg & L. Zhang (Eds.), *Perspectives on thinking, learning, and cognitive styles* (pp. 103-136). Mahwah, NJ: Erlbaum.

Entwistle, N., Meyer, J. H. F., & Tait, H. (1991). Student failure: Disintegrated patterns of study strategies and perception of the learning environment. *Higher Education, 21*, 249-261.

Entwistle, N., & Ramsden, P. (1983). *Understanding student learning*. London: Croom Helm.

Eronen, S., Nurmi, J.-E., & Salmela-Aro, K. (1998). Optimistic, defensive-pessimistic, impulsive and self-handicapping strategies in university environments. *Learning and Instruction, 8*(2), 159-177.

Epstein, I. (1987). Pedagogy of the perturbed: Teaching research to the reluctants. *Journal of Teaching in Social Work, 1*(1), 71-89.

Filinson, R., & Niklas, D. (1992). The research critique approach to educating sociology students. *Teaching Sociology, 20*, 129-134.

Forte, J. (1995). Teaching statistics without sadistics. *Journal of Social Work Education, 31*(2), 204-308.

Gal, I. (2000a). The numeracy challenge. In I. Gal (Ed.), *Adult numeracy development. Theory, research, practice.* Dresskill, NJ: Hampton Press, inc.

Gal, I. (Ed.) (2000b). *Adult numeracy development. Theory, research, practice.* Dresskill, NJ: Hampton Press, inc.

Gal, I., & Ginsburg, L. (1994). The role of beliefs and attitudes in learning statistics: Towards an assessment framework. Online: *Journal of Statistics Education, 2*(2). http://www.amstat.org/publications/jse/v2n2/gal.html

Gal, I., Ginsburg, L., & Schau, C. (1997). Monitoring attitudes and beliefs in statistics education. In I. Gal & J. B. Garfield (Eds.), *The assessment challenge in statistics education* (pp. 37-51). Amsterdam: IOS Press.

Gardner, P. L., & Hudson, I. (1999). University students' ability to apply statistical procedures. *Journal of Statistics Education, 7*(1). Online: http://www.amstat.org/publications/jse/secure/v7n1/gardner.cfm

Garfield, J., & Ahlgren, A. (1988). Difficulties in learning basic concepts in probability and statistics: Implications for research. *Journal for Research in Mathematics Education, 19*(1), 44-63.

Green, R. G., Bretzin, A., Leininger, C., & Stauffer, R. (2001). Research learning attributes of graduate students in social work, psychology, and business. *Journal of Social Work Education, 37*(2), 333-341.

Greer, B. (2000). Statistical thinking and learning. *Mathematical Thinking and Learning, 2*(1&2), 1-9.

Hafdahl, A. R. (2004). Bibliography on correlates on statistics anxiety. Unpublished manuscript.

Hakkarainen, K., Lonka, K., & Lipponen, L. (1999). *Tutkiva oppiminen. Älykkään toiminnan rajat ja niiden ylittäminen [Inquiry-based learning. Limits of and overcoming of the limits of intelligent behavior,* in Finnish]. Porvoo: WSOY.

Hakkarainen, K., Palonen, T., Paavola, S., & Lehtinen, E. (2004). *Communities of networked expertise. Professional and educational perspectives.* Oxford: Elsevier.

Halldén, O. (1999). Conceptual change and contextualization. In W. Schnotz, S. Vosniadou & M. Carretero (Eds.), *New perspectives on conceptual change* (pp. 53-66). Oxford: Elsevier Science Ltd.

Hannover, B., & Kessels, U. (2004). Self-to-prototype matching as a strategy for making academic choises. Why high school students do not like math and science. *Learning and Instruction, 14*(1), 51-67.

Hannula, M. S. (2002). Attitude towards mathematics: Emotions, expectations and values. *Educational Studies in Mathematics, 49*, 25-46.

Hauff, H. M., & Fogarty, G. J. (1996). Analysing problem solving behaviour of successful and unsuccessful statistics students. *Instructional Science, 24*, 397-409

Hiebert, J. & Lefevre, P. (1986). Conceptual and procedural knowledge on mathematics: An introductory analysis. In J. Hiebert (Ed.), *Conceptual and procedural knowledge: The case of mathematics* (pp. 1-27). Hillsdale, NJ: Lawrence Erlbaum.

Hinton, P. R. (1995). *Statistics explained. A guide for social science students.* London: Routledge.

Hoffmann, L. (2002). Promoting girls' interest and achievement in physics classes for beginners. *Learning and Instruction, 12*, 447-465.

Johnson, M. 1987. *The body in the mind. The bodily basis of meaning, imagination, and reason.* Chicago: University of Chicago Press.

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational Researcher, 33*(7), 14-26.

Järvelä, S. (2001). Shifting research on motivation and cognition to an integrated approach on learning and motivation in context. In S. Volet & S. Järvelä (Eds.), *Motivation in learning contexts: Theoretical advances and methodological implications* (pp. 3-14). Oxford: Elsevier Science Ltd.

Kallio, E. (1998). *Training of students' scientific reasoning skills.* Doctoral dissertation. Jyväskylä studies in education, psychology and social research.

Kelly, M. (1992). Teaching statistics to biologists. *Journal of Biological Education, 26*(3), 200-203.

Kiley, M., & Mullins, G. (2005). Supervisors' conceptions of research: What are they? *Scandinavian Journal of Educational Research, 49*(3), 245-262.

Klahr, D. (2000). *Exploring science. The cognition and development of discovery process.* Cambridge: The MIT Press.

Kuhn, D., Amsel, E., & O'Loughlin, M. (1988). *The development of scientific thinking skills.* San Diego: Academic Press, Inc.

Lakoff, G. 1987. *Women, fire, and dangerous things. What categories reveal about the mind.* Chicago: University of Chicago Press.

Lakoff, G., & Johnson, M. 1999. *Philosophy in the flesh. The embodied mind and its challenge to western thought.* New York: Basic Books.

Lakoff, G., & Núñez, R. 1997. The metaphorical structure of mathematics: sketching out cognitive foundations for a mind-based mathematics. In L. English (Ed.), *Mathematical reasoning: Analogies, metaphors, and images* (pp. 21-89). Hillsdale, NJ: Erlbaum.

Latour, B. (1988). *Science in action: How to follow scientists and engineers through society.* Harward: Harward University Press.

Laukkanen, R. (2001). Tutkimustiedon käyttö päätöksenteossa: yhteiskuntatieteiden näkökulma [Use of research information in policymaking: a view of social sciences]. *Kasvatus, (4)*, 419-425.

Lehti, S., & Lehtinen, E. (2005). Computer-supported problem-based learning in the research methodology domain. *Scandinavian Journal of Educational Research, 49*(3), 297-323.

Lehtinen, E. (2002). Developing Models for Distributed Problem-Based Learning: Theoretical and Methodological Reflection. *Distance Education, 23*, 109-117.

Lehtinen, E., Vauras, M., Salonen, P., Olkinuora, E., & Kinnunen, R. (1995). Long-term development of learning activity: Motivational, cognitive, and social interaction. *Educational Psychologist, 30*(1), 21-35.

Lehtinen, E. & Rui, E. (1995). Computer-supported complex learning: An environment for learning experimental methods and statistical inference. *Machine-Mediated Learning, 5*(3&4), 149-175.

Limón, M., & Carretero, M. (1999). Conflicting data and conceptual change in history experts. In W. Schnotz, S. Vosniadou & M. Carretero (Eds.), *New perspective on conceptual change* (pp. 137-160). Killington, Oxford: Elsevier Science.

Lindblom-Ylänne, S., & Lonka, K. (1999). Individual ways of interacting with the learning environment - are they related to study success? *Learning and Instruction, 9*(1), 1-18.

Linn, M. W., & Greenwald, S. R. (1974). Student attitudes, knowledge, and skill related to research training. *Education for Social Work*, 48-54.

Lonka, K., & Lindblom-Ylänne, S. (1996). Epistemologies, conceptions of learning, and study practices in medicine and psychology. *Higher Education, 31*, 5-24.

Marasinghe, M. G. (1996). Using graphs and simulations to teach statistical concepts. *American Statistican, 50*(4), 342-351.

Marton, F., & Säljö, R. (1976). On qualitative differences in learning: I. Outcome and process. *British Journal of Educational Psychology, 46*, 4-11.

Mayer, R. E. (2000). What is the place of science in educational research? *Educational Researcher, 29*(6), 38-39.

McGinn, M. K. & Roth, W-M. 1999. Preparing students for competent scientific practice: Implications of recent research in science and technology studies. *Educational Researcher, 28*(3), 14-24.

McKenna, M. C., Robinson, R., & Miller, J. (1990). Whole language: A research agenda for the nineties. *Educational Researcher, 19*(8), 3-6.

Meletiou-Mavrotheris, M., & Lee, C. (2005). Effects of technological tools on introductory statistics students' understanding of sampling distribution and statistical inference. A paper presented at the EARLI conference, August 23-27, Nicosia, Cyprus.

Merenluoto, K., & Lehtinen, E. (2004). Number concept and conceptual change: towards a systemic model of the processes of change. *Learning and Instruction, 14*(5), 519-534.

Merenluoto, K., & Murtonen, M. (2004). Tilastotieteen ja matematiikan ero. Kasvatustieteen opiskelijoiden näkemyksiä [Difference between statistics and mathematics: views of the educational science students]. A paper presented at the annual conference of the Finnish Educational Research Association, Joensuu, November 25.-26.

Mevarech, Z. R. (1983). A deep structure model of students' statistical misconceptions. *Educational Studies in Mathematics, 14*, 415-429.

Meyer, J. H. F. (1991). Study orchestration: The manifestation, interpretation and consequences of contextualised approaches to studying. *Higher Education, 22*, 297-316.

Meyer, J.H.F., & Land, R. (2003). Threshold concepts and troublesome knowledge: linkages to ways of thinking and practising within the disciplines. In C. Rust (Ed.), *Improving Student Learning. Improving Student Learning Theory and Practice — 10 years on*, OCSLD, Oxford, 412-424.

Meyer, J. H. F., Shanahan, M. P., & Laugksch, R. C. (2005). Students' conceptions of research: I – a qualitative and quantitative analysis. *Scandinavian Journal of Educational Research, 49*(3), 225-244.

Mikkilä-Erdmann, M. (2001). Improving conceptual change concerning photosynthesis through text design. *Learning and Instruction, 11*, 241-257.

Mikkilä-Erdmann, M., Iiskala, T., & Murtonen, M. (in press). Experiences from a researcher workshop. Proceedings of the didactic symposium, Turku 11.2.2005.

Morris, T. (1992). Teaching social workers research methods: orthodox doctrine, heresy, or an atheistic compromise. *Journal of Teaching in Social Work, 6*(1), 41-62.

Murtonen, M. (2002). Student teachers' conceptions of research, mathematical ability, and situational orientations during a researcher workshop. A paper presented at the "Students' and supervisors' conceptions of research" symposium at the Quality in

Postgraduate Research conference, April 18-19, 2002, Adelaide, Australia.

Murtonen, M. (2003). Education students' conceptions of research on the basis of concept maps. A paper presented at the "Conceptions of research as a factor in post graduate research education"-symposium at the EARLI conference, August 26-30, Padova, Italy.

Murtonen, M. (2004). Motivaatio ja työtä koskevat käsitykset asiantuntijaksi kehittymisessä [Motivation and conceptions of work in developing to be an expert]. In P. Tynjälä, J. Välimaa, & M. Murtonen (Eds.), *Korkeakoulutus, oppiminen ja työelämä. Pedagogisia ja yhteiskuntatieteellisiä näkökulmia [Higher education, learning and work life. Pedagogical and social views*, in Finnish] (pp. 77-90). Juva: PS-kustannus.

Murtonen, M., Iiskala, T., Merenluoto, K., & Tähtinen, J. (2002). Tutkivaksi opettajaksi tutkimustyöpajassa [Becoming a researching teacher in a research workshop]. In E. Lehtinen & T. Hiltunen (Eds.) *Oppiminen ja Opettajuus* [*Learning and Teachership, in Finnish*] (pp. 177-202). University of Turku, Department of Education publications B:71.

Murtonen, M., & Lehtinen, E. (2005). Introduction to the special issue on conceptions of research and methodology learning. *Scandinavian Journal of Educational Research, 49*(3), 217-224.

Murtonen, M., & Merenluoto, K. (2002). Concept maps in conceptual change studies - a methodological perspective. Proceedings of the third European symposium on Conceptual Change, EARLI (pp. 56-61), June 26-28, Turku, Finland. http://www.edu.utu.fi/konf/

Mäkinen, J., & Olkinuora, E. (2004). University students' situational reaction tendencies: Reflections on general study orientations, learning strategies, and study success. *Scandinavian Journal of Education, 48*(5), 477-492.

Newstead, K. (1998). Aspects of children's mathematics anxiety. *Educational Studies in Mathematics, 36*, 53-71.

Nicholls, J. G. (1983). Conceptions of ability and achievement motivation: A theory and its implications for education. In S. G. Paris, G. M. Olson, & H. W. Stevenson (Eds.), *Learning and motivation in the classroom* (pp. 211-237). New Jersey: Lawrence Erlbaum Associates, Inc.

Näätänen, M. (2000). *Matematiikka, naiset ja osaamisyhteiskunta [Mathematics, women and the know-how-society]*. Vantaa: WSOY.

Olkinuora, E. & Salonen, P. (1992) Adaptation, Motivational Orientation, and Cognition in a Subnormally Performing Child: A Systemic Perspective for Training. In Wong, B.Y.L. (Ed.), *Contemporary Intervention Research in Learning Disabilities. An International Perspective* (pp. 190-213). Springer-Verlag: New York.

Onwuegbuzie, A. J. (1997). Writing a research proposal: The role of library anxiety, statistics anxiety, and composition anxiety. *Library & Information Science Research, 19*(1), 5-33.

Onwuegbuzie, A. J. (2000). Statistics anxiety and the role of self-perceptions. *Journal of Educational Research, 93*(5), 323-330.

Onwuegbuzie, A. J., & Daley, C. E. (1998). The relationship between learning styles and statistics anxiety in a research methodology course. A paper presented at the annual conference of the American Educational Research Association, April, 13, San Diego, CA.

Onwuegbuzie, A. J., & Leech, N. L. (2005). Taking the "Q" out of research: Teaching research methodology courses without the divide between quantitative and qualitative paradigms. *Quality and Quantity: International Journal of Methodology, 39*(3), 267-295.

Onwuegbuzie, A.J., Leech, N. L., Murtonen, M., & Tähtinen, J. (2005). Utilizing Mixed Methods in Teaching Environments to Reduce Statistics Anxiety. A paper presented at the EARLI conference, August 23-27, Nicosia, Cyprus.

Op't Eynde, P., De Corte, E., Verschaffel, L. (2001). "What to learn from what we feel?": The role of students' emotions in the mathematics classroom. In S. Volet & S. Järvelä (Eds.), *Motivation in learning contexts: Theoretical advances and methodological implications* (pp. 17-31). Oxford: Elsevier Science Ltd.

Orr, J. E. (1990). Sharing knowledge, celebrating identity. War stories and community memory among service technicians. In D. S. Middleton & D. Edwards (Eds), *Collective remembering: Memory in society*. London: Sage Publications Limited.

Paulos, J. A. (1991). *Numerotaidottomuus [Innumeracy]*. Helsinki: Art House.

Petersson, G. (2005). Medical and nursing students' development of conceptions of science during three years of studies in higher education. *Scandinavian Journal of Educational Research, 49*(3), 281-296.

Pretorius, T. B., & Norman, A. M. (1992). Psychometric data on the statistics anxiety scale for a sample of south african students. *Educational & Psychological Measurement, 52*(4), 933-937.

Quinn, P., Jacobsen, M., & LaBarber, L. (1992). Utilization of group projects in teaching social work research methods: benefits to students and faculty. *Journal of Teaching in Social Work, 6*(1), 63-76.

Rautopuro, J., Väisänen, P., & Malin, A. (2004). Sulje silmäsi vain… Tutkimustulosten päätelmät kuin iskelmien lempi [Just close your eyes… Research conclusions like from a song]. A paper presented at the annual conference of the Finnish Educational Research Association, November 25.-26, Joensuu, Finland.

Rosenthal, B. C., & Wilson, W. C. (1992). Student factors affecting performance in an MSW research and statistics course. *Journal of Social Work Education, 28*(1), 77-85.

Royse, D., & Rompf, E. L. (1992). Math anxiety: A comparison of social work and non-social work students. *Journal of Social Work Education, 28*, 270-277.

Ryder, J., Leach, J., & Driver, R. (1999). Undergraduate science students' images of science. *Journal of Research in Science Teaching, 36*(2), 201-219.

Salonen, P., Lehtinen, E., & Olkinuora, E. (1988). Expectations and beyond: The development of motivation and learning in a classroom context. *Advances in Research on Teaching, 7*, 111-150.

Schoenfeld, A. H. (1989). Explorations of students' mathematical beliefs and behaviour. *Journal for Research in Mathematics Education, 20*(4), 338-355.

Séré, M-G., Journeaux, R., & Larcher, C. (1993). Learning the statistical analysis of measurement errors. *International Journal of science education, 15*, (4), 427-438.

Siegel, D. H. (1983). Can research and practice be integrated in social work education? *Journal of Education for Social Work, 19*(3), 12-19.

Smith, J. K. (1997). The stories educational researchers tell about themselves. *Educational Researcher, 26*(5), 4-11.

Snow, C. P. (1964). *The two cultures: A second look*. Cambridge: University Press.

Soro, R. (2002). Opettajien uskomukset tytöistä, pojista ja tasa-arvosta matematiikassa [Teachers' beliefs about girls, boys, and equity in mathematics]. Doctoral dissertation. Department of teacher education, University of Turku.

Spitzer, M. (1999). *The mind within the net. Models of learning, thinking and acting*. Massachusetts: The MIT Press.

Statistica (1995). Statistics II, Volume III. Tulsa, OK: Statsoft, Inc.

Sweller, J., & Chandler, P. (1994). Why some material is difficult to learn? *Cognition and Instruction, 12*(3), 185-233.

Tashakkori, A., & Teddlie, C. (2003). *Handbook of mixed methods in social & behavioural research.* Thousand Oaks: Sage Publications, Inc.

Tennyson, R. D. (1996). Concept learning. In E. D. Corte & F. E. Weinert (Eds.), *International encyclopedia of developmental and instructional psychology* (pp. 381-385). Oxford: Elsevier Science Ltd.

Thompson, B. W. (1994). Making data-analysis realistic: Incorporating research into statistics courses. *Teaching of Psychology, 21*(1), 41-43.

Thompson, T., & Richardson, A. (2001). Self-handicapping status, claimed self-handicaps and reduced practise effort following success and failure feedback. *British Journal of Educational Psychology, 71*, 151-170.

Townsend, M. A. R., Moore, D. W., Tuck, B. F., & Wilton, K. M. (1998). Self-concept and anxiety in university students studying social science statistics within a co-operative learning structure. *Educational Psychology, 18*(1), 41-54.

Tynjälä, P. (1999). Towards expert knowledge? A comparison between a constructivist and a traditional learning environment in the university. *International Journal of Educational Research, 31*, 357-442.

Tynjälä, P., Helle, L., Lonka, K., Murtonen, M., Mäkinen, J., & Olkinuora, E. (2001). A university studies perspective into the development of professional expertise. In E. Pantzar, R. Savolainen, & P. Tynjälä (Eds.), *In search for a human-centred information society* (pp. 143-169). Reports of the Information Research Programme of the Academy of Finland, 5. Tampere: Tampere University Press.

Tynjälä, P., Helle, L., & Murtonen, M. (2002). A comparison of students' and experts' beliefs concerning the nature of expertise. In E. Pantzar (ed.), *Perspectives on the age of the information society* (pp. 29-49). Reports of the Information Research Programme of the Academy of Finland, 6. Tampere: Tampere University Press.

Tynjälä, P., Merenluoto, K. & Murtonen, M. (2002). *What has been meant with a 'concept' and 'change' in conceptual change studies?* Proceedings of the third European symposium on Conceptual Change, EARLI (pp. 28-45), June 26-28, Turku, Finland. http://www.edu.utu.fi/konf/

Töttö, P. (2000). *Pirullisen positivismin paluu. Laadullisen ja määrällisen tarkastelua. [Return of the devilish positivism. Considerations on qualitative and quantitative, in Finnish.]* Tampere: Vastapaino.

Vauras, M., Salonen, P., Lehtinen, E., & Lepola, J. (1999). Long term development of motivation and cognition in family and school context. In S. Volet & S. Järvelä, *Motivation in learning context. Theoretical advances and methodological implications* (pp. 295-315). Amsterdam: Pergamon.

Vermunt, J. D. (1996). Metacognitive, cognitive and affective aspects of learning styles and strategies: A phenomenographic analysis. *Higher Education, 31*(1), 25-50.

Vosniadou, S. (1992). Mental models of earth: A study of conceptual change in childhood. *Cognitive Psychology, 24*, 535-585.

Vosniadou, S. (1994). Capturing and modelling the process of conceptual change. *Learning and Instruction*, *4*, 45-69.

Vosniadou, S., & Brewer, W. F. (1987). Theories of knowledge restructuring in development. *Review of Educational Research, 57*(1), 51-67.

Väisänen, P., Rautopuro, J., & Haapala, A. (2004). *Concept map in statistics education. A collection of haphazard links or a tool for active learning?* University of Joensuu, Research reports of the Faculty of Education, N:o 90.

Watts, D. G. (1991). Why is introductory statistics difficult to learn? And what can we do to make it easier? *American Statistican, 45*(4), 290-291.

White, R. T. (1994). Commentary: Conceptual and conceptional change. *Learning and Instruction, 4*, 117-121.

Wilson, W. C., & Rosenthal, B. S. (1992). Anxiety and performance in an MSW research and statistics course. *Journal of Teaching in Social Work, 6*(2), 75-85.

Winn, S. (1995). Learning by doing: Teaching research methods through student participation in a commissioned research project. *Studies in Higher Education, 20*(2), 203-214.

Yukhnovetsky, M., & Hoz, R. (2001). Conceptional change and the acquisition of large bodies of knowledge: Formulations and validations a theoretical framework. A paper presented at the EARLI Biennial Meeting, August 28 - September 1, Fribourg, Switzerland.

Zanakis, S. H., & Valenzi, E. R. (1997). Student anxiety and attitudes in business statistics. *Journal of Education for Business, 73*(1), 10-16.

Zeidner, M. (1991). Statistics and mathematics anxiety in social science students: some interesting parallels. *British Journal of Educational Psychology, 61*, 319-328.

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Difficulties Experienced by Education and Sociology Students in Quantitative Methods Courses

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ABSTRACT *This study describes difficulties experienced in learning quantitative methods by university students. Education and sociology students were asked to rate different topics on the basis of their difficulty. It was found that statistics and quantitative methods were experienced as more difficult than other domains, such as qualitative methods and the students' main subject. Overall, it seems that students tend to polarise the academic subjects into 'easier' language, major and qualitative subjects, and 'harder' mathematical, statistical and quantitative subjects. The students were also asked to answer open-ended questions concerning the most difficult aspects of methodology courses and the reasons for their difficulties. Five main categories of reasons for difficulties were established: (1) superficial teaching, (2) linking theory with practice, (3) unfamiliarity with and difficulty of concepts and content, (4) creating an integrated picture of research in order to really understand it, and (5) negative attitudes toward these studies. The students who gave high ratings for the difficulty of statistical and quantitative subjects cited teaching most frequently as the reason. Those students who did not have many problems in statistical and quantitative subjects, but who still had more trouble with them in comparison to their major subject studies, mentioned negative attitudes as the main reason for difficulties.*

Introduction

The information society requires its citizens to develop many new and complex skills. One rapidly developing area is the increasing amount of information produced and made available by computers. At the same time, the amount of information based on research and statistical analysis is growing (e.g. Greer, 2000). In many future occupations workers will need skills to handle this information. Students studying social sciences at university typically take several compulsory courses in research methodology in order to be able to handle information. Research methodology is, however, found to cause many problems to many social science students. Quantitative methods, including statistics courses, are particularly likely to be found unattractive and difficult.

Universities are investing substantial resources to teach students research skills, but the learning outcomes of methodology courses are not as good as expected (Lehtinen & Rui, 1995; Garfield & Ahlgren, 1988). It has been found that students in many disciplines dread statistics courses: in social work (Rosenthal & Wilson, 1992; Forte, 1995), in psychology (Pretorius & Norman, 1992; Thompson, 1994; Hauff & Fogarty, 1996; Townsend *et al.*, 1998), in sociology (Filinson & Niklas, 1992), in education (Lehtinen & Rui, 1995; Onwuegbuzie & Daley, 1998; Murtonen, 2000), and social science in general (Zeidner, 1991). The

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goal of this article is to examine the problems students have in learning research methodology in the social sciences, and to gain an understanding of how to study the problem further and improve instruction.

There are good reasons to claim that the learning of quantitative methods in university is not a well-researched area. Empirical research is more common on learning statistical concepts and statistics anxiety. There are some reports describing experiments with course improvements, but which do not provide deeper theoretical discussion or empirical data. In order to get a more solid basis for the development of methodological studies, we need a better understanding of students' difficulties and motivation, and of their naive conceptions of research and statistics. It is also important to know how difficulties in learning research methodology are related to students' skills in other subject domains, and how knowledge of research methodology improves during methodology courses.

The research on learning statistical concepts has indicated that a large portion of university students do not understand many of the basic statistical concepts they have studied (Mevarech, 1983; Garfield & Ahlgren, 1988; Séré *et al.*, 1993; Marasinghe, 1996). Anxiety about statistics among university students has been reported in many studies (Pretorius & Norman, 1992; Forte, 1995; Townsend *et al.*, 1998). Anxiety may have several sources. Usually it is assumed to relate to problems in learning mathematics. Zeidner (1991) reports that poor prior experiences with mathematics, poor prior achievement in mathematics and a low sense of mathematical self-efficacy are antecedent correlates of statistics anxiety. According to Garfield and Ahlgren (1988), inadequacies in prerequisite mathematics skills and abstract reasoning are part of the statistics learning problem.

In addition to aversion towards mathematics, statistics anxiety may be related to some, more general, even culturally embedded conceptions or attitudes. For example, there may be a conception that skills in mathematics and languages are mutually exclusive and opposing. Some people may consider the world in terms of 'soft' and 'hard' issues or values, where hard issues are based on technical and numerical approaches and cannot be mastered by a person who behaves and thinks according to the soft approach.

There is a reasonable body of empirical data showing that the conceptions people hold do have implications for their learning outcomes. For example, students' conceptions of learning have been shown to be related to their study orientations, approaches to learning and study outcomes (e.g. Marton & Säljö, 1976; Entwistle & Ramsden, 1983). Lonka and Lindblom-Ylänne (1996) found that conceptions of learning and conceptions of knowledge are related. They also concluded that conceptions of knowledge may guide not only comprehension standards, but also study strategies and orientations. Lindblom-Ylänne and Lonka (1999) found that students' ways of interacting with the learning environment were related to study success. Meaning-oriented independent students succeeded best in their studies, while reproduction-oriented and externally regulated students achieved the lowest grades. Similarly, it could be assumed that the conceptions students hold about statistics and methodology can have an impact on their learning of the subject.

It has been argued that mindfulness is a crucial presupposition for successful learning (e.g. Langer, 1997). In the field of quantitative methods, many teachers have good experiences of improving courses by using real data or linking research method courses to other courses or to real life (e.g. Kelly, 1992; Thompson, 1994; Winn, 1995). According to Thompson (1994), artificial data sets remove students from the data-collection process and thus create or reinforce an artificial separation of research and data analysis, two processes that are in practice inseparable. Real data help students to see these links. Kelly (1992) calls for creating a link between statistics and everyday life and other parts of the degree programme. Methodological expertise requires large amounts of conceptual knowledge ('knowing what'), although the research process in itself requires procedural knowledge ('knowing how') (Hiebert & Lefevre, 1986). Students may find it hard to convert abstract conceptual knowledge into the procedural knowledge needed to conduct research and to truly understand research activity.

The cognitive problems that students face may arise from several factors. Firstly, the language that research methodology teachers use can be hard for students to understand. Scientific communities are characterised by their specific forms of discourse (McGinn & Roth, 1999), and disciplines have their own vocabularies. For example, statisticians may try to teach some statistical concepts by using statistical language that is familiar to them, but inaccessible to students. Secondly, students' prior knowledge is perhaps not at the level that teachers assume it to be. This increases the amount of content to be learned and causes cognitive overload. According to Sweller and Chandler (1994), some material can be difficult to learn because of the heavy cognitive load. The cognitive load associated with the material to be learned is strongly related to the extent to which the elements of that material interact with each other. The interactions between the various elements may provide the whole point of what must be learned, so the elements of the task cannot be learned in isolation because they interact with each other. In these circumstances, learning is not just a function of the number of elements that must be learned but also of the elements that must be learned simultaneously.

According to Lehtinen and Rui (1995), problems in methodology studies appear partly because of the complexity of the domain: methodological knowledge includes several challenging properties for the learner. For example, the subdomains are highly abstract and partly controversial, the links between them are abstract and based partly on structural analogies, and comprehension of the domain requires that the concrete procedures should be understood in the framework of the whole complex system. In the case of statistics learning, Watts (1991) concludes that a major difficulty that confounds beginning students and inhibits the learning of statistics is that the important fundamental concepts of statistics are quintessentially abstract. Anderson *et al.* (1988, p. 163) have explored how students learn to programme recursive functions. They concluded that learning recursive programming is difficult because it is an unfamiliar activity, with hidden complexities, that must be learned in an unfamiliar and difficult domain. In the domain of methodology, students face many concepts they have not heard before, or which they are not very familiar with. For example, principles of scientific research and statistical inference can be far from students' everyday activities, research activities in certain domains are very complex, and the connection between theory and practice can be difficult to see.

We can try to reduce the complexity of problems by trying to give students hands-on experience with research, as suggested in the literature of research methodology learning. In this way, we will create possibilities to understand and link theoretical concepts in real situations and to learn the crucial tacit knowledge in the field. However, the ideas that guide course improvements are based on teachers' views of what is difficult for students. In addition to the teachers' experience, we will need the students' view on the subject and also careful research about methodology learning to help then learn better. In this study we aimed at exploring how students experience methodological and statistical courses in relation to other academic disciplines. We also wanted to get a deeper insight into students' experienced problems.

Method

Participants

The participants in the study were 19 education and 15 sociology students at a Finnish university. The research was done during methodology courses and all students in the courses were given a questionnaire ($n = 65$), but only 52% (education 59% and sociology 45%) took part in the research. Both student groups participated in a course on quantitative methods offered by their own department. The courses in these disciplines were very similar. In both disciplines they included lectures and small group practice sessions with computer programs. The goal of the courses was to give students proficiency in quantitative data handling and in common statistical tests like the *t*-test, analysis of variance and regression analysis. The courses lasted approximately three months in the spring term. The teachers were not statisticians, but they had graduated in the same disciplines in which they taught the courses. The teachers had taught these courses for some years in their departments.

The students had studied from two to four years at the university before enrolling in the methodology course. They were taking a master's degree programme, which lasts between four and seven years in Finland. The students in both disciplines had already taken a statistics course and a general introduction to methods, and they also had dealt with some methodological material in their university entrance examination, so they were not complete novices. Education students tended to be older than sociology students: 32% of education and 73% of sociology students were under 25 years old, while 42% of education and 7% of sociology students were over 30 years old.

Materials and Procedures

Most of the studies on problems related to the learning of research methodology are based on teachers' views about what kind of problems the students have. There are no studies of which we are aware concerning students' own interpretations of their problems. In this study, we wanted to get the students' own views without directing then too much, and this is why we used open-ended questions on very general topics. Many of the studies on statistics anxiety have been done with structured questionnaires. Gal and Ginsburg (1994) found that there might be uncertainty for students about what the term 'statistics' means when using survey questionnaires, and recommend the use of open-ended questions.

The questionnaire booklet consisted of three different tasks, and two background questions about the students' major subject and age. The booklet was a kind of learning diary, which students filled in during the quantitative methods course whenever they had something to write down about their experience. In the first task, the students were asked to place 11 academic subjects within a dimensional field, i.e. a coordinate system with two dimensions: easy–difficult and concrete–abstract, each ranging from -5 to $+5$ with the origin set at 0. The academic subjects included different methodological issues, students' major subject studies and foreign languages. We wanted to compare students' experience of methodology with their major subject study, and also to explore the relationship between methodology and languages. The reason for taking languages into the research was the assumption of a conception that mathematics and language skills are somehow opposed to each other.

The second task was an open-ended question, in which the students were asked to write down during the course all the difficult things and concepts in their methodology course whenever they faced them. They were also asked to write down how they understood the particular point and why they experienced it as difficult. The third task was also open-ended; the students were asked to consider why the learning of research methodology is difficult. In both of the latter tasks, students were also asked to write about their experience if they felt these studies were easy, and to give comments on other areas of methodology learning, e.g. qualitative methods and statistics. We also asked students to note the dates when they wrote their comments.

Students were asked to fill in the booklet during their methodology course and quantitative method exercises. The booklets were distributed at the beginning of the courses and collected at the end of them. The researcher handed the booklets to the students, and the teachers were responsible for returning the booklets at the end of the course. The reason for asking the students to write down their thoughts during the course, instead of at one specific moment, was the assumption that students might not immediately remember problematic themes or relevant concepts.

Only two of the 15 sociology students noted dates in their open-ended answers, and both only one date, whereon the education students were more thorough: 15 of 19 students mentioned some dates. Most of the dates noted were in April, indicating that students did not start filling in the booklet immediately after getting it. We assume that students noted the difficult points when they occurred or came into their minds. It was hoped that the long survey period would give the students time to consider their problems. By giving them time to answer, we allowed students to report their problems at the moment they experienced them.

While methodology as a whole was the object of our study, we also directed the students to report especially on their problems with quantitative methods. Students did mainly tell us about difficulties with quantitative methods, but we also got some comments on general methodology and qualitative methods. The theme of the courses would also direct the student answers towards quantitative problems. Our hypothesis was that there might be some more general reasons for the difficulties encountered than just problems with specific concepts, and thus we needed to look at the whole area of methodology to find the answers. We also wanted to explore the relationship between the difficulties in qualitative and quantitative methods.

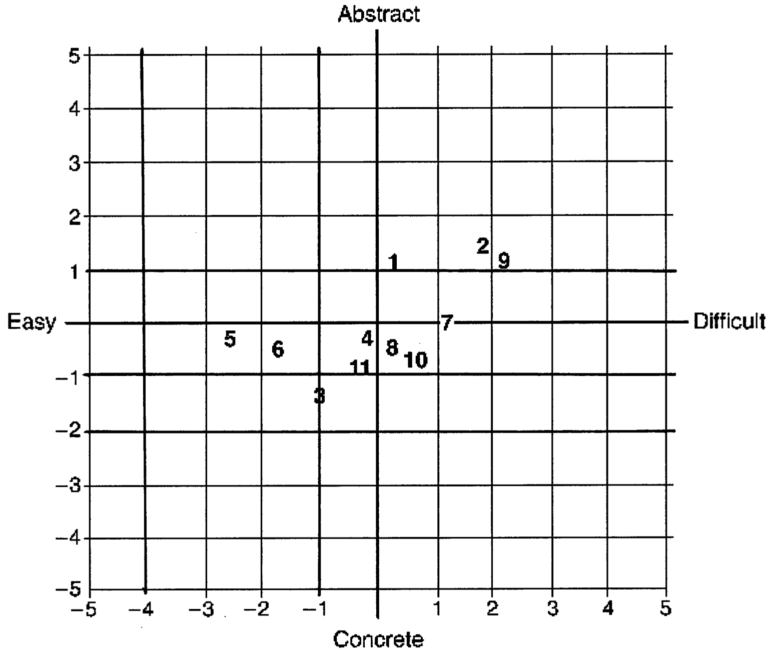
Results

The Experience of Difficulty

In the dimensional task, students placed different academic subjects within a coordinate system. Figure 1 shows the coordinate system and the means for the coordinates where the students placed the academic subjects. Due to the high positive correlation between most of the difficult and abstract dimensions in one topic, we concentrate here mainly on the difficulty dimension.

Students rated *Statistics in general* as the most abstract subject and *The statistical test for significance* as the most difficult subject. *The introductory course of the student's major subject* was rated as the easiest and *Foreign languages* as the most concrete. If we split the coordinate system into easy and difficult, we find that *Research methodology in general* is in the middle and all mathematical, statistical and quantitative subjects are on the difficult side, with student's main subject, foreign languages and qualitative methods on the easy side. These results suggest that these students thought that methodological topics, especially themes related to quantitative methods, were more difficult than their other studies. The education and sociology students did not differ from each other on any variable. Overall, it seems that students tended to polarise the academic subjects to 'easier' language, major and qualitative subjects, and to 'harder' mathematical, statistical and quantitative subjects.

There were some interesting correlations among the academic subject ratings (see Table I). *Mathematics in general* correlated positively with *Statistics in general* and with *Students'*



Note: Students placed the given subjects within the dimensional field according to how easy or difficult and how concrete or abstract they found the subjects. The subjects were rated from –5 to 5. Means and standard deviations are in brackets.

1. Mathematics in general (x = *M* 0.2 / *SD* 2.5; y = *M* 1.1 / *SD* 2.3)
2. Statistics in general (x = *M* 1.8 / *SD* 2.0; y = *M* 1.4 / *SD* 2.2)
3. Foreign languages (x = *M* –1.0 / *SD* 2.1; y = *M* –1.3 / *SD* 1.9)
4. Research methodology in general (x = *M* –0.1 / *SD* 1.4; y = *M* –0.1 / *SD* 1.9)
5. Introductory course of the student's major subject (x = *M* –2.6 / *SD* 1.4; y = *M* –0.2 / *SD* 2.2)
6. Student's major subject without methodology studies (x = *M* –1.9 / *SD* 1.5; y = *M* –0.4 / *SD* 2.2)
7. Use of statistical programmes with the computer (x = *M* 1.0 / *SD* 2.4; y = *M* 0.0 / *SD* 2.3)
8. Statistical parameters (e.g. mean and standard deviation) (x = *M* 0.1 / *SD* 2.2; y = *M* –0.3 / *SD* 2.1)
9. The statistical test for significance (e.g. t-test) (x = *M* 2.0 / *SD* 2.0; y = *M* 1.1 / *SD* 2.7)
10. Quantitative research methods (x = *M* 0.6 / *SD* 1.7; y = *M* –0.5 / *SD* 1.9)
11. Qualitative research methods (x = *M* –0.4 / *SD* 2.0; y = *M* –0.7 / *SD* 2.1)

FIG. 1. Students' experience of the difficulty of different academic subjects.

major subject. Statistics in general correlated positively with *Statistical parameters*, with *Statistical test for significance* and with *Quantitative research methods*. All of the last three mentioned correlated positively with each other. Students seemed thus to experience problems in all sections of quantitative methods if they had problems in one section. *Foreign languages* had a negative correlation with *Quantitative research methods*. This could suggest that students believed that these skills are contradictory, i.e. if you are good at languages, you will probably not be good at quantitative methods and vice versa.

Grouping of Students on the Basis of Experienced Difficulties

Several cluster analyses (k-means) were run to see if distinct subgroups of students could be

TABLE I. Pearson correlation coefficients for the academic subjects that students rated on the dimension easy vs. difficult

r	1	2	3	4	5	6	7	8	9	10
1. Mathematics	1									
2. Statistics	0.34*	1								
3. Languages	−0.19	−0.24	1							
4. Methodology	0.09	0.29	0.06	1						
5. Introductory course	0.21	−0.09	−0.07	0.17	1					
6. Major	0.34*	−0.09	0.15	−0.01	0.15	1				
7. Programs	−0.13	0.26	−0.13	0.17	0.11	−0.17	1			
8. Parameters	0.02	0.65*	−0.17	0.45*	−0.07	−0.08	0.34*	1		
9. Tests	−0.13	0.51*	0.09	0.36*	−0.14	−0.19	0.31	0.56*	1	
10. Quantitative	0.21	0.56*	−0.32*	0.30	−0.07	0.05	0.19	0.46*	0.52*	1
11. Qualitative	−0.04	−0.08	0.26	0.11	−0.31	0.19	0.17	0.04	0.11	0.26

* $p < 0.05$

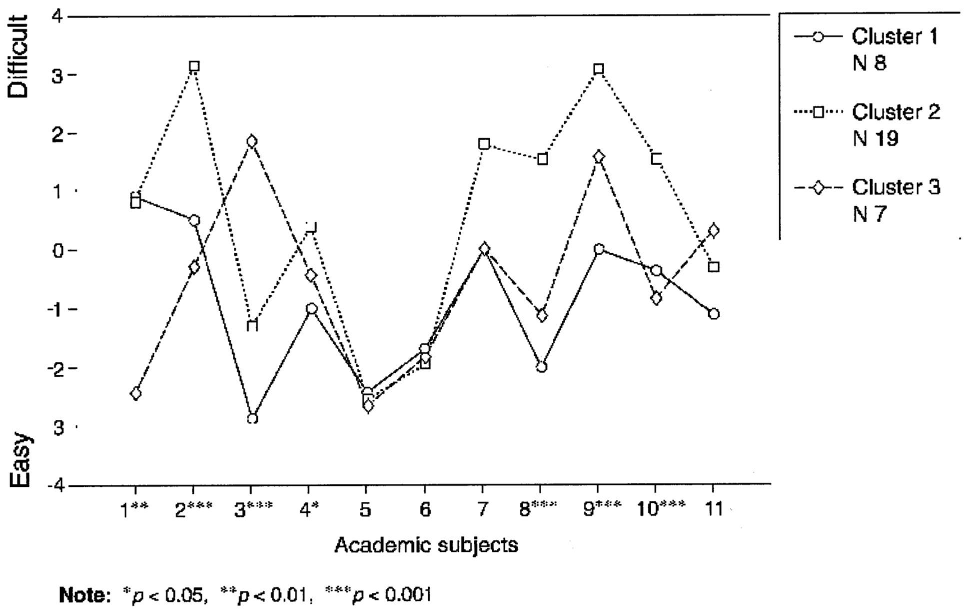


FIG. 2. A three-cluster solution of students in terms of their experience of difficulty in different academic subjects. Values: < 5 = easy, > 5 = difficult.

found. A three-cluster solution was selected on a theoretical basis (see Fig. 2). It distinguished between three kinds of students: Students in cluster 2 experienced lots of problems with statistical and quantitative subjects. Students in clusters 1 and 3 did not have as many problems as group 2. Cluster group 2 ($n = 19$) was over twice as large as the other groups combined ($n = 8$ and $n = 7$).

Groups 1 and 2 had quite a similar profile, except that the magnitude of experienced difficulties was greater for group 2 than for group 1. Group 2 rated *Statistics in general* exceptionally difficult and they also experienced other subjects related to statistics and quantitative methods as more problematic than the other groups. Both groups 1 and 2 rated *Foreign languages* as much easier than mathematical and statistical subjects. Group 3 had a contracting profile. They rated *Mathematics in general* as very easy and *Foreign languages* as the most difficult. They also found *Statistical test for significance* difficult, but they did not experience all subjects related to statistical and quantitative methods as hard. The groups' ratings of mathematical and statistical subjects in comparison to the *Foreign languages* variable confirms the hypothesis that a belief in people being either mathematically or linguistically able does exist for some.

The three groups did not differ in *Major subject introductory course* or in *Major subject without methodology studies*. All groups gave low ratings on these subjects, i.e. the students thought these subjects were easy. This suggests that, for group 2, problems in quantitative methods studies were not related to general study difficulties. The groups did not differ either in *Use of statistical programes with computer* or in *Qualitative research methods*. According to a t-test for dependent samples, there was no statistically significant difference between the difficulty of qualitative and quantitative methods in groups 1 and 3, but group 2 rated qualitative methods easier than quantitative methods, ($t(18) = 3.76$, $p < 0.01$).

Reasons for Difficulties

For the second task, students were asked to evaluate *why methodology studies are difficult, i.e. what are the factors that make the learning and understanding hard.* Students were also asked to say if they did not have any difficulties. Altogether 29 out of 34 responded. For the third task, *what are the most difficult things*? 27 of the 34 students provided answers. The answers for the two tasks were combined. If someone gave the same answer to both tasks, it was counted only once. Five categories were developed by first reading the answers through a couple of times, and after that reading them again, tentatively classifying the themes in the answers. Finally, the themes were gathered together and final categories constructed. Categories were named after the most common themes in each category. A few students wrote that they had no unsolvable difficulties with methodology, but because we directed the question towards the difficult points, we do not here stress how many had problems, but try to understand what the students thought caused the problems. The illustrations given are coded by disciplines (E = education and S = sociology) and the number of the respondent.

One of the most frequently mentioned problems was *superficial teaching* (15/34). Individual teachers and their ways of teaching got only a couple of comments, but the whole system of arranging the teaching of methodology was criticised in many answers. Methodology studies were assessed as superficial and too rushed. Courses were too packed, there was not enough time to clarify new concepts, examples were not adequate and students felt that the teaching of computer programes was more important to teachers/faculty than a deep understanding of the procedures. Here are some examples:

> All lecturers mention and use methodological concepts and methods, but no one bothers (i.e. does not take the responsibility) to teach them. (E 6)

> Part of the problem can be explained by too superficial treatment. Deeper and wider review would help. (S 3)

> They are introduced idiotically; qualitative methods with stupid analogies and quantitative methods mathematically. Teaching is bad and not holistic. It is incoherent, and superficial, nothing is dealt with thoroughly. Generally, method courses at the university are just something you have to swallow. There is no concern about understanding. (S 4)

Many students had problems with *linking theory and practice* (12/34). Books and abstract examples by teachers were not enough to create a deep understanding of concrete research procedures. A lack of real need for the methods did not encourage learning. Many students quoted the old saying, 'learning by doing'.

> The best way to learn methods is when you really have to use some method in your own research—a so-called general introduction of many basic methodological points does not lead to understanding. (S 5)

Unfamiliarity with and difficulty of the concepts and content also caused problems for some students (9/34). Lack of concretisation was mentioned often. This may follow from the task that students carried out before the open questions, where the dimension abstract–concrete was used, as students may tend to consider difficult things to be also abstract. Students indicated that new concepts were introduced too fast and superficially, and some of them were not explained at all. Teachers might have expected the students to know statistical concepts, even if they might not know students' level of skills. The students did not understand the language the statisticians used on the courses. The feeling of difficulty was caused both by the name and the content of the concepts. Most names of concepts used in Finnish research terminology are taken directly from English and this may cause problems. The contents may be unfamiliar and complex, which makes understanding and recall hard. The number of new concepts is confusing:

> There are too many method options and often, for example, different variables are so abstract, that you cannot find them. (E 13)

> Abstractness and newness. These are not familiar at all, even if I had an extensive mathematics course in high school, statistical methods were then gone through quite fast. (S 2)

Creating an integrated picture of the different parts of scientific research and really understanding it was viewed as difficult by some students (8/34). The things learned were experienced as separate pieces of information, and the links between them were fuzzy. The field of research was confusing. Students felt they were able to do what was asked, but they did not understand what they were doing. For example, concepts might look familiar, but in fact they did not understand them. Here are some illustrative examples of the students' problems:

> That the facts are separate from each other and there is no connection between them. For example, what can be the relationship between statistical analysis and validity or reliability! The hard thing in statistical analysis is the mathematics (although the computer does the calculations), those are really hard to understand. (E 14)

> Statistica is an easy program to use, but I can't always understand what the program does and why. (S 1)

> This describes my knowledge well: I can't even answer the question about what are difficult things in methodology; I can't name the things! I simply can't remember the concepts without books. (S 6)

Finally, negative attitudes towards these studies was author problem (8/34). Methodology, especially quantitative methods, did not interest students, who saw it as too mathematical. Students reported negative attitudes towards all mathematical things and they felt they were non-mathematical persons and as such could not learn these things. Some students thought that in human sciences relevant information can not be obtained by quantitative methods and that is why they did not want to bother to learn them. One student wrote:

> Mathematical terminology with its abbreviations is as important for a human scientist as a mountain bike for a goldfish. (S 6)

This reflects stable attitudes towards certain domains, which are probably very difficult to change. Negative attitudes towards mathematics are probably related to the choice of qualitative methods over quantitative methods. The following examples do not actually say that the students prefer qualitative methods, but in practice these probably are the reasons for choosing qualitative methods instead of quantitative methods. Negative attitudes are not always hidden; some students recognise there themselves, as in the first quotation:

> The hard thing in methodology is that you cannot pay attention, even in the middle of your studies, to the methods you yourself find interesting. It's a question of

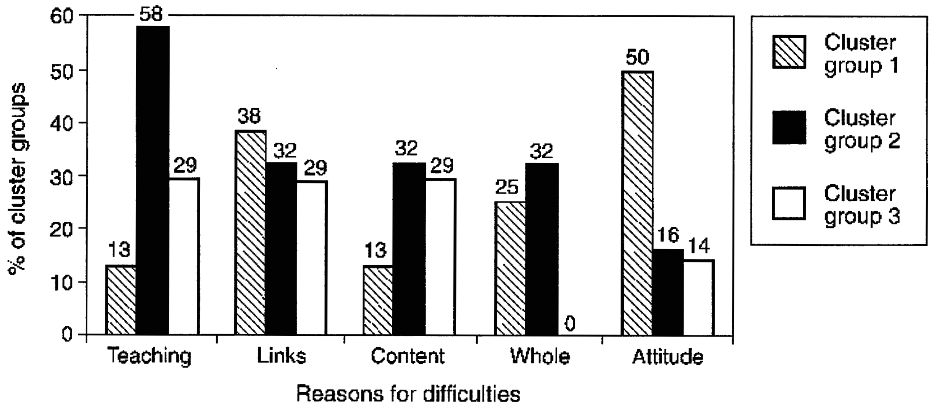


FIG. 3. The cluster groups compared in the five most common reasons for difficulties.

> problems in attitude. It would be sensible (when you know what you are interested in, and you know about the other options, so that the interest is not blind) to go into the methodology you are interested in as early as possible. On the other hand, there are not shockingly many compulsory method courses. You just notice that you get frustrated when you do not find a statistics course, that you have to take, meaningful for yourself. I thought it [studying a statistics course] was like 'a price paid' for reading social sciences in a world that pays too much attention to statistical means. Now the price is paid and I can once again concentrate on the main things, i.e. the big courses of human life and remarkable variants of it and radical options etc. (S 7)

> Understanding qualitative methods is easier, but carrying them out in practice is hard, for example, discourse analysis. (S 13)

> I assume methodological studies are hard because methodology with its methods is tightly connected to mathematics. I myself am a less mathematical person, a humanist, for whom this kind of thinking is far from my real interest. Though I have to admit that when you get even a bit acquainted with these things, they appear to be even interesting! (E 1)

Students mentioned some other themes in addition to the problems in the five categories above, including the abstruse literature, the increased workload associated with learning methodology, and their own laziness. What was not mentioned as difficult was the use of a computer.

Prior Conceptions and the Experiences of Difficulty

The three cluster groups were compared in terms of the five categories of reasons for difficulties derived from the open-ended questions. No statistical tests could be conducted due to the small group frequencies. The percentages of the mentioned answers in the cluster groups were calculated and are shown in Fig. 3.

Almost 60% of cluster group 2, which had most problems with statistical and quantitative subjects, noted that the reason for difficulties might be bad teaching. They did not mention their own negative attitude to be a problem as frequently as group 1, of whom 50%

cited this as a reason for difficulties in learning. Cluster groups 1 and 2 mentioned problems with understanding the whole, integrated picture of science, while none of group 3 mentioned this as a reason. All groups mentioned the links between theory and practice and the content as being problematic.

Discussion

This study confirmed the assumption that some students do consider quantitative methods and statistics as more difficult than qualitative methods, foreign language studies and major subject studies. The two groups (education and sociology students) did not differ from each other in their experience of difficulty. This suggests that the experience of difficulty did not occur because of the major subject or any specific teacher, but because of some more general reason.

On the basis of cluster analysis we can conclude that the difficulties in methods studies are not necessarily related to overall study difficulties. The group that experienced quantitative methods and related subjects as more difficult did not experience qualitative methods, major subject studies or foreign languages as difficult.

Two of the groups rated foreign languages as much easier than mathematics and quantitative method subjects. By contrast, the third group rated foreign languages as very difficult and mathematics as very easy. This confirms our hypothesis that a belief in people as being either mathematically or linguistically skilled does exist for some. The categories 'good at mathematics' and 'good at languages' are seen as being mutually exclusive. This conception may be one factor behind the problems with quantitative methods courses. It was also interesting that the students rated languages as concrete. This could be due to the method used, which locates the easy and concrete topics in the bottom left of the coordinate system, but it can also indicate that, for these students, languages were easier to connect to everyday life than were mathematical domains.

Students' answers to open-ended questions showed that they had problems with the basic understanding of methodology. The students suggested many possible reasons for their difficulties. Five main categories of reasons emerged: (1) Superficial teaching, (2) Linking theory and practice, (3) Unfamiliarity with and difficulty of the concepts and content, (4) Creating an integrated picture of the different parts of scientific research and really understanding it, and (5) Negative attitudes towards these studies. Superficial teaching, and especially the lack of time, refer to problems in handling new information, i.e. students' prior knowledge was not at a sufficient level to help in understanding the teaching and in managing the cognitive load (e.g. Sweller & Chandler, 1994). Linking theory and practice is a problem of conceptual and procedural knowledge (e.g. Hiebert & Lefevre, 1986), i.e. it is hard for students to see the connection between methodology courses and practical research activities. Creating an integrated picture of scientific research and really understanding it may reflect the complexity of the domain (Lehtinen & Rui, 1995). Different areas of methodology may be hard to link, and also different methodology courses may be hard to relate to each other. Negative attitudes reflect motivational problems, anxiety (e.g. Zeidner, 1991) and underlying negative conceptions toward methodology studies (e.g. Lonka & Lindblom-Ylänne, 1996). Unfamiliarity and difficulty with concepts and content emerged in many students' answers. The domain of methodology is not clearly related to students' everyday life and, thus, research activity and concepts are experienced as difficult (e.g. Anderson *et al.*, 1988; Watts, 1991).

The majority of cluster group 2, which had most problems with statistical and quantitative subjects, indicated that the reason for their difficulties might be bad teaching. They did not mention their own negative attitudes, as did group 1 students, where half of them reported negative attitudes as a reason for difficulties in learning. Thus, it seems that group 2 students might have thought that their difficulties in learning could not be explained by reasons that are connected to them. This might be related, for example, to low self-regulation strategies (e.g. Vermunt, 1998). Cluster groups 1 and 2 mentioned problems with understanding the whole, integrated picture of science, while none of the students in cluster group 3 mentioned this as a reason. This suggests that having problems with statistical and quantitative subjects can be connected to the problems of seeing the bigger picture of the domain. If you can understand the scope of the domain and the interrelations inside it, you may not experience difficulties when you have some harder detail to learn. All groups saw the links between theory and practice and the content as problematic.

The low percentage of the returned questionnaires does not allow us to conclude how many students on the courses had problems. Because the questionnaires were anonymous, we could not examine who the students were who did or did not answer. What we can say is that the majority of the students who answered had some problems. The method used in this study seemed to work well, except with regard to the low return rate.

Implications for Instruction

Our results suggest that we should pay more attention to the development of deep and holistic understanding of research as an integrated whole. We need to research students' prior knowledge and adjust teaching better to it. Students' messages about hurried courses should make us pause and ask; 'Are our courses too packed?' If the students' prior knowledge is on a much lower level than we assume, we might consider leaving some topics out of the study plan and concentrate more thoroughly on particular topics. Anxiety and negative attitudes that students have will not decrease if they feel they cannot understand what they are taught on a course. Anxiety and negative attitudes should be researched more and we should attempt to reduce such negative responses.

The students mentioned that linking theory with practice is hard. We should reconsider our materials and course arrangements to help students to see the connections between topics. One idea is to provide real-life research situations to give students a concrete insight to the research process (e.g. Kelly, 1992). Research courses could then be better linked to other courses, for example, by involving students in research projects. Another way to help understanding is to use real data, which has been used in some projects (e.g. Thompson, 1994). It should, however, be further considered what makes the data 'real' for students. Is it the fact that the data are from real research, or does 'reality' need students to take part in the actual data collection process? If students need to take part in the data collection process to give them an understanding of the research process, do they need to take part in designing the instrument, or is it enough to collect the data with ready-made questionnaires?

The students did not report difficulty in using the computer, but they said they cannot always understand what the computer does and why. We suggest that it is more important for social science students to understand what the tests are for, what the differences between the statistical tests are and when they should be used, than to know what button to press in some statistical programme. By carefully clarifying the central procedures and concepts and paying less attention to the technical use of the computer and statistical programes we might obtain better results. It is important to discuss with students their conceptions of different methods, and to pay attention to clarifying the meaning and goals of scientific research and statistics in general. By getting students to understand the importance of statistical and other methods we might be able to decrease their negative attitudes.

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REFERENCES

ANDERSON, J.R., PIROLLI, P. & FARRELL, R. (1988) Learning to program recursive functions, in: M.T.H. CHI, R. GLASER & M.J. FARR (Eds) *The Nature of Expertise* (Hillsdale, NJ, Lawrence Erlbaum).

ENTWISTLE, N. & RAMSDEN, P. (1983) *Understanding Student Learning* (London, Croom Helm).

FILINSON, R. & NIKLAS, D. (1992) The research critique approach to educating sociology students, *Teaching Sociology*, 20, pp. 129–134.

FORTE, J. (1995) Teaching statistics without sadistics, *Journal of Social Work Education*, 31, pp. 204–308.

GAL, I. & GINSBURG, L. (1994) The role of beliefs and attitudes in learning statistics: toward an assessment framework, *Journal of Statistics Education*, 2 (online).

GARFIELD, J. & AHLGREN, A. (1988) Difficulties in learning basic concepts in probability and statistics: implications for research, *Journal for Research in Mathematics Education*, 19, pp. 44–63.

GREER, B. (2000) Statistical thinking and learning, *Mathematical Thinking and Learning*, 2, pp. 1–9.

HAUFF, H.M. & FOGARTY, G.J. (1996) Analysing problem solving behaviour of successful and unsuccessful statistics students, *Instructional Science*, 24, pp. 397–409.

HIEBERT, J. & LEFEVRE, P. (1986) Conceptual and procedural knowledge on mathematics: an introductory analysis, in: J. HIEBERT (Ed.) *Conceptual and Procedural Knowledge: the case of mathematics* (Hillsdale, NJ, Lawrence Erlbaum).

KELLY, M. (1992) Teaching statistics to biologists, *Journal of Biological Education*, 26, pp. 200–203.

LANGER, E. (1997) *The Power of Mindful Learning* (Reading, MA, Addison-Wesley).

LEHTINEN, E. & RUI, E. (1995) Computer-supported complex learning: an environment for learning experimental methods and statistical inference, *Machine-Mediated Learning*, 5(3 & 4), pp. 149–175.

LINDBLOM-YLÄNNE, S. & LONKA, K. (1999) Individual ways of interacting with the learning environment—are they related to study success? *Learning and Instruction*, 9, pp. 1–18.

LONKA, K. & LINDBLOM-YLÄNNE, S. (1996) Epistemologies, conceptions of learning, and study practices in medicine and psychology, *Higher Education*, 31, pp. 5–24.

MARASINGHE, M.G. (1996) Using graphs and simulations to teach statistical concepts, *American Statistician*, 50, pp. 342–351.

MARTON, F. & SÄLJÖ, R. (1976) On qualitative differences in learning: I. Outcome and process, *British Journal of Educational Psychology*, 46, pp. 4–11.

MCGINN, M.K. & ROTH, W.M. (1999) Preparing students for competent scientific practice: implications of recent research in science and technology studies, *Educational Researcher*, 28(3), pp. 14–24.

MEVARECH, Z.R. (1983) A deep structure model of students' statistical misconceptions, *Educational Studies in Mathematics*, 14, pp. 415–429.

MURTONEN, M. (2000) Social science students' difficulties in research methodology learning, paper presented at the *Innovations in Higher Education 2000 Conference*, Helsinki, Finland.

ONWUEGBUZIE, A.J. & DALEY, C.E. (1998) The relationship between learning styles and statistics anxiety in a research methodology course, paper presented at the *Annual Conference of the American Educational Research Association*, San Diego.

PRETORIUS, T.B. & NORMAN, A.M. (1992) Psychometric data on the statistics anxiety scale for a sample of South African students, *Educational & Psychological Measurement*, 52, pp. 933–937.

ROSENTHAL, B.C. & WILSON, W.C. (1992) Student factors affecting performance in an MSW research and statistics course, *Journal of Social Work Education*, 28, pp. 77–85.

SÉRÉ, M.-G., JOURNEAUX, R. & LARCHER, C. (1993) Learning the statistical analysis of measurement errors, *International Journal of Science Education*, 15, pp. 427–438.

SWELLER, J. & CHANDLER, P. (1994) Why some material is difficult to learn, *Cognition and Instruction*, 12, pp. 185–233.

THOMPSON, B.W. (1994) Making data-analysis realistic: incorporating research into statistics courses, *Teaching of Psychology*, 21, pp. 41–43.

TOWNSEND, M.A.R., MOORE, D.W., TUCK, B.F. & WILTON, K.M. (1998) Self-concept and anxiety in university students studying social science statistics within a co-operative learning structure, *Educational Psychology*, 18, pp. 41–54.

VERMUNT, J.D. (1998) The regulation of constructive learning processes, *British Journal of Educational Psychology*, 68, pp. 149–171.

WATTS, D.G. (1991) Why is introductory statistics difficult to learn? And what can we do to make it easier? *American Statistician*, 45, pp. 290–291.

WINN, S. (1995) Learning by doing: teaching research methods through student participation in a commissioned research project, *Studies in Higher Education*, 20, pp. 203–214.

ZEIDNER, M. (1991) Statistics and mathematics anxiety in social science students: some interesting parallels, *British Journal of Educational Psychology*, 61, pp. 319–328.

NOVICES' AND EXPERTS' KNOWLEDGE ON STATISTICS AND RESEARCH METHODOLOGY

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Abstract

Many social science students in university constantly experience difficulties with research methodology and statistics courses. In this study we compared novice students', advanced students' and experts' knowledge on these complex and difficult domains. The results of the study refers to a tendency for novices, especially when they have had problems with mathematical subjects, to place the contents to emotional or other irrelevant categories which restricts or blocks their other cognitive activities on these subjects. There was a remarkable difference in the fragmentation of concept maps and explanations between novices, advanced students and experts. The novices were also not able to use sufficient representations to understand the concepts.

Introduction

Research methodology and statistics courses are constantly experienced as difficult by many university social science students (Filinson & Niklas, 1992; Forte, 1995; Lehtinen & Rui, 1995; Murtonen, 2000). When learning research methodology and statistics, students often face the situation when they for example may have some everyday experiences of statistical phenomena and implicit conceptions or "theories" of these phenomena, but they cannot relate these experiences to their studies. Their statistical knowledge may be composed of fragmented and isolated pieces, which do function at a sufficient level in specific situations, but do not connect the phenomenon into a wider context. Students may also try to understand the concept on the basis of the surface structure of the name of the concept. It is also possible that an integrated whole of statistical concepts is not possible to attain without enough operational understanding and experiences of the methods (Sfard 1991).

According to Chi (1992), conceptual change occurs when concepts are transferred from one ontological category to another. In Chi's model, the ontological entities belong to different ontological categories. This refers to an objectivist, Aristotelian ontological assumption that the categories exist in the world. In contrast, cognitive theories suggest that categories do not exist in the world, but in the humans' minds. According to Lakoff's and Johnson's (Lakoff, 1987, Lakoff and Johnson, 1999) embodied philosophy, categories are humans' way of behaving in the environment. On the basis of this theory we assumed that there might be several categories in humans' minds, which vary from person to person. There might also be emotional categories like "difficult things" that students form on the basis of their experiences. For example, if a student has experienced difficulties with mathematics, he or she might have placed the whole subject into a category of difficult or unpleasant things. Later, they may place statistics into this same category, because statistics reminds them of mathematics. This kind of a categorisation seems to function as an obstacle to other cognitive activities.

According to Núñez, advanced mathematical abilities are not independent of the cognitive apparatus used outside of mathematics. Rather, it appears that the cognitive structure of advanced mathematics makes use of the kind of conceptual apparatus that is the stuff of ordinary everyday thought such as image schemas, aspectual schemas, conceptual blends, and conceptual metaphor. (Núñez, 2000.) Similarly, to understand statistical phenomenon students should be able to relate them to their everyday experiences and thoughts.

The aim of this study is to compare novice students', advanced students' and experts' conceptions of research and statistical concepts in order to find the major differences between them. We hypothesise that novices, especially when they have mathematical problems, do place contents to emotional or other irrelevant categories that block other cognitive activities, while those with more positive experiences do not do so. We also assume that novices' knowledge is more fragmented than experts' knowledge, and that they lack operational understanding and experience and because of that they try to understand concepts on the basis of the surface structure, and that they are less capable of using representations and metaphors to help understanding.

Method

This study consisted of two phases. In the first phase, a questionnaire was filled in by 31 education students in the beginning of a statistics course. Two questionnaires were used. The first one was a test of statistical content knowledge measuring the understanding of e.g. mean, deviation, correlation and statistical inference. Students were also asked to estimate their certainty in each of the tasks. The other questionnaire dealt with students experienced difficulties in quantitative research methods, attitudes on research and learning orientations. On the basis of these questionnaires, four students were selected for further research. Two of the chosen students succeeded well in the statistical test, were confident in doing the tasks, did not experience difficulties in quantitative methods, had positive attitude towards the methods and their orientation was deep and task oriented. They will be called the 'advanced students' because of their good success in the statistics tasks. The other two students had considerable problems in the statistics tasks, had experienced difficulties in quantitative methods and they were not confident in the tasks. They will be called the 'novice students'. They experienced problems in learning quantitative methods and they did not appreciate the methods. They were not deep oriented toward learning methodology but were more self-defensively oriented and less task oriented than the other two students.

In the second phase these four students were interviewed after the statistics course. We also interviewed two experts to be able to compare the students' answers to an expert view. The experts were psychologists who had been working as researchers for many years. All interviewees were female. The interviews were conducted in pairs on each expertise level. Both two researchers were present all the time. The interviews lasted from 1 to 2 hours. The reason for interviewing two students/experts at the same time by two researchers was to encourage a discussion between students and also between students and researchers.

The interview was about conceptions of scientific research and statistics. The interviewees were asked to explain what scientific research is and simultaneously to draw a concept map of scientific research. During and after drawing a concept map the students were asked questions concerning their attitudes and conceptions of different domains of scientific research and especially about statistics. Specific questions about statistics were asked on what they think that happens in a t-test and do they know what the p-value really stands for.

Results

A category of difficult things

In the questionnaires we asked the students about the difficulty of quantitative method courses. In order to confirm that we found the students we were looking for, we asked the students in the interviews about their experiences. We started with novice students:

> *Interviewer:* How do you experience research methodology as a subject to be learnt?
>
> *Laura:* It feels more difficult than other courses. It might be that when one specific subject is easy to learn, then this [methodology] is kind of a clump. It somehow frightens. It feels somehow foggy and difficult to learn.
>
> *Interviewer:* Does it include the whole research or just some specific domain?
>
> *Laura:* I cannot figure out the specific domains, but as a whole. Just the research - everything else feels detached from it.
>
> *Emma:* Well, at least statistics feels very difficult. It would be good to have a link from it to something more practical. It has now got a bit clearer, when I have been doing my practice work, but at the beginning it was really hard.

Laura's notion about the research being a clump seems to be a good example of a category of difficult things. She has no tools for managing research domain and she is also frightened about it. She cannot even name a domain inside methodology that is the most problematic. When Emma identifies statistics, Laura agrees with her. Laura refers to other study subjects which are comprehensible to her as independent domains, but methodology represents to her a domain that she cannot link to the other study subjects and she cannot understand the subdomains of research methodology. Emma mentions that things have become clearer when she has been working with her practise work, which refers to the importance of practise and operational activity in the elementary understanding of statistical concepts. The advanced students had a very different view on methodology and statistics:

> *Maria:* Well, if you think about statistics, you sure have to work on them, but I haven't had any problems that I couldn't have overcome. Rather, I would say it's refreshing, to have something else, something different. I have always liked mathematics, for to have something else, too.

Jenny: And it is different from... if you think about our major subject in general, it's much about building up aggregate domains and understanding things, but here you have to learn also by heart what they mean and think how they are connected. It's not difficult. Maybe demands more work, but it's not more difficult.

In Maria's comment there is a reference to positive experiences with mathematics and she even talks about statistics as a 'refreshing' part of her studies. In Jenny's comment there is a reference to the difficulty of the subject but also a confident reassurance that she is going to work to be able to comprehend the things. She did not find the work impossible.

Concept maps

The concept maps of the student pairs and the experts were very different from each other. The maps are shown in Figures 1-3. The advanced students started to do the given task eagerly and they were confident about what they were doing. The experts asked if we wanted some specific kind of a map or can they just draw what they want (they were told to draw what they want). The novice students were worried about how they will do and they didn't know where to begin. They were asked to just start somewhere to write concepts on the paper. The concept map they produced was more fragmented than the others' map. It did not have as much content as advanced students' map and the concepts were just floating it the air. The map did not show much logic in the placement of the concepts. The advanced students did have a coherent structure that proceeded chronologically in the same sequence as ideal research. They drew first a small map of principles in science and then they were asked to think about practise also. They drew a different map of research in practise, but they said in the interview that these two could have been drawn in the same map.

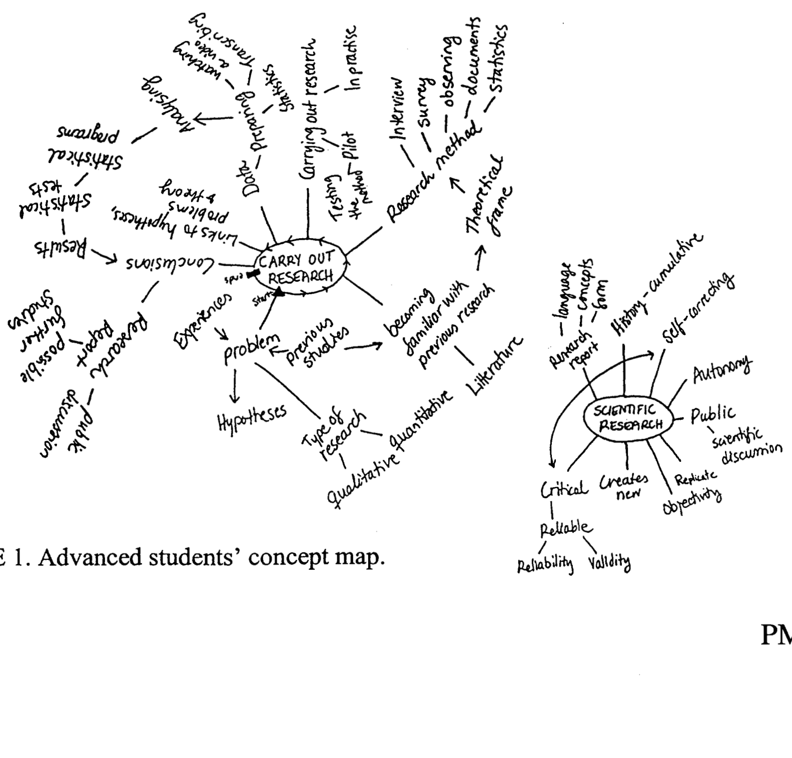

FIGURE 1. Advanced students' concept map.

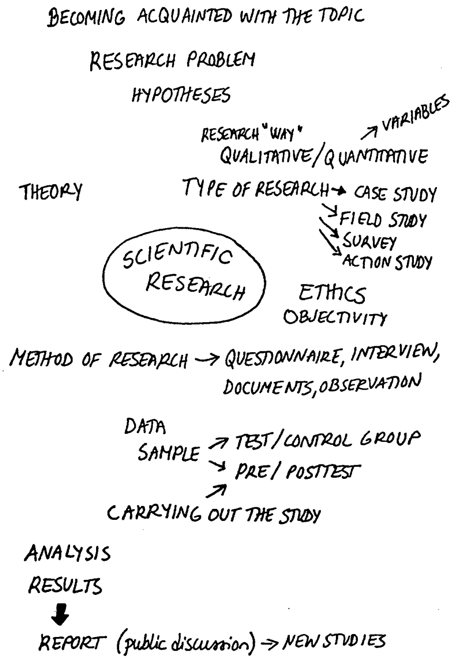

FIGURE 2. Novive students' concept map.

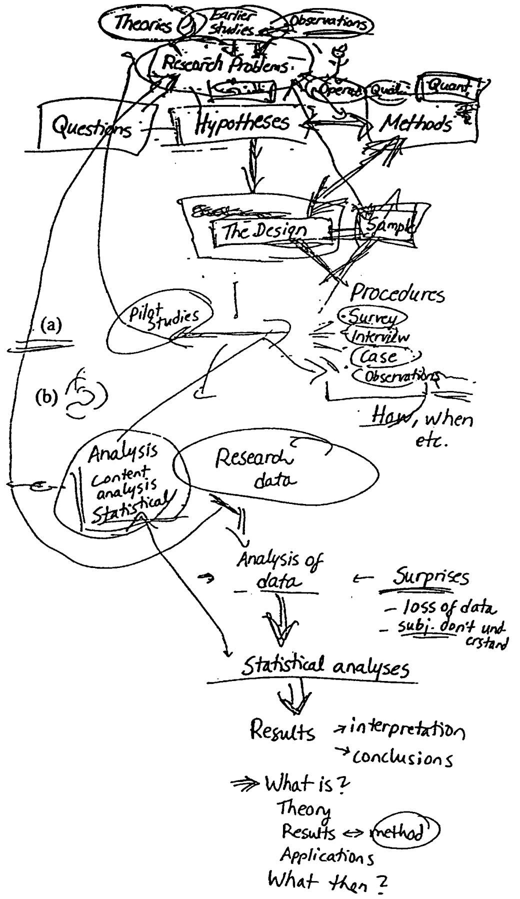

FIGURE 3. Experts' concept map.

The experts' concept map had many dimensions. They constantly talked about "interaction" between the subdomains and they also drew lines and arrows to describe the interaction:

> *Eva:* And these are, of course, constantly interacting with each other. You cannot draw a research like this. [Eva drew the pattern (a) in Figure 3]
> *Irma:* Yes, you cannot.
> *Eva:* Instead, it is something very complicated… [Eva drew the pattern (b) in Figure 3]

Although the advanced students did have lots of connections between the concepts in their map, they did not talk about the interaction between the domains. The experts mentioned that it is difficult to draw a figure of research, because it does not progress linearly. They ended up with a conclusion that research has to be organized somehow to be able to report it and thus it can be represented as a product. According to them, research description is like schemata that frame the research processes. Research report also gives opportunity to replicate the study, which in turn is an important tool for assessing the validity and reliability of a research. The experts noticed that research problems can rise from many different view points. They drew a researcher in the right upper corner of the concept map to point out that it depends on the researcher's individuality how he or she does the research. The student pairs did not mention the impact of an individual researcher.

While both of the student pairs always sought for a conception that they could both agree about, the experts did not consider it a problem to have a different conception about some issues. In the end they concluded that this concept map represented only a small piece of scientific research, which is an activity of a research community and some local research groups with their own activities are just a small part of the bigger unit. They thus saw research as a very wide concept, while students only saw it as one practical research project.

Eva: And here we get to our beloved, research design
Irma: I thought it goes here with these (shows the methods)
Eva: Well, not quite… actually
Irma: Well, for me it belongs there
Eva: Ok, you could put it there if you were writing a section about research methods
Irma: Yes, then it would be it's own section below the methods.
Eva: For me this (research design) is a very important part. This is the core of the reasoning when we are building up the research logic.

The maps and the processes that the researchers saw when the students drew the maps suggest that the novice students did not have a clear conception about how research proceeds in practise.

Representations of statistical concepts

The novice students were asked if they are familiar with t-test. They said it was introduced superficially, but they did not know it very well. Then the interviewer asked if they knew what the p-value stands for. The students had just finished a statistics course, where they had studied the p-value, so they should have been familiar with it. We had the following conversation:

Emma: I was just looking for the practice work, well, it (p-value) is a kind of, I mean, how it goes…
Laura: … significant and almost significant…
Emma: Well, that how they go, all the commas and nulls and others… I asked about it in a statistics lecture and the teacher tried to explain. She wrote this awful formula on the blackboard and explained that it is based on that and there is some theoretical thing in the computer and it comes from all of these… and … (laughing) it is not clear to me…
Interviewer: Is it somehow mystical?

Emma: No, it has been explained

Laura: Yes, it has been explained that, how it goes... But, when you should explain it in the results... It is quite easy to look it from the papers, that what is significant and so, but, strictly speaking, I don't get it at all.

Emma: Those certain numbers are in all of them, I mean that p is smaller than this and this, well, the significant is easy, but when it gives you all the numbers, then I cannot understand where these all numbers belong to.

The conversation above shows again how unconfident the novice students are about their knowledge and also how fragmented and fuzzy their knowledge is. When talking about t-test with the advanced students, Maria explains about two groups and simultaneously keeps her both hands in the air in front of her as to show two groups. The interviewer asks what the hands represent:

Maria: Well, t-test reminds me about two groups

Interviewer: Do you see some kind of distribution figures in your mind?

Maria: No, I don't

When we asked the same question about t-test from the experts, they grasped pens eagerly and wanted to draw. They were, however, first asked to explain without paper and pencil. They showed similar hand representations as the advanced student did when she was describing the comparison groups. When allowed to draw, the experts drew two distribution lines partly overlapping each other. They had thus helpful representations about the asked test.

Discussion

The interviews showed that we succeeded to find with our questionnaires a pair of novice students, who had problems with statistics content knowledge and also attitudinal problems, and a pair of students who were good with the content knowledge and did not have attitudinal problems. The interviews about the difficulty of methodology referred to the tendency of some students to create a category of difficult things, a "clump", where they place all things they think that are not possible for them to learn. This kind of a categorisation seems to function as an obstacle to further cognitive activities. The novice students also called for more practices, which suggests that they suffer from the lack of operational understanding and helpful representations of the concepts.

The major difference in the concept maps of the interviewees was their state of fragmentation. The map of the novices was a static picture composed of fragmented pieces of external knowledge with hardly any connections between them. The map of the advanced students had more structural elements, connections between the domains and indications of a process' like knowledge, even some dynamics. There was, however a noticeable difference between the concept maps of the students and the one of the experts. The map of the experts formed an integrated whole of the research, which was clearly structured but simultaneously had the dynamics of the research in action. Besides the formal knowledge of research methodology there was also a vision of the important informal knowledge reflecting the experience of the experts. The experts had also clear ways of representing the given statistical concepts, while novices had hardly any indications of representations.

The most important finding of this study was the evidence of a category of difficult things, which the novice students had, but the more advanced did not have. We suggest that this kind of mental categorisation might be one of the serious challenges to the learning of statistical methods. In order to support the learning in this kind of a complex domain, deliberate teaching arrangements are needed to help student to reassign the "difficult" things into a category of "possible for me to learn" things.

References

Chi, M. T. H. (1992). Conceptual change within and across ontological categories: Examples from learning and discovery in science. In R. N. Giere (Ed.), *Cognitive models of science. Minnesota studies in the philosophy of science* (pp. 129-186). Minneapolis, MN: University of Minnesota Press.

Filinson, R., & Niklas, D. (1992). The research critique approach to educating sociology students. *Teaching Sociology* 20, 129-134.

Forte, J. (1995). Teaching statistics without sadistics. *Journal of Social Work Education* 31(2), 204-308.

Lakoff, G. (1987). *Women, fire, and dangerous things. What categories reveal about the mind.* Chicago: University of Chicago Press.

Lakoff, G., & Johnson, M. (1999). *Philosophy in the flesh. The embodied mind and its challenge to western thought.* New York: Basic Books.

Lehtinen, E. & Rui, E. (1995). Computer-supported complex learning: An environment for learning experimental methods and statistical inference. *Machine-Mediated Learning* 5(3&4), 149-175.

Murtonen, M. (2000). Social science students' difficulties in research methodology learning. A paper presented at the Innovations in Higher Education 2000 Conference, 30.8. - 2.9.2000, Helsinki, Finland.

Núñez, R. E. (2000). Mathematical idea analysis: What embodied cognitive science can say about the human nature of mathematics. *Proceedings* of the 24th Conference of the International Group for the Psychology of Mathematics Education, T. Nakahara, & M. Koyama (eds), Hiroshima University, 1, 3-22.

Sfard, A. (1991). On the dual nature of mathematical conceptions: Reflections on processes and objects as different sides of the same coin. Educational studies in Mathematics, 22(1), 1-36.

Earlier mathematics achievement and success in university studies

MARI MURTONEN & NATHANIEL TITTERTON

This study explores connections between earlier mathematics achievement in high school, success in university statistics and quantitative methods courses and experienced difficulties in quantitative methods courses. Earlier achievement in mathematics correlated with statistics grade in university studies, but not with quantitative methods course grade. Earlier achievement in mathematics was related to the experience of one's own ability in mathematical subjects and quantitative methods, but it was not related to other experienced difficulties. Ability in mathematical subjects and quantitative methods was further connected to other difficulties experienced in quantitative methods. The experienced difficulties and achievement in university courses were not related.

Many university social science students consider their quantitative methods and statistics courses problematic and more difficult than their other courses (e.g. Filinson & Niklas, 1992; Forte, 1995; Garfield & Ahlgren, 1988; Hauff & Fogarty, 1996; Lehtinen & Rui, 1995; Murtonen & Lehtinen, in press; Onwuegbuzie & Daley, 1998; Pretorius & Norman, 1992; Rosenthal & Wilson, 1992; Thompson, 1994; Townsend et al, 1998; Zeidner, 1991). The experience of difficulty in methods courses may be connected to students' previous experiences and achievement in similar domains, e.g. mathematics. The goal of this paper is to analyse how earlier achievement in high school mathematics is related to difficulties experienced in quantitative methods learning and to what kinds of difficulties, as well as whether the experienced difficulties are connected to achievement in university courses. No previous studies have been done on difficulties

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experienced in quantitative methods studies in relation to earlier mathematics achievement and achievement in university, but there are studies concerning statistics anxiety, prior knowledge and achievement.

Statistics anxiety has been noted as a serious problem in social sciences' quantitative methods and statistics courses (e.g. Birenbaum & Eylath, 1994; Forte, 1995; Pretorius & Norman, 1992; Townsend et al, 1998; Zeidner, 1991). The studies on statistics anxiety have their roots in mathematics anxiety and beliefs studies. Anxiety toward mathematics has been found to begin at an early age, as over 60 % of 9- to 11-year-old pupils reported some degree of mathematical anxiety in Newstead's study (1998). Schoenfeld (1989) has explored the relation between mathematical beliefs and achievement. He concludes that the students' sense of their own mathematical ability, their expected mathematical performance and their overall academic performance all correlate strongly with each other. Mathematics anxiety in university students has also been studied. In the studies by Betz (1978) and Clute (1984), high mathematics anxiety was found to be related to poor achievement in mathematics courses. On the contrary, Resnick et al (1982) found that mathematics anxiety did not predict mathematics performance in a large sample of university students. In the case of university students the connection between mathematics anxiety and performance in mathematics is thus not clear.

The connection from mathematics to statistics has inspired some researchers to investigate the impact of mathematics anxiety on statistics learning in university students and to develop specific statistics anxiety measures. According to Zeidner's results (1991), statistics anxiety paralleled some known features of mathematics anxiety in the same behavioural science student population. Zeidner's study revealed that negative prior experiences with mathematics, poor prior achievement in mathematics and a low sense of mathematical self-efficacy are meaningful antecedent correlates of statistics anxiety. Birenbaum and Eylath (1994) explored different correlates of statistics anxiety among students of educational sciences and found that mathematics and statistics anxiety were related, both being connected to a low earlier high school mathematics grade. Earlier mathematics achievement thus seems to be related to statistics anxiety.

Birenbaum and Eylath (1994) have studied the impact of experience with statistics on statistics anxiety. They concluded that the previous experience with statistics courses, i.e. whether or not the student had previously taken courses in statistics, did not affect statistics anxiety. Thus, although previous experiences in high school mathematics are related to statistics anxiety, the experience at university does not reduce or increase anxiety.

When focusing on achievement in university courses, Townsend et al. (1998) found that university psychology students' mathematics background did become a significant predictor of overall achievement in the statistics course. The students who had taken more mathematics courses had higher statistics grades than the students with fewer mathematics courses. Although the number of courses taken was connected to success, earlier achievement seems not to be so clearly related to success at university. Birenbaum and Eylath (1994) found that the earlier high school mathematics grade was only weakly connected to the statistics course grade at university.

Pretorius and Norman (1992) compared psychology students on a research methodology course in terms of passing or failing. They found that the most anxious students did not pass the courses. On the contrary, Townsend et al (1998) found that self-concept and anxiety were not strongly associated with achievement. Also in Rosenthal's and Wilson's study (1992) on a social work master students' research course, it was found that confidence in undertaking the research course was not related to performance. In the study of Birenbaum and Eylath (1994), neither statistics nor mathematics anxiety was connected to the statistics-related course grade.

In summary, previous research suggests that earlier achievement in mathematics correlates with statistics anxiety and also weakly with achievement in university statistics and methodology courses, but that there is not necessarily any relationship between anxiety and achievement, at least when achievement is looked at as a grade. Figure 1 shows the possible connections.

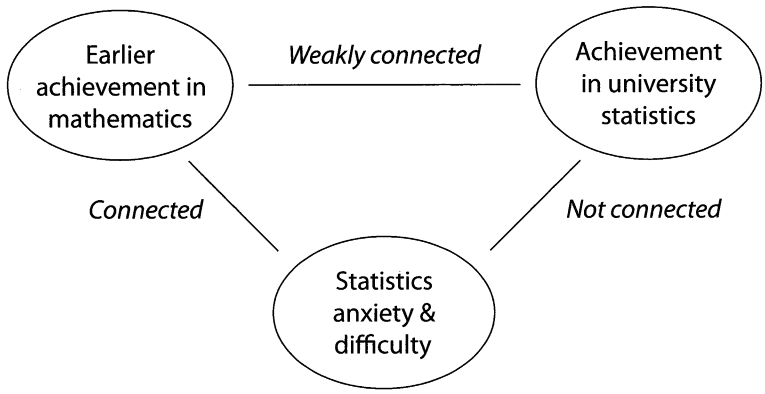

Figure 1. *Assumed relationship magnitudes between earlier achievement in mathematics, statistics anxiety and difficulty, and achievement in university statistics.*

University students experiencing difficulties in their quantitative methods courses might, however, not only have problems that are related to statistics anxiety. The questions in statistics anxiety questionnaires usually concern emotional states, such as feeling anxious about using statistical tables, reading a formula or signing up for a statistics course (e.g. Zeidner, 1991). In this study we were interested in studying also other kinds of problems that the students may have, and whether they are related to achievement.

In the study of Murtonen and Lehtinen (2003), students were asked to give descriptions of their difficulties during a quantitative methods course. They described different kinds of problems concerning 1) method of teaching and lack of time, 2) linking theory with practice, 3) establishing an integrated picture of the parts of scientific research in order to really understand it, 4) negative attitude toward these studies, and 5) unfamiliarity and difficulty of concepts and content. None of these categories, except category 4, fit under the label "anxiety", although they may well be connected to it. These problems are more cognitive and may have their origin in instruction. In this paper, we investigate the different kinds of experienced difficulties described above in relation to earlier achievement in mathematics and study success at university.

Method

The sample consisted of 74 social science and education students in Finland. The students were from three departments: education (29), psychology (26) and sociology (19). All the students present at the data collections filled out the questionnaire. The students were approximately third year students and doing a master's degree. (In Finland, the students are committed from the outset of their studies to doing a master's degree.) In our previous research (Murtonen & Lehtinen, in press; Murtonen, 2001), we have found that social science students and education students do not differ from each other in their experienced difficulties and that is why we study these groups here as one group (and as shown later, there were no differences between the groups in this study either). All students had enrolled in some introductory courses in methodology in previous terms. The sociology students were enrolled in a qualitative methods course, while the education and psychology students were enrolled in quantitative methods courses (each department taught a separate course). Of the subjects, 56 (77 %) were women and 17 (23 %) were men.

The instrument was a questionnaire concerning Difficulties in Quantitative Methods (DQM). The questionnaire was developed on the basis of the results of Murtonen and Lehtinen (2003), and comprised 17 statements concerning experienced difficulties in quantitative methods learning and courses. The statements covered instruction in courses, interest in quantitative methods, superficiality in courses, students' ability in mathematical subjects and lack of connection between parts in the methodology domain (see Table 1). Students responded to each item on a Likert scale ranging from *strongly disagree* (1) to *strongly agree* (5). The statements were not restricted to a specific course but were more general in nature.

Students were asked to give their high school mathematics grade in the questionnaire. University statistics and quantitative methods course grades were taken from the university's student registry, and standardised within the major subject groups. Data collection took place in the beginning of the methods courses. The teacher was responsible for both distributing the questionnaires to the students and collecting them. Students filled in the questionnaires at the beginning of a lecture. The questionnaire began with a short note for the students about the research project and about the importance of their answers for the study.

Results

A principal component analysis was run with the 17 questions of the DQM instrument. The loadings are shown in Table 1. This solution was satisfactory both theoretically and statistically, explaining 65 % of the total variance.

Sum variables were constructed on the basis of the components for further analysis. The first sum variable (PC1) was named Instruction (M=3.36, SD=.81), because most of the questions concerned teachers and instruction. The second (PC2) was named Interest (M=2.64, SD=.83), as it dealt with attitudes toward learning and quantitative methods courses. The third component (PC3) was called Superficiality (M=3.46, SD=.79), since the items were about the time spent on and the depth of learning in courses. The fourth component (PC4) was named Ability (M=2.92, SD=1.00), which refers to the students' own conceptions of themselves as learners of mathematical and technical subjects, as well as the amount of effort this kind of course requires of them. The last component (PC5) was named Unconnection (M=3.45, SD=.81), because the items were about the degree to which different parts of the research methodology were felt to be unconnected.

On the basis of the means of the sum variables, the students saw issues related to Instruction, Superficiality and Unconnection as the most problematic ones, while they reported fewer problems with their Ability and Interest. The mean of Ability was, however, almost 3, which indicates that the students had problems with the feeling of their own ability.

Table 1. *Principal component loadings (a 5-component Varimax solution) of items in DQM inventory*

Variable	Principal component				
	PC1	PC2	PC3	PC4	PC5
1. I'm not interested in quantitative methods		.79			
2. There is not enough real world application in courses			.72		
3. I'm not good at mathematics and that's why I'm not good at methodology				.79	
4. Computers are difficult to use when doing analyses				.79	
5. The teaching is too superficial			.79		
6. The teaching is too hasty: there is no time in the lecture to really get familiar with the subject			.78		
7. Examples used in courses are not interesting		.54			-.54
8. Methodological skills are easy to forget, because you don't need them daily					.61
9. The data used in courses are not interesting because they do not feel real/my own		.67			
10. It's hard to see links between different parts of research methodology	.49				.62
11. Methodological concepts are hard to understand	.79				
12. Too many new concepts are introduced too fast during courses	.83				
13. Teachers use too difficult language and do not explain things	.72				
14. Teachers do not see and understand students' problems	.61				
15. I have a negative attitude toward methodology studies		.80			
16. Methodological books are hard to understand		.32		.49	.59
17. Methodology courses need more work than other courses				.70	
Eigenvalues	4,31	2,52	1,92	1,19	1,16
Cronbach's Alpha's for selected variables	.78	.71	.71	.70	.60

Note. Decimal places and loadings less than .30 are omitted. Items selected for sum variables are underlined.

Analyses of variance between the major groups (education, psychology and sociology) were conducted to find out possible differences between the groups. The major groups did not differ from each other on any difficulty sum variable. It also follows that the students in different courses, i.e. qualitative or quantitative, did not differ from each other in their answers.

Relations among experienced difficulty and achievement variables

The Pearson product moment correlations between experienced difficulty sum variables, high school mathematics achievement, university statistics and quantitative methods grades are shown in Table 2.

Table 2. *Correlations among experienced difficulty sum variables, high school mathematics achievement, university statistics and quantitative methods grades (N=74)*

Variable		1	2	3	PC1	PC2	PC3	PC4
1.	High school maths							
2.	Statistics	.32*						
3.	Quantitative methods	.22	.32*					
PCl	Instruction	-.05	.00	-.15				
PC2	Interest	-.18	.12	-.16	.05			
PC3	Superficiality	-.10	.02	-.13	.32*	.21		
PC4	Ability	-.37*	.10	.03	.28*	.25*	.09	
PC5	Unconnection	.00	.10	-.09	.55*	.01	.30*	.38*

Note: $p < .05$*

High school mathematics grade had a positive correlation with statistics university grade, but no correlation with quantitative methods university course grade. Statistics and quantitative methods grades were intercorrelated, but they were not connected to experienced difficulty sum variables. This implies that the experienced difficulties in quantitative methods and statistics courses are not necessarily connected to the achievement on these courses (see also Figure 2).

Mathematics high school grade was connected to the Ability sum variable. This means that the previous achievement in mathematics is connected to the students' experience of themselves as learners of mathematical subjects. Mathematics high school grade was not connected to other difficulty sum variables. The difficulty sum variables were interconnected to each other.

Discussion

The results of this study on difficulties in quantitative methods courses were quite similar to the results of the previous studies on statistics anxiety. The results are also shown in Figure 2 in comparison to the Figure 1. Previous achievement in high school mathematics had some connection to university methods course achievement, but the connection was not strong. Earlier mathematics achievement turned out to be connected to only one kind of difficulty in quantitative methods learning, i.e. the way the students see themselves as learners of mathematics-related subjects. None of the experienced difficulties correlated with achievement at university.

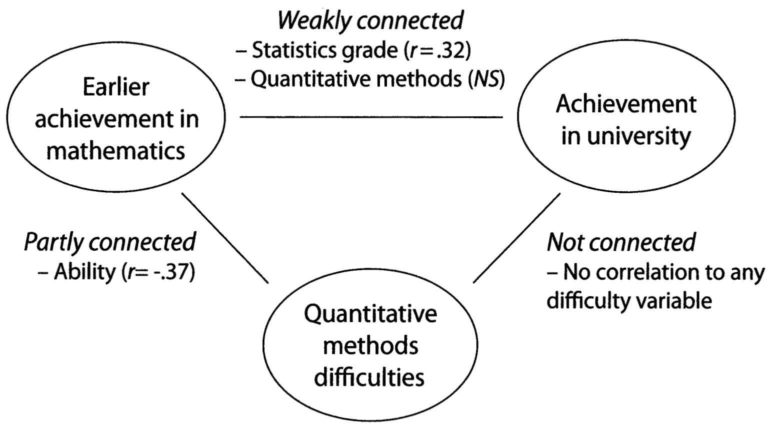

Figure 2. *Relationships between earlier achievement in mathematics, quantitative methods difficulty, and achievement in university quantitative methods related courses.*

The result that earlier mathematics achievement correlated with the way the learners see themselves as learners of mathematics may refer to the influence of previous experiences with mathematics (e.g. Schoenfeld, 1989). However, the correlation was not very strong, so there might also be other reasons for the negative conceptions of one's own mathematical and technical ability. The roots of beliefs in mathematical and technological domains may lie in broader conceptual and cultural structures, rather than individual bad prior experiences with mathematics. They might, for example, lie in something called the cultural conception of "hard" and "soft" values. Murtonen and Lehtinen (2003) found that people who thought languages were easy for them tended to view quantitative methods as not easy (that is, they were negatively correlated). Languages is just one example, but there might also be other areas that the students conceptualise according to the common distinction between "hard" and "soft" studies. These kinds of concepts may have an impact on people's behaviour somewhat like underlying framework theories that influence the understanding and conceptualising of more specific issues (e.g. Vosniadou, 1994). For example, some social science students may think they are not good at or do not want to commit themselves to mathematical subjects, and thus experience difficulties in these domains.

The students experienced the least problems in connection with their interest in quantitative methods. In other words, the students themselves experienced more problems with the instruction and the domain of quantitative methods learning than with their own interest. Motivational and conceptual reasons for difficulties may thus not be the only reasons for difficulties; in the future we should carefully study the problems in learning arising from instruction and the subject of quantitative methods.

Many intercorrelations were found among the experienced difficulty sum variables. The different types of difficulties thus seem to form a connected web. A student who experiences difficulties in one sector is more likely to experience difficulties in other sectors, too.

Earlier mathematics achievement was measured in this study by self-reported high school mathematics grades. There is a possibility of not getting reliable results, because students may not remember their grades accurately, or may actively bias their estimate (under- or overestimating it). The method was used in this study because gaining access to the previous grades would have been very difficult, especially because of the problem with information security. The method of asking students about their mathematics grade has, however, been used successfully in other studies (e.g. by Birenbaum & Eylath, 1994).

Another limitation was that we used the information of the university student register information to evaluate the students' performance in university courses, and this is a rather broad measure. For more elaborate analysis of the relation between the experience of difficulty and quantitative methods performance, it might be better to use some specific knowledge tests. It may be that students try to attain good grades in spite of experienced difficulties or negative attitudes.

In the study by Townsend et al. (1998), mathematics self-concept and anxiety were not associated with achievement. They concluded that this does not mean that we should be unconcerned about them, because students' beliefs and attitudes influence not only their enjoyment of the subject but also the likelihood that they will select it for further study. Similarly in this research, the fact that the experience of difficulty was not related to achievement in university courses does not mean that there are no consequences. It is possible that these already highly selected students have developed methods needed for gaining good results in their courses, independently of their motivation, beliefs and attitudes. The real consequences might appear later in further course selections or in their working life. The impacts from negative self-beliefs and experiences of difficulty on later behaviour need to be further studied. Interesting avenues to explore include students' conceptions of their future work and the need of research skills in it, the types of jobs and responsibilities people take on after their studies, and the ways in which they use statistical information and deal with research results in these jobs.

Acknowledgements

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References

Betz, N. E. (1978). Prevalence, distribution, and correlates of math anxiety in college students. *Journal of Counseling Psychology* 25, 441–448.

Birenbaum, M., & Eylath, S. (1994). Who is afraid of statistics? Correlates of statistics anxiety among students of educational sciences. *Educational Research* 36, 93–98.

Clute, P. M. (1984). Mathematics anxiety, instructional method, and achievement in a survey course in college mathematics. *Journal for Research in Mathematics Education* 15, 50–58.

Filinson, R., & Niklas, D. (1992). The research critique approach to educating sociology students. *Teaching Sociology* 20, 129–134.

Forte, J. (1995). Teaching statistics without sadistics. *Journal of Social Work Education* 31, 204–308.

Garfield, J., & Ahlgren, A. (1988). Difficulties in learning basic concepts in probability and statistics: Implications for research. *Journal for Research in Mathematics Education* 19(1), 44–63.

Hauff, H. M., & Fogarty, G. J. (1996). Analysing problem solving behaviour of successful and unsuccessful statistics students. *Instructional Science* 24, 397–409.

Lehtinen, E., & Rui, E. (1995). Computer-supported complex learning: An environment for learning experimental methods and statistical inference. *Machine-Mediated Learning* 5(3&4), 149–175.

Murtonen, M., & Lehtinen, E. (2003). Difficulties experienced by education and sociology students in quantitative methods courses. *Studies in Higher Education* 28, 171–185.

Murtonen, M. (2001, August). *Conceptions of research methodology, consistency of conceptions and experienced difficulties on quantitative methods courses*. Paper presented at the EARLI Biennial Meeting, Fribourg, Switzerland.

Newstead, K. (1998). Aspects of children's mathematics anxiety. *Educational Studies in Mathematics* 36, 53–71.

Onwuegbuzie, A. J., & Daley, C. E. (1998, April). *The relationship between learning styles and statistics anxiety in a research methodology course.* Paper presented at the annual conference of the American Educational Research Association, San Diego, U.S.A.

Pretorius, T. B., & Norman, A. M. (1992). Psychometric data on the statistics anxiety scale for a sample of South African students. *Educational & Psychological Measurement*, 52, 933–937.

Rosenthal, B. C., & Wilson, W. C. (1992). Student factors affecting performance in an MSW research and statistics course. *Journal of Social Work Education* 28, 77–85.

Resnick, H., Viehe, J., & Segal S. (1982). Is math anxiety a local phenomenon? A study of prevalence and dimensionality. *Journal of Counseling Psychology* 29, 39–47.

Schoenfeld, A. H. (1989). Explorations of students' mathematical beliefs and behavior. *Journal for Research in Mathematics Education* 20, 338–355.

Thompson, B. W. (1994). Making data-analysis realistic: Incorporating research into statistics courses. *Teaching of Psychology* 21(1), 41–43.

Townsend, M. A. R., Moore, D. W., Tuck, B. F., & Wilton, K. M. (1998). Self-concept and anxiety in university students studying social science statistics within a co-operative learning structure. *Educational Psychology* 18, 41–54.

Vosniadou, S. (1994). Capturing and modelling the process of conceptual change. *Learning and Instruction* 4, 45–69.

Zeidner, M. (1991). Statistics and mathematics anxiety in social science students: some interesting parallels. *British Journal of Educational Psychology* 61, 319–328.

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Sammanfattning

I denna undersökning studerades samband mellan prestationerna i matematik i gymnasiet, prestationerna i universitetskurser i statistik och i kvantitativa metoder och upplevda svårigheter i kurser i kvantitativa metoder. Tidigare prestationer i matematik korrelerade med prestationerna i universitetskurser i statistik, men inte med prestationerna i kurser i kvantitativa metoder. Tidigare prestationer i matematik uppvisade ett samband med upplevd egen förmåga i matematik och i kurser i kvantitativa metoder, men inte med andra upplevda svårigheter. Vidare uppvisade upplevd egen förmåga i matematik och i kurser i kvantitativa metoder samband med andra upplevda svårigheter i kurserna i kvantitativa metoder. Det fanns inte något samband mellan upplevda svårigheter och prestationerna i universitetskurserna.

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University Students' Research Orientations: Do negative attitudes exist toward quantitative methods?

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This paper examines university social science and education students' views of research methodology, especially asking whether a negative research orientation towards quantitative methods exists. Finnish ($n=196$) and US ($n=122$) students answered a questionnaire concerning their views on quantitative, qualitative, empirical, and theoretical methods, their readiness to use quantitative and qualitative methods in their own research, and the difficulties they experienced in quantitative methods' learning. Students were clustered in groups according to their views. Students had varying combinations of views on the methods, that is different research orientations towards methods were found in both countries. Some of the students had a dichotic attitude towards quantitative and qualitative methods; they seemed to "choose their side" between these methods. In both countries a negative research orientation towards quantitative methods was found. It was connected with either difficulties in quantitative methods' learning or with a lower appreciation of empirical methods than that of other students. Major subject and study year had no effect, so the views were not discipline-specific and students seemed to already have them on entering university. Views were quite stable during the course. A reduction in difficulties experienced with quantitative methods' learning was connected with a lowered over-appreciation of qualitative methods at the end of the course.

Keywords: *Conceptions of research; Learning of research; Quantitative methods' learning; Research orientation*

Introduction

Research methodology courses of university undergraduate and postgraduate programmes in the social sciences continuously cause problems for many students (Forte, 1995; Hauff & Fogarty, 1996; Lehtinen & Rui, 1995; Pretorius & Norman, 1992; Rosenthal & Wilson, 1992; Wisker, Robinson, Trafford, Creighton, & Warnes, 2003). Many students have problems, especially with quantitative methods and statistics. This was also found in a study by Murtonen and Lehtinen (2003)

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conducted on students in the social sciences. When asked to rate different academic subjects on the basis of their difficulty it was found that the students frequently considered their research methodology courses, especially quantitative methods and statistics, more difficult than their major subject studies. The reasons given for the difficulties by the students varied from superficial teaching and a weak understanding of the integrated picture of research to the difficulty of the subject domain. Some students noted that they had negative attitudes towards quantitative methods.

To explore the possible reasons for the negative attitudes, difficulties, and anxiety experienced in statistics and quantitative methods' courses some studies have looked at students' prior experiences with mathematics. However, success in high school mathematics courses seems to only weakly explain the difficulties or anxiety experienced on university statistics-related courses (Birenbaum & Eylath, 1994; Murtonen & Titterton, 2004). Moreover, course performance in university statistics-related courses has been found to be only weakly or not at all connected with statistics or mathematics anxiety (Birenbaum & Eylath, 1994; Zeidner, 1991). There was also no connection between statistics-related course grades and difficulties experienced on university quantitative methods' courses (Murtonen & Titterton, 2004). On the basis of these results, performance in courses, past or present, is not an important or at least not the only factor explaining the anxiety and difficulties experienced and the negative attitude.

Research on learning has revealed that students' views, images, or conceptions have an impact on learning. University students' conceptions of learning have been found to be related to students' study orientations, approaches to learning, and study outcomes (see, for example, Entwistle & Ramsden, 1983; Marton & Säljö, 1976). Lonka and Lindblom-Ylänne (1996) found that conceptions of learning and conceptions of knowledge are related. They also concluded that conceptions of knowledge may guide not only comprehension standards, but also study strategies and orientations. Similarly, it could be assumed that the views and conceptions that students hold about research methods can have an impact on their learning of the subject, for example on whether they have difficulties in learning or whether they are motivated to learn and use those methods.

Ryder, Leach, and Driver (1998) examined university science students' images of science. According to them these images are particularly important because students' actions during science learning tasks can be influenced by their ideas about the nature of scientific knowledge. Gal and Ginsburg (1994) stated that in order to make the learning of statistics less frustrating, less fearful, and more effective, further attention should be focused on the beliefs, attitudes, and expectations that students bring into the statistics classroom or develop during their educational experiences.

Meyer, Shanahan, and Laugksch (2005) found that postgraduate students do not have a uniform approach to conceptualizing research or the research process. Brew (2001) and Kiley and Mullins (2005) have studied senior researchers and supervisors and found that they do not have unifying views on research either. Brew (2001) concluded that different views should be discussed to make us aware of the varying conceptions about research that we have. According to Kiley and Mullins (2005) students and supervisors may have different conceptions of research which may cause difficulties in completing degrees.

Conceptions have been found to be resistant to change (see, for example, Chi, 1992; Vosniadou, 1994). Petersson (2005) found that medical students' conceptions of research did not change much during instruction. This sets a challenge to instruction. The question also arises of where the students' conceptions, beliefs, and views of research come from and how they can be changed.

Students' beliefs are often thought to arise from their own experiences, such as in the hypothesis above about previous bad experiences with mathematics, inferring that the students' own situations create the problems. The sources for beliefs, attitudes and expectations can, however, be various. The educating institution, relatives, friends, or the whole society can create and maintain beliefs that may foster or impede learning. Orr (1990) has suggested that people tell stories about their work to build their identity and to show that they are competent members of the community. In the same way it could be assumed that people in the field of research set standards for their work by telling stories about it and emphasizing the points that they think are relevant. In this way a general view is created and it is also likely to be taught to new members of the community. In addition to teachers, older students can also socialize new students to the prevailing beliefs. Sometimes, however, the beliefs may not be beneficial for the community.

The Quantitative–Qualitative Division

One example of an often harmful conception held widely in Western society is the division of several issues into technical and humanistic domains, or to hard and soft values. In the social sciences quantitative research is often considered to be more technical and qualitative methods more humanistic. According to Becker (1996) the social sciences have to some extent divided into these two scholarly communities that have constituted worlds of their own, with their own languages, journals, organizations, presidents, prizes, and all the other paraphernalia of a scientific discipline. For these reasons the two methodologies are also considered somehow intrinsically different. Töttö (2000) wrote about the tendency of the different camps, the qualitative and the quantitative, to emphasize their own excellence by inveighing against the other. Especially with the rise of the qualitative tradition, the quantitative tradition has been used as an example of bad research, which is not able to produce new theories but only to test old ones.

If scholars tend to divide themselves into two camps, it is probable that students also have some views on these methods. While the goal of formal education is to prepare the students with skills in both paradigms, it is harmful if some students get the impression that they may or even have to choose which “camp” to join. The choice of “camp” may be due to many factors.

Hannover and Kessels (2004) suggested a prototype theory that people use to compare themselves and a favourite or a least-liked prototype. On the basis of their findings they suggested that high school students do not like mathematics and science because the prototypes they have for people who like these subjects is not what they want to be like themselves. Whereas these prototypical mathematics-liking students were considered socially incompetent, isolated, and uncreative, prototypical German and English language-liking students were seen in a positive light. This may be the situation on quantitative methods courses too; a student may have a prototypical image of a student who likes quantitative methods or of a worker using these skills in working life and he or she does not want to be like that. Hannover and Kessels also suggested that these kinds of prototypes may be culturally formed and taught.

Cotner, Intrator, Kelemen, and Sato (2000) interviewed doctoral students in education about their attitudes to qualitative research. They found that the students described varying degrees of sympathy and interest in qualitative research even before taking their first methodology class in their doctoral programme. Some of the students said that “it never crossed my mind to do anything but a qualitative dissertation” and “I’m a more qualitative person in general”. This shows that even students can have widely generalized conceptions about research that guide their choices and decisions.

In an earlier work we found some evidence (Murtonen & Lehtinen, 2003) that some students in the social sciences do make a difference between qualitative and quantitative in terms of their preference when selecting courses or carrying out their coursework and theses. They either described having an aversion to one method or they simply said they felt themselves to be a specific kind of person, for example a qualitatively oriented person. In this paper our aim is to study whether different orientations toward qualitative and quantitative methods can be found among students.

We also found some evidence in our previous study of specific kinds of confused conceptions that some students may have about the relations of qualitative, quantitative, empirical, and theoretical (Murtonen & Lehtinen, 2003). According to Töttö both qualitative and quantitative research methods are empirical and both can be equally close to or far from theory. Some students, however, seemed to think differently. Among the descriptions concerning qualitative methods there were mentions of qualitative methods being somehow not empirical. Töttö (2000) suggested a similar kind of confusion. Qualitative research is sometimes described as theoretical in comparison with quantitative research. By this it is meant that only qualitative research can create a theory. This automatically implies that qualitative research would be “deeper and more profound” than quantitative research and, thus, quantitative research cannot be deep and profound; in fact, the whole thinking process becomes impossible in quantitative research.

Quantitative and qualitative methods can also be misunderstood, with quantitative being seen as theoretical and qualitative as empirical. On the basis of our preliminary analysis of education students' concept maps on a methodology course (Murtonen & Merenluoto, 2002) we assume that this view comes from the idea of "testing of hypothesis" in quantitative research, which refers to the theory on which the hypothesis is based. Thus, quantitative would be theoretical. Qualitative, in contrast, could be considered to be empirical because with qualitative methods the researcher is in "the real world" acting with "real people" instead of, for example, working with questionnaires in an office.

Aims of the Research

Bearing in mind all the possible views, confusions, and misconceptions suggested above, we intended to find out whether students share similar views on research methods or do they differ in their views and also in their preferences for quantitative, qualitative, empirical, and theoretical methods. We had an especial interest in students' views on quantitative methods, that is do they have some kind of negative research orientation and if yes, what is it connected to?

To study students' views on and possible aversions to different research methods we approached the question by asking about their appreciation of these methods. Appreciation was used because previous studies indicate that values are closely attached to, for example, task and goal orientation, as well as to self-efficacy and performance (Wolters, Yu, & Pintrich, 1996). We were interested in how students appreciate quantitative, qualitative, empirical, and theoretical methods. We also wanted to know how ready they were to use quantitative and qualitative methods themselves. In this research we use the concept "aversion" to mean low appreciation or low readiness to use a method.

The connections between these factors were of especial interest: we wanted to find out whether different subgroups could be found among students with respect to their appreciation of the methods and their readiness to use them, that is did students have different "personal research orientations". Further interest lay in the question of whether these "research orientations" were connected to difficulties experienced on quantitative methods courses, measured by means of a questionnaire. Differences between the major subject and study years were examined, as well as the question of whether views changed during one course.

The intention of this study was not to find out what kinds of views or conceptions students have, because our questions were in the form of ready-made claims in a questionnaire. Nor was the aim to find possible misconceptions, but to find out what combinations of views students may have.

In this study we use the term "view" rather than "conception" because we assume that students answers to our claims are based on some kind of transient view rather than more stable conceptions. If several combinations of views are found, this offers information that can be applied in teaching, in that attention should be paid to these varying views and that there are perhaps no simple solutions to avoid possible misconceptions or other harmful views about these methods.

Method

Subjects

The data were collected over three years from different research methodology course students. In the first year the participants consisted of students on three courses: 29 education, 26 psychology, and 19 sociology students in a Finnish university. The second sample consisted of 43 education, 11 psychology, and 22 social policy students in a Finnish university. The participants in the third measurement consisted of 46 education students in a Finnish university and 122 psychology students in one of the highest rated universities in the USA. Thus, there were altogether 196 Finnish students and 122 US students (n=318). All disciplines had their own methodology courses provided by their own faculties. The courses were about quantitative methods, except for the sociology group in the first measurement year, which had a course on qualitative methods. Finnish students were either advanced undergraduate or beginning masters programme students, except the psychology students, whose course was held in their first study year. US psychology students were mainly third year undergraduate students.

Materials and Procedures

A questionnaire was used which consisted of sets of statements. First, four statements measured the appreciation of quantitative and qualitative methods and the readiness to use these methods. Then, four statements were presented to measure appreciation of empirical and theoretical methods. A total of 18 items was used to measure the experience of difficulty in quantitative method studies. The items were based on the responses that students' gave when they were asked in a study by Murtonen and Lehtinen (2003) what makes the learning of quantitative methods difficult. Students were motivated at the beginning of the task by the sentence: "Here are some statements about reasons *why quantitative methods might cause difficulties for you*". The topics ranged from, for example, "I'm not interested in learning quantitative methods" to "it's hard to see links between different parts of research methodology", "methodological concepts are hard to understand", "methodological books are hard to understand", "teachers do not see students' problems" and "examples used in courses are not interesting". All statements were measured on a Likert scale, ranging from disagree (1) to agree (5).

The students filled in the questionnaires during lectures or small group working at the beginning of the courses. The questionnaires were handed out and collected by the researcher or the teacher. A second measurement at the end of the courses was carried out among the first measurement year education and psychology students and among the third measurement year Finnish and US students.

Statistical Procedures

Since altogether seven different groups of Finnish students were used, we needed to find out if we could combine the groups, that is handle them as a single group called "Finnish students". We used between-group analyses to study how the discipline groups differed from each other in their research methodological views. There were only few differences among the groups and these were small and non-systematic. Thus, the Finnish groups were summed together to form one group. This result agrees with the findings of Murtonen and Lehtinen (2003), that Finnish education, sociology, and social policy students did not differ in the difficulties experienced on research methodology courses.

A *k*-means clustering by cases procedure was carried out to create groups of students. First, several cluster analyses were run using a method of maximizing between-cluster distances. This gave the researcher a conception of the possible groups of students, that is how many groups there were that had different profiles. The results from this *k*-means clustering method depend to some extent on the initial configuration, that is the method uses the first *n* cases as cluster centres (Statistisca, 1995, p. 3187). This is why the final cluster analysis was conducted with the "choose the first *n* (number of clusters) cluster observations" option, which provides the user full control over the choice of the initial configuration (Statistica, 1995, p. 3187). Thus, representatives of the theoretically most interesting groups and those most differing from each other were manually selected and moved to the top of the data sheet. Those cases were used as the basis for the final clusters. This clustering by sample cases method produced very similar groups to those found by the clustering by maximizing the initial between-clusters distances method. The *k*-means cluster analysis is based on "ANOVA in reverse" (Statistica, 1995, p. 3173) and thus these ANOVA results are utilized in this study.

In other between-group comparisons and repeated measurement tests parametric methods (ANOVA, *t* test) were used. Some of the topics were measured by only one item, which is problematical when using parametric methods. The results were confirmed with non-parametric methods (*U* test, Wilcoxon test) if there were problems in, for example, the homogeneity of variances. The LSD test was used for post hoc comparisons.

Space Triangulation

The subjects of this study were Finnish and US students. According to previous studies students' problems with quantitative research learning are world wide. We wanted to study the generality of the results and validate the results of this study by the space triangulation method. According to Cohen, Manion and Morrison (2000,

p. 113) “space triangulation attempts to overcome the limitations of studies conducted within one culture or subculture”. On the basis of this argument, if the results with Finnish and US students are similar, they are more widely applicable to at least other Western cultures compared with data from only one cultural sample.

Results

Views on Quantitative and Qualitative Research Methods

In both countries the mean for quantitative methods appreciation was over 3.0 (see Figure 1), as was the mean for qualitative methods;that is the students think that interesting results are obtained with both methods. Students in both countries were also ready to conduct a study of their own with both methods (means >3.0). Thus, no clear aversion to quantitative methods was found among the students as a group in either of the countries.

Finnish and US students differed from each other in their appreciation of both methods, with the Finnish students having higher means [QUANT FIND: SF mean=3.74 ± 0.91 (SD); US mean=3.47 ± 0.92; $t(314)=2.53$, $p<.05$; QUAL FIND: SF mean=4.31 ± 0.62; US mean=3.57 ± 0.91; $t(315)=8.71$, $p<.001$]. Students in both countries were equally interested in conducting a study of their own with quantitative methods, but the Finnish students were more eager to use qualitative methods than the US students [QUAL DO: SF mean=4.19 ± 0.82; US mean=3.13 ± 1.33; $t(315)=8.78$, $p<.001$]. Thus, it may be said that the Finnish students as a group had a more positive orientation towards qualitative than towards quantitative methods, but because the means were over 3.0, as stated above, their orientation towards quantitative methods as a whole group was not negative.

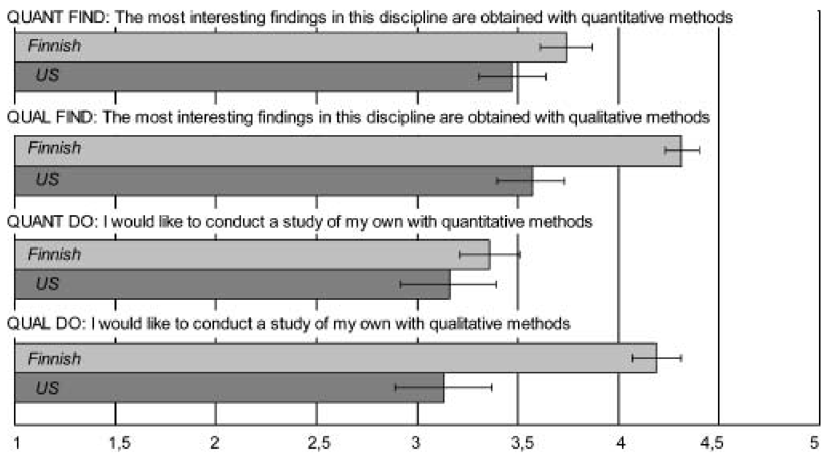

Figure 1. The means and 95% confidence intervals for the statements concerning appreciation of and readiness to use quantitative and qualitative methods

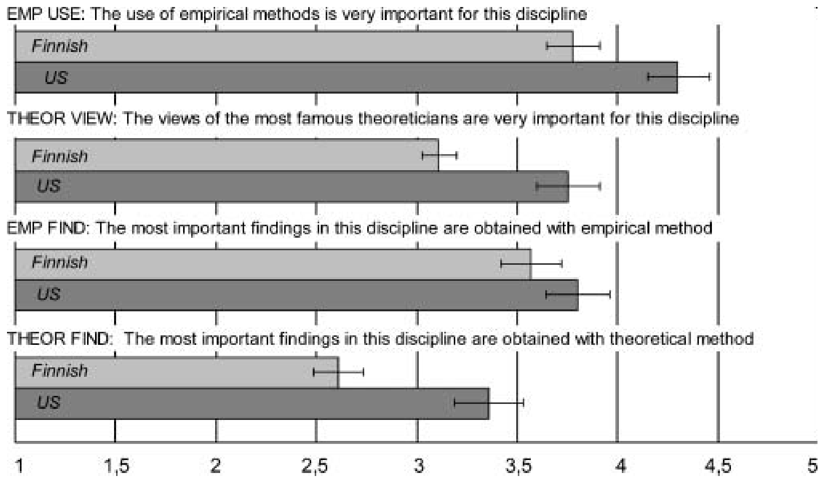

Figure 2. The means and 95% confidence intervals for the statements concerning research methodological views

Views on Theoretical and Empirical Methods

In order to determine students' views on theoretical and empirical methods, four claims about these were presented. Empirical methods were quite highly appreciated in both countries, with a mean of over 3.5 (see Figure 2). Theoretical methods were not so highly appreciated, and Finnish students especially ranked them quite low. The US students in general ranked both methods higher than the Finnish students [EMP USE: SF mean $=3.78\pm0.93$; US mean $=4.31\pm0.86$; $t(315)=-5.00$, $p<.001$; THEOR VIEW: SF mean $=3.11\pm0.97$; US mean $=3.75\pm0.87$; $t(316)=-6.01$, $p<.001$; EMP FIND: SF mean $=3.57\pm0.91$; US mean $=3.80\pm0.89$; $t(315)=-2.25$, $p<.05$; THEOR FIND: SF mean $=2.61\pm0.97$; US mean $=3.36\pm0.95$; $t(316)=-6.81$, $p<.001$].

Different Groups Regarding Research Methodological Views

Although no aversion towards quantitative methods was found at the country group level, we were interested to find out if subgroups of students with negative views on quantitative methods could be found. We also wanted to see how other research methodological views were combined with the views on quantitative methods, that is what kinds of combinations of views the students had. To determine this we conducted cluster analyses of students for each country separately. All eight variables presented above were selected for clustering by cases analyses. Four Finnish and five US student groups were identified. The groups had $p<.001$ differences in both countries on all variables, except that the Finnish groups did not differ in appreciation of qualitative methods (QUAL FIND). The cluster solutions for both countries are shown in Figures 3 and 4.

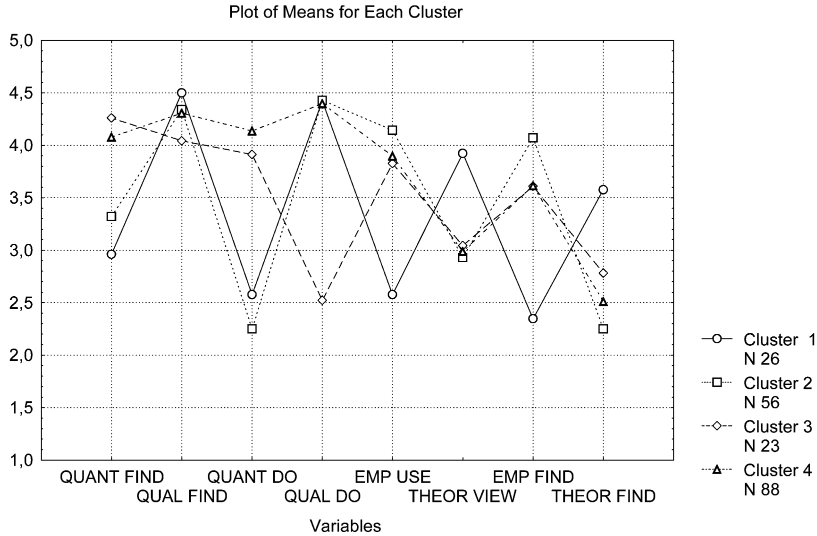

Figure 3. The Finnish cluster groups

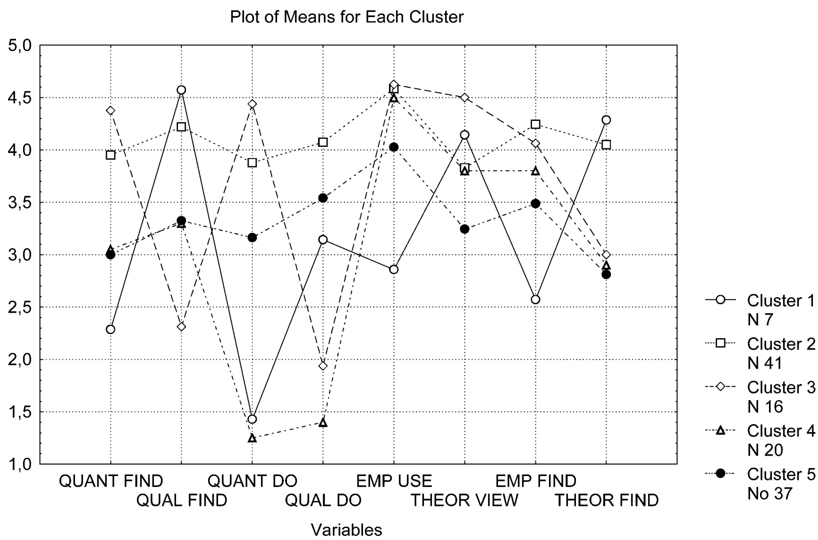

Figure 4. The US cluster groups

Groups with Quantitative and Qualitative Views

In this paper if both appreciation of and readiness to use a method are low we term it a negative research orientation (or, briefly, negative orientation), especially if the same group has high scores for appreciation of and readiness to use the other method.

In both countries groups of students were found who had given lower scores than other groups for appreciation of quantitative methods (QUANT FIND). These were called groups 1 and 2 in Finland and group 1 in the USA. The same groups also had lower scores than other groups on their readiness to use quantitative methods (QUANT DO). The groups had high scores on qualitative methods variables. These groups can thus be said to have a negative research orientation towards quantitative methods. This could also be termed a qualitative research orientation, in that it is likely that they prefer qualitative over quantitative methods in their latter choices. The number of Finnish students in groups 1 and 2 was 82, which was 42% of the sample. In the USA 6% belonged to this group.

Finnish group 4 had high scores for all four variables. They seemed to be ideal students, appreciating and being ready to use all methods. However, in their profile as well quantitative methods variables are lower than qualitative methods variables. Group 3 differed from other groups by not being ready to use qualitative methods but being ready to use quantitative methods, and appreciating both.

Among the US students group 1 was the only group with a clearly negative orientation towards quantitative methods. They were not as ready to use qualitative methods by themselves as the Finnish students, so they cannot be said to have a strong qualitative research orientation. Groups 2 and 5 had slightly higher means for qualitative methods than for quantitative methods. Students in group 4 had moderate appreciation of both methods, but were extremely low in readiness to use either of the methods. This group was quite large, being 17% of the students. US group 3 had a high appreciation of quantitative methods and they were also very interested in using these methods, whereas, in contrast, they did not appreciate qualitative methods and were not ready to use them. These students could be said to have a negative orientation towards qualitative methods; that is they had a quantitative research orientation.

Groups with Theoretical and Empirical Views

Figures 3 and 4 indicate that while other groups rank the use of empirical methods (EMP USE) more highly than the views of the most famous theoreticians (THEOR VIEW) and appreciation of empirical methods (EMP FIND) more highly than appreciation of theoretical methods (THEOR FIND), group 1 in both countries behaves in the opposite way.

The Finnish group 1 differed from other groups on all four variables. The US group 1 differed from other groups on all variables except on the variable concerning the views of theoreticians. Moreover, US groups 1 and 2 did not differ on the variable concerning appreciation of theoretical findings.

To conclude, we can say that group 1 in both countries appreciated empirical methods less than other groups and also that group 1 did not appreciate empirical over theoretical methods, as the other groups did.

Connections between Views

In group 1 in both countries a negative orientation towards quantitative methods and appreciation of qualitative methods was connected with a low appreciation of empirical methods and a high appreciation of theoretical methods. The other groups scored the items in the opposite way, that is they appreciated empirical methods more than theoretical methods. Finnish group 2, which had a negative orientation towards quantitative methods, appreciated empirical more than theoretical methods. Thus, no clear combinations of views can be found. In both countries, however, group 1 showed a very different profile in comparison to other groups, and that was connected to a negative orientation towards quantitative methods. Equal appreciation of and readiness to use both methods was connected with appreciating empirical over theoretical methods.

Cluster Groups and Difficulties Experienced in Quantitative Methods Studies

Difficulties experienced in quantitative research methodology were measured with a questionnaire that consisted of 18 questions measuring the feeling of difficulty in quantitative research methodology learning. Cronbach's α for these 18 questions was .81 for the Finnish sample and .91 for the US sample. The Finnish students (mean=3.08 ± 0.52) experienced more difficulties than the US students (mean=2.58 ± 0.66) at the beginning of the courses [$t(292)=7.25$, $p<.001$]. When considering how many of the students experienced difficulties, we looked at how many had a mean over 3.0 (1=does not experience difficulties; 5=experiences many difficulties). Of the Finnish students, 58% reported experiencing difficulties, while 21% of the US students had a mean over 3.0.

The four Finnish cluster groups differed in their experienced difficulties [$F(3,171)=4.25$, $p<.01$]. The post hoc test showed that group 2 (mean=3.27 ± 0.48), which had a negative orientation towards quantitative methods but a high appreciation of empirical methods, had more difficulties than the other groups (group 1: mean=3.00 ± 0.48; group 3: mean=2.83 ± 0.63; group 4: mean=3.07 ± 0.48). Group 1, which had a negative orientation towards quantitative methods and a low appreciation of empirical methods, did not differ from the other groups. The five US cluster groups did not differ in their experience of difficulties.

Timing and Subject of Courses

The timing of the courses given by different disciplines varied from the first to fourth study year. The Finnish psychology students had their course during their first study year while the other Finnish groups were mainly third or fourth-year students. There were no differences between the psychology group and the other discipline groups in their views on methods or in difficulties experienced. Thus, there was no effect of study year, that is when the course was taken. This also implies that the Finnish psychology students either had already formed their views and even their feeling of difficulties before starting university studies, or that the views were formed immediately at the beginning of their first year. It is probable that the views are already formed before entering the university, or that there are several links between the views on methods and other conceptions concerning more general beliefs, such as the technical - humanistic division discussed above.

The subject of the course did not have an effect on the answers, since the sociology students' course was on qualitative methods. Thus the views and also the difficulties experienced are more stable than just being "ad hoc" for a specific course.

Consistency of Views and Difficulties Experienced

A second measurement was carried out at the end of the courses for four groups: Finnish education (n=15, 52% of the group at the beginning of the course) and psychology (n=21, 81%) students in the first measurement year and Finnish education (n=31, 67%) and US psychology (n=45, 37%) students in the last measurement year. Views on research methodology did not change much during the courses. The Finnish psychology students rated their interest in using qualitative methods higher at the end of the course than at the beginning [beginning mean=4.38 ± 0.67; end mean=4.67 ± 0.48; $t(20)=-2.34$, $p<.05$]. In the last measurement the Finnish education group rated appreciation of qualitative methods lower at the end of the course [beginning mean=4.42 ± 0.66; end mean=4.09 ± 0.95; $t(32)=2.24$, $p<.05$]. The US psychology students rated appreciation of theoretical/philosophical methods lower at the end [beginning mean=3.67 ± 0.63; end mean=3.30 ± 0.94; $t(45)=2.32$, $p<.05$].

The difficulties experienced remained at the same level for the first education group (beginning mean=3.21 ± 0.41; end mean=2.96 ± 0.63), rose for the Finnish psychology group [beginning mean=3.03 ± 0.50; end mean=3.38 ± 0.51; $t(20)=-3.30$, $p<.01$] and also rose for the US psychology group [beginning mean=2.51 ± 0.60; end mean=2.73 ± 0.59; $t(44)=-2.57$, $p<.05$]. Difficulties decreased for the education group in the last measurement year [beginning mean=2.92 ± 0.45; end mean=2.72 ± 0.40; $t(30)=3.37$, $p<.01$].

As was seen above, the Finnish students had a very high appreciation of qualitative methods and a high readiness to use them. This may reflect some kind of weakness in the students' belief in their own abilities to use quantitative methods and, thus, they overrated qualitative over quantitative methods to such an extent. The later education group students' high appreciation of qualitative methods decreased during the course as their difficulties with quantitative methods learning decreased. Thus, their previous over-appreciation of qualitative methods may have been caused by their problems in quantitative methods learning. The converse phenomenon seemed to occur in the Finnish psychology student group: their interest in using qualitative methods rose when they had more difficulties with quantitative methods learning during the course.

The changes in difficulties experienced were also examined at cluster-group level for the two countries. The difficulties experienced at the end of the course were compared among the original cluster groups and the results were compared with those at the beginning of the course. One change among the Finnish groups was that the difficulties experienced by Finnish group 1 rose to the same level as those of group 2. However, this difference between the groups reached only symptomatic statistical significance [$F(3,63)=2.68$, $p<.055$] and there were only four group 1 students present at the second measurement, so the result is not reliable. The question arises why only 15% of the group 1 students were present at the second measurement, while, for example, 45% of the students in group 4 were present? Perhaps they had difficulties and because of them no longer attended lectures. There was no change in the US cluster groups' situation; that is there were also no differences between the groups at the end of the course.

Conclusions

The results of this study show that not all students view research methods similarly. Instead, students had a wide range of combinations of views on methods. These findings indicate that some of the students do "choose their side" between quantitative and qualitative methods. It could thus be said that some students may have a more qualitatively or quantitatively directed research orientation. Subgroups of students with a negative research orientation towards quantitative methods were found in both countries. In Finland 42% of the students were classified as having a negative orientation towards quantitative research methods, while in the US sample the corresponding share was 6%. Among US students a negative orientation towards qualitative methods was found.

When asked about difficulties experienced in learning quantitative methods 58% of the Finnish students and 21% of the US students reported such difficulties. The difficulties experienced were connected to a negative orientation towards quantitative methods for some of the students. However, not all students with a negative orientation towards quantitative methods reported difficulties in learning them. This was the case for group 1 in both countries. Students in these groups had different profiles from other students with respect to appreciation of empirical and theoretical methods: they did not appreciate empirical methods more than theoretical methods, unlike the other groups. Whether a certain type of negative research orientation towards quantitative methods with an appreciation of theoretical over empirical methods somehow "protects" a person from experiencing difficulties in learning should be studied in more depth. Furthermore, possible misconceptions about methods in each of the groups should be studied.

Views on methods were quite stable during the courses, although there were some changes. The high over-appreciation of qualitative methods shown by education students decreased as their difficulties experienced in learning quantitative methods decreased during the course. In contrast, the increased difficulties of psychology students were connected with an increased readiness to use qualitative methods. Thus, difficulties in learning quantitative methods were connected with the attractiveness of qualitative methods. A question arises from the observation that there were only 4 of 26 students that had a negative orientation towards quantitative methods and that appreciated theoretical over empirical methods present in the second measurement. Why did they not come to the last lecture? A question for further research is do some students give up a course or lose interest in coming to lectures because of their negative orientation?

There was no effect of students' year level, major subject or subject of the course, so it seems that the students had already formed their views when they enrolled at the university or that they formed their views at the very beginning of their university studies.

The space triangulation method of this study between Finnish and US samples exposed the expected result: a dichotic attitude towards qualitative and quantitative methods was found in both samples, that is some of the students in both countries "chose their side" between quantitative and qualitative. Concern about students' difficulties with statistics and learning of research methodologies has been reported before by researchers in many Western countries. The results of this study further support the hypothesis that problems do exist. In general, Finnish students were more positively oriented towards qualitative methods than towards quantitative methods, but they also appreciated and were ready to use quantitative methods. The US students showed no differences as a group between the appreciation and readiness to use the different methods. Empirical methods were more appreciated than theoretical methods in both countries. It is a question for further research whether there are cultural factors involved, that is do countries differ in the share of students negatively oriented towards quantitative methods and the level of difficulties experienced. In this study the US students did not report many difficulties in their learning of quantitative methods and only 6% of the students were classified as having a negative orientation to quantitative methods. The sample was selected from one of the highest ranked universities and consisted of only one course group, which may have had an effect on the results. The seven Finnish sample groups were selected from different disciplines and courses, which makes the results more generalizable to all Finnish universities.

In this study the views on research methods were measured with single items, which can cause problems with respect to reliability of the data. The problems with the measurements in this study also lie in the validity of the results: as it was thought that students have a weak understanding of the concepts studied, their answers may not tell us what we expect them to. Students' views, conceptions, and orientations towards research methods should be further researched in more detail to obtain a better understanding of the phenomenon. At this time this research can serve only as a starting point for further studies in this little researched domain.

Implications for instruction

Students' views and conceptions of research are not simple to understand. It is not just the instruction that forms their views, but many cultural conjunctions and previous experiences they have had with related issues are embedded in their conceptions. On the basis of this study students seem to form their views on research methods before or right at the beginning of their studies. This challenges the instruction to not only try to avoid the forming of negative attitudes but also to try to reduce already formed negative views. The dichotic attitude found among some students in this study may help us to better understand students' behaviour on methods courses. However, we need to do more research on these students' views and conceptions.

In the information society we need experts who can handle all kinds of information. The amount of information based on research and statistical analysis is growing (see, for example, Greer, 2000) and the skills to handle this information are needed. Students who experience anxiety or have a negative research orientation towards some kinds of research or data are not in the best possible situation to face the requirements of these tasks. The goal of instruction, in addition to understanding students' views better, is to try to reduce the negative research orientation and also to get students to evaluate, understand, and challenge their own views and conceptions. The students should be asked what is behind their views if, for example, they have a dichotic view of qualitative and quantitative methods, and whether there are any good reasons to retain these conceptions. The conceptions and views of teachers and institutions should also be researched and discussed. It is possible that the students' views reflect the views of others.

Instruction should be planned to reduce anxiety and support the students' feelings of control and mastery of issues they consider difficult. New computer-supported learning environments (see Lehti & Lehtinen, 2005) may offer new ways of presenting the domain to be learned and new equipment to make the content easier to understand. They can also offer tools to consider certain research from multiple perspectives, for example should it be carried out by qualitative or quantitative methods, and thus be able to reduce the gap between these methods.

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References

Becker, H. (1996). The epistemology of qualitative research. In R. Jesser, A. Colby, & R. A. Shweder (Eds.), *Ethnography and human development. Context and meaning in social inquiry* (pp. 53–71). Chicago: University of Chicago Press.

Birenbaum, M., & Eylath, S. (1994). Who is afraid of statistics? Correlates of statistics anxiety among students of educational sciences. *Educational Research*, *36*, 93–98.

Brew, A. (2001). Conceptions of research: A phenomenographic study. *Studies in Higher Education*, *26*(3), 271–285.

Chi, M. T. H. (1992). Conceptual change within and across ontological categories: Examples from learning and discovery in science. In R. N. Giere (Ed.), *Cognitive models of science. Minnesota studies in the philosophy of science* (pp. 129–186). Minneapolis, MN: University of Minnesota Press.

Cohen, L., Manion, L., & Morrison, K. (2000). *Research Methods in Education.* 5th Edition. London: RoutledgeFalmer.

Cotner, T., Intrator, S., Kelemen, M., & Sato, M. (2000). *What graduate students say about their preparation for doing qualitative dissertations: A pilot study*. New Orleans, LA: Paper presented at the AERA Conference, April 24–28.

Entwistle, N., & Ramsden, P. (1983). *Understanding student learning*. London: Croom Helm.

Forte, J. (1995). Teaching statistics without sadistics. *Journal of Social Work Education*, *31*(2), 204–308.

Gal, I., & Ginsberg, L. (1994). The role of beliefs and attitudes in learning statistics: Toward an assessment framework. *Journal of Statistics Education*, *2*(2).

Greer, B. (2000). Statistical thinking and learning. *Mathematical Thinking and Learning*, *2*(1/2), 1–9.

Hannover, B., & Kessels, U. (2004). Self-to-prototype matching as a strategy for making academic choises. Why high school students do not like math and science. *Learning and Instruction*, *14*(1), 51–67.

Hauff, H. M., & Fogarty, G. J. (1996). Analysing problem solving behaviour of successful and unsuccessful statistics students. *Instructional Science*, *24*, 397–409.

Kiley, M., & Mullins, G. (2005). Supervisors' conceptions of research: What are they? *Scandinavian Journal of Educational Research*, *49*(3), 245–262.

Lehti, S., & Lehtinen, E. (2005). Computer-supported problem-based learning in the research methodology domain. *Scandinavian Journal of Educational Research*, *49*(3), 297–324.

Lehtinen, E., & Rui, E. (1995). Computer-supported complex learning: An environment for learning experimental methods and statistical inference. *Machine-Mediated Learning*, *5*(3/4), 149–175.

Lonka, K., & Lindblom-Ylanne, S. (1996). Epistemologies, conceptions of learning, and study practices in medicine and psychology. *Higher Education*, *31*, 5–24.

Marton, F., & Säljö, R. (1976). On qualitative differences in learning – I. Process and outcome. *British Journal of Educational Psychology*, *46*, 4–11.

Meyer, J. H. F., Shanahan, M. P., & Laugksch, R. C. (2005). Students' conceptions of research. I: A qualitative and quantitative analysis. *Scandinavian Journal of Educational Research*, *49*(3), 225–244.

Murtonen, M., & Lehtinen, E. (2003). Difficulties experienced by education and sociology students in quantitative methods courses. *Studies in Higher Education*, *28*(2), 171–185.

Murtonen, M., & Merenluoto, K. (2002). Concept map as a tool for tracing the process of conceptual change – a methodological perspective. In *Proceedings of the Third European Symposium on Conceptual Change, EARLI*. Turku, Finland, June 26–28.

Murtonen, M., & Titterton, N. (2004). Learning difficulties in quantitative methods courses in relation to earlier mathematics achievement and study success in university. *Nordic Studies in Mathematics Education*, *9*(4), 3–13.

Orr, J. E. (1990). Sharing knowledge, celebrating identity. War stories and community memory among service technicians. In D. S. Middleton, & D. Edwards (Eds.), *Collective remembering: Memory in society* (pp. 169–189). London: Sage.

Petersson, G. (2005). Medical and nursing students development of conceptions of science during three years of studies in higher education. *Scandinavian Journal of Educational Research*, *49*(3), 281–296.

Pretorius, T. B., & Norman, A. M. (1992). Psychometric data on the statistics anxiety scale for a sample of South African students. *Educational & Psychological Measurement*, *52*(4), 933–937.

Rosenthal, B. C., & Wilson, W. C. (1992). Student factors affecting performance in an MSW research and statistics course. *Journal of Social Work Education*, *28*(1), 77–85.

Ryder, J., Leach, J., & Driver, R. (1999). Undergraduate science students' images of science. *Journal of Research in Science Teaching*, *36*(2), 201–219.

Statistica. (1995). *Statistics II* (Vol. III). Tulsa, OK: Statsoft Inc.

Töttö, P. (2000). *Pirullisen positivismin paluu* [The return of devilish positivism; in Finnisk]. Jyväskylä: Vastapaino.

Wisker, G., Robinson, G., Trafford, V., Creighton, E., & Warnes, M. (2003). Recognising and overcoming dissonance in postgraduate student research. *Studies in Higher Education*, *28*(1), 91–105.

Wolters, C. A., Yu, S. L., & Pintrich, P. R. (1996). The relation between goal orientation and students' motivational beliefs and self-regulated learning. *Learning and Individual Differences*, *8*(3), 211–238.

Zeidner, M. (1991). Statistics and mathematics anxiety in social science students: Some interesting parallels. *British Journal of Educational Psychology*, *61*, 319–328.

"Do I need research skills in working life?" - Students' motivation and difficulties in quantitative methods courses

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Abstract
This study explored students' views of whether they will need research skills in their future work in relation to their approaches to learning, situational orientations on a learning situation of quantitative methods and difficulties experienced in quantitative research courses. Education and psychology students in both Finland and the USA (Finnish N=46, US N=122), who thought they would need research skills in their future work differed significantly from the other students who were not sure if they would need these skills. The students who considered the methodological skills important for their future work were more task-oriented, used a deeper approach to learning and had fever difficulties in the learning of research skills than the other students. This finding implies that the experiences in learning and the orientations related to it are further related to expectations about the future work. For instruction, this means that if we could somehow change the students' experiences and orientations toward research into more positive direction, the students might be better prepared for their future work.

1. Introduction

Academic education should prepare students with an understanding of the need for research skills in society and their future working life. University is not, however, always able to equip students with realistic conceptions concerning their future work (e.g. Tynjälä, Helle & Murtonen, 2002). Students' views on the need for research skills in working life may also be influenced by other factors than academic instruction, such as cultural conceptions and beliefs of their peers. Students' views, conceptions and beliefs may play an important role in their study motivation and preparedness for their future work. The aim of this study is to find out whether students think they will need research skills in their future work, and whether these views are connected to difficulties experienced in research methodology courses and motivational orientations to studying.

University research methods courses are often experienced as difficult, dull and uninteresting by many university social and behavioural science students (e.g. Epstein, 1987; Murtonen, 2005). Universities are spending vast amounts on research instruction, but the outcomes are not as good as expected (Lehtinen & Rui, 1995), while the difficulties experienced by students are not decreasing but rather increasing during courses (Murtonen, 2005). Problems in the learning of research can result in slow progression rates (Meyer, Shanahan & Laugksch, 2005; Kiley & Mullins, 2005), and in other types of procrastination during education. Some students may think that research courses are not useful and that they will not need these skills in their future working life, and thus they are not motivated to learn them or select courses on them. Difficulties in the learning of research may even have an effect on students' future career selections (e.g. Onwuegbuzie, 1993).

Knowledge about research methods, skills in statistics, and the ability to critically evaluate statistical information are very important today in many academic and professional fields (Lehtinen, Lehti & Salmi, 2003). Research and development can be seen not only as a generator of knowledge, but also as a contributor to economic growth, employment and social cohesion (Busquin 2001). Consequently, the amount of research conducted and the training of researchers have increased rapidly during recent years, as is shown in the European Commision publication "Towards a European Research Area" (2001), and will continue to increase in the future. Greer (2000) points out that the amount of information based on research and statistical analysis is growing in our society. Technical development and the increasing amount of information produced and made available by computers and electronic networks require the skills to handle this information in many occupations, especially in professions demanding an academic education.

2. Theoretical framework

2.1. Difficulties in the learning of research methodology

The problems that students face in university research courses are diverse. The most problematic research courses for social science, psychology and education students tend to be quantitative methods and statistics courses. Murtonen and Lehtinen (2003) explored education and sociology students with open-ended questions concerning problems that they had experienced in quantitative methods courses. Students reported problems concerning superficial teaching, linking theory with practice, unfamiliarity with and difficulty of concepts and content, constituting an integrated picture of the parts of scientific research, and they also reported negative attitudes toward quantitative methods studies. Similar problems have been reported in other studies and in other disciplines, such as in social work (Forte, 1995; Rosenthal & Wilson, 1992), in psychology (Hauff & Fogarty, 1996; Pretorius & Norman, 1992; Thompson, 1994; Townsend et al, 1998), in sociology (Filinson & Niklas, 1992), in education (Lehtinen & Rui, 1995; Onwuegbuzie & Daley, 1998), and in social science in general (Zeidner, 1991).

The learning of quantitative methods, as well as the learning of research in general, have not been extensively studied. Difficulties in the learning of quantitative methods have traditionally been thought to arise from previous bad experiences with mathematics, leading to anxiety toward mathematical subjects, and thus toward statistics, and maybe toward the domain of research as a whole (e.g. Onwuegbuzie, 2000). The problems may also be due to other factors, such as beliefs and conceptions about research, that may be fostered by peers and society. Hannover and Kessels (2004) have studied high school students' dislike of mathematics and science from a social psychology perspective. They suggest a prototype theory, i.e. that students' self-views are closer to their view of a prototypical peer who likes humanities than to the view of a peer who favours mathematics and science studies. Similarly, for example, a psychology university student may have a favourite-work-prototype of a psychologist whose work is solving people's problems by talking with them, and a least-liked-work prototype of a psychologist who runs data with a computer creating statistics, the former psychologist being nearer to his or her own self-view than the latter. These kinds of prototypes can direct students' views on their future work, and so affect their motivation and choices in courses. Thus, university students having problems with the learning of quantitative methods do not necessarily have problems primarily with the learning of mathematical subjects, but their views and beliefs do not support the learning of them.

There may also be some factors in instruction that do not foster learning. For example, Hannover and Kessels (2004) refer to a study conducted by Klieme, Knoll and Schümer (1998), who videotaped classroom situations and found that mathematics teaching in the poor-achieving countries, Germany and the USA, consists mostly of narrow-focused class work, while lessons in top-performing Japan included group work, students' presentations and discussions about different ways of solving a problem. Hannover and Kessels (2004) conclude that the former style of instruction may create for students a prototype of the typical student favouring these subjects, one who is socially incompetent, isolated, and not creative. Students do not want to be like that and thus they are not interested in the subject.

Students may also have other kinds of views that hinder learning. Students' conceptions of research have been studied by Meyer, Shanahan and Laugksch (2005). They found that students have various conceptions of research, and that a wide range of misconceptions does exist, such as "research becomes true after it is published". Problems may occur, for example, if students' conceptions are incongruent with teachers' conceptions (see also Kiley & Mullins, 2005).

The students' struggle with research courses is not evidently visible in their study success at the level of course grades (Birenbaum & Eylath, 1994; Murtonen & Titterton, 2004). According to Murtonen and Titterton (2004), this might be due to these highly selected students' well-developed strategies for gaining good results in their courses, independently of their motivation, beliefs and attitudes. Townsend et al. (1998) concluded that although the problems are not necessarily seen on the level of grades, this does not mean that we should be unconcerned about them, because students' beliefs and attitudes influence not only their enjoyment of the subject but also the likelihood that they will select it for further study. The consequences might also appear later in career selections (e.g. Onwuegbuzie, 1993). Students' learning experiences are often related to their cognitive approaches and motivational orientation, as well as to their future orientation (Nurmi, Aunola, Salmela-Aro & Lindroos, 2002).

Approaches to learning and situational orientations

Students' conceptions of the learning of research methods might be embedded in more general conceptions of learning and studying. According to Entwistle, McCune and Walker (2001), conceptions of learning are derived from the cumulative effects of previous educational and other experiences, and so tend to be relatively stable and to influence, to some extent, subsequent ways of thinking and acting. Thus, in the learning of research methods, students' previous experiences influence their way of thinking about the learning tasks, and these influence their ways of learning when attending research methodology courses.

Students' ways to approach learning have been found to be mainly deep, surface or strategic, the first indicating aiming at understanding, the second as reproducing, and the third as achievement or time management goals (e.g. Marton & Säljö, 1976, Entwistle &

Ramsden, 1983). According to Lindblom-Ylänne and Lonka (1999), students' conceptions of learning, approaches to learning, and the level of processing may be roughly divided into two categories: surface-level reproduction (or memorizing) versus deep-level transformation (or construction) of knowledge, the latter being associated with qualitatively better learning.

While approaches to learning are found to be deep or surface (Marton & Säljö, 1976), more general ways to orient oneself towards learning have been called 'learning orientations'. According to Vermunt (1996), learning orientations refer to the whole domain of personal goals, intentions, attitudes, worries and doubts of students in relation to their studies, and they are supposed to influence learning because students mainly use the activities they think are best suited to realize their personal goals. A broader still concept is 'study orientation', referring to students' general ways to orient themselves to studying, including their learning approaches and motivational factors (e.g. Entwistle, Meyer & Tait, 1991). Meyer (1991) introduced the term 'study orchestration' to indicate that the association of constructs that represent approaches to studying at an individual level is a context-specific response, and is affected by the qualitative level of perception of the individual towards certain key elements of the learning context. The notion of context specificity is very important in the case of learning of research skills.

A type of motivational orientation describing students' learning, situational orientation, has been studied by Lehtinen, Vauras, Salonen, Olkinuora and Kinnunen (1995). Situational orientations are concerned with the target of the student's focus at a specific moment. When given a task, some people start to solve the given task, i.e. focus on the task, while others are more interested, for example, in how to please the teacher or just getting themselves out of the problem-solving situation. Olkinuora and Salonen (1992) have found that students do have situational orientations to learning that may not foster learning. Some students are not task-oriented, but instead they have an ego-defensive or a socially motivated orientation, that draws their cognitive activities away from the task. Ego-defensive orientation means that the student is most concerned about the coping of 'the self' when given a task, and her or his self-efficacy is low. The socially-oriented student uses her/his energy to please the teacher and does not really try to solve the task. The task-oriented person is eager to solve the task and does not give up even if the solution does not come easily. (Olkinuora & Salonen, 1992.)

Situational orientations seem to be established gradually through children's and adolescents' learning histories in family and school contexts (Vauras, Salonen, Lehtinen & Lepola, 2001). In the case of university students' research learning, previous experiences are important. For example, students' conceptions about mathematics might be laden with negative emotions, which subsequently result in ego-defensive orientation in domains such as research methodology because of the superficial similarity with mathematics. One defensive strategy that students might use in this kind of situation is to deny the practical meaning of the research skills for their future life.

In the case of the learning of research by university social science students, anxious feelings and behaviour in the learning situation have been reported (e.g. Onwuegbuzie, 2000). Thus, an interesting question here is how students orient themselves in learning in the specific situation of learning. Eronen, Nurmi and Salmela-Aro (1998) have studied university students' achievement strategies in study situations. They identified four types of strategies: optimistic, defensive-pessimistic, impulsive, and self-handicapping. These categories have similarities with the classification of Olkinuora and Salonen concerning situational orientations, such as self-handicapping and ego-defensiveness, as both are concerned with potential failure and thus may lead the student to concentrate on task-irrelevant behaviour. A student who is ego-defensive may self-handicap herself or himself, for example, by giving up or claiming that the task is not important rather that taking the risk of failing to solve the problem. According to Thompson and Richardson (2001), the benefit of self-handicapping lies in sparing the individual from conclusions of low ability, as self-handicapping blurs the link between ability and performance. University research course students may behave ego-defensively, for example, by saying that these skills are not important, with the aim of avoiding the possibility of first working hard for a research course and then achieving only a low grade.

The goal of this paper is to examine students' orientations in a specific domain, i.e. quantitative methods, and also in the specific learning situation. Thus, we will look at students' situational orientations and domain-specific approaches to studying quantitative research methods.

2.2. Students' views of their need for research skills

Research has shown that the conceptions people hold have implications for or relations to their other beliefs, orientations or behaviour, as was discussed above. In the educational context, students' conceptions of learning have been found to have an impact on study outcomes, study orientations, and approaches to learning (e.g. Lonka & Lindblom-Ylänne, 1996; Marton & Säljö, 1976; Entwistle & Ramsden, 1983; Vermunt, 1996). Also when studying other populations, such conceptions have been found to be connected to other factors. When studying teachers, Trigwell and Prosser (1996) found that the strategy adopted by university science teachers matches the intentions they have in their teaching. Boulton-Lewis et al. (2001) found that secondary teachers' conceptions of student learning are generally consistent with their conceptions of teaching. Similarly, it could be assumed, on the one hand, that students' conceptions, views and beliefs on research learning have an impact on their learning and also on their view of the importance of research skills in their future work, while on the other hand, these views would have an impact on their preparedness for their future work.

In the case of research methods and statistics, some students may think that these skills are not needed in real working-life situations, and thus they do not bother to study them. In a study by Onwuegbuzie (1997), students who displayed the highest levels of statistics anxiety tended to view statistics as irrelevant for their future academic or career development. If students think that these skills are not needed, the question is whether this is due to the instruction or to other factors.

Traditional formal education with minimal work practice may not be able to prepare students with realistic conceptions of the nature of their future work and the skills needed in it. For example, in a study concerning professionals' and students' beliefs about skills needed in the domain of education and computer science, it was found that professionals rated the need for decision-making skills, problem-solving skills and higher-order thinking skills in general higher than students (Tynjälä, Helle & Murtonen, 2002). Many aspects of instruction may have an effect on students' views on the subject. As discussed above in the context of prototype theories, if the subject to be learnt is experienced as dull and uninteresting, it may arouse prototypical images of people working in the field as dull and uninteresting and thus students do not want to become like that (Hannover & Kessels, 2004). The general views and stories that students and even teachers may tell at university may be harmful (e.g. Orr, 1990). For example, teachers may guide students to prefer some methods by preferring them themselves, or by telling stories that make certain methods sound acceptable, or, on the other hand, old-fashioned or even bad.

Students' views may, of course, also be influenced by other factors than academic instruction. For example, cultural conceptions, such as "mathematical subjects are hard to understand", or stories and attitudes of peers, parents, the media etc. may create the basis for one's own conceptions. Students may also have formed negative or unrealistic views of future working life even before they start their education at university. On entering university, some students may not know that their major subject includes research courses, or that research courses include statistics. These students probably do not understand before their education that such skills are needed in jobs they will apply for in the future. If they were aware of this these, they might have considered choosing another major subject. A possible way to cope in this situation is starting to believe that there really is no need for these skills in real working life.

Mistaken views of future work requirements may be harmful for students in many ways. First, these views may direct their motivation toward learning and the selection of courses. This is very probable on the basis of the studies on conceptions and behaviour, as noted above. Second, students may enter working life with insufficient knowledge and inadequate or false views concerning their tasks. Thus, they may not be able to perform their job to the best of their ability.

3. Method

The goal of this study was to investigate whether the different factors concerning the learning of research are interconnected. The aim was also to find out whether the result was bound only to a specific population, e.g. to Finnish students, or would it be more general. To study this, we used a space triangulation method. According to Cohen et al (2000), space triangulation attempts to overcome the limitations of studies conducted within one culture or subculture. To study whether the results are similar in different populations, we used samples in two countries, Finland and the USA.

The participants of the study were 46 education students in Finland, and 122 psychology students in the USA. The questionnaires were handed out and collected by the teacher or by the researcher at the beginning and at the end of a quantitative research course.

Recent studies on motivation have emphasised the impact of context and situation. In the learning of research, these are important factors. To study the context, i.e. a specific domain to be learnt, and also in a specific learning situation, we conducted the measurements in methods classes, asking students to imagine a statistical task-solving situation when answering how they believe they would behave. This, of course does not give us the kind of information about real behaviour in the situation that socio-constructivist theories aim at with interviews and video-stimulated recall interviews (e.g. Op't Eynde, De Corte & Verschaffel, 2001), but it does give us information about how students believe they would feel and behave.

The questionnaire consisted of four parts. First, 21 questions measured the experience of difficulty in quantitative methods course. The items were based on a study by Murtonen and Lehtinen (2003), where students answered open-ended questions about the difficulties in the learning of quantitative methods. Items were, for example: "I'm not interested in quantitative methods", "I'm not good at mathematics and that's why I'm not good at methodology", "Statistical tests are difficult to understand (i.e. what they do and why)", "The teaching is too superficial", "Methodological skills are easy to forget, because you don't need them daily", "It's hard to see links between different parts of research methodology", "Too many new concepts are introduced too fast during courses", "Teachers don't see and understand students' problems" and "Methodological books are difficult to understand". The scale was from 1 = strongly disagree to 5 = strongly agree.

The second part of the questionnaire was aimed at measuring the learning approaches. It consisted of 8 questions that were based on the work of Entwistle and Ramsden (1983) and Marton and Säljö (1976). The items about surface orientation stated, for example, "I try to learn as much as possible by heart for the examination" and "I expect the teacher to say exactly which tasks will be in the examination", and questions about deep orientation, for example, "I am thinking how I could apply the knowledge in everyday life" and "If I can't understand something during a lecture or when I read the text book, I try to find more information about the subject by myself".

In the third part of the questionnaire, 12 questions were set to measure situational orientations, based on the theory by Olkinuora and Salonen (1992). Four items measured task-orientation, four items social orientation, and four items ego-defensive orientation. Task-orientation items were, for example, "I begin to solve the problem at once, because I want to solve it for myself" and "I am eager to try to solve it so that I can learn more". Examples of social orientation items were: "I try to solve it because the teacher might remember it when giving me my grade", and "I want to solve the problem so that other students can see how smart I am". Examples of ego-defensive orientation items were: "I refuse to even try to solve it, because I would fail anyway" and "I feel uncomfortable in the situation".

Finally, there was a question measuring the view of the need for research skills in working life: "Do you think you will need research methodology and statistics skills in working life?" Alternative answers were "Yes", "No", and "Maybe".

The questionnaire was pre-tested and inoperative questions were removed. Group comparisons were conducted with parametric tests, and for post hoc tests the Tuckey HSD test was used.

4. Results

4.1. *Students' views of their future work*

The question measuring the students' views of their future work "Do you think you will need research methodology and statistics skills in working life?" had three alternative answers: "Yes", "Maybe", and "No" (see Figure 1). Only 2 of the 46 Finnish students checked the box "No" (4%), so we used the "Yes" and "Maybe" answers as a grouping variable and left the two students who answered "No" out of this analysis. The two groups were quite equal in number; 21 answered "Yes" and 23 answered "Maybe". The US students used the "No" option slightly more often. Of 122 students, 11 answered "No" (9%), 53 "Maybe" and 58 "Yes". All the US groups were used in the analysis.

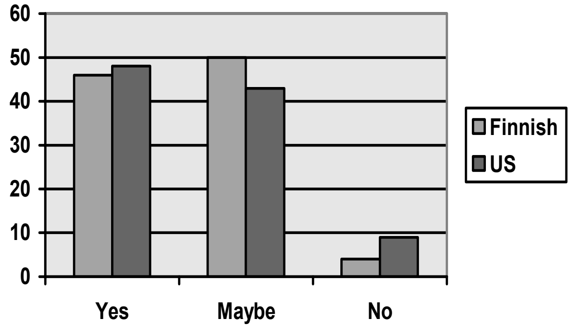

Figure 1. Percentages of students' answers on whether they think they will need research and statistics skills in their future working career at the beginning of the course.

4.2. Situational orientations

The 12 questions measuring orientations were divided on a theoretical basis into three groups: task-orientation (4 questions, Cronbach's alpha for Finnish .76 and for US .79), social orientation (4 questions, Cronbach's alpha for Finnish .85 and for US .79) and ego-defensive orientation (4 questions, Cronbach's alpha for Finnish .68 and for US .64).

The Finnish students' answers were on a moderate level in the task-orientation scale (M = 2.96, SD = .75), while the US students' task-orientation was slightly higher (M = 3.29, SD = .92; $t(164) = -2.12$, $p < .05$). Also in ego-defensive orientation, the Finnish students (M = 2.44, SD = .79) had rated the items lower that the US students (M = 2.81, SD = .83; $t(164) = -2.56$, $p < .05$). On the social-orientation scale, the differences between the countries were highest, because the Finnish students (M = 1.99, SD = .74) rated these questionnaire items very low compared to the US students' ratings that were quite moderate (M = 2.99, SD = .94; $t(165) = -6.40$, $p < .001$).

Next, the "work view" groups were compared in their situational orientations (see Table 1). Both Finnish and US work view groups differed significantly in task-orientation and in ego-defensive orientation. The Finnish group, which saw research skills as useful in their future work, i.e. the "Yes" group, was more task-oriented and less ego-defensively oriented than the other group. The US "Yes" group, was more task-oriented than the "No" group and less ego-defensively oriented than the "No" and "Maybe" groups. None of the groups either in Finland or the US differed as regards social orientation. To conclude, seeing research skills as important was connected to high task-orientation and low ego-defensiveness.

Table 1. Finnish and US students' situational orientations in different work view groups.

	View on the need for research and statistics skills in working life						
	Finnish students			*US students*			
Situational Orientation:	*"Yes"* *M/SD*	*"Maybe"* *M/SD*	*t*	*"Yes"* *M/SD*	*"Maybe"* *M/SD*	*"No"* *M/SD*	*F*
Task-orientation	3.23/.76	2.66/.63	$t(41)=2.67$ *	3.44/.96	3.27/.83	2.52/.76	$F(2,118)=4.98$ **
Social orientation	1.99/.73	1.99/.71	$t(42)=-0.01$	2.90/.96	3.13/.89	2.73/1.03	$F(2,119)=1.31$
Ego-defensive orientation	2.18/.89	2.66/.66	$t(42)=2.66$ *	2.59/.82	2.96/.83	3.25/.49	$F(2,117)=4.71$ *

Note: * $p < .05$, ** $p < .01$, *** $p < .001$

5.3. Learning approaches

For learning approaches, 4 questions were used to measure a deep approach (Cronbach's alpha for Finnish .74 and for US .57) and 4 questions to measure a surface approach (Cronbach's alpha for Finnish .58 and for US .52) in the learning of quantitative methods. The alphas were low, so the results concerning learning approaches should be considered preliminary.

In general, students in both countries reported high deep approach values (FIN: M = 3.65, SD = .71; US: M = 3.74, SD = .70), and there were no differences between the countries. In surface approach, the US students (M = 3.69, SD = .72) reported high values, while the Finnish students had only moderate values (M = 3.10, SD = .66; $t(166) = -4.88$, $p < .001$).

Both the Finnish and the US work view groups differed in their deep learning approach. The "Yes" groups reported deeper approaches than the Finnish "Maybe" group and the US "No" group. The US groups did not differ in surface approach, where all values were high. The Finnish "Yes" group had a lower mean on surface approach than the other group, but the difference did not reach statistical significance. In any case, the results on surface approach should be considered with caution, because the Cronbach's alphas for sum variables in both samples were low. The main conclusion concerning the learning approaches is that the students with a deep approach were most sure of the need for research skills in working life.

Table 2. Finnish and US students' learning approaches in different work view groups.

	View on the need for research and statistics skills in working life						
	Finnish students			*US students*			
Learning approach	*"Yes" M/SD*	*"Maybe" M/SD*	*t*	*"Yes" M/SD*	*"Maybe" M/SD*	*"No" M/SD*	*F*
Deep approach	3.95/.71	3.36/.54	$t(42)=3.13^{**}$	3.84/.70	3.78/.61	3.00/.71	$F(2,117)=7.53^{***}$
Surface approach	2.89/.71	3.23/.58	$t(42)=-1.72$, $p=.09$	3.60/.77	3.76/.70	3.84/.46	$F(2,119)=0.96$

Note: * $p< .05$, ** $p< .01$, *** $p< .001$

4.4. Experience of difficulty

All 21 questions measured the experienced difficulty in the learning of quantitative methods. (Cronbach's alpha for 21 questions was for Finnish .89 and for US .92). The Finnish students (M = 2.93, SD = .50) experienced more difficulties than the US students (M = 2.60, SD = .65; $t(163) = 3.11$, $p< .01$). The Finnish work view groups differed in their experience of difficulty. The group who saw these methods as important in their working life experienced fewer difficulties in methods courses. The US "Yes" and "Maybe" groups had fewer difficulties than the "No" group. The US groups' variances differed significantly, so we conducted a Kruskal-Wallis median test to confirm the difference. The test resulted in an almost significant difference ($X^2(2) = 5.62$, $p = .06$).

Table 3. Finnish and US students' experienced difficulty in university quantitative research courses in different work view groups.

	View on the need for research and statistics skills in working life						
	Finnish students			*US students*			
	"Yes" *M/SD*	*"Maybe"* *M/SD*	*t*	*"Yes"* *M/SD*	*"Maybe"* *M/SD*	*"No"* *M/SD*	*F*
Experienced difficulty	2.72/.46	3.04/.40	*t*(41)=-2.47*	2.46/.60	2.62/.61	3.21/.73	*F*(2,117)=6.88**

Note: * *p*< .05, ** *p*< .01, *** *p*< .001

4.5. Do views alter during a course?

The students were asked to answer the question "Do you think you will need research methodology and statistics skills in working life?" both at the beginning and at the end of the course. Of the 46 Finnish students who returned the questionnaire at the beginning of the course, 33, i.e. 72 % were present and returned the questionnaire at the end of the course. Of the students who answered "Yes" the first time, 71% were present at the second measurement at the end of the course, and 20% of them had changed their opinion to "Maybe". Of the students who answered "Maybe" at the beginning, 78 % were present in the end, and 28% of them answered "Yes" at the end of the course. The two students who answered "No" at the beginning, were not present at the end. Altogether, at the end, 17 students answered "Yes" and 16 "Maybe". In general, the Finnish students' views did not seem to change much during the course, although a change might be seen toward a slightly more positive view.

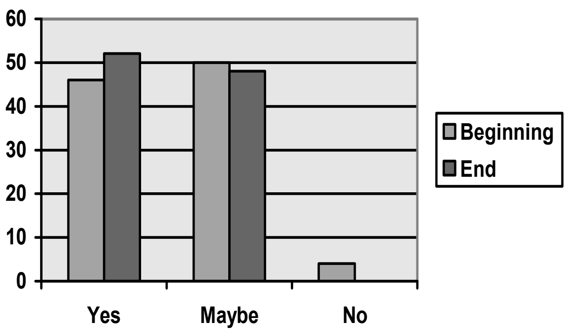

Figure 2. Percentages of Finnish students' answers at the beginning and at the end of the course to whether they think they will need research and statistics skills in their future working life.

Only some of the 122 US students were present at the end of the course, resulting in a response rate as low as 48%. Of these 58 students, 14 could not be identified as students who gave an answer at the beginning, i.e. they were either not present in the first lecture or they did not give their name, and thus it was impossible to identify them. Of these 14 students, 13 answered this question.

Of the students who answered "Yes" in the first time, 38% were present at the second measurement, and 45% of them had changed their opinion to "Maybe", while two

(9%) had changed their opinion to “No”. Of the students who answered “Maybe” at the beginning, 36% were present in the second measurement. Of these 19 students, 58% kept their view, 32% changed it to “Yes”, and 10% changed it to “No”. Of the four students who answered “No” at the beginning and were present at the second measurement, three answered “No” and one answered “Maybe” at the end of the course. Due to the low response rate, we cannot really say whether the views did or did not remain the same at the beginning and at the end. Some kind of change might be said to have occurred toward a less positive view.

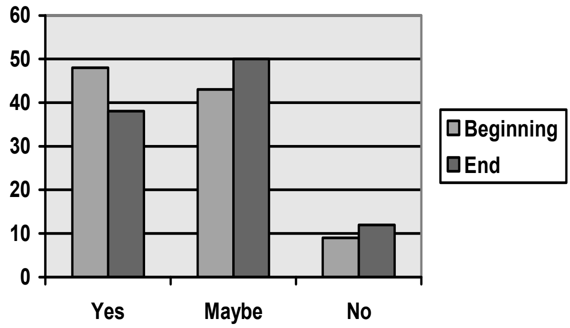

Figure 3. Percentages of US students’ answers at the beginning and at the end of the course to whether they think they will need research and statistics skills in their future working life.

5. Discussion

About half of the students in both countries were not convinced that they would need research and statistics skills in their future work. This is quite worrying when we think about the central role of understanding, using and applying research knowledge in the information society. It is not only researchers who need these skills, but they are needed in all kinds of jobs where it is important to constantly follow new knowledge and understand phenomena with the aid of scientific thinking skills. This naturally includes the skills to understand how the knowledge is acquired. If students do not see the value of these skills for their future work, how can they motivate themselves to learn? If the only goal is to pass compulsory courses or get a thesis done, we should be asking why waste a great deal of time and resources teaching these students research skills. If we agree that the contents of the education are meant for real life, not just for course work, we should make students understand why these skills are important for their future working life.

The Finnish and the US students did give different answers to the question on views of future work. This may be due to cultural differences in answering these types of questions. There is also a possibility that the country groups or discipline groups may differ from each other. Regardless of the fact that the Finnish students did not use the “No” option, the results were very similar in both groups. The groups in both countries expressed quite high task-orientation in an imaginary statistical task-solving situation, and reported quite low ego-defensive orientation.

The results of this study showed that views of future work, motivational factors and difficulties were connected to each other. In both countries, the students who were not sure whether they will need research skills in their future work, were less task-oriented and less deep-oriented, more ego-defensive, and had more difficulties in quantitative research courses than the groups who thought they would need these skills. Thus, it is probable that, in the learning situation, they cannot concentrate on leaning as well as students who reported better task-orientation. On the basis of the situational orientation theory (Olkinuora & Salonen, 1992), the ego-defensively oriented students may see possible future work tasks that require skills in research as a threat to the ego, and thus they deny the value of these skills. Thus, nor do they approach these studies with a deep learning approach. The high difficulties experienced by these students compared to other groups also reflect problems with understanding the subject to be learnt.

On the basis of the Finnish students' answers at the second measurement, views did not change much during the one semester course. Only 37% of the US students were present at the end of the course, so we cannot be sure how the whole group's views changed or did not change. The students who were present had changed their views in a more negative direction.

These results show that learning approaches, situational orientations, difficulties and views of future work form a connected web. The difficulties and harmful views seem to accumulate for some students, and although we do not know how they will behave in their future work, we know from these results that the students who had difficulties did think they might not need research skills in their future work. This may have some impact on their behaviour in their later studies, i.e. what courses they select, or on their future work, i.e. how able and willing they are to deal with problems that require statistical understanding. Thus, it is important to consider these problems in research teaching.

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References

Birenbaum, M., & Eylath, S. (1994). Who is afraid of statistics? Correlates of statistics anxiety among students of educational sciences. *Educational Research, 36*, 93-98.

Boulton-Lewis, G. M., & Smith, D. J. H., McCrindle, A. R., Burnett, P. C., & Campbell, K. J. (2001). Secondary teachers' conceptions of teaching and learning. *Learning and Instruction, 11*, 35-51.

Busquin, P. (2001). Preface to: Towards a European research area. Key figures 2001. Special edition. Indicators for benchmarking of national research policies. European Commission, Research Directorate General. http://europa.eu.int/comm/research/area/benchmarking2001.pdf

Cohen, L., Manion, L., & Morrison, K. (2000). Research methods in education. 5th edition. London: RoutledgeFalmer.

Entwistle, N., McCune, V., & Walker, P. (2001). Conceptions, styles, and approaches within higher education: Analytic abstractions and everyday life. In R. J. Sternberg & L. Zhang (Eds.), *Perspectives on thinking, learning, and cognitive styles* (pp. 103-136). Mahwah, NJ: Erlbaum.

Entwistle, N., Meyer, J. H. F., & Tait, H. (1991). Student failure: Disintegrated patterns of study strategies and perception of the learning environment. *Higher Education, 21*, 249-261.

Entwistle, N. J., & Ramsden, P. (1983). *Understanding student learning*. London: Croom Helm.
Epstein, I. (1987). Pedagogy of the perturbed: Teaching research to the reluctants. *Journal of Teaching in Social Work, 1*(1), 71-89.
Eronen, S., Nurmi, J.-E., & Salmela-Aro, K. (1998). Optimistic, defensive-pessimistic, impulsive and self-handicapping strategies in university environments. *Learning and Instruction, 8*(2), 159-177.
Filinson, R., & Niklas, D. (1992). The research critique approach to educating sociology students. *Teaching Sociology, 20*, 129-134.
Forte, J. (1995). Teaching statistics without sadistics. *Journal of Social Work Education*, *31*(2), 204-308.
Greer, B. (2000). Statistical thinking and learning. *Mathematical Thinking and Learning, 2*(1&2), 1-9.
Hannover, B., & Kessels, U. (2004). Self-to-prototype matching as a strategy for making academic choises. Why high school students do not like math and science. *Learning and Instruction, 14*(1), 51-67.
Hauff, H. M., & Fogarty, G. J. (1996). Analysing problem solving behaviour of successful and unsuccessful statistics students. *Instructional Science, 24*, 397-409
Kiley, M., & Mullins, G. (2005). Supervisors' conceptions of research: What are they? *Scandinavian Journal of Educational Research, 49*(3), 245-262.
Lehtinen, E., Lehti, S., & Salmi, S. (2003). The challenge of ICT in vocational learning. In F. Achtenhagen & E.G. John (Eds.), Milestones of vocational education and training (259-296). Bielefeld: Bertelsmann Verlag.
Lehtinen, E. & Rui, E. (1995). Computer-supported complex learning: An environment for learning experimental methods and statistical inference. *Machine-Mediated Learning, 5*(3&4), 149-175.
Lehtinen, E., Vauras, M., Salonen, P., Olkinuora, E. & Kinnunen, R., (1995). Long-term development of learning activity: motivational, cognitive and social interaction. *Educational Psychologist, 30* (1), 21-35.
Lindblom-Ylänne, S., & Lonka, K. (1999). Individual ways of interacting with the learning environment - are they related to study success? *Learning and Instruction, 9*(1), 1-18.
Lonka, K., & Lindblom-Ylänne, S. (1996). Epistemologies, conceptions of learning, and study practices in medicine and psychology. *Higher Education, 31*, 5-24.
Marton, F., & Säljö, R. (1976). On qualitative differences in learning - I. Process and outcome. *British Journal of Educational Psychology, 46*, 4-11.
Meyer, J. H. F., Shanahan, M. P., & Laugksch, R. C. (2005). Students' conceptions of research – a qualitative and quantitative analysis. *Scandinavian Journal of Educational Research, 49*(3), 225-244.
Meyer, J. H. F., Parsons, P., & Dunne, T. T. (1990). Individual study orchestrations and their association with learning outcome. *Higher Education, 20*, 67-89.
Murtonen, M. (2005). University students' research orientations – Do negative attitudes exist toward quantitative methods? *Scandinavian Journal of Educational Research, 49*(3), 263-280.
Murtonen, M., & Lehtinen, E. (2003). Difficulties experienced by education and sociology students in quantitative methods courses. *Studies in Higher Education, 28*(2), 171-185.
Murtonen, M., & Titterton, N. (2004). Earlier mathematics achievement and success in university studies in relation to experienced difficulties in quantitative methods courses. *Nordic Studies in Mathematics Education, 9*(4), 3-13.
Nurmi, J.E., Aunola, K., Salmela-Aro, K., & Lindroos, M. (2002). The role of success expectation and task-avoidance in academic achievement and satisfaction: Three

studies on antecedents, consequences and correlates. *Contemporary Educational Psychology, 28*, 59-90.

Olkinuora, E. & Salonen, P. (1992) Adaptation, Motivational Orientation, and Cognition in a Subnormally Performing Child: A Systemic Perspective for Training. In Wong, B.Y.L. (Ed.) *Contemporary Intervention Research in Learning Disabilities. An International Perspective.* Springer-Verlag: New York, 190-213.

Onwuegbuzie, A. J. (1997). Writing a research proposal: The role of library anxiety, statistics anxiety, and composition anxiety. *Library & Information Science Research, 19*(1), 5-33.

Onwuegbuzie, A. J., & Daley, C. E. (1998). The relationship between learning styles and statistics anxiety in a research methodology course. A paper presented at the annual conference of the American Educational Research Association, April, 13, San Diego, CA.

Onwuegbuzie, A. J. (2000). Statistics anxiety and the role of self-perceptions. *Journal of Educational Research, 93*(5), 323-330.

Op't Eynde, P., De Corte, E., Verschaffel, L. (2001). "What to learn from what we feel?": The role of students' emotions in the mathematics classroom. In S. Volet & S. Järvelä (Eds.), *Motivation in learning contexts: Theoretical advances and methodological implications* (pp. 17-31). Oxford: Elsevier Science Ltd.

Orr, J. E. (1990). Sharing knowledge, celebrating identity. War stories and community memory among service technicians. In David S. MIDDLETON and Derek EDWARDS (Eds), *Collective remembering: Memory in society*. London: Sage Publications Limited.

Pretorius, T. B., & Norman, A. M. (1992). Psychometric data on the statistics anxiety scale for a sample of south african students. *Educational & Psychological Measurement, 52,* (4), 933-937.

Rosenthal, B. C., & Wilson, W. C. (1992). Student factors affecting performance in an MSW research and statistics course. *Journal of Social Work Education, 28*(1), 77-85.

Thompson, B. W. (1994). Making data-analysis realistic: Incorporating research into statistics courses. *Teaching of Psychology, 21*(1), 41-43.

Thompson, T., & Richardson, A. (2001). Self-handicapping status, claimed self-handicaps and reduced practice effort following success and failure feedback. *British Journal of Educational Psychology, 71*, 151-170.

Townsend, M. A. R., Moore, D. W., Tuck, B. F., & Wilton, K. M. (1998). Self-concept and anxiety in university students studying social science statistics within a co-operative learning structure. *Educational Psychology, 18*, (1), 41-54.

Trigwell, K., & Prosser, M. (1996). Congruence between intention and strategy in university science teachers' approaches to teaching. *Higher Education, 32*, 77-87.

Tynjälä, P., Helle, L., & Murtonen, M. (2002). A comparison of students' and experts' beliefs concerning the nature of expertise. In E. Pantzar (ed.), *Perspectives on the age of the information society.* Reports of the Information Research Programme of the Academy of Finland, 6 (pp. 29-49). Tampere: Tampere University Press.

Vermunt, J. D. (1996). Metacognitive, cognitive and affective aspects of learning styles and strategies: A phenomenographic analysis. *Higher Education, 31*(1), 25-50.

Vauras, M., Salonen, P., Lehtinen, E., & Lepola, J. (1999). Long term development of motivation and cognition in family and school context. In S. Volet & S. Järvelä, *Motivation in learning context. Theoretical advances and methodological implications* (pp. 295-315). Amsterdam: Pergamon.

Zeidner, M. (1991). Statistics and mathematics anxiety in social science students: some interesting parallels. *British Journal of Educational Psychology, 61*, 319-328.