Learning Educational Research Methods through Collaborative Research: The PhICER Initiative

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Abstract

To accommodate an increasing interest in phenomenography among the computing education research community, the authors of this paper have organised two workshops, or intensive courses, in phenomenography, intended for researchers in computing education at a university level. Although the workshop programs contained lectures and smaller exercises, the emphasis was on preparing one joint publication from each of the workshops. The publication from the first workshop discussed the experience of being a teacher in computing, while the second focused on teachers' experiences of the problems their students encounter when learning computing. The workshops and their impact on the community are discussed in this paper.

Keywords: computing education research, phenomenography, PhICER

1 Introduction

Phenomenography (Marton & Booth, 1997) is an educationally oriented qualitative approach to research. Two workshops, or intensive courses, both called PhICER (Phenomenography in Computing Education Research), were offered to the computing education research community in 2006. The key aim of these workshops was to make qualitative research more accessible within our community, introducing a tool that computing education researchers might use to tackle new questions.

2 Background

We sketch the background to the PhICER workshops by first highlighting some aspects of the current development within Computing Education Research (CER). We then turn to a brief discussion of phenomenography and its current role in CER. Finally we present some other initiatives that inspired us to conduct the PhICER workshops.

2.1 Computing Education Research

Most researchers in CER have their education and background in computer science (Clancy, Stasko, Guzdial, Fincher, & Dale, 2001). Since this academic training encourages quantitative, rather than qualitative, research methods, most CER studies published at leading CER conferences and journals use quantitative research methods.

However, recent years have seen the development of complementary perspectives as interest has increased in qualitative research within CER. This is manifested, for example, in publications discussing the applications of qualitative research in CER (Ben-Ari, 2001, 2004; Berglund, 2006; Berglund, Daniels, & Pears, 2006; Kinnunen & Malmi, 2004) and panel sessions at leading computing education research conferences (Ben-Ari, Berglund (organiser), Booth, & Holmboe, 2004; Holmboe, McIver, & George, 2001). There are also an increasing number of research papers, methodologically anchored in educational research, accepted to conferences in CER, particularly to Koli Calling – the Baltic Sea

Conference of Computing Education Research[2], and ACM ICER – International Computing Education Research Workshop[3]. Lately graduate courses teaching research methodologies for Computing Education Research have been offered (see for example Berglund, Kinnunen, & Malmi, 2008).

Despite this growing interest in using new methodologies in CER, a core question remains: How and where can computing academics learn a new research method for CER, especially a qualitative method?

2.2 Phenomenography in Computing Education Research

Phenomenography is a way to perform research, in this paper referred to as a *research approach,* which has its origin and theoretical roots in educational research. It is an empirical, qualitative approach that aims to describe the different ways in which a phenomenon (normally the object of learning, for example, the computer science concept of 'object') is understood within a cohort (such as a group of students) (Marton & Booth, 1997). Data for phenomenographic studies is normally collected through interviews with a set of individuals, selected to represent the diversity of the group under scrutiny. The outcome is a set of related categories; each category describes a particular way in which the object of learning is understood, and the set describes the full range of ways of understanding the object of learning.

The focus on how students understand the object of their learning has made phenomenography successful for research in higher education. The approach was introduced to CER by the seminal work of Booth (1992). Since then, the interest in phenomenography for CER has grown steadily (Berglund, 2006). This is manifested, for example, in Berglund (2005) and Berglund & Lister (2007) on computer networking; Berglund & Eckerdal (2006) on students' aims in studying CS; Doyle & Lister (2006) on Unix; Eckerdal & Thuné (2005) on introductory object-oriented programming; Lister, Box, et al. (2004) on data structures; Stamouli & Huggard (2006) on program correctness. The authors of this paper are aware of about a dozen phenomenographically anchored research projects in computing education that are currently being undertaken in different parts of the world. The development accelerated during 2006, when phenomenographic papers were represented at the five most important yearly conferences in computing education: ACE – Australasian Computing Education conference[4], Hobart, Tasmania, Australia (Kutay & Lister, 2006; Thompson, Hunt, & Kinshuk, 2006); ACM SIGCSE – Technical Symposium on Computer Science Education[5], Houston, USA (in the Doctoral Consortium, Boustedt, 2006); ACM ITiCSE – Innovation and Technology in Computer Science Education[6], Bologna, Italy (Berglund & Wiggberg, 2006); ACM ICER – International Computing Education Research Workshop, Canterbury, UK (Stamouli & Huggard, 2006); Koli Calling – Baltic Sea conference of Computing Education Research, Koli, Joensuu, Finland (Vartiainen, 2006; Wiggberg, 2006).

Phenomenographers traditionally learn the research approach as apprentices from more experienced colleagues. It is hard to learn this way in an emerging and growing community such as the CER community: there are simply too few senior phenomenographers within the community to meet the demand.

2.3 Workshops in Research Methodology for the CER community

Our model to disseminate a CER research methodology, as used in the PhICER workshops, is adapted from earlier approaches, the 'Bootstrap' initiative and the ITiCSE Working Group initiative. The theoretical rationale for these initiatives can be found in the work on situated learning proposed by Wenger (1998) and Lave and Wenger (1991). These authors describe learning as a development of practice within a community, through collaborative social interaction aiming for a joint enterprise, shared repertoire and mutual engagement. In our interpretation, this implies that academics are likely to learn a new CER methodology better if they work on a real problem, with a shared set of intellectual tools, towards the joint aim of writing an article.

There have been several initiatives aimed at disseminating research methodologies in the CER community. The type of initiative described in this section differs from others with similar purposes in its strong integration of the international community in the activity (not, for example, limiting itself to a particular university or indeed country), in the practical work on concrete research projects, and in the impact on the community (see section 4 for a further discussion).

2.4 The Bootstrap Initiative

In 2002, the NSF-funded Bootstrap project (Tenenberg & Fincher, 2006) was launched. Two workshops took place with the same participants, in two consecutive years, with an intervening year of research work for the participants. The aim of the project was to improve the state of CER by educating a group of computer academics (with little or no prior experience in CER) in the theory, design, conduct and management of research. The project was also intended to facilitate relationships between these academics that would continue beyond the duration of the Bootstrap project.

Prior to the first full workshop, the principal investigators (Sally Fincher, Josh Tenenberg and Marian Petre) designed and piloted the research project that all the project participants subsequently carried out. The project

[2] http://cs.joensuu.fi/kolistelut/

[3] http://www.cs.kent.ac.uk/events/conf/2006/icer/

[4] http://www.sistm.unsw.edu.au/conference/ace2006/

[5] http://www.cs.rit.edu/~sigcse06/

[6] http://www.iticse06.cs.unibo.it/

was described in great detail in a 26-page *Experimental Kit* (Fincher, 2002).

The first full workshop was run for four days and consisted of two related activities: (1) a series of lectures by the principal investigators on research methods, drawing when they could from examples in the CER literature; and (2) work by the participants on developing their own research projects, with feedback from the principal investigators and other participants.

During the subsequent year the participants collected data for a common research project.

One year after the first workshop, the group met for another four days. The collected data was pooled and the subgroups worked on complementary forms of data analysis, with frequent plenary sessions to discuss the work of each subgroup. By the end of the second workshop, a preliminary data analysis had been completed and early drafts of various sections of a joint paper had been written. However, much analysis and writing went on for months after the second workshop, coordinated by the principal investigators.

This Bootstrap model – two four-day workshops, a year apart, with data collected on a common project between the two workshops – has been applied, with minor modifications, in three subsequent projects.

Scaffolding Research in Computer Science Education (2003): The first four-day workshop immediately followed the second Bootstrap workshop. There were 18 participants.

Building Research in Australasian Computing Education (BRACE) (2004): The workshops were held in conjunction with ACE2004 (Dunedin) and ACE2005 (Newcastle). There were 11 'student' participants (Haden, Fincher, & Petre, 2004).

Stepping Stones (2006): This Swedish version held its workshops in 2006 and 2007. Unlike earlier versions, this version was broadened beyond computing education, to include engineering education[7].

These projects have been reviewed and evaluated elsewhere by their organisers (Fincher et al., 2005; Fincher & Tenenberg, 2006).

2.5 ITiCSE Working Group initiative

The ITiCSE conference has hosted working groups[8] since its inception, but until recently these groups did not undertake empirical research projects. The first group to do so was the 'McCracken Group' (McCracken et al., 2001), which studied the programming ability of novices. Prior to meeting at the conference, some group members collected data from their students. At the conference, the group analysed that data. As with most ITiCSE working groups, the group effort was aimed at producing a paper, which was submitted for review approximately one month after the conference. Three years after the McCracken Group, the 'Leeds' ITiCSE working group (Lister, Adams, et al., 2004) blended the collaboration models of the McCracken Group and the Bootstrap initiative.

The ITiCSE working groups were never intended to be vehicles for teaching research methodology. In fact, most of the participants in both the McCracken and Leeds groups were experienced CER researchers.

3 The PhICER workshops

The first of the two PhICER workshops[9], held in Australia in conjunction with the ACE conference in January 2006, was organised by Raymond Lister, Anders Berglund and Ilona Box, with the assistance of Chris Cope and Arnold Pears; the second[10], held in the UK in conjunction with ICER in September 2006, was organised by Anders Berglund and Anna Eckerdal, with the assistance of Arnold Pears.

3.1 Aims

We had several concrete aims with these workshops.

Aim1. Create an increased awareness and understanding of the use of phenomenography in CER

We wanted to increase the awareness of and interest in qualitative research, particularly phenomenography, in the CER community. Our assumption was that research within the field would benefit from the researchers being more conscious about, and capable of using, educationally based, non-positivistic research approaches such as phenomenography.

Aim2. Offer a hands-on experience with phenomenography

We wished to offer a 'hands-on' experience with the 'handicraft' of phenomenography.

Aim3. Jointly run a research project, important to CER, and write joint research publications

We aimed at writing joint publications, one from each of the workshops. These papers were to analyse, describe and discuss important topics within computing education at the university level. As a consequence, the papers would also illustrate the kinds of result that phenomenographic research could bring.

3.2 The participants

The Australian workshop involved 21 participants, including the workshop leaders, from 16 different institutions; the UK workshop involved 14 participants

[7] http://www.it.uu.se/research/group/cetuss/events/2006-06/

[8] See for example http://iticse2007.computing.dundee.ac.uk/workinggroups.asp

[9] http://www-staff.it.uts.edu.au/~raymond/phicer/

[10] http://www.it.uu.se/research/group/upcerg/PhICER

from 11 institutions. The participants had different backgrounds: some were PhD students in CER, others were lecturers in computer science, and still others were active researchers in CER.

3.3 The content

The proponents of situated learning (Lave & Wenger, 1991; Wenger, 1998) argue that the lessons learnt from participating in joint projects are long-lasting; this is certainly the experience from the Bootstrap and BRACE projects. Furthermore, the experience of working together on a joint project builds relationships between the participants that outlast the specific project. This is important as we intended not only to teach phenomenography, but also to build a nascent phenomenographic research community within computing education.

The project of the first workshop was to explore the different ways in which computing academics understand their own teaching. The research contribution to the CER community from the first workshop is summarised by Lister et al. (2007):

> First, the study offers computing academics an insight into the understandings that underlie their teaching. Second, an awareness of these understandings can help by providing a framework for the analysis of proposed teaching methods and materials. (ibid., p. 105)

The focus of the second workshop was somewhat narrower:

> Our focus is on teachers' understanding of and interaction with students' difficulties and success. (Berglund et al., in preparation)

3.4 The organisation of the workshops

The key results from the workshops were presented in publications jointly written by all participants: from the first workshop, Lister et al. (2007); from the second, Pears et al. (2008) and Berglund et al. (in preparation). Learning phenomenography and writing parts of a joint publication demanded a considerable amount of work from the participants.

Before the workshop: The participants were asked to read some phenomenographic papers (Åkerlind, 2005; Eckerdal & Thuné, 2005; Ingerman & Booth, 2003; McKenzie, 2002) and selected parts of a book (Ramsden, 2003), and to do some exercises such as identifying the terminology of phenomenography. The participants were also asked to perform one or more interviews, based on a script distributed by the organisers, and to transcribe those interviews.

Day 1, morning: Introductory interactive lectures and discussions. Since almost all of the participants had done their preparation, the introduction focused on the participants' questions. There was also time to discuss the interviews and what insights an analysis of them might be able to offer.

Day 1, afternoon: Introduction to the research projects. The participants broke into subgroups to explore the research questions.

The joint formulation of the research questions is of particular interest. First, each subgroup formulated one or more candidate research questions based on their reading of the interviews, their understanding of phenomenography, and their perception of the computing education research community. These candidate questions were then discussed in plenum, in order to discern some interesting topics for their work in the workshop. Finally, the whole group split into new sub-groups, each formed around one particular question. This division into subgroups remained in place for the rest of the workshop and is mirrored in the resulting papers.

Day 2, morning: Lectures for about an hour on advanced topics, such as quality and trustworthiness in phenomenographic research. For the rest of the morning the participants worked in their teams on the research questions.

Late in the morning the 'judging room' opened. Some of the workshop leaders, 'coaches', continued to work with the participants. The remaining leaders, the 'judges', moved to a separate room, where they met with each group to discuss what they had so far discovered. Apart from providing feedback on the complete work of the team (and not only on what they chose to discuss with the coaches), the judging room was intended to bring some pressure on the work of the subgroups.

Day 2, afternoon: The afternoon was dominated by research time, with the judging room staying open. Finally a plenary discussion focused on issues such as future work and ownership of the material.

After the workshops: The subgroups continued to explore their research questions and to write one section each of a joint paper. The final paper, based on the contributions of the subgroups, was edited by one of the organisers.

Social activities: To encourage a sense of community and an obligation to the project and the subgroups, we organised joint lunches, coffee breaks, and dinners, so that the participants could get to know each other socially.

As organisers, we were happy to see that most of the participants had done their 'homework', and that after the workshops they participated actively in the work for the joint publication.

4 The outcome of the workshops

Evaluating the effects of a project such as the PhICER workshops is a delicate issue. For obvious reasons, it is not possible to make any kind of comparative study. An analysis of a single parameter, whether quantitative or qualitative, would not do justice to the complex influences that the PhICER workshops might or might not have on the CER community.

We begin this discussion on the outcome of the PhICER workshops with reference to a set of metrics introduced

by Fincher and Tenenberg (2006) for the Bootstrapping project. After introducing the indicators that form the core of these metrics, we examine PhICER in terms of the indicators. Finally, we use the indicators to evaluate how well PhICER has succeeded in achieving the aims (section 3.1) that we formulated for the workshops.

4.1 Indicators of success

The main metrics proposed by Fincher and Tenenberg (2006) are a set of seven indicators for the success of the Bootstrapping project. They distinguish between *visible indicators*, based on commonly used criteria of success, and *invisible indicators*, shaped by the answers they received from an e-mail enquiry to the Bootstrapping participants.

Their suggested visible indicators are:

Ind1. Publications
Ind2. Network density
Ind3. Replication

Their invisible indicators (local effect, professional activity, further collaboration and professional service) are founded in and developed from data specific for the Bootstrapping initiative, and are thus hard or impossible to generalise. Rather than trying to use these same invisible indicators, we took inspiration from the idea and developed our own invisible indicators for the PhICER project.

Below we discuss the PhICER workshops in terms of both the visible and invisible indicators, which are summarised in Figure 1.

4.1.1 Visible indicators

These indicators are basically measurable, and can thus be used to compare one initiative with another.

Ind1. Publications

As was previously mentioned, the two workshops have led to three joint publications. In addition, workshop subgroups have so far written five papers (Carbone, Mannila, & Fitzgerald, accepted for publication; Kinnunen, McCartney, Murphy, & Thomas, 2007; Simon, de Raadt, & Venables, 2007; Simon, de Raadt, Sutton, & Venables, 2006; Tutty, Sheard, & Avram, submitted for peer review). More publications inspired by the PhICER workshops are currently in preparation. Particularly we wish to mention the paper that is currently being prepared by Moström et al. (in preparation), entitled *How (and why) to Read a Phenomenographic Paper: a Guide for the Uninitiated.*

Ind2. Network density

This criterion describes social connectedness and refers to the number of relationships between pairs of individuals. The data for this measurement, as it is used by Fincher and Tenenberg and based on Granovetter (1973), is founded in co-authorship in the publications that are judged to be a result of the Bootstrapping project. The PhICER workshops are too recent for this metric to be usefully employed.

	Visible Indicator
Ind1	Publications
Ind2	Introduction Network density
Ind3	Replication
	Invisible Indicator
Ind4	Individual learning of phenomenography
Ind5	Awareness of phenomenography within the CER community
Ind6	Resulting events in the CER community

Figure 1: Indicators of success used in the evaluation of the PhICER workshops. Inspired by Fincher & Tenenberg (2006).

Ind3. Replication

Replication is a key criterion in the arguments put forth by Fincher and Tenenberg. The PhICER workshops are to an important degree modelled after the Bootstrapping project, but are adapted to a different topic and to differences in time-frame, etc. Thus the PhICER workshops can be seen as adaptations and replications of the Bootstrapping project. Seen in this way, they confirm the value of the Bootstrapping model, but this criterion cannot be used to evaluate the PhICER workshops themselves. However, we argue that because we modelled PhICER after Bootstrapping, and because Bootstrapping is a success (according to the argument in Fincher and Tenenberg (2006)), the model used for PhICER will clearly be replicated.

4.1.2 Invisible indicators

Our invisible criteria constitute non-measurable, non-generalisable indicators. These are built on different forms of data, in some cases collected from the stories of the participants and from different sources within the community. Thus these indicators are based in and developed from the data we have to hand, as were the invisible indicators presented in the evaluation by Fincher and Tenenberg (2006). Although these indicators lack generalisability, we believe that they contribute to the full picture of the PhICER workshops.

Ind4. Individual learning of phenomenography

Many of the participants have advanced well in their learning of phenomenography. We base this impression on our discussions with the participants during and after the workshops, as well as on the papers that have been produced and are still being produced as a result of the workshops. A two-day workshop is certainly not enough to learn phenomenography and to conduct a phenomenographic research project, but the workshop has served as a launch pad. It is through the writing process following the workshop that we have noticed a growing capacity among the participants to conduct phenomenographic research.

Ind5. Awareness of phenomenography within the CER community

In 2007 we have seen indications of a growing awareness of phenomenography in the computing education research community. Phenomenography has been discussed at some of the leading CER conferences as something that is taken for granted. This can be illustrated by the comments of an anonymous reviewer on a phenomenographic paper that was submitted to a CER conference by one of the authors of this paper. The paper included an extensive introduction to phenomenography, which led the reviewer to state: "Over the past few years, due in part to workshops held at [name of conference] and other CER events, phenomenography has become reasonably well known and accepted in the field". The paper was rejected.

Ind6. Resulting events in the CER community

Two PhICER-related workshops or mini-conferences on the use of phenomenography in CER were held in the first half of 2007. The First Australasian Workshop on Applications of Phenomenography in Engineering, Computing and Science Education[11], with eight participants, was organised in Sydney in January, This workshop concentrated on applications of phenomenography and the creation of an Australasian community. The First Nordic Workshop on Phenomenography in Computing Education Research[12], with 17 participants, focused on the development of phenomenography as such to suit application in CER. Many of the participants at these workshops were former PhICER participants, others were recommended to attend by former PhICER participants.

4.2 Did we meet our aims?

Based on these indicators, we judge that we have met our aims (see section 3.1) for the workshops. Our arguments are summarised in the following list:

Aim1. Create an increased awareness and understanding of the use of phenomenography in CER

Indicators Ind4, Individual learning of phenomenography, Ind5, Awareness of phenomenography within the CER community, and Ind6, Resulting events in the CER community, point to the PhICER workshops as having stimulated an increased understanding and use of phenomenography, which was our first aim. Our assumption was that research within the field would benefit from the researchers becoming more conscious about educationally based, non-positivistic research approaches.

Aim2. Offer a hands-on experience with phenomenography

The participants have collaborated on the three joint publications (see indicator Ind1) and on five publications from the subgroups. They have also, in several cases, continued to write and publish phenomenographic papers. We take this as evidence that the second aim is fulfilled.

Aim3. Jointly run a research project, important to CER, and write joint research publications

The third aim, the performing of joint research, is met by the first indicator (publications).

4.3 Individual learning and development of the community

We can trace further effects that are not directly related to our aims, but that we nevertheless judge to be important. In this section we will briefly mention these effects.

Individual/Collective learning: Based on the indicators we can see that the profile of phenomenography in CER has grown. This holds both for individuals (indicators Ind1, Ind4 and Ind5) and for the community at a collective level (indicators Ind1, Ind3, Ind5 and Ind6). Although there are many reasons for this, we argue that the PhICER workshops are important. We base this on there being many PhICER participants among the authors of phenomenographic papers in CER, and on the mini-conferences described in indicator Ind6.

The value of resulting papers: The value of the resulting papers must be seen in the light of their impacts on the community. The papers are parts of ongoing debates both on how to teach computer science and on CER. If the resulting papers progress our understanding of the questions they address, an aim is reached. Since two of the main joint papers were presented only recently, and the other one is still in preparation, we can only speculate on how they will be received in the long term by the community.

Teaching phenomenography: It *is* possible to find new ways to 'teach' educationally based research to a computing science community and to spread an awareness of and interest in phenomenography.

5 Conclusions

In this paper we have described the two PhICER workshops, presenting an overview of their content, their outcome in terms of research papers, and other indicators of success.

We have also argued that the PhICER workshops have opened new questions for research in CER by making a 'new' research approach available to the community. Researchers whose research approaches essentially belong to a single research tradition, such as positivistic research, can benefit from learning and having a hands-on experience with a different way of thinking about and doing research. We believe that a variation in the way a researcher thinks can be a catalyst to help the researcher discern the richness of the variety of available research approaches. She or he would then understand that each approach fulfils different purposes and needs. With a broad repertoire of theoretical knowledge and experiences, she or he is more prepared to undertake the research needed to attain the aims of a new project.

[11] http://www-staff.it.uts.edu.au/~raymond/appphenecse/

[12] http://www.it.uu.se/research/group/upcerg/WSPhenCER

Furthermore, we believe that PhICER has helped to spread some knowledge about research performed within pedagogy. Such competence is useful within our community, since it helps us to 'borrow' and adapt tools from other disciplines instead of re-inventing them.

Finally, we express our hope that PhICER has contributed to the ways in which the participants can tackle different research questions, and that as a consequence our community will perform many new and interesting projects.

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