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## **PHENOMENOGRAPHY IN THE CENTRE FOR INFORMATION TECHNOLOGY INNOVATION (CITI)**

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### PHENOMENOGRAPHY IN INFORMATION TECHNOLOGY RESEARCH – THE WIDER PICTURE

Phenomenography has its roots in educational research (Marton and Booth, 1997), but has since been adopted in other domains including business (Sandberg, 1994), health (Barnard, McCosker and Gerber, 1999), information science (Bruce, 1999a,b) and information technology (Bruce and Pham, 2001) as well as information systems. Emerging phenomenographic research in areas other than education, has been interdisciplinary, often bringing together technology, education and a host discipline such as health or business.

In Australia, phenomenography has been used in information technology (IT) related research primarily in Victoria and Queensland. These studies have pursued the latter two of three established lines of phenomenographic research: 1) the study of conceptions of learning; 2) the study of conceptions in specific disciplines of study and 3) the study of how people conceive of various aspects of their everyday world that have not, for them, been the object of formal studies (Marton 1988, p.189). Information Technology researchers have predominantly pursued the latter two lines of research.

At La Trobe University, in Victoria, Australia, the focus has been on information technology, and in particular information systems education, in pursuit of the second line of phenomenographic research. Cope's (2000) study represents a classical use of phenomenography in response to particular kinds of teaching and learning questions – what does it mean to learn about information systems? What kinds of learning outcomes can be found amongst groups of IS students, and what kinds of learning outcomes are desirable? Students' different ways of seeing information systems have been the object of investigation, providing insights into how students ways of seeing differ from the views of experts in the field. The differences identified are educationally critical, in that each way of seeing information systems involves different ways of assigning meaning to, and perceptually structuring, such systems. Phenomenography has also been used to explore how information systems are conceived by academics, students and practitioners (Cope, Horan and Garner, 1997).

In the broader field of IT Education, in Sweden, Booth (1992) has similarly investigated students' different ways of conceiving programming and learning to program. Berglund (2002) has investigated variation in computer science students' understanding of networking protocols, and McDonald (2002) is opening an investigation into computer science students' experience of algorithmic thinking. If we accept that the character of university learning involves achieving a level of competence which involves seeing the world as experts do (Bowden and Marton, 1998), then educational research like this is critical to the design of effective professional education, and of some importance to information technology educators.

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The first phenomenographic investigation in Queensland, into ways of seeing information systems, was conducted by a team of Geographical Information Systems (GIS) and geography educators and researchers in Brisbane and Perth (Gerber, Buzer, Worth and Bruce, 1992). Twenty-six GIS vendors, Government and industry users, as well as educators and researchers were asked to describe their experience and views of GIS, including how they would use GIS for particular tasks. Outcomes of the investigation revealed that GIS were experienced in five qualitatively different ways, each involving different foci. GIS were found to be experienced as 1) a graphics interface - foci on a user and the graphical interface; 2) a geographical data organizer - foci on the user and the underlying database; 3) data collection representation - foci on the user, the graphical interfaces and the database; 4) the process of interaction between an expert in geographical information and extensive datasets to solve geographical problems - foci on an expert user and problem solving; and 5) an evolving spatial technology - foci on an expert user and research and development. Clearly the more sophisticated ways of interpreting GIS are associated with different foci, raising important questions for university and workplace educators, researchers, systems designers and implementers. What kinds of educational strategies will elicit and expand the foci of learners? How can systems be designed to facilitate more sophisticated ways of experiencing the technology?

#### PHENOMENOGRAPHY IN INFORMATION TECHNOLOGY RESEARCH – THE CENTRE FOR INFORMATION TECHNOLOGY INNOVATION.

At the Queensland University of Technology, largely in the Information Systems Management Research Centre, and now the Centre for Information Technology Innovation, the focus has been on information and technology experiences in both educational and workplace settings. A growing group of researchers here have been concerned with the second and third line of phenomenographic research, investigating people's experiences that have and have not been the formal object of learning. Those pursuing the third line of research are interested in investigating the different meanings associated with working with information and technology, in both workplace and community settings, with implications derived for education, training and systems design. Those pursuing the second line of research are interested in learning at both the collective level (research) and at the individual level (student learning). Taken together the studies are beginning to provide some insights into the views of students and researchers about aspects of the information technology discipline. Such insights have potential for use in both undergraduate and postgraduate studies, in developing the research community and in consultancy applications.

The studies and references to papers here are not intended to be exhaustive, however they do represent most of the work in this area conducted by researchers in the Centre to date.

#### **A first investigation into information use**

The first investigation completed by a researcher in what is now the Centre for Information Technology Innovation (CITI), investigated variation in ways of experiencing effective information use (information literacy), (Bruce, 1997, 1999a)

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and was conducted in Australian universities. Sixty academics, librarians, IT professionals, academic developers and student learning advisors described their experience of using information effectively at work, and made observations about colleagues and friends. Outcomes revealed that professional employees, in technologically sophisticated workplaces, experience information literacy as 1) using IT for information awareness and communication – focus on IT; 2) finding information from appropriate sources – focus on information sources; 3) executing a process – focus on information process; 4) controlling information – focus on information control; 5) building up a personal knowledge base in a new area of interest – focus on critical analysis; 6) working with knowledge and personal perspectives in such a way that novel insights are gained – focus on intuition; and 7) using information wisely for the benefit of others – focus on personal values.

Critical insights included the need for technology to be increasingly unobtrusive as information use becomes more sophisticated, the significance of collaboration or interdependence between colleagues and the need for partnership of information intermediaries. Questions arise for managers interested in fostering learning organizations, staff development and change management; information systems managers interested in training and education of systems users; and educators preparing learners for their chosen profession. How can university students and professionals be helped to use information more effectively; both through systems design and professional development or educational programs? How can the different foci be effectively harnessed in fostering workplace cultures suited to knowledge management and learning organizations? This investigation also served to raise awareness of the potential of phenomenography as a research approach to the information science domain (Bruce, 1999b).

### **Investigations into aspects of student learning in information technology education**

The investigations into student learning thus far have been conducted in a range of different discipline areas including programming, information studies, and information management. New investigations are likely to be implemented in the area of learning about data networks. Investigations have yielded interesting information to teachers working in particular sub-disciplines. There have not, however, been sufficient studies in any one area to yield theoretical insights that may be of interest to other sub-disciplines or to suggest an emerging theoretical framework specific to information technology education.

Klaus (2000) investigated the varying conceptions of thesaurus use amongst neophyte researchers searching social science databases. Approximately ten participants discussed their experience of searching indexing and abstracting databases, and were encouraged to attend to how they worked with thesauri in that context. Three different kinds of experience were discovered. In the first, category 'zero', the thesaurus is essentially indistinguishable from the database, it is neither seen nor understood by the user who simply enters keywords and scans extensive sets retrieved for relevant data. In the second, category one, the thesaurus is experienced as an intrinsic part of the database, essentially inseparable from it. Searchers with this perspective use the thesaurus to improve their searching, essentially to broaden and refine queries. In the third and final category the thesaurus is understood as an entity separable from the

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database, the internal structure of the thesaurus is recognized; and its evolving nature, and therefore its deficiencies are understood. Implications of this research may be drawn for both education of database users and for database design, in order to maximize the value of thesaurus features for users.

Bruce and Middleton (1999) explored variation in postgraduate coursework students' approach to portfolio style assessment in the Faculty of Information Technology. Portfolios were one of a number of strategies used to assist students to reflect upon and engage in professional practice opportunities, including fieldwork, peer review and colloquia. A phenomenographic investigation suggested that students approached their portfolio experience in four different ways. Approach A is labelled an assessment oriented approach, Approach B an employment oriented approach, Approach C a reflective approach and Approach D a combination of the pragmatic and reflective. Students' approaches and responses to the portfolio experience suggested a range of strategies for use in learning experiences.

Working with students from a range of faculty's studying in the Faculty of Information Technology, Edwards and Bruce, (2002) have investigated experienced variation in learning to search the internet. Four critically different categories have been found to date, with the possibility of more being uncovered as the investigation is widened to incorporate first year students. Each category is associated with different approaches to learning and appears to be associated with different search outcomes. The outcomes of the investigation are being used to redesign assessment and learning experiences in the relevant unit, and resources for academic staff development are being prepared.

The most recent phenomenographic project in CITI has as its research object, students' experience of learning to program. Teaching and learning of programming is internationally recognised as a challenging area. In the Faculty of Information Technology the focus to date has been on investigating students' experience of the act of learning to program, that is how they see themselves as going about learning to program. Our first investigation has revealed differences in the experience of students learning in introductory programming units (Bruce, McMahon, Buckingham, Hynd and Roggenkamp, forthcoming). Implications for teaching of the different categories found have also been explored with members of the teaching team.

Future developments in the area of researching students' experience and understanding are likely to be in the areas of learning to program and learning about computer networking and data communications.

### **Investigations into aspects of information technology researchers' collective consciousness.**

Since 2000, two projects have been conducted into learning at the collective level in the information technology discipline. The first examined variation in the research community's views about the significance and value of IT research projects. The project raised the following questions: What are the different ways in which significance and value are constituted by academics and by industry professionals? Investigating the views of academics and industry professionals separately allowed the commonalities and complementarities in their ways of seeing to be revealed. This

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project is reported in Bruce, Pham and Stoodley (2002 a,b), and Pham, Bruce and Stoodley, (2002). The second project (Bruce, Pham and Stoodley, 2002c) enquired into researchers' views of information technology research, its objects and territories. Both projects were completed in the hope that they may, through making complementarities visible, improve communication between different groups of researchers and facilitate the development of intradisciplinary research projects. While the end goal is still a matter for the future, the outcomes are of significant interest for research students and supervisors and the pedagogy of postgraduate supervision.

A conceptual investigation of the collective consciousness of information literacy research formed a prelude to the above investigations (Bruce, 2000).

### **Investigation into varying experience of phenomena in the information technology industry and community context.**

Investigations conducted into experience of phenomena in the industry and community context have occurred in the information systems sub-discipline.

Interest in knowledge management and enterprise resource systems have been combined to investigate senior managers' understandings of knowledge management in the context of enterprise systems (Klaus and Gable, 2000). Six interviewees from major ERP vendors, consulting companies and government agencies participated in extensive interviews (up to seventy-five minutes) focusing on their experience of knowledge management. The depth of data proved sufficient for a phenomenographic analysis, revealing three differing categories of experience: Knowledge management is seen as 1) change management for implementing and maintaining an ERP system; 2) corporate information management based on and beyond an ERP system; and 3) integrating corporate information management and change management by means of an ERP system. Each of these different ways of experiencing knowledge management is associated with a set of foci that is configured differently in each specific experience, namely temporal – the phase of the system life cycle concerned; social – the categories of people involved; topical – the object of knowledge management, i.e. the system, business processes or data, or the business environment; dynamic – the state of information preferred; and instrumental – formal aspects of knowledge management such as the use of databases, templates and decision rules. Surprisingly, this group made no distinction between information management and knowledge management. The research outcomes provide an important aid to communication, surfacing major differences in ways of thinking about knowledge management between vendors, consultants and client groups.

The business-IT relationship has also been subject to phenomenographic investigation (Stewart and Klaus, 2000). Twenty two senior business executives, IT executives and IT managers were interviewed to elicit their experience of leading business and IT executives, and to probe the relationship between Business and IT professionals. Four distinctive ways of experiencing that relationship were identified: 1) an impersonal relationship in which one party undertakes a simple transaction of service with others; 2) An ambiguous relationship in which both parties are enmeshed in conflict prone contexts; 3) A supportive relationship characterized by both parties referring to each other in a positive manner; and 4) A lateral-creative relationship in which either the

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business executives or the IT function assume the leading role in providing for the organisation's strategic framework. These outcomes provide a model for characterizing Business-IT relationships in a range of organizations and may be applied to determine the 'health' of the relationship between these groups. Thus issues arise for chief executive officers, senior executives personally involved in such relationships and consultants with a focus on the Business-IT function. How can we discern what kind of relationship exists? How do particular kinds of relationships come to be established? How can existing relationships be reconstructed to form more synergistic practices?

McMahon and Bruce (2002) report an investigation into the information literacy needs of local staff in cross-cultural development projects. The project explored development workers' perceptions of information literacy needs amongst staff participating in community development projects in cross-cultural situations. Five qualitative different understandings of information literacy needs within development contexts were discovered; with the results revealing possible directions for those involved in bringing information and communication technologies into workplace settings within developing communities.

Stewart, as part of a broader study into information technology leadership using an action research framework (Stewart, 2001), investigated variations in conceptions of leadership success. The phenomenographic sub study attended particularly to ways of seeing leadership amongst senior business, including information technology executives. A key finding from the study was that the view of leadership adopted by information technology executives often differed from those adopted by their business counterparts. Papers associated with this study include Stewart (1998, 1999, 2000).

## SUMMARY

This paper has provided an overview of the research being undertaken by a number of groups in the Centre for Information Technology Innovation at the Queensland University of Technology. The work embraces a number of areas including investigations of student learning, the experience of industry professionals and information technology researchers' collective consciousness. The insights yielded are still fragmented but provide an interesting picture of how phenomenography is being used in one discipline for a range of different purposes.

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