BRACE Yourself: CS Education Research Is Coming

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Computer science education is a fledgling research discipline. Only recently have CS educators begun to explore important issues and methodologies in computer science teaching. However, without a mature research community or a common theoretical model, it can be difficult to develop a coherent research program. Efforts are duplicated between institutions, projects become mired in methodological problems and experimental rigour is sacrificed. In an effort to combat these problems, Sally Fincher (University of Kent) and Dr Marian Petre (Open University) have developed a method for fostering coordinated research efforts between CS educators from different universities. A group of interested CS educators from various institutions participate in a methodology workshop, followed by a year-long research project where each participant gathers data from his or her own institution, and a second combined workshop for data interpretation and preparation of a research report. The Australasian instantiation of this approach is titled BRACE: Building Research in Australasian Computing Education. The BRACE project currently involves CS Educators from 15 tertiary institutions in New Zealand, Australia and the UK in a study of the determinants of early programming skill. This paper describes Fincher and Petre's methodology, the content of the current BRACE project, and the group's goals for the future.

INTRODUCTION

Over the last six decades, researchers in educational and cognitive psychology have produced a vast body of literature describing the mechanisms of learning for maths, language and reading. Teachers of traditional subjects are able to draw upon this substantial theoretical foundation to guide curriculum development and classroom technique. However, as rapid technological advances create new educational disciplines, it is not always clear how to apply existing human learning theory in the modern classroom. For example, teachers of computer programming will have a number of questions: Is teaching programming like teaching maths, or like teaching a second language? Is it most effective to use drills and rehearsal or to focus on abstract problem solving? Are there different styles of learning that need to be accommodated? And so on. These questions, and myriad others, need to be resolved before we can develop truly effective techniques for programming instruction.

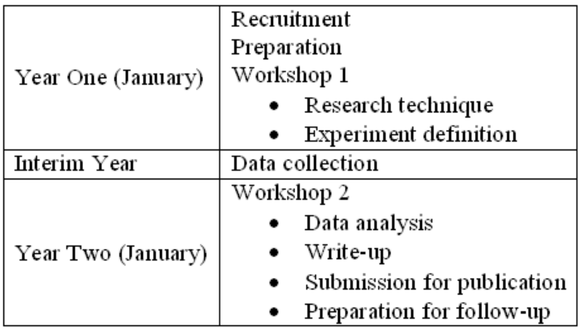
The one thing that needs no further demonstration is that we don't yet know how to teach programming well. The literature is filled with stories of disillusionment and dismay at the difficulty of producing good programmers (Barr, Holden, Phillips, & Greening, 1999; Duke, Salzman, Burmeister, Poon, & Murray, 2000; Robins, Rountree, & Rountree, 2001). Different teaching languages (Adams, 1996; Decker, & Hirshfield, 1994), course structures (Haden & Mann, 2003) and course philosophies (Fincher, S. 1999; Kearsley, & Shenderman, B., 1999; Stein, L. 1998) have all been attempted. The only common result is that most students struggle to learn to program. Even a cursory review of the literature demonstrates the need for a coherent research approach, and a cohesive research community.

However, most people actually working in programming education are teachers, not researchers. Programming education is too new a discipline to have developed the generations of experimentalists that are found in the study of maths, language and reading. Trained as teachers, CS educators often lack the technical knowledge necessary to produce effective research in the educational domain, and lacking research institutions focussed on the topic, their efforts are scattered and poorly coordinated.

It is to be hoped that this is a problem that will resolve itself naturally, given time. A hundred years from now there will, no doubt, be a coherent theory of programming education supported by relevant research. But two computer scientists from the UK are unwilling to wait that long. Sally Fincher of University of Kent and Dr Marian Petre of the Open University, have developed an approach designed to jumpstart the research process in computing education. Their system is designed to gather educators from different universities and provide them with a concentrated dose of technical training and a research experience that will help to build the skeleton for a coherent research community.

STRUCTURE OF THE PROJECT

Fincher and Petre's program comprises two workshops and a group experiment. The basic structure is shown in table 1.



Year One (January)	Recruitment Preparation Workshop 1 • Research technique • Experiment definition
Interim Year	Data collection
Year Two (January)	Workshop 2 • Data analysis • Write-up • Submission for publication • Preparation for follow-up

Recruitment

Interested CS educators are selected on the basis of submitted position papers and CVs. An attempt is made to select participants with a wide range of skills and backgrounds, and especially to encourage those CS educators who wish to increase their personal research activity in CS education.

Preparation

Each participant is required to select a paper – research or opinion – that they found particularly compelling or influential to their educational approach, and to write a commentary on it. The papers and commentaries, along with some supplementary material chosen by the workshop organisers, are provided to each participant in advance. This provides a common basis for discussion before the workshop actually begins.

Workshop 1

Workshop 1 comprises four full days. Fincher and Petre present a highly focussed yet comprehensive overview of issues in human research in general, and CS education research in particular. Presentations are given on basic experimental design, data analysis, research ethics, and the value of developing a strong research community. The workshop also includes a number of group exercises that help participants to delineate their research interests, to learn to focus those interests into testable hypotheses, and to develop skills in conducting empirical studies.

On the final day of the workshop, participants are briefed on their group project. This study is designed and developed by Fincher and Petre. Participants receive detailed experimental materials, background literature, and supporting documentation such as a template for ethics applications. The experimental protocol is discussed in depth with an opportunity for questions, feedback and, if necessary, modifications. Thus all workshop members, even those with limited research backgrounds, are able to participate in a sophisticated and robust research project.

Interim Year

After the initial workshop, the participants return to their home institutions and collect their data for the group project.

Workshop 2

One year after the initial workshop, the group reconvenes with their collected data. The results are pooled, analysed and interpreted, and writing up begins. The final product will be submitted to an appropriate journal for publication.

In addition, at this second workshop, each participant will have an opportunity to discuss and develop his or her future research plans. The hope is that experiencing the research process through the group project will provide the necessary skills and confidence for each CS educator to establish his or her own personal research program. The relationships developed from the workshop will foster collaboration and provide a group of like-minded academics who can furnish feedback and support of future endeavours.

ESSENTIAL GOALS:

In their recruitment literature, Fincher and Petre list the desired workshop outcomes as follows:

“On completion of the program, participants should:

- have a respect for theory, evidence, multiple methods and honesty;
- have a model of what constitutes good research and good research reporting;
- be able to frame research questions and have some idea about how to find out how to investigate them
- be able to conduct a study once specified
- know where to go for additional discourse and support”

Clearly, providing CS educators with these skills will speed the development of an effective research community, with concomitant benefit to the quality of CS education. It is an ambitious list of desired outcomes, but the results of the first three workshop groups show that it is achievable. The current paper will discuss the third workshop project, which is now in progress. Information about the previous two workshop projects can be found at http://depts.washington.edu/bootstrp/ and http://depts.washington.edu/srcse/.

Why This Structure Was Developed

The biggest cost in any community endeavour is the cost of establishing relationships. The workshops put people into a ‘hothouse’ - a place where ideas are nurtured and sustained through intensive interaction. However, the flaw with most workshops is that they end on the last day. Fincher & Petre’s model addresses this by providing explicit continuation of activities, and support for them, when participants return to their own departments. The piece of collaborative research and managed mailing list are designed as scaffolding for the propagation of community: bridging between the delivered content, the energy, and the discourse of the workshops into everyday working practice.

The model aims to consolidate a community of discourse, in which ideas can be generated, tested, examined and extended. The approach has been designed to address directly and effectively the needs and problems faced by emergent CS Education researchers. The approach is cost-effective because “enthusiasm comes free” - the hothouse is efficient and produces a quality of input that it isn’t possible to buy.

The experiences of intensive, extended discourse and the experience of mutually-supported activities have the natural consequence of developing a sustained, enthusiastic and actively participative network, which will carry on remotely. The whole program of activity (over time) is designed to engender skills and confidence that will allow participants to initiate subsequent research and engage in the wider research community.

The Workshop in Australasia

The Australasian version of the project is titled BRACE: Building Research in Australasian Computing Education. The group completed Workshop 1 in January 2004 in Dunedin, and is now in the data collection phase.

The BRACE project is organised by Dr. Anthony Robins from University of Otago in Dunedin, and Dr. Raymond Lister from University of Technology in Sydney. The group has 16 participants drawn from 15 tertiary institutions in New Zealand, Australia and the UK. The focus of the current BRACE project is on the teaching of Introductory Programming, especially on gaining an understanding of why some students take to programming so easily, and other students, who may excel in other academic subjects, find programming a continuing struggle.

During the first three days of Workshop 1, the group received the “training” portion of the workshop and engaged in vigorous and productive discussion of issues surrounding CS education research: its nature, priorities and relevance to real classroom experience. On the final day of the Workshop, the group was given the experimental protocol, and disbanded filled with enthusiasm for the research to be done.

In the intervening months, workshop participants have maintained active e-mail contact providing support on a variety of issues ranging from the exigencies of ethics application to the subtleties of interviewing technique. Data collection is ongoing at all participating institutions. Participants report enthusiasm for the process and pleased anticipation of Workshop 2, which will be held in Australia in January, 2005.

CONCLUSION:

It can take years, even decades, for a comprehensive body of literature to be developed. With computing technology advancing at an unprecedented rate, CS educators simply don't have time to let the research process move at its traditional laborious pace. By collecting a group of interested people, giving them a concentrated dose of research training, and jumpstarting their research programs with a ready-made experiment, Fincher and Petre hope to give CS educators a chance to develop a sound theory of CS education, a supportive research community, and a research-driven understanding of the best teaching approaches for their rapidly developing field.

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