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Introduction

Changes to the research centre structure at Griffith University now sees the Journal published through the recently established Centre for Learning Research The new Centre has a website (http://www.gu.edu.au/centre/clr/) which dedicates a page to the journal and provides a facility to look at the titles and authors of previous editions

This Volume presents a series of articles submitted by members of the new Centre for Learning Research The works are themed around 'problem-solving' and view this topic in a multi-faceted way. In the first article John Stevenson provides an overview that contextualises and introduces the other papers. As a result of John's first article my introduction needs to go no further.

Fred Beven,
Editor, May 2004

Problem-solving cognitive activity in technical education classrooms

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Abstract

This paper reports the extent of problem-solving activity that occurred during instruction in a range of classrooms in technical education. The two studies involved 43 theory and practical classes, across 5 colleges, 5 course areas, 14 teachers and 187 students, with 544 student observations across their several lessons. The samples included new and experienced teachers, and apprentice as well as prevocational learners. The studies used videotapes, interviews and a questionnaire to examine learner and teacher activities and the resources that were used in these classes, in order to develop a picture of teaching and learning. The research also related these activities to measures of press derived from the Cognitive Holding Power Questionnaire (CHPQ) in order to examine the validity of the dimensions of the questionnaire. These analyses provide a depiction of the extent to which learners are pressed into problem-solving cognitive activity and the teaching and learning activities that contribute, as well as a confirmation of the validity of the CHPQ.

Introduction

This paper reports the extent of problem-solving activity in a range of technical and further education classes in Queensland, Australia. The research used videotapes to examine learner and teacher activities and the resources that were used, and related the activities to measures of press for different kinds of cognitive activity, derived from the Cognitive Holding Power Questionnaire (Stevenson and Ryan 1994). The purpose was two fold: firstly to derive a picture of the kinds of instruction that occur in these classes, and secondly to see if the face validity of the two dimensions of the Cognitive Holding Power Questionnaire was re-affirmed in relation to teaching and learning activities that actually took place.

The study is based on the conceptualisation of the relationships among teaching and learning depicted in Figure 1.

Cognitive Structures

According to cognitive theory, knowledge is encoded as memory representations or cognitive structures. Various terms are used for these structures, such as scripts and plans (Schank & Abelson 1975, 1977), frames (Minsky 1975), schemes (Piaget 1970) and schemas (Bartlett 1932; Rumelhart & Ortony 1977). One of the basic differentiations (Ryle 1949) is between knowledge-that (declarative knowledge – knowledge of facts and information), and knowledge-how (procedural knowledge – knowledge of how to secure goals e.g. skills and techniques) (Anderson 1982, 1990). A further differentiation has been found helpful in the case of procedural knowledge among: procedural knowledge for familiar or routine tasks (specific or first order procedural knowledge); procedural knowledge for problematic tasks and associated meta-cognitive planning and monitoring (second order procedures); and the procedures that switch cognitive attention among different orders (third order or executive or control procedures) (Evans 1988, 1991a,b; Scandura 1980, 1981; Stevenson 1986a,b, 1991).

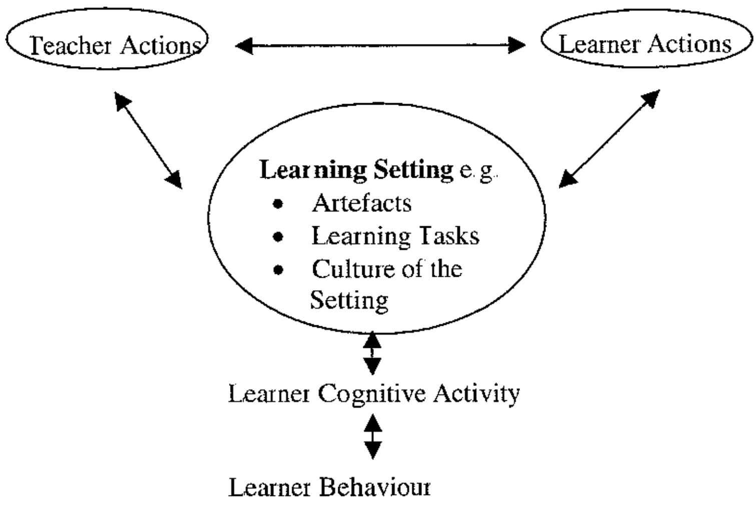

Figure 1: Relationships among teacher actions, learner actions, characteristics of the learning setting, its press of cognitive activity and learner behaviour

The present study explores teaching and learning activities directed at these various kinds of knowledge in technical and further education theory and practical classes. In summary, the categories of knowledge structures that are differentiated in the study are:

- Knowledge 'that' (information)
- Knowledge 'how' (procedures)
  - First Order Procedures (specific)
  - Second Order Procedures (general)
    - Problem-solving and associated meta-cognitive procedures
  - Third Order Procedures (switching)
    - Control of cognitive activity

Cognitive Holding Power

The psycho-social concept of an environmental press on learners for them to engage in different kinds of cognitive activity was advanced by Stevenson (1986a,b) and termed cognitive holding power. The concept is synthesised from arguments in setting theory and ecological psychology about the interactions between individuals and their environment and their consequent effects on behaviour (Barker 1978; Moos 1979; Murray 1938; Kounin & Sherman 1979; Pace & Stern 1958; Stokols 1977), as well as constructivist cognitive psychology about the cognitive activity in which learners engage as they construct the learning tasks which they encounter (Doyle 1979; Posner 1982). Thus the concept of cognitive holding power is based on the idea that features of learning settings (including the presented tasks, the climate, teacher and learner actions) press learners into cognitive activity, involving different kinds of cognitive structures, in order to handle the tasks that they construct (Stevenson

1986a,b, 1991). The separation of the press into first and second order cognitive holding power is based on the classifications of cognitive structures outlined above. The selection of just two categories is based on Royer's (1979) differentiation of near and far transfer: near transfer for familiar situations and far transfer for problematic situations. It is assumed that, for routine tasks, specific procedures are executed automatically; while, for problematic tasks, general problem-solving procedures are used to conceptualise the nature of the problem, plan the problem-solving, generate solutions (e.g. by drawing upon conceptual understanding and specific procedures as appropriate) and monitor the problem-solving process. Third order procedures are used to switch cognitive activity among different kinds of processing.

Cognitive Holding Power Questionnaire

Based on the earlier studies of Stevenson (1986b, 1991), an instrument has been developed to measure the two dimensions of cognitive holding power as summarised in Table 1 (Stevenson & Evans 1994). The instrument consists of 30 questions of which 27 are used: 13 to calculate first order cognitive holding power (FOCHP) and 14 to calculate second order cognitive holding power (SOCHP). Respondents select responses along a five point Likert Scale.

Table 1: Summary features of First and Second Order Cognitive Holding Power (Stevenson & Evans 1994)

	First Order Cognitive Holding Power	Second Order Cognitive Holding Power
Setting	Presses for taking instruction and for practising the routine	Presses for working things out, tackling problems, exploring
Teacher Actions	Modelling, telling, informing, generating, instructing, monitoring, showing patterns and relationships	Posing new and problematic tasks, encouraging exploration and confrontation of unfamiliar tasks and situations, responding, encouraging the finding of patterns and relationships, encouraging the checking of results against existing knowledge
Learner Actions	Performing as modelled, following instructions, relying on others for new ideas and procedures, executing provided plans, relying on the teacher for establishing connections and for confirming results, passively accepting new information and procedures, accepting results of activities	Interpreting new situations, making plans, solving new problems, relating existing and new knowledge, generating ideas, trying out new ideas and procedures, checking results against existing knowledge, monitoring
Cognitive activity	Encoding new propositional knowledge Encoding new specific procedures	Using and developing second order procedures for conceptualising problems, making plans, problem-solving and monitoring. Reconstructing

The reliability of these two dimensions has been demonstrated across numerous classes in schools, technical and further education (TAFE) classes, and higher education as summarised in Table 2 (Clarke & Dart 1991; Stevenson 1998; Stevenson & Evans 1994). A confirmatory factor analysis has also confirmed the factor structure, with an adjusted Goodness of Fit Index of 0.84 (p<0.000) (Stevenson & Evans 1994). Clark and Dart have also reported confirmation of expected correlations with Biggs' (1987) deep and surface strategies and approaches to learning.

Table 2: Reliability (Cronbach's α) of First Order Cognitive Holding Power (FOCHP) and Second Order Cognitive Holding Power (SOCHP)

		FOCHP		SOCHP	
Number of Items		13		14	
Sector	Classes	α	Mean	α	Mean
TAFE (Stevenson & Evans 1994)	49 classes, 706 students	.86	3.1	.82	3.3
Schools (Stevenson 1998)	47 classes, 1203 students	.84	3.2	.82	3.1
Higher Ed (Clark & Dart 1991)	32 classes, 470 students	.87		.85	

Method

Sample

Two studies involving 43 classes in 5 different colleges were studied, as follows.

For Study 1, the classes of 10 teachers (male) in 3 colleges teaching mechanics, fitting and machining, and butchery comprised the sample. This involved 127 students in 27 classes. In 10 of the classes the teacher was inexperienced, and for 17 classes, experienced. The classes were both theory (15) and practice (12). The learners (average age 18.4, mainly male) included both apprenticeship (16 classes) and prevocational (11 classes) students. Because 2-4 classes for each teacher were observed, students were taught more than once. The total number of student observations was 456. For some analyses there were fewer observations, because not all students in all classes completed all questionnaires.

For Study 2, the sample was extended to involve the classes of 4 teachers (male) in 2 colleges teaching electronic process control and carpentry and joinery. This involved 60 students in 16 classes. The total number of student observations was 195. In 8 of the classes the teacher was new; in the other 8, experienced. The classes were both theory (8) and practice (8). The learners (average age 23.7 years, all male) included both apprenticeship (12 classes) and prevocational (4 classes) students.

Procedures

For both Studies 1 and 2, the Cognitive Holding Power Questionnaire (CHPQ) was administered to students in each class. For Studies 1 and 2, a Knowledge and Learning Questionnaire (KALQ) was also administered to entire classes to ascertain the content of instruction and characteristics of the teaching and learning process. The Knowledge and Learning Questionnaire asked question about what was taught and how it was taught. Teachers and 2 selected students were also interviewed, for each class, with open-ended questions about what was being taught / learned and how it was being taught / learned.

For Study 1, the teaching and learning activity in each class was video-recorded and the activities over 2309 minutes coded for each minute (see below). Each minute of activity on the videotapes was coded for each of 7 features as given in Table 3. The codes can be considered alone (one-part coding) or in combination (4-part or 7-part coding) for that minute. For instance PLVT (4-part coding) would read as the teacher presented information to the whole group; PLVWIXT (7-part coding) would read as the teacher presented information to the whole group using written materials and pictures or diagrams. Alternatively, ESOY would read as one student elicited how to perform a specific procedure. It was found necessary to differentiate Knowledge-that into Knowledge-that (T) and Knowledge-about-how (A) because often instruction was not directed at the development of factual information (T) or at performance of a procedure (Y). Rather it was intermediary, involving information about how to perform without actual demonstration or performance. An additional code Monitoring (M) was also used to capture the occasions when the teacher was moving about checking on student work. Presumably this involved second order procedures on the part of the learner, but was distinguishable from direct student engagement in problem-solving (G)

Table 3: Coding of Videotapes

Code Part	Code	Explanation
1. Process	N, P, E	No activity or pause (N), Presentation (P), or Elicitation (E)
2. Initiator	L, S, R	Activity initiated by Teacher (L), Student (S) or Resources (R)
3. Group	V, F, O	Activity included the Whole Group (V), a few students (F) or one student (O)
4-6. Resources	W, I, C, X	Resources involved Written materials (W), Pictures or Diagrams (I), Equipment, materials or other concrete items (C) or no resources (X)
7. Primary Knowledge Content	T, A, Y, G, M	Knowledge that (T), Knowledge about how (A), Specific Procedures (Y), Second Order Procedures (G), Monitoring (M)

Also for Study 1, the teacher and two students from each class were interviewed with open questions directed at ascertaining what was taught/learned and how it was taught/learned. For Study 2, the KALQ was used, without video-recording, to collect data about teaching and learning activity as the findings from Study 1 confirmed that the interviews, the KALQ and the video-recording were consistent

Results

Teaching and Learning Activity

Taking the Study 1 sample as a whole, teacher presentation of information to the whole class accounted for 23% of the activity. The top 6 four-part codes accounted for 59% of all activity. In Table 4, the rank orders of one-part and four-part codes are given, with percentages for each category.

Table 4: Rank Orders of Most Frequent Activities for Study 1 (3 courses, 27 classes, 10 teachers, 127 students, 2309 minutes)

One-part code (% in brackets)	7-part code (% in brackets)
L (77%)	NXXXXXX (9)
P (59)	PLVWXXT (7)
W (51)	PLVWIXT (6)
V (48)	ELVWXXT (3)
C (44)	PLVXXXT (3)
T (40)	PLOXXCA (3)
I (38)	ESOXXCA (3)
E (32)	PLVXXCT (3)
O (26)	PLOXXCM (2)
A (21)	PLOWIXM (2)
F (16)	PLVXXCA (2)
M (16)	PLFWICM (2)
S (15)	ELVWIXT (2)
Y (13)	PLFXXCA (2)
N (9)	PLVWIXA (1)
G (2)	

There were found to be different patterns of activity across different classes as summarised in Table 5. This table shows considerable diversity (final row), with substantial differences especially between theory and practice. With practical lessons, apart from pauses, the most common actions involved one student and the content was procedural or knowledge about procedures. For theory lessons 40% of activity was of the same kind (presentation of information to the whole class) and 76% of all action was captured by just 6 codes. Differences across levels of teacher experience and student work experience were less pronounced (Table 5), although the emphasis on presentation of information to the whole class (about 23 %) overall, was higher for the prevocational students who have less work experience than apprentices. These differences were to be expected in a competency-based training environment, where the focus is demonstration of competence by learners.

Cognitive Holding Power

Correlations between measures of first and second order cognitive holding power (FOCHP and SOCHP) and major coding categories were determined for Study 1, and significant correlations are shown in Table 6. These correlations are as predicted, confirming the face validity of these two dimensions of the instrument. To analyse the relationships between independent variables

Table 5: Percent Time Engaged in Most Frequent Activities (Modes highlighted) (Study 1: 3 courses, 27 classes, 10 teachers, 127 students, 2309 minutes)

4-Part Code	Teacher Experience		Student Work Experience		Theory / Practice	
	Experienced	New	Apprentice	Prevocational	Theory	Practice
PLVT	25	20	19	29	40	
ELVT	8	13	8	11	16	
NXXX	10	6	10	7	6	12
PLVA	7		6	8	9	
PLOM	5		8		7	
ESOA						7
PLOY	7		7			8
ESOM						8
PLOA						7
PLFM		6				
PLVY					5	
PLFA						
PLFY						
PLFT						
% represented by these codes (top 81%)	57	53	50	61	76	42
Total No Different Actions (Diversity)	42	40	43	38	36	38

and each of FOCHP and SOCHP, analyses of variance were undertaken (Tables 6 and 7). Because of the size of the sample, and the fact that not all possible combinations of the various category values of each of the variables was available, only main effects were analysed. From Tables 6 and 7, the teacher was the main source of variance in FOCHP (16%) and SOCHP (14%). Different colleges and different trade areas also contributed significantly to each of FOCHP and SOCHP variance; and practical workshops and student work experience contributed significantly to SOCHP variance

To explore further the relationships between activities and Cognitive Holding Power, stepwise forward and backward linear regressions were performed for each of FOCHP and SOCHP for the four-part main action codes (e.g. PLVT). The results are given in Tables 9 and 10. Cumulative R^2 , F values and probabilities for FOCHP and SOCHP were as follows: FOCHP (R^2=0.88, $F_{9,17}$=14.0, $p<0.001$), SOCHP (R^2=0.61, $F_{2,24}$=18.9, $p<0.001$). These results confirm the predicted relationship: between FOCHP and the development of specific procedural knowledge (and knowledge about specific procedures) and whole-group presentation, as well as the negative relationship with single student elicitation of information; and between SOCHP and student elicitation of monitoring, as well as the negative relationship with teacher presentation of information to students.

Table 6: Significant Correlations of Teaching and Learning Activities with FOCHP and SOCHP (Study 1: 3 courses, 27 classes, 10 teachers, 127 students, 349 observations)

		FOCHP	SOCHP
Action	**Diversity**		.39
	Presenting	.42	-.40
	Eliciting	-.56	
	Teacher Initiating		-.59
	Student Initiating		.60
Group Size	Whole Group		-.42
	Small Groups		
	Teacher with one Student		52
Content	Information	-.44	
	Knowledge about how	. 39	
	Specific procedures		
	Higher order procedures	-.48	
	Monitoring		.38

Table 7: ANOVA Main Effects: FOCHP (Study 1: 3 courses, 3 colleges, 27 classes, 10 Teachers, 127 students, 349 observations)

	R^2	F	df	Direction
Teacher	.16	7.0***	9,339	
Experience	.01	4.6*	1, 347	None
College (A,B,C)	.07	12.4***	2, 346	A>B>C
Trade (1,2,3)	.11	22.1***	2, 346	1>2>3
(T)heory / (P)ractical	.00	.00	1, 347	T=P
(P)revocational / (A)pprentice	.02	6.01	1, 347	P>A

Table 8: ANOVA Main Effects: SOCHP (Study 1: 3 courses, 3 colleges, 27 classes, 10 Teachers, 127 students, 349 observations)

	R^2	F	df	Direct
Teacher	.14	6.1***	9, 340	
Experience	.00	.37	1, 348	E>N
College (A,B,C)	.07	12.4***	2, 347	A>B>C
Trade (1,2,3)	.06	11.9***	2, 347	2>1>3
(T)heory / (Practical)	.05	19.0***	1, 348	P>T
(P)revocational / (A)pprentice	.03	9.15**	1, 348	A>P

Table 9: Regression of Main Actions on First Order Cognitive Holding Power (Study 1: 3 courses, 3 colleges, 27 classes, 10 Teachers, 127 students, 349 observations)

Action	Cumulative R^2	Direction of Simple Correlation
ESOY	0.25^{**}	+
PLVA	0.45^{**}	+
PLVM	0.58^{*}	+
PLOY	0.70^{**}	+
ESOT	0.77^{*}	-

Table 10: Regression of Main Actions on Second Order Cognitive Holding Power (Study 1: 3 courses, 3 colleges, 27 classes, 10 Teachers, 127 students, 349 observations)

Action	Cumulative R^2	Direction of Simple Correlation
ESOM	0.54^{***}	+
PLFT	0.61^{*}	-

The data on sources of teaching and learning activities, from the Knowledge and Learning Questionnaire in Study 2, were also analysed in relation to Cognitive Holding Power. Multiple regressions with maximum R-square improvement were used to analyse the contribution of different sources for learning (Teacher, other Students, Self, Workbooks and manuals) to both FOCHP and SOCHP. The results are given in Tables 11 and 12. Workbooks and manuals were not found to contribute significantly to either measure. However, the results indicated that, together, the other three sources explain 22% of the variance in SOCHP - with self, teacher and other students contributing significantly in that order. These three sources explained only 10% of the variance in FOCHP and their contributions were in the order of teacher, other students, and self. These findings are also in agreement with those predicted, confirming the validity of the CHPQ.

Table 11: Regression: Sources on FOCHP (Study 2: 2 courses, 2 colleges, 16 classes, 4 Teachers, 60 students, 195 observations)

	Cumulative R^2	df	F	p
Learning from Teacher	04	1, 187	7.42	.007
Learning from students	.08	2, 186	7.76	000
Working things out	.10	3, 185	6.67	.000

Table 12: Regression Sources on SOCHP (Study 2: 2 courses, 2 colleges, 16 classes, 4 Teachers, 60 students, 195 observations)

	Cumulative R^2	df	F	p
Working things out	.12	1, 194	26.0	.000
Learning from Teacher	17	2, 193	20.3	.000
Learning from students	22	3, 192	21.9	.000

Conclusion

The studies suggest that there is a high overall level of teacher presentation of information to whole classes in technical education classes. This level is quite different across teachers, but, nevertheless somewhat similar across levels of teacher experience, with experienced teachers engaged in more presentation of information.

However theory and practical classes differed substantially with considerably more individualised instruction and more focus on procedural knowledge in practical classes. Also prevocational students, with limited work experience, were provided with more overall presentation of information than apprenticeship students The studies provided further confirmation of the validity of the two dimensions of the Cognitive Holding Power Questionnaire. They also confirm the teacher as the important primary source of variance in levels of first and second order cognitive holding power Therefore, attempts to change classroom press towards higher levels of problem solving (SOCHP) should, at least in the first instance, be directed to teacher professional development.

References

Anderson, J R 1982, Acquisition of cognitive skill. *Psychological Review, 89* (4), 369-406.

Anderson, J R 1990, *Cognitive psychology and its implications*. Third Edition. New York: W H Freeman and Company.

Barker, R G 1978, Theory of behaviour settings In Roger A Barker and Associates (Eds), *Habitats, Environments and Human Behaviour*. San Francisco: Jossey Bass.

Bartlett, F C 1932, *Remembering. A study in experimental and social psychology* Cambridge: Cambridge University Press.

Biggs, J B 1987, *Student Approaches to Learning and Studying* Hawthorn, Vic: ACER

Clarke, J A & Dart, B C 1991. *Tertiary Learning: A Symposium*. Paper presented at the Annual Conference of the Australian Association for Research in education. December. Gold Coast.

Doyle, W 1979, The tasks of teaching and learning in classrooms. Invited address to annual meeting of the American Educational Research Association, San Francisco, April, 1979

Evans, G T 1988, Getting learning under control. *Australian Educational Researcher, 15*, 1-18.

Evans, G 1991a, Student control over learning. In J B Biggs (Ed.), *Teaching for Learning: The View from Cognitive Psychology*. Hawthorn, Victoria: Australian Council for Educational Research.

Evans, G T 1991b, Lesson cognitive demand and student processing in upper secondary mathematics. In G T Evans (Ed.) *Learning and Teaching Cognitive Skills* Hawthorn, Vic: Australian Council for Education Research.

Kounin, J S & Sherman, L W 1979, School environments as behaviour settings. *Theory into Practice*, *18* (3), 145-151.

Minsky, M 1975, A framework for representing knowledge. In P H Winston (Ed.), *The Psychology of Computer Vision*. New York: McGraw Hill.

Moos, R H 1979, *Evaluating Educational Environments*. San Francisco: Jossey Bass.

Murray, H A 1938, *Explorations in Personality*. New York: Oxford University Press

Pace, C R & Stern, G 1958, An approach to the measurement of psychological characteristics of college environments. *Journal of Educational Psychology*, *49*, 269-277.

Piaget, J (trans. E Duckworth) 1970, *Genetic Epistemology*. New York: Norton.

Posner, G 1982, A cognitive science conception of curriculum and instruction *Journal of Curriculum Studies*, *14* (4), 343-351.

Royer, J M 1979, Theories of the transfer of learning. *Educational Psychologist*, *14*, 53-69.

Rumelhart, D E & Ortony A 1977, The representations of knowledge in memory. In R C Anderson, R J Spiro & WE Montague (Eds.), *Schooling and the Acquisition of Knowledge* (Chapter 4, pp. 99-135)

Ryle, G 1949, *The concept of mind*. London: Hutchinson.

Scandura, J M 1980, Theoretical foundations of instruction: a systems alternative to cognitive psychology. *Journal of Structural Learning*, *6* 347-394.

Scandura, J M 1981, Problem solving in schools and beyond: Transitions from the naive to the neophyte to the master. *Educational Psychologist*, *16* (3), 22-26.

Schank, R & Abelson, R 1975, Scripts, plans and knowledge. In *Advance Papers of the Fourth International Joint Conference on Artificial Intelligence* (pp. 151-157). Tbilisi, Georgia, USSR.

Schank, R & Abelson, R 1977, *Scripts, plans, goals and understanding*. Hillsdale: Erlbaum.

Stevenson, J C 1986a, Adaptability: theoretical considerations *Journal of Structural Learning*, *9* (2), 107-117

Stevenson, J C 1986b, Adaptability: empirical studies *Journal of Structural Learning*, *9* (2), 119-139.

Stevenson, J C 1991, Cognitive structures for the teaching of adaptability in TAFE. In G Evans, (Ed.), *Learning and teaching cognitive skills*, pp 144-163. Hawthorn, Victoria: Australian Council for Educational Research.

Stevenson, J C 1998, Performance of the Cogntitive Holding Power Questionnaire in schools. *Learning and Instruction*, *8* (5), 393-410.

Stevenson, J C & Evans, G T 1994, Conceptualisation and measurement of Cognitive Holding Power. *Journal of Educational Measurement*, *31* (2), 1-20.

Stevenson, J & Ryan, J 1994, *Cognitive Holding Power Questionnaire Manual*. Queensland, Centre for Skill Formation Research and Development, Griffith University.

Stokols, D 1977, Origins and directions of environment-behavioural research In D Stokols (ed.), *Perspectives on Environment and Behavior: Theory, Research and Application*. New York: Plenum Press.