

# Integrating Qualitative Research Approaches in Traditional Introductory Statistics Courses: Pros and Cons

Irena Ograjenšek

*University of Ljubljana, Faculty of Economics*

*Ljubljana, Slovenia*

*irena.ograjensek@ef.uni-lj.si*

Iddo Gal

*University of Haifa, Department of Human Services*

*Haifa, Israel*

*iddo@research.haifa.ac.il*

*In this paper we seek to add to a scholarly dialogue concerning the arguments for and against integrating selected qualitative research approaches in traditional introductory statistics courses. Given recurring concerns about students' motivation, achievements, and eventual understanding of the role of (quantitative and qualitative) data in providing answers to real-world problems, we look beyond the strict borders of the discipline of statistics. We advocate a guided exposure of learners to qualitative methods based on a 'triangle model' of context, demands of the learning process, and learners' acquired knowledge and skills. Some of our arguments pertain to expectations and needs of learners and their prospective employers; emerging knowledge regarding the nature and complexity of the learning of statistics; and the structure of real-world data-based queries. The model points to a need for a broad multi-method-grounded knowledge as well as communicative and interpretive skills that are not being developed in many introductory statistics courses.*

## 1. Introduction

This paper aims to provide a rationale for examining the inclusion of selected ideas from the field known as "qualitative research methods" in the context of statistics education, both for non-statisticians taking introductory statistics classes and for statistics majors. This is certainly a controversial idea, given that statistics and statistics education are normally viewed as a strictly quantitative arena, and given the long history of tensions between qualitative and quantitative "camps", which in some circles exist even today.

With the above in mind, the paper is designed as a conceptual treatise which aims to provide a broad conceptual foundation and describe several related but separate motivations for considering an introduction of some ideas from qualitative research methodology in introductory statistics courses.

Apart from Introduction and Discussion, the paper has four core parts. Part 2 sketches key educational needs in statistics education that require a fresh look at the content of statistics education. Part 3 outlines selected key ideas associated with qualitative research methodology. Part 4 argues that some ideas from qualitative research are an inherent part of all research, whether quantitative or qualitative. Part 5 outlines a further rationale for our proposal, based on a newly developed triangle model involving 3 'Es': **E**ducational goals, **E**mployer needs, and **E**mpowerment of learners. In the Discussion we present some suggestions for qualitative topics which could be examined for their relevance to statistics education contexts from a 'pros vs. cons' perspective.

## 2. Educational needs

The teaching of introductory statistics courses at the college level presents several related challenges to educators (Aliaga et al., 2010). One such challenge is how to make the fundamental technical and conceptual knowledge acquired within an introductory statistics class appear relevant and interesting to students, i.e., a *motivation* issue (e.g., Gordon, 2004; Ograjenšek and Bavdaž, 2003; Papanastasiou, 2005). A second challenge involves understanding why data are needed in the first place, who uses them and for what purposes, and how they help both the description and understanding of various phenomena in the world, but also underlie or inform various decisions. Thus, this challenge involves issues of *purpose*, which in turn depend on understanding the broader ecology within which statistics operates and to which statistics aims to add its inputs, insights, and findings. A third challenge involves increasing the chance that students will be able to apply what they have learned outside the statistics class, i.e., that it will add to how they function in their workplace or in their career, when they participate in civic activities, listen to or read media reports, etc. This is an issue of *skill transfer*, which to date has been only scarcely accounted for in the literature on statistics education (Lovett & Greenhouse, 2000).

We believe that the motivation, purpose, and skill transfer issues noted above, which are all interconnected, have to be re-examined every so often by educators, given that we live in a dynamic world where life roles and contextual demands change, and where students themselves change. The motivation, purpose, and skill transfer issues ultimately involve the process of acquiring, understanding, and connecting the knowledge learned within the classroom to the roles that statistics may play in learners' lives beyond the classroom wall. Such roles involve, among other things, an ability to act as informed, reflective and critical "consumers" and/or "producers" of statistics. Given the above, and in light of recurring concerns about students' motivation, achievements, and eventual understanding of the role of statistics in providing answers to real-world problems, we believe the time is ripe to look for answers beyond the strict borders of the discipline of statistics. Towards that end, in this paper we advocate a guided exposure of learners to selected ideas and methods taken from what is generally termed "qualitative research methods".

## 3. A sketch of qualitative research methods and related ideas

There is a vast literature on qualitative methods, and in this short paper we can only note some key ideas. In general, the use of qualitative methods builds on the core assumption that there are important social phenomena or behavioral and organizational processes that cannot be measured quantitatively. It is often argued that while quantitative research is essentially an *inferential* endeavor (i.e., it ultimately hopes to generalize from samples to whole populations and identify general trends), qualitative research is primarily an *interpretive* endeavor. An interpretive view implies that qualitative research aims to understand phenomena within the context in which they happen, combining both *emic* perspectives (i.e., how the world is viewed from the point of insiders, the individuals or groups being studied; those who are experiencing a phenomena or participating in a process) and *etic* perspectives (how the world, and the same phenomena or experiences, is viewed by outside observers such as the researchers, managers, politicians, journalists, etc.).

Qualitative methods often aim to understand complex social phenomena by examining the behaviors or cognitions of persons or organizations involved, including their thoughts, values, symbols, beliefs, attitudes, and emotions (Frankfort-Nachmias & Nachmias, 2000). Such examinations are done by analyzing data generated via four key channels: talk/speech, documents/texts, observations, and visual objects such as photographs, drawings or video. Such data can be collected, for example, by one-on-one interviews, participant observations, focus groups, analysis of documents, audio and video recordings of

conversations and encounters, and so forth. Overall, the working assumption is that researchers need to collect rich ("thick") data from different sources using multiple methods, in order to maximize the quality and credibility of their information base, and reduce bias that may emerge when using a single data source (Baszinger & Dodier, 2004).

Qualitative researchers argue for the need to employ methods enabling discovery of information that goes beyond the researcher's initial beliefs. They point to a need to remain open to elements that cannot be codified at the time of the data collection, and to connect (i.e., ground) collected information and its interpretation to the context from which it emerged (Baszinger & Dodier, 2004). Strauss & Corbin (1998) claim that qualitative methods go beyond exploratory processes. They provide researchers with a systematic as well as a creative process for analyzing complex data, and identify or generate multiple meanings from them. In their view, qualitative methods enable researchers not only to describe compound phenomena, but also to conjecture about underlying factors that influence them, thus helping the creation of a tentative theory about the phenomena of interest. Qualitative researchers argue that in contrast, confirmatory research as traditionally viewed in the quantitative literature, relies on structured tools and on measures that are defined prior to data collection. Consequently, a quantitative approach is seen as less flexible when it comes to dealing with new phenomena.

An example from Noss et al. (2007) shows that similarly to the literature on quantitative research, the literature on qualitative research (e.g., Klein & Myers, 1999), emphasizes the need to use various processes as well as intensive analytical methods to establish or improve the reliability and validity of the analyses and interpretations of the information collected through qualitative channels. Noss et al. (2007) studied "techno-mathematical" literacies in the workplace and employed a mix of qualitative methods, such as ethnographic research, observations, worker interviews, etc. In describing their study, which focused on understanding workers' use and interpretations of production graphs in a manufacturing setting, they noted:

*Our general method... is to organize feedback and validation meetings for the purposes of triangulation. In feedback meetings, which are company specific, we present our findings to a group of managers in the company and discuss how far they resonate with their own experience. In broader validation meetings, we present our conclusions to managers from different companies within the sector in order to draw out similarities and differences.*

From the example it follows that various methods can be used to analyze and compare ("triangulate") the rich data that was collected from different sources and possibly by different techniques, to increase the breadth of the available data and improve the soundness of the emerging conclusions. This is in line with Leech & Onwuegbuzie (2008) who argue that when possible and justified by the research question, two or more coders should conduct systematic content analysis, and interrater agreement can be measured and reported.

**4. Qualitative and quantitative research themes are always mixed.** The preceding review, and the quote, illustrate that research does not happen in a vacuum and is grounded in a certain reality. We argue that despite the seeming difference between qualitative and quantitative approaches to research, quantitative *and* qualitative elements co-exist or interact within all three general phases of every research endeavor:

- *Initiating and shaping the study.* All research, whether qualitative or quantitative, emerges from what we can simply call "Need to know", i.e., the particular information need that motivates a research or data collection endeavor (Gal & Ograjenšek, 2010). Thus, research by default has a qualitative core, because the

world view of the individuals or groups that initiate the study helps to shape its goals, i.e., ideas as to what needs to be studied and why, as well as determines the methods deemed acceptable or useful for reaching these goals.

- *Conducting the study.* Diverse types of exploratory research methods which are qualitative in nature (e.g., one-on-one interviews with key informants or pilot respondents, observations, focus groups, analysis of customer complaints, etc.) are often used to sharpen the sense of what is important to study or measure, what can be studied or measured, and how it can be systematically studied (Johnson & Onwuegbuzie, 2004). Sometimes these are just the first step towards a standardized quantitative study, sometimes they are self-sufficient, and sometimes their use is integrated in a planned way in a mixed-method research design.
- *Interpreting the results and grappling with meanings and implications.* For research to influence actual decision-making processes in living organizations, its results have to be examined and in turn adopted by policy-makers, managers, and administrators. This implies that the meanings of the data and the conclusions emerging from them will be examined or generated by such actors in light of *their* "need to know" questions, taking into account criteria *they* may have in mind for data quality and credibility and *their* existing beliefs (i.e., paradigms, judgments) about the relevance or generalizability of the findings to the "real world". Thus, we argue that metaphorically speaking, both emic and etic perspectives have impact on the interpretation of research results, regardless of whether research employed quantitative or qualitative methods. That view of the interpretation of results of course implies immersion into a certain topic and activities that go well beyond the picture of a detached quantitative analyst 'beating data into shape' in the confines of his computer lab (Ridenour, & Newman, 2008).

### 5. The triangle model – the 3Es

Having briefly sketched some of the ideas and methods related to qualitative research, we now return to our proposal to consider the inclusion of selected ideas from qualitative research in the introductory statistics courses. We organize our ideas regarding the motivation for this proposal under a '3E triangle model' comprised of three interlocking and somewhat overlapping elements: Educational goals, Employer needs, and Empowerment of learners. Below we separately examine each of them.

***Educational goals.*** We live in an era of rapid social, economic, and technological changes, and this requires constant realignment of educational goals and plans. Skills and knowledge bases deemed essential a few decades ago, and directions and methods for achieving them, are constantly being reevaluated; adjustments are being continuously made at all levels of educational systems in many countries. This process manifests itself in the area of mathematics and statistics education as well by the release of new curricular specifications in different countries, such as the 2010 Common Core State Standards in the USA ([www.corestandards.org](http://www.corestandards.org)), or the National Curriculum Statements in Australia (Australian Curriculum, Assessment and Reporting Authority, 2011).

It seems that the context of education is constantly shifting in light of conflicting expectations or pressures, both for stability (transmit traditionally valued content, use familiar methods) and for controlled social change (seeking to improve processes and products, as well as social equity) (Owens, 1995). The tensions between desires for stability and change also manifest themselves in the introductory statistics courses. Numerous textbooks still support quite fixed procedural curricula emphasizing technical elements ("the mechanics of

calculations”), while recommendations for change are also being made such as the GAISE Standards in the USA (Aliaga et al., 2010), or recent calls for developing informal inferential reasoning (Wild et al., 2011) where general goals are defined, but specific methods for achieving them are left open for innovative experimentation. Probably in light of such tensions, in a well-known exchange in *The American Statistician*, Hogg (1999) called for a “continuous quality improvement” approach to statistics education, in order to optimize the quality of system outputs, introduce value-added elements, and eliminate waste as we go along.

Taking into account that statistics educators need to constantly seek ways to integrate stability and change in their course curricula at the same time, we feel it is well-justified to keep reflecting on the content and methods of traditional introductory statistics courses, considering constant reports about problems with students motivation, achievement and attitudes (Meng, 2009), and the attempts to introduce more general elements of quantitative literacy (Steen, 2001; Madison & Steen, 2008) into college-level education for the 21<sup>st</sup> century citizens. Our argument in this paper is that the general development of quantitative literacy cannot be approached without introducing some ideas from *qualitative* research.

***Employers and workplace demands.*** When it comes to employers and workplace demands, our premise is that in the labour market employers are looking for competent decision-makers. These should be familiar with pros and cons of different (qualitative and quantitative) research methods and resources even if they are not carrying out research themselves: they have to be capable users of other people’s research output.

This premise got confirmed in the 2009 and 2010 strategic discussions which were carried out between educators at the University of Ljubljana’s Faculty of Economics and a panel consisting of the CEOs of Slovenian largest and most successful companies as part of the study programmes’ quality improvement loop. As a consequence, the goal to ‘enable students to become capable users of other people’s research output’ is written in the Introductory Statistics course description.

Kenett et al. (2010) define research as “a critical activity leading to knowledge acquisition and formulation of policies and management decisions”. As such it is the basis of informed decision-making processes. Every research process starts with a research question or a research problem to solve. From it a clear articulation of research goals is needed, followed by a research plan incorporating a detailed description of steps towards achievement of each specific research goal. Often, the main research problem has to be divided into manageable subsets of partial problems.

The literature emphasizes the fact that research clearly differs from routine problem analysis: it should be exploratory and embrace lateral thinking. In this respect, modern quality improvement approaches, such as *Six Sigma* and *Lean Thinking*, can offer valuable help and suggestions to avoid waste and duplication.

Going beyond what is usually taught in a statistics *course*, the broader role of data in the business or managerial world is to support informed decision-making in the face of uncertainty. Whatever its source, clearly data is not necessarily limited to *quantitative* only. It is therefore prudent to recognise the importance of exploratory (usually qualitative) research to save time and money. In other words: pragmatism should be introduced into the classroom and we see examination of the role of *qualitative* data and related research methods in statistics courses as the first step towards achieving it, thereby laying the foundations for an easier and more real-life-relevant skill transfer. This way we could move away from practices such as ‘learn what you are told even if it bears no practical relevance’ and ‘start your career and forget everything you learned because it bears no practical relevance’, and enable our

graduates a less painful flow through important milestones: student > graduate searching for a job > trainee > young professional > senior professional.

***Empowerment and competence perspectives.*** Having discussed the need to constantly reexamine educational goals in a changing world, and to consider what is expected of graduates in diverse workplaces, it is next important to ask what is the ultimate goal of educational systems. While this question can be answered from a range of perspectives, we start here from the assumption that educational systems should produce *empowered graduates who possess a range of competences*.

The notion of competence we adopt here is a broad one, based on extensive work conducted as part of the Definition and Selection of Competencies project (DeSeCo; see Rychen & Salganic, 2003). The DeSeCo perspective, which was adopted by OECD and informed the design of assessment scales for the PISA (15-year-olds) and PIAAC (adult ages 16-65) assessment programmes, viewed competence as the ability to meet individual or social demands successfully, or to carry out an activity or a task. In this context, a competence is a complex action system encompassing two elements that constantly interact with each other: (a) cognitive skills and knowledge-bases, and (b) attitudes and other non-cognitive components such as motivation, value orientation, emotions, etc. Together the two elements should be mobilized for effective action in various life circumstances (Rychen & Salganic, 2003).

The notion of competence is also related to the general expectation that educational systems will build various "literacies" that are needed in the information age. OECD countries define such literacies very broadly as *"The interest, attitude, and ability of individuals to access, manage, integrate, and evaluate information, construct new knowledge, and communicate with others in order to participate effectively in the information age"* (OECD, 2006). This general conceptualization of desired competencies of citizens also underlies conceptions of constructs that are more directly related to the goals of statistics education, such as the need to develop graduates who possess *numeracy, statistical literacy, or quantitative literacy* (Steen, 2001; Gal, 2002; Ograjenšek, 2002).

The prior notions suggest that we should aspire to create educated citizens and workers who can function in a dynamic world, and who can understand and deal with data-based queries. This in turn leads to a vision of *the empowered person/learner*, i.e., a person with a mix of cognitive skills on one, as well as with positive dispositions (e.g., self-efficacy, motivation, positive beliefs about the value of statistics) on the other hand. This expectation is supported by ample theoretical and empirical literature on empowerment going back at least 30 years, whether about empowerment of employees, students, citizens, or people in other life contexts (Thomas & Velthouse, 1990; Spreitzer, 1995). A recurring theme in writings of educators interested both in adult literacy and adult numeracy (Freire, 1972; Frankenstein, 1989) is that empowered individuals are also able to critically evaluate their environment. If this expectation applies to learners of statistics as well, they should become more fully aware of limitations of their own skills and arsenal of methods. This can be greatly helped not only by discussing both the advantages and disadvantages of quantitative methods, but also by learning some aspects of qualitative research methods, and in what ways they complement, or make up for limitations of, quantitative research methods.

## 6. Discussion

The primary purpose of this paper is to provide a rationale for examining the inclusion of selected ideas from the field known as "qualitative research methods" in the context of statistics education, both in general introductory statistics classes and for statistics majors. Towards that end, we discuss a 3E model of justifications related to Educational

goals, Employer needs, and Empowerment of learners. In addition, the co-existence of qualitative and quantitative themes during all phases of research processes is noted. We believe that the inclusion of core ideas related to qualitative methods, as outlined in part 2, can help to improve aspects of motivation and skill transfer noted in the Introduction. Given that qualitative ideas co-exist with quantitative ideas even in quantitative studies, we think that their inclusion can also improve the potential of statistics courses to create empowered, reflective and competent graduates who are more likely to transfer these qualities and tendencies into real-life situations in the workplace or elsewhere.

That said, the preceding parts of this paper naturally lead to questions about what educational practices should educators use, and how. Many ideas about issues and dilemmas in the teaching of qualitative methods in research methods courses can be found in reflections of educators such as Franklin (2001) or Clark & Lang (2002). Given the limited scope of this paper, we only focus on illustrative issues concerning implementation.

One of the main problems statistics educators working in a tertiary introductory statistics context usually face is a crowded curriculum. To counter this obstacle we envision different ways or levels of involvement at which qualitative methodology can be incorporated into instruction. Perhaps the simplest way is to refer to the existence of qualitative methods throughout the course, where appropriate. Here are two examples:

- mention the use of one-on-one interviews and focus groups as essential tools when developing research questions, or testing research instruments;
- use illustrative examples for contexts in which qualitative methodology is an inherent aspect of work, i.e. contexts are of practical relevance for students' subsequent careers, such as use of qualitative methodology in customer satisfaction studies and quality improvement efforts conducted by service organizations.

The integration of qualitative elements into traditional introductory statistics courses will most certainly be met with skepticism from veteran teachers who believe that statistical methods should not be diluted by inexact methodology. However, our experience is that students, more so than instructors, are quick to identify the inherent logic of mixed methods, especially if instruction does not focus on presenting a long laundry list of isolated techniques, but is problem-based, i.e., it starts with the "need to know" that exists in real-life situations. It follows that a first idea to be conveyed to students is the importance of *context* – substantive considerations are the basis for methodological and analytical choices. Such an approach can help students to realize that some aspects of qualitative methods are part and parcel of every research process in applied settings and hence familiarity with the logic and mutual influences of qualitative and quantitative methods is imperative.

The decision which qualitative methods to include in a course should not be informed only by the internal structure of the domain (i.e., what are statistical or research methods), but should also stem from the structure of the real-world data-based queries which the domain is dealing with. It is critical to build student motivation and understanding of the relevance of what they are studying for multiple contexts, i.e., their current and future professional life as well as life of informed and responsible citizens. In both of these contexts, the external environment will require a descriptive picture of the world, as well as a basic understanding of the cause-and-effect relationships of available alternative choices. Thus, students could also be helped to understand that given a specific "need to know", selected qualitative methods, in particular *content analysis*, are essential in enabling organizations or researchers to discover, describe and understand behaviors, cognitions, motives, preferences, beliefs, needs, and experiences of different target populations (Clark & Lang, 2002; Gremler, 2004). A current example is the emergence of methods for conducting "text-analytics" on qualitative data generated during interactions between customers and service personnel in contact

centers, i.e., content analysis and then quantification of repeating themes in voice recordings or e-mails, as part of marketing and quality management efforts aimed at improving customer experiences and service levels in for-profit and non-profit organizations.

Coming back to the general rationale for inclusion of qualitative ideas in quantitative courses, one has to reflect on the question, "what is the desired outcome of an introductory statistics class". This question can be answered from a learner perspective, from a teacher perspective, from an educational institution perspective, or from an employer perspective. While answers may vary, certainly there is a need to strengthen students' familiarity with core questions regarding *credibility of the conclusions and validity of the interpretations of results*, i.e., "how certain are we?" (Ben-Zvi, 2003). Such questions are an inherent element in scientific reasoning and relate to all modes and types of research (Cohen, Manion, & Morrison, 2007). For this reason we believe that students need to come out of a statistics class with an understanding not only of the advantages but also of the limitations of quantitative methods such as potential problems with the reliability and validity of data, or the stability and trustworthiness of the conclusions based on a sample of a given size. Understanding of these issues can be strengthened by examining the value of the information provided by quantitative methods from an external perspective, i.e., that of *qualitative* research. Paradoxically, limitations of quantitative methods are usually missing from statistics textbooks - yet listed in the literature advocating the use of qualitative methods and techniques (Ridenour & Newman, 2008)! Nonetheless, it is not possible to discuss limitations of quantitative methods without also offering solutions to some of them – and in some cases these are offered by qualitative methods.

Overall, the ideas sketched in this paper suggest that statistics instruction can link substantive and methodological issues via problem-based elements, i.e., focus on the "need to know" that exists in the real workplace situations. This can help students to see that in real life, they may be in positions where they are both "producers" and "consumers" of data (Gould, 2010) and have to be familiar with conceptual as well as methodological details before making a decision and facing its consequences. We believe that from there it is a relatively small step to realization that familiarity with the logic and technical details of statistical analysis is also imperative. In other words: by introducing qualitative methodology in introductory statistics courses we actually help raise the regard for usefulness of quantitative methodology.

## REFERENCES

- Aliaga, M., et al. (2010). Guidelines for assessment and instruction in statistics education: College report. American Statistical Association.  
Online: <http://www.amstat.org/education/gaise/GAISECollege.htm>
- Australian Curriculum, Assessment and Reporting Authority (2011). *The Australian Curriculum*. Retrieved April 22, 2011: [www.AustralianCurriculum.Edu.au/Home](http://www.AustralianCurriculum.Edu.au/Home)
- Baszinger, I., & Dodier, N. (2004). Ethnography: Relating the part to the whole. *Qualitative research: Theory, method and practice*. In D. Silverman (ed.), 12-39. London: Sage Publications.
- Ben-Zvi, D. (2003). Reasoning about variability in comparing distributions. *Statistics Education Research Journal*, 3(2), 42-63.  
Online: [www.stat.auckland.ac.nz/~iase/serj/SERJ3\(2\)\\_BenZvi.pdf](http://www.stat.auckland.ac.nz/~iase/serj/SERJ3(2)_BenZvi.pdf)
- Clark, R., & Lang, A. (2002). Balancing Yin and Yang: Teaching and learning qualitative data analysis within an undergraduate quantitative analysis course. *Teaching Sociology*, 30, 348-360.

- Cohen, L., Manion, L., & Morrison, K. (2007). *Research Methods in Education*. New York: Routledge.
- Frankenstein, M. (1989). *Relearning mathematics: A different third 'R' – Radical maths*. London: Free Association Books.
- Frankfort-Nachmias, C. & Nachmias, D. (2000). *Research methods in the social sciences*. New York: Worth Publishers.
- Franklin, C. (2001). Learning to teach qualitative research: reflections of a quantitative researcher. *The methods and methodologies of qualitative family research*. In J. F. Gilgun & M. B. Sussman (eds.), 241-274. New York: Haworth Press.
- Freire, P. (1972). *Pedagogy of the oppressed*. New York: Penguin.
- Gal, I. (2002). Adult statistical literacy: Meanings, components, responsibilities. *International Statistical Review*, 70(1), 1-25.
- Gal, I., & Ograjenšek, I. (2010). Qualitative research in the service of understanding learners and users of statistics. *International Statistical Review*, 78(2), 287-296.
- Gordon, S. (2004). Understanding students' experiences of statistics in a service course. *Statistics Education Research Journal*, 3(1), 40-59, <http://www.stat.auckland.ac.nz/serj>.
- Gould, R. (2010). Statistics and the modern student. *International Statistical Review*, 78(2), 297-315.
- Gremler, D.D. (2004). The Critical Incident Technique in service research. *Journal of Service Research*, 7, 65-89.
- Hogg, R. V. (1999). Let's use CQI in our statistics programs. *The American Statistician*, 53(1), 7-14.
- Johnson, R. B. & Onwuegbuzie, A.J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational Researcher*, 33, 14-26.
- Kenett, R., Coleman, S., & Ograjenšek, I. On quality research : An application of InfoQ and PSE to the research process. *European Network for Business and Industrial Statistics (ENBIS) 10, 12-16 September 2010, Antwerp, Belgium*. CD-ROM. Antwerp: ENBIS, 2010.
- Klein, H. K. & Myers, M.D. (1999). A set of principles for conducting and evaluating interpretive field studies in information systems. *MIS Quarterly*, 23, 67-88.
- Leech, N. L., & Onwuegbuzie, A.J. (2008). Qualitative data analysis: A compendium of techniques and a framework for selection for school psychology research and beyond. *School Psychology Quarterly*, 23, 587-604.
- Lovett, M. C., & Greenhouse, J. B. (2000). Applying cognitive theory to statistics instruction. *The American Statistician*, 54(3), 196-206.
- Madison, B. L. & Steen, L. A. (2008). Evolution of numeracy and the National Numeracy Network. *Numeracy 1(1)*. Online: <http://services.bepress.com/numeracy/vol1/iss1/art2>
- Meng, X. (2009). Desired and feared—what do we do now and over the next 50 years? *The American Statistician*, 63, 202-210.
- Noss, R., Bakker, A., Hoyles, C., & Kent, P. (2007). Situating graphs as workplace knowledge. *Educational Studies in Mathematics*, 65, 367-384.
- OECD (2006). Planning for the direct assessment of literacy competencies in the information age for PIAAC. (Report EDU/EC/CERI(2006)25). Paris, Author.
- Ograjenšek, I. (2002). *Business Statistics and Service Excellence: Applicability of Statistical Methods to Continuous Quality Improvement of Service Processes*. Ljubljana, Slovenia: Faculty of Economics.
- Ograjenšek, I., & Bavdaž Kveder, M. (2003). Student acceptance of ITT-supported teaching and internal course administration: Case of business statistics. *IASE/ISI Satellite Conference*, Berlin, <http://www.stat.auckland.ac.nz/~iase/publications/6/Ograjensek.pdf>

- Owens, R. G. (1995). *Organisational Behavior in Education*. Boston, Massachusetts (USA): Allyn and Bacon.
- Papanastasiou, E. C.. (2005). Factor structure of the wattitudes toward research scale. *Statistics Education Research Journal*, 4(1), 16-26.  
Online: <http://www.stat.auckland.ac.nz/serj>
- Ridenour, C. S., & Newman, I. (2008). *Mixed methods research: Exploring the interactive continuum*. Carbondale: Southern Illinois University Press.
- Rychen, D. S., & Salganic, L. H. (Eds.)(2003). *Key competencies for a successful life and a well-functioning society*. Gottingen, Germany: Hogrefe & Huber.
- Steen, L. A. (2001). *Mathematics and democracy: The case for quantitative literacy*. Washington, DC: Woodrow Wilson National Fellowship Foundation.
- Strauss, A. & Corbin, J. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory*. Thousand Oaks: Sage Publications.
- Thomas, K. W. & Velthouse, B. A. (1990). Cognitive elements of empowerment: An interpretive model of intrinsic task motivation. *The Academy of Management Review*, 15(4), 666-681.
- Spreitzer, G. M. (1995). Psychological empowerment in the workplace: Construct definition, measurement and validation. *Academy of Management Journal*, 38(5), 1442-1465.
- Wild, C. J., Pfannkuch, M., Regan, M., & Horton, N. J. (2011). Towards more accessible conceptions of statistical inference. *Journal of the Royal Statistical Society Series A*, 174(Part 2), 247–295.