

RESEARCH INFORMING PRACTICE: INSTRUCTIONAL DESIGN FOR WORKPLACE LEARNING

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ABSTRACT

The research described in this paper is still in progress. The paper takes a critical stance on the development of instructional materials and methodologies to support flexible delivery, and argues that quality client centred flexible delivery requires data to be generated on the learning preferences and context of learners in the workplace.

Early research data indicates that there can be some confidence in the development of training materials and methodologies that are based on client learning preferences.

Learning Preferences and the Construction of Knowledge

Although there has been widespread acknowledgment in Australia and overseas that flexible delivery has a major contribution to make to education and training, Sadler-Smith (1996) has been able to accurately observe that the designers of instructional materials to support flexible delivery still assume that learners are "by and large uniform" (p185). The same comment was made earlier by Riding, Buckle, Thompson and Hagger (1989, p.393) when they wrote "In designing training materials there is often the assumption that all trainees learn in a similar manner". Additionally, Mitchell and Bluer (1997), in an Australia wide study of the use of new technologies observed, somewhat depressingly, that in the VET sector it had been "...difficult to find eight reasonable coherent and illuminating case studies" (p2). In investigating the small number of case studies where planning had been effective, Mitchell and Bluer gathered data on student response to the methodologies. They concluded that the effectiveness of the new methodologies was related to a number of variables, including the characteristics of individual students and student groups. There was no evidence for the implementation of the Sadler-Smith (1996) suggestion that the learning styles and preferences of learners be considered part of a sophisticated training needs analysis. Sadler-Smith has suggested that an 'adaptive' approach to training design and delivery is one that tries to customise content and delivery to learner needs and preferences, while a 'non-adaptive' approach, rather differently from what the term implies, is one that comprises several different approaches to the learning task such that the learner can self select on the basis of cognitive preference. He suggests that a practical and cost efficient paradigm for the design of learning programs through flexible delivery is to generate the alternative approaches on the basis of typical client preferences, to yield a range from which the client can choose. Studies by Vermunt (1995) and McGregor and Quam (1996) have shown, however, that although learning is enhanced through instruction based on learning preferences, learners are in fact not particularly adept at recognising their own preferences and, in turn, are not good at choosing learning methodologies that best suit them.

Sadler-Smith's contention that there is a need to cater for learning preferences in the design of training is supported by evidence from a number of studies. For example, Kennington, Sitkolutek, Rakowska and Griffiths (1996) showed that the development of management training for Polish managers was enhanced through knowledge of their learning styles, while Lenehan, Dunn, Ingham, Signer and Murray (1994) showed statistically higher learning performance among nursing students when instructional methods were based on their identified learning preferences. Reushle (1995) writes that focal to the task of designing hypermedia courseware is knowledge of the learners - their learning styles, prior knowledge and the context for learning.

There is also the view expressed in the literature (eg. Gregorc, 1979; Kolb, 1984; Cleverly, 1994) that teaching methodology focussed on preferred learning styles ultimately disadvantages the learner since it fails to develop in them adequate responses to other forms of instructional delivery. That view is recognised as valid and useful in the context of educational institutions but, in an industrial setting where the primary interest is in the work performance resulting from training, a desire to contain training costs, and a strong interest in returns on training investment, it is unlikely that there will be strong interest in the development of learning styles and preferences as a remediation exercise.

Additionally, the literature displays confusion in the conceptualisation of such terms as 'learning styles', 'learning preferences', 'learning strategy', 'cognitive strategy', and 'cognitive style'. In this presentation there is not time to unpack those issues, but the larger research project that we are currently undertaking intends to place some emphasis on those conceptualisations.

There is also considerable evidence in the literature that flexible delivery of training that is reliant almost entirely on the disembodied use of learning materials, be they print, video, CD ROM or on-line, is likely to have little success in terms of quality learning outcomes.

For learners to effectively progress from the novice to the expert stage (see Dreyfus, 1992) requires the development of knowledge that DiVesta and Rieber (1987) have identified as flexible, durable, transferable and self-regulated, leading to understanding that provides for material to be assimilated and integrated into the learner's knowledge structure. The need for this level of understanding in the development of workplace knowledge is repeatedly commented upon in the literature (eg. Glaser 1982; Kidd 1987; Ryder and Redding 1993; Redding 1995) as necessary in an age of increasingly complex workplace tasks and equipment. Socio-cognitive constructivist theory provides that such learning is achieved through the learner taking responsibility to construct meaning through self-dialogue or dialogue with others. Billett (1996, 1998) has reviewed the literature and research available on workplace learning (or 'situated learning') and concludes that knowledge in the workplace is co-constructed through the operation of cognitive structures and socio-cultural events and that this co-construction involves the presence in the training context of human interaction where the knowledge to be acquired includes conceptual development.

The research project currently under way intends to not only investigate the learning preferences of enterprise based learners, but also to identify the cognitive processes that they use in constructing knowledge from flexibly delivered, resource based training programs. This research is designed to provide information to assist client friendly training materials and flexible delivery strategies.

Informing Practice through Research

The larger research project we are currently undertaking has been the result of a sense of frustration and inadequacy on my own part when my job was to design flexible learning materials for students enrolled in a TAFE institution. With my original training in psychology, I was interested in individual differences in information processing, cognitive style, and learning styles and preferences, but it seemed to me we never took much account of that in our design of learning materials. We were not in position to take a sophisticated, or differentiated, approach to the development of training materials that did take cognitive differences into account simply because we didn't have the necessary data. We developed our materials in the same way that Sadler-Smith (1996) and Mitchell and Bluer (1997) were to criticise. We just assumed that one size fitted all.

A colleague and I competed for and won a research grant to enable us to research the learning preferences of TAFE students. That research used the standardised Canfield Learning Styles Inventory, which yields quantitative data on 16 subscales of preference, grouped into Conditions of Learning, Content of Learning and Mode of Learning. A total of 570 TAFE students were tested, 294 males and 276 females, across a range of TAFE programs. The research data indicated differences between the genders and between part-time and full-time students and, most importantly, considerable differences between program groups (see Smith and Lindner, 1986). The results of that research are too complex to develop in this paper but, in summary, the program data showed that students tended to group themselves fairly accurately. For example, students in the caring professions showed preferences for content consistent with their program, and modes of learning that were more interactive and qualitative. On the other hand, students in the technical and apprenticeship programs tended to prefer working with things rather than people, to be less concerned with the human relationships formed as part of the learning process, and to prefer quantitative content.

For these results to be useful for instructional decision making, they clearly had to be reliable. In other words, if we replicated the study, would the same client groups show the same characteristics, or would they be different? If there were large differences in replication of the study, the use of the results would be highly questionable. With one thing and another, I didn't get around to replicating the study until 1994 at which time I re-tested the program groups (or their updated equivalents where programs had changed), and was stunned by the similarities with the 1986 finding for each program area. In 1994 we tested 547 TAFE students.

Figures 1, 2 and 3 show examples of the closeness in the similarity between the 1986 and the 1994 data, subscale by subscale, for:

- Electrical Mechanic Apprentices
- Office and Secretarial students
- Sheetmetal Apprentices.

These relationships between the 1986 and 1994 data were developed for all seven programs compared but, in a conference paper such as this, it is not possible to show all seven graphs. Of the three chosen for portrayal here, the Electrical Mechanics data and the Office and Secretarial data typify the closeness of the comparison for six of the programs groups, while the Sheetmetal Apprentice data is shown since it is the group exhibiting greatest variation between the two years.

In reading the graphs in Figures 1, 2 and 3, it needs to be recalled that the Canfield is a ranking test. Therefore, the lower the mean score, the more preferred is that subscale.

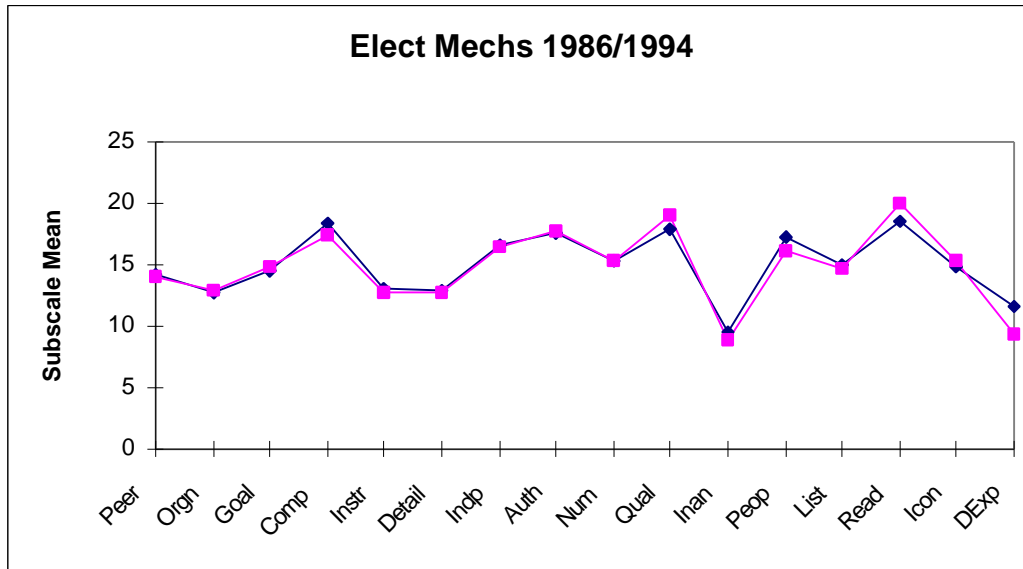


Figure 1: Graphical comparison of subscale means 1986 and 1994 samples - Electrical Mechanics

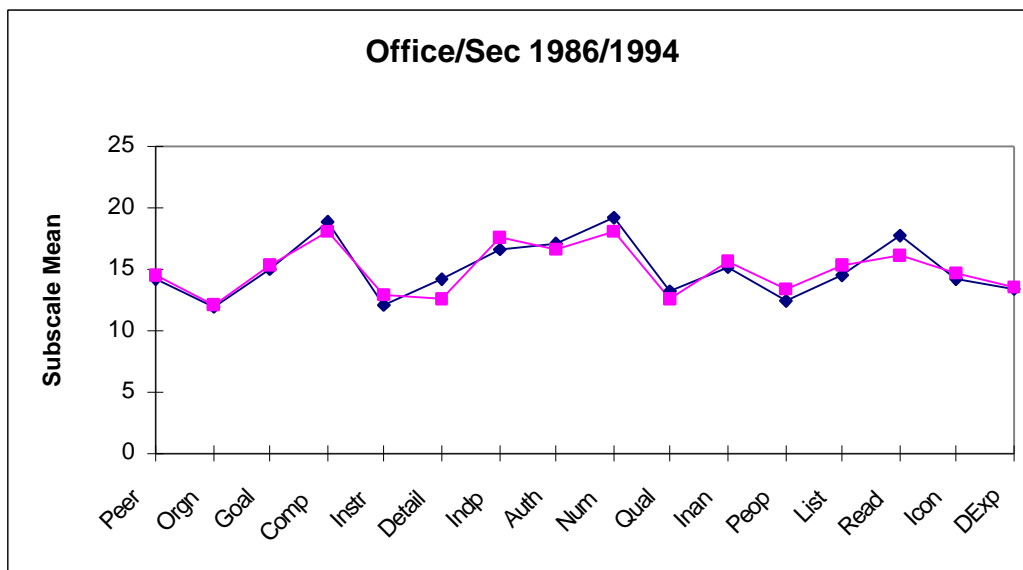


Figure 2: Graphical comparison of subscale means 1986 and 1994 samples - Office and Secretarial

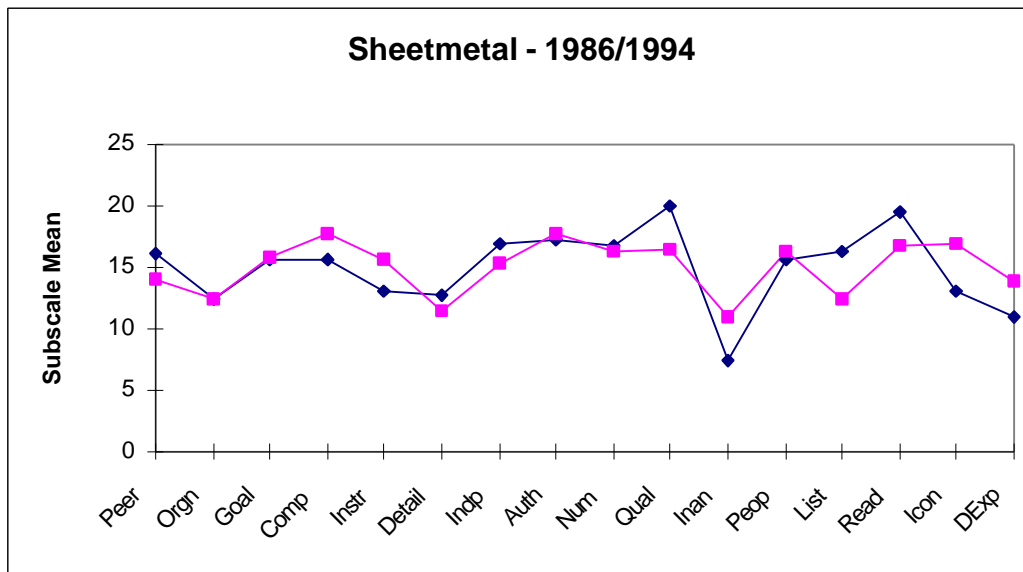


Figure 3: Graphical comparison of subscale means 1986 and 1994 samples – Sheetmetal

Clearly, I was on to something, with these results compared across so many intervening years, indicating reliability in the findings, and the possibility of making reliable instructional decisions being the result.

As part of an early attempt to develop a VET learner typology, in the 1994 study I conducted a factor analysis (varimax solution with orthogonal rotation) across all data for all students tested. That factor analysis was heartening with strong subscale loadings on three identifiable factors which were, even more hearteningly, consistent with what common sense would suppose. A fourth factor was identified with a smaller number of subscales loading on it, and rendering it possibly unstable. The four factors were:

**Factor 1: Textual - Non textual
(Eigenvalue = 2.48; variance accounted for = 15.5%)**

This factor indicates that students spread along a dimension of strongly preferring content that is textually based and learning from text to, at the other end of the dimension, learning about physical objects from direct hands on experience.

**Factor 2: Independent Learning
(Eigenvalue = 2.13; variance accounted for = 13.3%)**

This factor indicates students were spread along a dimension which at one end comprised a strong preference for independent learning and, at the other end, a strong preference for learning in a collegiate context with other students and the instructor.

**Factor 3: Content of Learning
(Eigenvalue = 1.88; variance accounted for = 11.8%)**

Students were spread along a dimension that, at one end, involves a preference for content associated with people and/or qualitative issues while, at the other end, there is strong preference to work with numbers and/or objects.

**Factor 4: Organisation of Learning
(Eigenvalue = 1.69; variance accounted for = 10.6%)**

At one end of this dimension students are characterised by a preference for a well detailed program with learning and assessment tasks laid out for them. At the other end students preferred to set their own learning goals. This factor is not as strong as the first three, with only three Canfield subscales loading significantly on it. Additionally, a negative loading on the Independence subscale was weak compared to strong positive loadings from the Organisation and Detail subscales. The factor is, therefore, considered to be relatively unstable.

I can find no equivalent research with learners in enterprise settings. The current research project aims to begin providing such data for learners in such settings. The results from the TAFE students have clear practical application in terms of the methodologies used to provide learning programs through flexible delivery.

First, Factor 1 provides empirical evidence that, indeed, one size does not fit all in the design of learning materials. There are significant differences between learners in the ways in which they prefer to receive information, and client focussed learning systems will need to provide a variety of learning media at least between different learner groups, and possibly within the different learner groups. This view is consistent with Sadler-Smith's (1996) notion of adaptive and non-adaptive learning systems. Second, Factor 2 provides the evidence that not all learners are the same in their requirement for instructor support in the context of flexible delivery and while some learners have little apparent need for instructor support, others need it and want it. In terms of Billett's (1996, 1998) observations about construction of knowledge in the workplace, this result implies that the level of support required differs between learners. Factor 3 probably has little that is new to assist in the development of workplace flexible delivery, since the result is most likely a function of the different program groups used in the research. Factor 4 indicates a dimension whereby students preferences are strongly related to the level of organisation provided in the program of learning, and the amount of detail they are provided with on such things as expected outcomes and assessment.

Just prior to this conference we have started to much more closely analyse the data for the 389 apprentices in the total sample of students tested. Although the intended analysis is much more sophisticated, at this stage the rank ordering of apprentice preferences for each of the Canfield subscales is interesting. Table 1 shows the rank ordering by mean of each Canfield subscale for the apprentice group, organised under the headings of the major scales of the Canfield.

Table 1: Canfield Subscales ranked by mean within major scales - Apprentices only

Subscale Rank Order	Mean
<i>Conditions of Learning</i>	
Organisation	12.76
Detail	13.10
Instructor	13.24
Peer	14.16
Goal Setting	14.73
Independence	15.83
Authority	17.78
Competition	18.09
<i>Interest</i>	
Inanimate	10.99
People	15.14
Numeric	16.85
Qualitative	17.15
<i>Mode</i>	
Direct Experience	12.49
Iconic	14.22
Listening	14.86
Reading	18.20

This simple ranking of the subscales in order of preference provides further insight into, and confirmation of the factor analysis. First, the strong preference for Direct Experience in comparison with the low preference for Reading indicates that apprentices fall towards the Nontext end of the Text-Nontext dimension identified by the factor analysis. Second, the ranking indicates that Independence and Goal Setting are placed lower than Peer and Instructor, indicating that apprentices tend towards the dependent end of the Independent Learning dimension identified. Content of

Learning was also identified as a dimension in the factor analysis, and the means associated with People/Qualitative and Numeric/Inanimate content would indicate a tendency for apprentices to spread more widely along that dimension. Finally, the high ranking of the Organisation and Detail subscales indicates that apprentices lie at the high end of the Organisation of Learning dimension identified in the factor analysis.

Applications to the Workplace

The research with students provided confidence that learning preferences were stable within identified learner groups; and the literature on the matching of learning preferences to instructional design and method gives confidence that positive results can be derived from that matching. Additionally, it is argued that enterprises are faced with choices on how to develop their training resources, how to organise delivery, and how best to deploy their training dollar. Selection of training provider, resources and methodologies in the context of the new Training Packages is an issue for enterprises with which they have to engage. It is intended, therefore, to apply the same research paradigm to enterprise based learners to identify learning preferences. However, to make effective use of the preferences data for enterprise learners, data is also required on the ways in which enterprise based learners construct knowledge in the workplace. This demands data to be generated on the cognitive strategies used in the workplace to construct knowledge, and the behaviours that workers engage in to assist in the knowledge construction. It is expected that the research will take place in three different enterprises.

The learning preferences data will be obtained through the use again of the Canfield Learning Styles Inventory since it has been used in our previous research, and has good technical data in terms of subscale reliability and validity. The only negative aspects of the CLSI are that it is a rather expensive instrument to purchase, and the ipsative nature of the data it generates needs some care in interpretation. Data from the CLSI will be used to identify common learning preference patterns. Biodata and occupational data will also be collected from participants to enable relationships between learning preferences and other variables to be identified.

The data relating to the use of flexible delivery materials and methodologies in the construction of knowledge will be collected using the 'stimulated recall' methodology employed by Marland, Patching and Putt (1992) in their study of the ways in which distance education students use the learning materials provided to them. Marland *et al* videoed students as they worked with their materials and subsequently used the video to stimulate recall by students of their cognitive processes as they worked.

In the current research it is not intended to use video for two reasons. First, it is an unnecessarily contrived mechanism in the current study and, second, it is inappropriate in an industrial setting to quarantine learners from the work environment. In the intended research stimulated recall will be achieved by interviewing employees very soon after they have completed the training program, with recall stimulated by working through the learning material with them. In that way, the study will not just identify the cognitive processes used as learners worked with the materials, but will identify other socio-cultural processes used to construct knowledge such as discussion with, or observation of, a more expert worker, or the use of experimentation and problem solving on the equipment in the workplace. It is intended to interview eight learners from each enterprise.

The research then intends to involve management and operator personnel to develop a set of models for the features of learning resources that best fit the learners in the enterprise, and a set of methodologies appropriate to the construction of knowledge in that workplace. These models form the applied outcomes of the research project, and will inform enterprises on the methods through which flexible delivery can most effectively be employed to achieve desired training outcomes.

REFERENCES

- Billett, S 1996, Situated learning: Bridging sociocultural and cognitive theorising, *Learning and Instruction*, 6 (3), 263-280.
- Billett, S 1998, Appropriation and ontogeny: identifying compatibility between cognitive and sociocultural contributions to adult learning and development, *International Journal of Lifelong Education*, 17 (1), 21-34.
- Canfield, A 1980, *Learning Styles Inventory Manual*. Ann Arbor: Humanics Media.
- Clevery, D 1994, Learning styles of students: development of an eclectic model, *International Journal of Nursing Studies*, 31 (5), 437-450.
- DiVesta, F J & Rieber, L P 1987, Characteristics of cognitive engineering: The next generation of instructional systems, *Educational Communication and Technology Journal*, 35 (4), 213-230.

- Dreyfus, S E 1982, Formal models vs human situational understanding. Inherent limitations on the modelling of business expertise, *Office: Technology and People*, 1, 133-165.
- Glaser, R 1982, Instructional psychology: past, present, and future, *American Psychologist*, 37 (3), 292-305.
- Gregorc, A 1979, Learning/teaching styles: their nature and effects. In National Association of Secondary School Principals, *Student Learning Styles: Diagnosing and Prescribing Programs*, Virginia: NASSP.
- Kennington, C, Sitkolutek, A, Rakowska, A & Griffiths, J 1996, Matching training to the needs of Polish managers, *Management Learning*, 27 (4), 465-483.
- Kidd, A L 1987, *Knowledge Acquisition for Expert Systems: A Practical Handbook*. New York: Plenum Press.
- Kolb, D A 1984, *Experiential learning: Experience as the source of learning and development*. New Jersey: Prentice Hall.
- Lenehan, M, Dunn, R, Ingham, J, Signer, B & Murray, J 1994, Effects of learning-style intervention on College students achievement, anxiety, anger, and curiosity, *Journal of College Student Development*, 35 (6), 461-466.
- Marland, P, Patching, W & Putt, I 1992, *Glimpses inside the minds of distance learners*. Townsville: James Cook University.
- McGregor, M & Quam, K F 1996, Student choice, problem based learning, and academic acumen, *Teaching and Learning in Medicine*, 8 (2), 83-89.
- Mitchell, J & Bluer, R 1997, *A Planning Model for Innovation: New Learning Technologies*. Melbourne: Office of Training and Further Education.
- Redding, R E 1995, Cognitive task analysis for instructional design, *Distance Education*, 16 (1), 88-106.
- Reushle, S E 1995, Design considerations and features in the development of hypermedia courseware, *Distance Education*, 16 (1), 141-156.
- Riding, R J, Buckle, C F, Thompson, S & Hagger, E 1989, The computer determination of learning styles as an aid to individualised computer-based training, *Education and Training Technology International*, 26 (4), 393-398.
- Ryder, J M & Redding, R E 1993, Integrating cognitive task analysis into instructional systems development, *Educational Technology Research and Development*, 41 (2), 75-96.
- Sadler-Smith, E 1996, 'Learning styles' and instructional design, *Innovations in Education and Training International*, 33 (4), 185-193.
- Smith, P J & Lindner, C 1986, *Learning style preferences of Technical and Further Education students, and delivery methods in selected teaching programs*. Melbourne: Office of the TAFE Board.
- Vermunt, J D 1995, Process-oriented instruction in learning and thinking strategies, *European Journal of Psychology of Education*, 10 (4), 325-349.