Relationship between academics' educational beliefs and conceptions and their design and use of computer software in higher education

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Understanding the influence of information technology on student learning cannot be accomplished without reference to the epistemological and educational assumptions of the academic teachers who design and use computer-facilitated learning (CFL) programs.

The focus of the paper is the first stage of an ARC project in which thirty-six technology-based CAUT projects from a number of disciplines were examined. This study was based on archive material only (the initial application and final report for each project). Projects were sorted into categories in each of which the educational presumptions and practices were similar. Categories were then compared and refined.
so as to reveal their major sources of similarity and difference. The resulting framework is one in which the use educational technology in higher education can be interpreted in terms of several key qualitative dimensions which reflect academics' beliefs about the origin of knowledge, the learning framework, control of the direction of learning, the nature of the knowledge and of the learning process.

The research reported here is the first of two studies concerned with the relationships between academics' educational beliefs and conceptions and the ways in which they design and incorporate computer-facilitated learning (CFL) into their course units.

The impetus for the work came from recent interest in the beliefs and understandings that academics bring to their teaching in general (Fox, 1983; Samuelowicz & Bain, 1992; Trigwell, Prosser & Taylor, 1994) as well as to their use of educational technology (Bain & McNaught, 1996; Laurillard, 1993). The importance of educational beliefs and conceptions in framing educational practice is now becoming apparent in the school sector, despite the countervailing influence of educational training (Clark & Peterson, 1986; Kagan, 1992; Pajares, 1992), and it is to be expected that similar belief framing will be observed in higher education, particularly as most academics have not undertaken educational training and do not refer to educational literature when developing their teaching practices (Laurillard, 1993; Ramsden, 1993).

There is some research suggesting that academics' educational beliefs
do frame their teaching practices (Ballantyne, Bain & Packer, 1997; Trigwell & Prosser, 1996), but more work is needed to uncover the details of the relationships involved, particularly in relation to the use of educational technology (Reeves, 1992).

An additional motivation for the present research derives from the urgent need to understand the influence of CFL on student learning (Laurillard, 1993; Wills & McNaught, 1996), acknowledging that the evaluation of any educational innovation is complex (Reeves, 1997) and is not fully addressed by methods designed primarily to establish that CFL is superior to conventional techniques (in which context it has been argued that CFL has no influence beyond the pedagogy realised in the technology--Clark, 1992). Although the research reported here is not directly concerned with the evaluation of learning outcomes, it is concerned with the educational context in which technology is used, because, as many have observed, the impact of technology cannot be understood without reference to its place in the whole teaching/learning environment (Crook, 1994; Elton, 1988; Laurillard, 1993; Reeves, 1997; Wills & McNaught, 1996).

Two literatures are of immediate relevance to the present research: studies concerned with academics’ educational beliefs and conceptions (Dall'Alba, 1990; Fox, 1983; Kember & Gow, 1994; Martin & Balla, 1990; Prosser, Trigwell & Taylor, 1994; Samuelowicz & Bain, 1992) and recent work exploring pedagogical frameworks for interpreting and evaluating the role of CFL in education (e.g., Perkins, 1991; Reeves, 1992).
We'll briefly consider these in turn.

Academics’ educational beliefs and conceptions

Research into academics’ educational beliefs and conceptions is of relatively recent origin and has not yet converged on a common framework, although there is some agreement that a major difference between academics can be captured by the distinction between teacher-centred and student-centred views (Gow & Kember, 1993; Prosser, Trigwell & Taylor, 1994; Samuelowicz & Bain, 1992). In the framework reported by Samuelowicz and Bain, for example, five different sets of beliefs were found to be sufficient to describe the educational orientations of academic staff sampled from science and social science disciplines. As shown in Table 1, educational beliefs are arranged as contrasts on qualitative belief dimensions in this framework, while orientations are the distinguishable patterns of beliefs expressed by groupings of academic staff. The five orientations described by Samuelowicz and Bain indicate the range and character of views which range from imparting information (teacher-centred) to supporting student learning (student-centred). Similar patterns of conceptions/beliefs have been reported by Prosser, Trigwell and Taylor (1994) for science academics.
Table 1

Teaching/learning orientations reported by Samuelowicz & Bain (1992)

This table can be viewed at the following web site:


The teacher-centred/student-centred ordering of academics' orientations to teaching and learning would appear to correspond with the contrast between instructional and constructivist approaches to CFL (Boyle, 1997; Reeves, 1992; Reiber, 1992). Instructional CFL, for example, emulates teacher-driven learning episodes in which there is limited scope for the student's understandings and interests to be accommodated. Constructivist CFL, on the other hand, emphasises the role of the student in structuring and managing the learning experience and in building an adequate understanding for themselves. However, as we will note in more detail below, the picture may turn out to be more complex than this juxtaposition would suggest.

Some frameworks for interpreting CFL

We will not pretend to do justice in this section to the wealth of sophisticated analysis of educational technologies which is now available (e.g., Boyle, 1997; Crook, 1994; Dills & Romiszowski, 1997; Jonassen, 1996; Khan, 1997; Laurillard, 1993; Müldner & Reeves, 1997).
Rather, our purpose is to characterise some useful frameworks for the research we are to report.

One approach to the analysis of CFL is to group applications into functionally similar categories and highlight the learning processes and outcomes which are likely to be ‘afforded’ by each category. The instructionist/constructivist contrast noted above is one such grouping, and of course it can be elaborated to take account of important variants (e.g., Boyle, 1997, p. 108). Perkins (1991), who was concerned with this contrast, analysed the resources typically found in classroom learning environments, resulting in a classification that includes educational technology:

* information banks (provide content information, such as textbooks, databases);

* symbol pads (general purpose tools that support cognitive tasks, such as calculators and wordprocessors);

* construction kits (domain relevant tools such as lab equipment, and authoring and modelling software);

* phenomenaria (packages that make phenomena accessible to scrutiny and manipulation, such as videos, microworlds, simulations); and

* task managers (what runs the learning process, such as teachers,
Although this scheme is valuable for the sorts of purposes that Perkins was pursuing, it has the disadvantage of all such schemes of focusing exclusively on the prototypical properties of CFL. This may be appropriate in circumstances where the learning environment is largely defined by the technology, but these circumstances are rare. In higher education CFL is usually only one of the teaching/learning resources deployed, and the method of its use may depend both on the other resources available and the particular purposes to which the CFL is directed. For example, an academic located towards the student-centred end of the Samuelowicz and Bain (1992) scheme might use a drill-based CFL (a task manager in Perkins' scheme) as a complement to more 'constructive' learning activities which themselves may or may not be implemented as CFL (cf. Crook, 1994, pp. 14-15). On the other hand, a teacher-centred academic might use drill-based CFL as one of several teacher-centred methods. The learning processes and outcomes in the two contexts are unlikely to be the same in character. And, more to the point of the present research, without attending to the broad character of the teaching/learning environment, it might be difficult to fully understand the connections between academics' educational beliefs and their CFL practices.

Consider another hypothetical example of an academic who develops a simulation to demonstrate the properties of a system that is difficult to study in reality. This CFL might only be used in lectures, or it
might be made available to students to use in association with exercises and assessments. Again, operating only on the prototypical features of the CFL, we might infer that its potential influence on learning is quite substantial, and that the thinking behind its development was prototypically student-centred, but neither may be correct.

In short, although the various CFL classification schemes now available draw attention to the potential properties of CFL packages, we are interested in how CFL is actually used, partly because from an educational perspective, that is what we need to know to understand its likely impact on student learning, but also because we suspect that we will not adequately understand the linkages between academics' educational beliefs and their use of CFL without close attention to how the CFL is deployed. However, as will be noted in detail in the Methods section, we have not abandoned the use of classification; on the contrary, categories of CFL practice are an important feature of our method. Nevertheless, the classifications we have adopted are grounded in the practices of academics rather than being determined a priori by the prototypical properties of CFL packages.

An alternative approach to the analysis of CFL is to evaluate each case against suitable criteria. Laurillard (1993), for example, argues for twelve processes derived from a conversational analysis of effective teaching and learning in higher education. The presumptions of this analysis are that learning occurs as students are assisted (through
conversation and related supports) to translate fluently between
descriptions of the world and the abstract conceptualisations favoured
by academic analysis. This is both a teacher-driven and student-driven
process in which both participants share their understandings
(conceptions) and dialogue is adapted by the teacher to ensure that the
student's understanding approaches that of the teacher. This certainly
is not a process in which students are left to their own devices, nor
is it one which relies on one-way instruction, and hence it has the
potential to reflect the range of belief orientations described in the
literature. Moreover, it would be possible to apply Laurillard's
criteria to whole learning environments rather than to classes of
educational media (as she did), but we elected to adopt another
approach, about which more will be said in a moment.

An alternative to Laurillard's approach is the 14 pedagogic dimensions
proposed by Reeves (1992). Whereas Laurillard's criteria derive from
conversation analysis, Reeves' bipolar dimensions derive from the
constructivist literature and tend to oppose characteristics associated
with constructivist and instructivist approaches (examples are:
epistemology (objectivism vs constructivism); pedagogical philosophy
(instructivist vs constructivist); goal orientation (sharply focussed
vs unfocussed); value of errors (errorless learning vs learning from
experience); structure (high vs low); learner control (non-existent vs
unrestricted); user activity (mathemagenic vs generative)). These
dimensions are not intended to be independent or exhaustive, but they
are continua rather than qualitative categories. Reeves provides
analyses of two CFL packages to demonstrate how each has a distinctive 'profile' across the dimensions, one 'located' towards the instructivist end of the continua, the other towards the constructivist end.

As with Laurillard's criteria, we could have adapted Reeves' dimensions to our purposes by rating the overall CFL environment of each case in our sample, but our preference was to allow the dimensions (in addition to the categories) to emerge from the data rather than be overly framed by any one theoretical perspective. We also did not wish to be constrained by assumptions about the nature of the dimensions. Those used by Samuelowicz and Bain (1992), for example, involve qualitative distinctions (different beliefs), those advocated by Reeves (1992) are continua, but we wanted to keep the options open. It would be disingenuous of us to imply that we approached the analysis from a fully neutral position (see Bain & McNaught, 1996, for example), but our intention nevertheless was to develop categories of CFL practice, and the dimensions needed to describe that practice, as much as possible from the cases in front of us. Moreover, given our overall intention to seek the connections between academics' educational beliefs and CFL practices, we anticipated that the categories and the dimensions would incorporate aspects of educational beliefs.
Method

Sample

This study was based entirely on archival material and was designed in part to provide the sampling plan for a second study drawing upon extensive interviewing as well as archival material. The cases included in this study (and in the second one, which is now in progress) were funded by the Committee for the Advancement of University Teaching (CAUT), a federal government organisation which operated in Australia from 1993 to 1996. The sample was restricted to CAUT-funded projects because the documentation required by CAUT required academics to attend to the educational framing of their projects as well as to the learning processes and outcomes involved. Thus there was some prospect of gaining access to information about educational beliefs as well as about CFL design and implementation.

All 36 projects included in the present study involved the implementation of CFL, and were in progress during 1993-1994. Later projects could not be included (but are being sampled for the second study) because we required both the project application and the final report for our analyses. Final reports were not due until 18 months after commencement, but some 1994 project reports were not available until late 1995. The discipline into which the CFL was embedded was not a feature of project selection for the current study. An analysis of disciplines across the sample indicated that 21 were from science
disciplines, 8 from medical disciplines and 7 from humanities disciplines. Six projects were omitted because the technology was used as a measuring instrument, design tool or training tool, rather than as a tool to enhance teaching and learning.

Analysis

The two documents for each project (grant application and final report) were analysed jointly with the 'conceptual field' method of Samuelowicz and Bain (1992). Ideally, the first phase of this procedure involves the formation of categories of projects based on global impressions formed through the constant comparative method (Glaser & Strauss, 1967). In practice, because of the wealth of detail involved, it was necessary to make notes to summarise the salient details of each project, and this inevitably drew attention to their properties. However, the main focus at this stage remained on forming stable impressions of the global similarities of cases within a nascent category, and the global differences between categories. Once stable categories were formed, emphasis shifted to the second stage which involved a systematic comparison of the categories to reveal the major bases (dimensions) upon which they were similar and different. Note that this process operated at the category, not the individual project level, with the consequence that similarities and differences that might have been apparent between individual projects were disregarded unless they applied at the category level as well. The third phase required that each project be checked against the dimensions to ensure
that the descriptions applying to its category also applied to it
individually.

The above characterisation of the analysis method, while broadly
correct, is something of an idealisation of what actually happened. We
began the first phase with two coders working independently to gain
some sense of how 'compelling' the categories might be. There were
many similarities in the two categorisations, but there also were
differences, from which we inferred that there were conspicuous and
subtle differences between the projects, the latter lending themselves
to different emphases. An intensive two-day meeting resulted in a
substantially agreed set of categories and first approximations to the
dimensions, but the process was a complex one in which discussion
shifted between categories, dimensions and cases in a type of mutual
constraint satisfaction process. Subsequently, during detailed
checking of cases against the descriptive framework (third phase), we
found that a few cases did not adequately fit the category into which
they had initially been placed and this resulted in the a rechecking of
the descriptive framework before cases were reassigned. Interspersed
amongst all these deliberations were repeated attempts at refining our
terminology to ensure that it adequately characterised all cases in the
sample. So, in reality, the phases were more like the emphases of an
iterative process aimed at satisfying four constraints: the categories,
their dimensions, the category membership of each project, and the
terminology used to describe the salient features of categories. We do
not claim that the framework we report here is the only way to
interpret the data, but we are confident that it is defensible, reproducible and a credible description of the data available to us.

Findings

Preliminary observations

Nothwithstanding the reporting requirements of CAUT, the documents available to us varied considerably in the extent to which they made the academic's teaching and learning assumptions clear, and in the detail they provided about the teaching/learning environment in which the CFL was deployed. These limitations probably resulted in fewer overt belief dimensions than might be obtained from an interview study (such as we are now conducting), and we tended to emphasise properties of the CFL more than anticipated. However, it should be noted in relation to the last point that it was not the type of the CFL that distinguished between the categories (Table 3, last column), but rather the way in which the CFL was used by students, and the structure and support associated with its use, whether 'built in' or supplied in other ways.

As far as we were able to discern, the CFL in most of the projects was congruent with the teaching, learning and assessment practices of the course unit. That is, most academics in the sample designed CFL that supported their expressed educational framework and objectives, although in some cases the implementation fell short of desired goals.
for technical or resource reasons, or it was altered in response to student evaluation. There were few instances in which the CFL was used 'out of character' as a complement to the prevailing teaching/learning environment.

Three major categories emerged from the conceptual field analysis, within each of which there are a number of subcategories. A broad outline of the major categories follows, and the detailed categories are given in Table 3.

Category 1 is characterised predominantly by the fact that students are encouraged to construct their own defensible interpretations of the knowledge base through examining evidence and considering different perspectives. Students follow their own lines of reasoning within the framework provided by the academic which is designed to foster the development of critical reasoning skills.

Category 2 is characterised by teaching and learning situations in which students are given some freedom to explore concepts and ideas within the domain structure. The notion that students should actively engage with and explore concepts in order to enhance or change their existing conceptual understanding is embraced by the academic. Tasks generally are open-ended in nature with the academics providing varying amounts of guidance and structure to the students’ own
construction process.

Category 3 is characterised by teaching and learning situations where the academic takes responsibility for structuring the domain concepts in the way in which they should be received by students. Activities are usually closed in nature, focusing on students being able to review and reproduce the understanding modelled for them by the academic.

The dimensions

Five qualitative dimensions emerged that both united projects within a specific category and kept them distinct from other categories. The dimensions identified are sketched below, while details are provided in Table 2:

1. The learning framework refers to the degree of structuring provided by the teaching/learning environment, ranging from facilitated (in which the support is akin to 'semiotic mediation'--Brooks, 1994, pp. 85-88), through guided (a stronger sense of what is required), to structured.

2. The origin of the knowledge (student/collaborative, academic/discipline) refers to the source of the knowledge base itself and its openness to alternative defensible interpretations.

3. Learning directions (student-managed/ teacher-managed) refers to
the extent to which students have control in selecting their own pathways through the knowledge base.

4. Knowledge focus refers to the focus of the teaching and learning environment (conceptual/procedural reasoning, conceptual/procedural knowledge, case-based reasoning).

5. The learning process refers to the design and implementation of the teaching activities and learning opportunities provided.

The classification framework

Table 3 summarises the classification framework developed during this study. The table shows the combination of dimension descriptions which define the categories and sub-categories.

Category 1 is distinguished from the other categories because students are required to develop their own interpretations or arguments assisted by the CFL. Thus the origin of knowledge is the student (or the student in collaboration with the teacher) and the learning process is one which involves challenge to existing interpretations as new ones are constructed. Within this process there are different levels of teaching support sufficient to distinguish two subcategories, namely 1a in which the learning framework is facilitated (in the sense of 'semiotic mediation' emphasised by Crook, 1994, pp. 85-88), and 1b in which guidance is provided through questioning, feedback or good
practice exemplars.

Category 2 differs from Category 1 in focusing on discipline knowledge, often with less scope for full knowledge construction, although students manage the directions of their learning, as in Category 1. Three subcategories derive from the learning framework, the learning process and the focus of knowledge. In 2a for example, the CFL and associated pedagogy is designed to facilitate learning (there is 'semiotic support'), whereas in the other subcategories a clearer sense of the correct or preferred interpretations is conveyed by such means as feedback or model answers. The other subcategories differ in the learning process they encourage, partly as a consequence of the focus of the knowledge (case-based reasoning in 2b, conceptual and procedural knowledge in 2c).

Category 3 differs from the other categories because its learning framework is more structured, the learning directions are substantially determined by the CFL, and the learning process is more passive. The subcategories differ in their learning processes, 3a being concerned with the emulation of discipline ideas and skills, 3b with the uptake of factual knowledge.

Tables A.1-A.4 in Appendix A provide brief descriptions of projects which illustrate four of the subcategories. These descriptions are organised in terms of their constituent dimensions, but in project-specific detail and terminology.
Table 2

Details of the qualitative dimensions

Learning Framework

Facilitated

Learning opportunities are created in which students are encouraged to actively explore the subject/content matter in their own way and build/challenge their own knowledge representations.

Guided

Learning opportunities are provided in which students are able to explore the subject/content matter in their own way but the process is actively guided through feedback, model answers or good practice exemplars.

Structured

The learning opportunities provided are highly structured. Information is provided and students are given set tasks to perform using the given information.

Origin of Knowledge
Student/Collaboration

Knowledge resulting from the reasoned interpretation of information.
Different equally valid interpretations of the same information are possible.

Academic/Discipline

Knowledge that is drawn from a well-defined discipline base with a received interpretation.

Learning Directions

Student-Managed

The student is given freedom or opportunity to explore her/his own lines of reasoning or questioning within the knowledge domain.

Teacher-Managed

The teacher controls the flow of information, questioning and directions pursued within the program. A student may be free to review an aspect of choice but then, within that area the paths are laid down by the teacher.
Table 2 continued

Knowledge Focus

Conceptual/Procedural Reasoning

The development of higher order thinking, reasoning and metacognitive skills used in conjunction with discipline concepts, principles and procedures.

Conceptual/Procedural Knowledge

The content, concepts and principles of a discipline and the associated procedural skills.

Case-Based Reasoning

The development of professional reasoning or decision-making skills in the application of knowledge to case-based problems.

Learning Process

Knowledge Construction/Challenge

Students are challenged to consider presented information from
different perspectives or reconsider their own understandings so as to construct new interpretations.

Knowledge Elaboration/Challenge

Students are provided with learning opportunities that extend and/or challenge their existing conceptual understanding or interpretive skills often by allowing them to explore the consequences of their interpretations.

Knowledge Synthesis/Elaboration

Students are required to synthesise knowledge from a variety of sources often to solve case-based problems. Through this process their conceptual understanding may be elaborated.

Knowledge Elaboration

Students are invited to explore nuances of concepts, find new examples and extend their existing understanding of the concepts.

Knowledge Emulation

Ideas/concepts are connected and understandings developed in line with
the received wisdom of the discipline base. The aim is for students to be able to emulate expert understanding and thinking.

Table 2 continued

Knowledge Assimilation

Factual knowledge is presented in a fairly fragmented way with little structuring, elaboration or transformation required of the students who instead are to assimilate the knowledge.

Table 3: The categories described in terms of their distinguishing and unifying dimensions

This table can be viewed at the following web site:


Discussion

The categories

One feature of the categories reported above is that they represent a range of views between teacher-centred (Category 3) and student-centred perspectives (categories 2 and 1), consistent with the research on
academics' educational beliefs and conceptions (Kember & Gow, 1993; Prosser, Trigwell & Taylor, 1994; Samuelowicz & Bain, 1992). The numbering system we have used implies an ordering along such a continuum, but at best that ordering is a simplification of the complex patterns of beliefs and practices constituting the differences between categories. For example, part of the teacher- vs student-centred variation is reflected in the learning framework in which the CFL is embedded (whether it is structured, guided or facilitated by the CFL or associated support), but that dimension alone does not distinguish between the three major categories. The origin of knowledge is relevant (1 vs 2 and 3) as are the ways in which the directions of learning are managed (3 vs 1 and 2) and the way in which the learning process is conceived (1 vs 2 vs 3). One conclusion we draw from this is that no single continuum, like teacher-centred vs student-centred, or Reeves' (1992) pedagogical philosophy (instructivist versus constructivist), is likely to characterise the differences between academics' beliefs and practices adequately. These involve a mapping of multiple dimensions onto one, a convenient shorthand which captures some but not all of the differences of importance.

Another feature of the categories, one which is most apparent in the dimensions, is that they were not formed to capture the academics' educational beliefs (specifically), nor to capture their CFL and related practices (specifically). Rather, the categories were formed to represent the overall similarities and differences between the educational contexts described in the archival documents. Thus the
categories are composites of beliefs and practices, as indeed is the set of pedagogical dimensions proposed by Reeves (1992). From the standpoint of positivist research this could be seen as weakening our ability to make any claims about the relationships between beliefs and practices. From that perspective we would require operationally distinct sources of evidence about beliefs and practices to which some form of relational analysis is applied (cross tabulations, for instance). While not eschewing such an approach (we will explore it with the data from Study 2), we also endorse the view articulated by Marton and Svensson (1979) that it is appropriate to examine the kinds of relationships of interest here with an 'internal relatedness' method, one which seeks the best qualitative fit between descriptions and relations and adjusts both until such a fit is achieved. Although we did overtly undertake such a process in the present study, we nevertheless have produced a descriptive framework in which beliefs and practices are seemlessly knitted together in each category. We do not pretend to have exhausted either the belief or practice descriptions that may be necessary to accommodate the full range of academics' uses of CFL, if only because of the limitations of our data. However, we do claim that the categories give some sense of the complexity and diversity that is involved, and how the 'parts' fit together to form coherent patterns. In short, there are relationships between beliefs and practices evident in our data even if the dimensions cannot be labelled as one or the other.
If we move into a form of 'external relatedness' mode for a moment, it may be worth noting that there are some rough correspondences between the belief orientations reported by Samuelowicz and Bain (1992) and the categories reported in Table 3. For example, categories 3a (which emphasises expertise emulation) and 3b (knowledge assimilation) appear to share features with the transmitting knowledge and imparting information orientations respectively of Samuelowicz and Bain. Also, category 1 of the present scheme is differentiated from category 2 partly in terms of the origin of knowledge (whether it is created by the student, or the received wisdom of the discipline). This distinction is the basis of the difference between supporting student learning and changing students' conceptions in Samuelowicz & Bain's orientations. In their sample student creation of the knowledge was linked with postgraduate education, but in our sample it was associated with undergraduate projects in which alternative interpretations were acceptable if appropriately defended (for example, the project summarised in Appendix A, Table A.1.). We regard these possible connections between our work and Samuelowicz and Bain's study as just that-- possibilities to be explored once we have appropriate data to hand.

The last point we wish to make in relation to the categories is that they do not map in any systematic way onto the types of CFL involved (Table 3, last column). Although we have characterised the CFL in terms of Perkins' (1991) scheme, much the same conclusion follows from
other typologies. So, what the categories represent are
teaching/learning environments in which CFL is foregrounded, not types
of CFL. This is a non-trivial point. Most of the available analysis
of CFL is focussed on the prototypical properties of the technology,
with minimal attention to its function and impact in real
teaching/learning environments. Our framework, although more 'messy',
has the potential to describe and interpret the ways in which CFL is
deployed in higher education.

The dimensions

Relative to the 12 processes proposed by Laurillard (1993) or the 14
bimodal dimensions of Reeves (1992), our 5 qualitative dimensions
appear rather frugal. This may or may not be an issue, depending on
one's purposes. The analytic procedure used for this study limits the
number of descriptive dimensions to those needed to characterise the
similarities and differences between categories, not cases. More
dimensions, and distinctions on dimensions, might be appropriate if
cases were the focus of the analysis, a prospect we encountered
repeatedly as we cycled between levels of analysis. Several dimensions
were near to inclusion, but ultimately were omitted either because they
did not operate at the category level or because some case documents
did not include sufficient information to enable a judgment to be made.
Table 4: Comparison of the dimensions of the present study with those of Reeves (1992) and Samuelowicz & Bain (1992)

This table can be viewed at the following web site:


Despite differences in approach, there are some interesting similarities between the dimensions that emerged from our analytic procedure and the dimensions proposed by Reeves (1992). These are summarised in Table 4 and discussed more fully below, taking each of our dimensions in turn.

Origin of knowledge: Reeves' epistemology dimension reflects the extent to which, on the one hand, knowledge exists separately from sentient beings for whom learning is the acquisition of objective truth, versus on the other hand the assumption that knowledge is a human construction which is learnt as each individual makes sense of the world. This is not a direct parallel of our origin of knowledge dimension, although it is possible that the underlying presumptions may be those highlighted by Reeves. In our data, the distinction is much more about whose knowledge is being studied (the discipline's or the student's) than about the nature of knowledge itself (the same distinction appears in the content dimension of Samuelowicz & Bain, 1992). However, the willingness of academics to adopt a postmodern approach to their disciplines, and thus allow students to propose and defend alternatives
to received wisdom, probably depends on their basic epistemological assumptions, to which we did not have access in most cases.

Learning framework: We have tentatively aligned our learning framework dimension (structured, guided, facilitated) with Reeves' structure dimension. In Reeves' scheme structure refers to the extent to which pathways are prescribed by the program. That is part of our learning framework dimension, especially in relation to structured frameworks, but in many of our cases learning supports were provided in addition to the CFL, and these varied in the ways in which they influenced students' learning. This, therefore, is one of the circumstances anticipated in the introduction where the learning context, CFL plus supporting materials and requirements, has been taken into account, not just the CFL alone.

Learning directions: Our learning directions dimension appears to be a variant of learner control in Reeves' framework inasmuch as each is concerned with whether the learner or the CFL controls what material is studied and in what sequence.

Knowledge focus: There does not appear to be a workable alignment between our knowledge focus dimension and any of Reeves' (1992) proposals. It might be thought that his experiential value (concrete versus abstract) dimension corresponds with the distinction between case-based tasks (which refer to complex real world instances) and the others, but this is an inaccurate characterisation of the distinction
we have made, which has more to do with the difference between using theory to interpret instances (case-based reasoning) in contrast to using examples to assist with the understanding of theory and the development of discipline-specific reasoning. Our distinction has more in common with Samuelowicz and Bain's (1992) nature of knowledge dimension, although that dimension reflects whether the academic wants students to view the world in a different way (interpretation of reality) or to acquire a body of academic knowledge (understanding of curriculum).

Learning process: This dimension includes six variants which vary in several aspects in tandem: the extent to which knowledge and skill are to be absorbed rather than constructed by the student; the extent to which knowledge construction involves challenge more than elaboration of ideas; and how the progression from simple to complex occurs (in parts or as increasing refinements of wholes). We elected not to separate these components so as to retain a global sense of each learning process, but is is possible that some decomposition would be profitable in later work. It is perhaps only at the level of the component distinctions that some correspondences with Reeves (1992) become apparent. For example, his instructional sequencing dimension contrasts mastery of component knowledge and skills (reductionist) with successive refinements of knowledge about the whole (constructivist). This clearly has to do with how the progression from simple to complex
occurs. Reeves also draws on Hannifin’s (1992) work to distinguish between acquiring representations of knowledge (mathemagenic) versus creating or elaborating representations for oneself (generative). This user activity dimension appears to correspond with the difference between knowledge emulation (mathemagenic) and knowledge extension and construction (generative).

Missing dimensions: We debated at length the inclusion of two dimensions that seemed to be ‘required’ on the basis of previous research but which did not emerge from our initial analysis of the similarities and differences between the categories: namely, whether (and how) academics take account of students’ conceptions of phenomena in their discipline5, and the nature of the understanding and learning being sought (cf. the students’ conceptions and learning outcomes dimensions respectively in Samuelowicz & Bain, 1992). Although the documents for some projects would have permitted coding of these dimensions, this was not generally the case. In other words, neither dimension was ‘present’ to influence the categorisation process, hence neither could be extracted in the dimensional analysis. If nothing else, this fact serves to reinforce our claim that, as far as possible, the framework was not influenced by our preconceptions.

The advantages of the analysis

What then are the virtues of a grounded description and interpretation of academics’ beliefs and CFL practices if, on the one hand, the
resulting framework can be approximated by distinctions that others have already made, and if, on the other hand, some established distinctions are not supported? The answer lies partly in what we have achieved thus far and partly in what remains to be done. The main claims that we would make about our framework are that:

a) it represents what academics actually think and do when developing and using CFL;

b) it gives weight only to those characteristics which distinguish between broadly different approaches to teaching with CFL;

c) it incorporates not only the immediate properties and consequences of CFL but also the supporting pedagogy; and

d) it provides an amalgam of educational beliefs and practices in a form that, with further development, should assist us to understand the function and impact of CFL in higher education.

On the other hand, largely because of limitations in the project documentation, we cannot claim to have resolved the categories and dimensions, nor have we been able to state confidently what the raison d'etre of each category is--the 'theme' that makes the category coherent and 'understandable'.

Where to from here?
The second study in this series is now in progress. It draws on interviews and demonstrations as well as archival material. The sample comprises projects tentatively categorised according to the framework outlined in Table 3 (on the basis of CAUT documentation), including projects from the present study. The interview protocols explore a wide range of issues, some concerned with the CFL and its associated teaching/learning environment, some concerned with educational beliefs and conceptions, some with the connections between CFL development and scholarship. We expect that our present framework will be refined as a consequence of having more complete data with which to work. We may also need to make adjustments once we compare the impressions gained from an 'internal relatedness' analysis of all the data (as in the present study), with those provided by a cross-tabulation of separately coded beliefs and practices. Application of Reeves (1992) scheme may also assist us to refine the distinctions we need to make. A major addition to the present analysis will be an attempt to determine the governing rationale of each category, much as Fox (1983) described for his four orientations to teaching. If that level of interpretation can be provided for each category it will not only provide a thematic sense of why the beliefs and actions are thematically coherent, it will also corroborate the integrity of the categories.
References


July, Griffith University, Brisbane.


Appendix A: Some illustrative cases

Table A.1

Illustrative Case of Category 1

(Subject: History, Education and Computer Studies, Griffith University)

Origin of Knowledge - Student/Collaboration

Students are presented with a database consisting of primary source material, video footage, photographs, newspaper articles, etc. They are able to manipulate and transform data in the process of generating new knowledge. They are challenged to apply their own hypotheses and demonstrate the validity of their own interpretation.

Learning Framework - Facilitated

The CFL supports a historical inquiry approach to teaching, with the
CFL offering an alternative to the expound and discuss method through direct use within lectures and individual and small group use by the students. Students are able to actively explore different perspectives about what it means to be an Australian, they are able to shift the focus of their investigations to construct their own knowledge representations. The CFL is claimed to combine information transfer with constructivism. At the time of the final report the program had not been incorporated significantly into any specific course.

Learning Directions - Student-Managed

The nature of the interactivity allows students to determine their own pathways through the material. The learner is given direct control of the processing of aural, visual and written material.

Knowledge Focus - Conceptual/Procedural reasoning

Students are constantly having to make decisions, evaluate their progress and apply higher order reasoning skills. The constant evaluation of information helps students develop the analytic skills necessary to think critically about information sources.

Learning Process - Construction/Challenge
Dominant cultural perspectives of historical events are challenged by the presentation of alternative interpretations of events. Students are encouraged to deconstruct received narratives through active manipulation of video and audio sequences and actively reconstruct their own versions of events.

Table A.2

Illustrative Case of Category 2a

(First Year Statistics For Behavioural and Social Sciences, La Trobe University).

Origin of Knowledge - Academic/Discipline

The course is designed to teach a number of key statistical concepts which have an accepted discipline interpretation and application. Examples include normal distributions, the central limit theorem and confidence intervals.

The Learning Framework - Facilitated

The flexible design of the CFL allows teachers to choose different emphases and orders of presentation within different curriculum frameworks. It can be used as a teaching aide in lectures, by groups of students or by individual students. Students are provided with the
opportunity to explore ideas and use their own initiatives in knowledge construction. Certain print and on-line materials do provide some support and guidance for students. The CFL consists of linked microworlds or playgrounds within which students are able to explore data representations, inter-relationships between summary statistics and sampling distributions. Linked multiple representations are provided.

Learning Directions - Student-Managed

The CFL enables a high degree of interactivity. Students are encouraged to actively explore the concepts and test intuitions within a game format. Printed activity sheets guide activities within each playground. In the sampling playground, all aspects of sampling are by user choice. Distributions can be manipulated by the user using on-screen handles and students are able to actively explore different relationships between certain statistical measures. There is a distinct sense in the materials provided that the developers would encourage active manipulation and exploration by the students and the CFL is designed to allow maximum scope for this.

Knowledge Focus - Conceptual/Procedural knowledge

The software and associated learning materials were designed to "assist students to build correct and strong understanding of the target concepts."
Learning Process - Elaboration/Challenge

The developers are aware of basic misconceptions in probability and statistics and target these areas of misconception using a computer simulation approach. Multiple-linked representations are provided and student explorations, appropriately framed, are encouraged. The intended outcome is a better understanding of the concepts involved. Some simple experiments which students can perform allow certain misconceptions to be confronted and more appropriate conceptions to be built.

Table A.3

Illustrative Case of Category 2b

(Physiology, University of Sydney)

Origin of Knowledge - Academic/Discipline

The course integrates knowledge of the basic sciences (physics, chemistry and biology) and professional disciplines with clinical situations. Thus, the underlying knowledge base has a received discipline interpretation.
Learning Framework - Guided

The CFL is based upon a constructivist approach to learning with tasks, resources and materials provided to lead students to construct their own knowledge. It uses a problem-based approach to facilitate the integration of knowledge from the basic sciences with clinical situations and to enable students to see how the various professional groups and clinical disciplines interact to solve given problems. The CFL is used in conjunction with tutorial group discussions, student collaborative learning groups and practical classes. Knowledge is "anchored in authentic situations and activities". Examples of clinical reasoning or thinking processes of practitioners are provided. Tutorial exercises encouraging the use of 'patient profiles' are also available. The 'patient' can be examined by a number of different health professionals which provides the student with multiple perspectives of one clinical case.

Learning Directions - Student-Managed

Students are given freedom to work through the case study and resources in any order they wish at their own pace. There is no pre-determined pathway for a student to follow. The developers claim a student-centred approach and value student control and ownership of learning.
Knowledge Focus - Case-Based Reasoning

Knowledge from different disciplines and professional subjects is integrated through use of the case study format. Examples of the thinking patterns of professionals are provided with the intention that students will learn how to generate and test hypotheses in the clinical setting. The skills in self-directed learning and problem solving are said to be essential competencies of health professionals.

Learning Process - Synthesis and Elaboration

Solution of the problem requires the application and integration of knowledge from the various scientific and professional disciplines. It is hoped that through this process students will be able to perceive the "integrated nature of the different disciplines" and their relevance to clinical problem solving. Animations and video clips of procedures and skills are available as part of the learning module. Diagrams, text, examples and analogies facilitate mastery of key concepts.

Table A.4

Illustrative Case of Category 3a

(First year Chemistry, University of Melbourne)
Origin of Knowledge - Academic/Discipline

The scope of this project spans an entire first year chemistry course.

A set of key concepts form the basis for the objectives which define the course aims and content.

Learning Framework - Structured

The CFL is integrated into a traditional lecture and laboratory program which consists of 3 lectures, 3 hours of interactive CFL tutorials, 1 hour face-to-face tutoring in smaller classes (includes a short answer test) and one 3-hour laboratory class per fortnight. The program is clearly set out to ensure that the content of the tutorials is keyed into the previous week's lecture thereby reinforcing the key ideas and focusing student attention on them through questioning. Pre-lab CFL tutorials prepare students for the practical and help to familiarise them with correct laboratory procedures. Each interactive tutorial comprises a number of cards which follow a pre-determined sequence, initially stating the objectives of the tutorial, providing information which could include the use of animations, videos or still pictures to help illustrate a concept, posing questions and providing feedback or detailed explanations depending on the students' response to a question. Hints are available if needed by the student to answer a specific question.
Learning Directions - Teacher-Managed

The course is highly structured. A set printed notes specifies the topics to be covered in the lectures and the tutorials each week. Within the CFL itself the tutorials follow a pre-determined sequence which the student must follow and the questions asked are closed in nature.

Knowledge Focus - Conceptual/Procedural knowledge

The objectives upon which the course is built focus on specific key concepts in chemistry and associated laboratory procedures. A computer-based diagnostic test is given at the start of the process to ascertain the students' existing knowledge base and allow corrective measures to be planned if necessary. The test items in the CFL require students to concentrate on specific course content and laboratory procedures.

Learning Process - Emulation

Students are provided with detailed explanations of key concepts together with appropriate illustrations in lectures. This is supported by the interactive tutorials and laboratory sessions. The content presented in the lectures is tested in the interactive tutorials and the short answer test given every fortnight. The teach-test nature of
the course suggests that the intention is for students to be able to emulate the received understandings with which they are presented.

Endnotes

1 We are using the term 'orientation' to refer to a coherent set of beliefs, 'belief' to refer to a disposition to interpret, value and act in particular ways, and 'conception' to refer to a way of experiencing or interpreting of a phenomenon (such as learning or teaching). Samuelowicz and Bain (1992), rather unhelpfully, used the term 'conception' to refer to all of these possibilities.

2 Prosser, Trigwell and Taylor (1994) conducted their research from a phenomenographic perspective which seeks to reveal conceptions rather than belief dispositions.

3 We are grateful to the CAUT secretariat for access to the project applications and final reports. We also wish to thank the academics involved for permission to include their projects in our research analyses and publications.

4 This is not to deny that Reeves (1992) proposed pedagogical philosophy as but one of 14 non-exhaustive dimensions. However, we would argue that pedagogical philosophy (teaching/learning orientation)
consists of multiple component beliefs about educational purposes and practices, some of which are accessed by Reeves' other dimensions, some not. The unidimensionality of his pedagogical philosophy dimension is thus a convenient simplification.

5 In Bain & McNaught (1996), for example, we distinguished between CFL that ignores students' understandings, CFL that seeks to preempt difficulties by providing more effective ways to represent ideas, and CFL which while achieving the latter also allows students to play with the ideas and have their understandings probed and stretched through conversation (Laurillard, 1993; Crook, 1994).