INTRODUCTION The concept of Cognitive Holding Power is synthesised from theories of settings and theories of cognitive structures, and is conceptualised as a characteristic of a learning setting which presses students into different kinds of cognitive activity. Cognitive structures are differentiated into different orders, and the role of learning settings in activating different kinds of structures is outlined. It is argued that settings can press students into using first or second order cognitive procedures and can be regarded as having first or second order cognitive holding power. The development of an instrument to measure cognitive holding power is outlined. The dimensions of the developed instrument and their reliability are also discussed. The potential contribution of this research to understanding the relationship between different approaches to the teaching of problem-solving and the ability to undertake problem-solving transfer tasks is outlined.

COGNITIVE HOLDING POWER The tendency for a learning environment to facilitate or impede individuals in goal attainment is called press (Murray, 1938). Pace and Stern (1958) extended the concept of press to include student perception of the atmosphere of a learning institution. Moos (1979) attributed behaviour elicited from settings to cognitive appraisal of the environment, leading to efforts to adapt to the setting and cope with it. Similar concepts have been used in setting theory (Barker 1978, Stokols 1977), where it has been argued that settings elicit behaviour from participants. Kounin and Sherman (1979) referred to the demands of learning settings as holding power.

Cognitive structures can be differentiated into those which represent knowledge 'that' (information, facts, assertions, propositions, etc) and those which represent knowledge 'how' (techniques, skills, ability to secure goals, etc) (Anderson, 1980; Norman and Rumelhart, 1975). Knowledge 'that' is called propositional and knowledge 'how', procedural. Three orders of cognitive procedures can be differentiated according to the specificity of the goals for which they are applicable (Stevenson, 1986a). Based on the theories of Anderson (1980, 1982), Scandura (1980, 1981) and Fischer (1980), Stevenson (1986a) has developed a hierarchy of procedures of three orders.

The first order (specific procedures) comprises procedures which enable the securement of specific goals, e.g. knowledge how to hammer a nail, play a familiar piece of music, apply a particular mathematical algorithm, or perform a particular stroke when playing tennis. Second order procedures achieve more general purposes by operating on specific procedures, combining them into useful sets and applying the new combinations to handle unfamiliar situations.

Knowledge of how to interpret unfamiliar situations and solve new problems constitutes second order procedures, e.g. designing a plan for a new house to meet a client's requirements, interpreting and playing an unfamiliar piece of music, selecting a strategy for the solution of a new mathematical problem, or developing a strategy for winning a tennis match. It has been argued (Stevenson 1986b) that engagement in learning activities which demand the use of second order procedures assists students in achieving far transfer (Royer, 1979), that is, transfer where there is no clear similarity between the
stimulus elements in the original learning and the transfer tasks. Second order procedures can be likened to Sternberg's meta components of intelligence (Sternberg and Davidson, 1989) which are involved in 'defining the problem, setting up a strategy to solve the problem and monitoring the consequences of one's problem solving' (p. 23).

Evans (in press) also differentiates two types of procedures which achieve student control over learning at a number of levels.

A third order of cognitive procedures is conceived as those procedures which achieve overall control of cognition and switch cognitive activity between orders. This control is variously called a flow of control (Anderson, 1982), a goal switching mechanism (Scandura, 1981), control through procedures (Fischer, 1980), and student control over learning (Evans, in press). Evans' third order comprises executive strategies which identify task or situation requirements, set goals and evaluate progress towards goal attainment. In his analysis, executive procedures activate the use of other procedures and propositional knowledge to modify, combine and control first order procedures to achieve specific goals.

The instrument described here measures the effect of the learning setting in activating the execution of first and second order procedures. It is assumed that third order procedures activate all cognitive activity switching activity between first and second orders (Stevenson, 1986a), and are not, directly, the subject of this research.

The concept of cognitive holding power is synthesised from these theories of cognitive structures and theories of learning settings. It is the tasks in which students engage which determine what they learn (Posner, 1982). A task consists of a goal and a set of operations necessary to achieve that goal (Doyle, 1979; Posner, 1982). Students shape their tasks on the basis of their internalised cognitive structures and external resources. A learning setting which presses students into the utilisation of specific procedures is conceived as one where the environment poses goals for the student which can be achieved through the direct execution of existing specific procedures or the direct acquisition (from the teacher) of the required specific procedures. In such an environment, students listen to what a teacher says and copy what a teacher does in learning how to accomplish specific tasks. Such a setting is conceived as possessing first order cognitive holding power (FOCHP).

A learning setting which presses a student into the utilisation of second order procedures is one which poses unfamiliar goals for the student, and elicits the execution of second order procedures to interpret the situation and to deal with the associated problems. Such a setting promotes the use of second order procedures and impedes the securement of goals through the direct application of specific procedures. Second order procedures are used to: make links between the features of the setting and existing knowledge, generate ideas, try out and test problem-solving strategies, monitor the effectiveness of approaches and check results. Specific procedures are used, but not directly. Selection, organisation and application of sets of specific procedures would be achieved through second order procedures. The trialing of novel sets of specific procedures and the monitoring of strategies for attacking the situational problems would also be accomplished by second order procedures activated as a result of the switching function of third order executive procedures. Such a setting is conceived as possessing second order cognitive holding power (SOCHP) which encourages students to confront problems and practise the assembly of new sets of specific procedures. The utilisation of second order procedures is transferable to other problematic situations and enables adaptation. Thus, learning settings can be conceptualised in terms of the cognitive holding power that they possess and cognitive holding power can be differentiated as first or second order in terms of the cognitive procedures which learners utilise in responding to setting demands. Unlike cognitive load, which refers to the demands made on learners who do not possess relevant schemata (propositional knowledge) or automated rules (specific procedures) (Sweller, 1988, 1989; Ward and Sweller, 1990), cognitive holding power refers to the press of the environment on students to activate procedures of different orders.
An instrument, outlined in the following section, has been developed to measure the extent to which particular learning settings press students into first or second order cognitive activity.

THE INSTRUMENT
The setting theory on which the instrument was based is ecological psychology (Stokols, 1977), which emphasises the collective processes by which groups adapt to the physical and social resources available in the environment. Ecological and environmental psychology are part of a continuum (Stokols, 1977). Existing instruments for the measurement of such psycho-social aspects of classroom environment, like the Individualised Classroom Environment Questionnaire (ICEQ) (Fraser, 1990) and the Classroom Environment Scale (CES) (Trickett and Moos, 1973) are derived from Moos' Social Climate Scales which fall under three general conceptual categories: interpersonal relationships, goal orientation or personal growth and system maintenance and change (Moos, 1974). Since these concepts and the derived instruments and sub-scales do not relate directly to cognitive holding power, it was necessary to develop a new instrument.

The basis for item identification was the association with the effect of the setting in eliciting activation of first order procedures for direct execution or second order procedures for problem-solving. Accordingly, items were selected to refer to activities related to cognitive holding power. For FOCHP, the following activities were chosen: students being told or shown by the teacher or students copying. For SOCHP, the following activities were chosen: trying out ideas, autonomous action, finding links, and checking results. Three basic forms of wording for activities were considered and elaborated in order to ensure measurement related to press rather than to the identity of the agent causing the press (e.g. student or teacher).

The three basic forms of questions were considered to be related to cognitive holding power (CHP) as follows:

Teacher             Students feeling      Students behaving Encouraging -->
impelled             -->    (Teacher applying   (Student feeling      (Student
responding CHP)                CHP)                  to CHP)

Items were phrased to embed theses aspects of activities as follows:

The teacher encourages students to (undertake an activity); I feel I have to (undertake an activity); and I undertake an (activity).

This type of phrasing generated multiple items for each activity and type of wording. 30 items, categorised as follows, were selected as the basis for the instrument.

Copying or Being Shown   (These items also relate to Autonomous Action)

6. I feel I have to copy what the teacher does. The teacher encourages students to copy what he (she) does. I feel I have to work exactly as shown. I copy what the teacher does. The teacher encourages students to do their work as they are shown. I work exactly as shown.

Being Told      (These items also relate to Autonomous Action)

5. I let the teacher tell me what to do. I get all my information from the teacher (also Finding out Information) I feel I have to do what the teacher tells me. I rely on the teacher for new ideas.
14. I do what I want to do. I do things my own way

Finding Links

3. The teacher encourages students to find the links between the things they know
13. I find links between the things I learn. I rely on the teacher to show me the links among things. I feel I have to find links between the things I learn

Finding out Information

4. I feel I have to find out information for myself. I get all my information from the teacher (also Teacher-Telling). I feel I have to find out things for myself. I find information for myself

Checking Results

1. I ask questions to check my results. I check my results against things I know. I feel I have to ask questions to check my results. I feel I have to check my results against things I know. The teacher encourages students to ask questions to check their results. I accept my results without question. The teacher encourages students to check their results against things they know

Trying Out Ideas

2. I feel I have to try out new ideas. The teacher encourages students to try out new ideas. I try out new ideas. I rely on the teacher for new ideas

The instrument was administered to 278 students in 30 classes at a TAFE college. A principal factor analysis with varimax rotation of factors with eigenvalues greater than 1 (SAS Institute, 1985) was undertaken without any recoding of questionnaire items. Eight factors, accounting for 41% of total variance, were extracted. Items were assigned to factors on the basis of their highest factor loadings (providing they exceeded 0.30). Intuitive labels for the factors are given in Table 1.

Table 1: Factors Analysis of Instrument

<table>
<thead>
<tr>
<th>Factor and Itemsa</th>
<th>Explained Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor 1 (5, 6, 8, 9, 16, 17, 18, 20, 22, 23, 24, 28, 30)</td>
<td>4.35 Listening and Watching (35%)</td>
</tr>
<tr>
<td>Factor 2 (3#, 13, 21, 29)</td>
<td>1.56 Encouraged to Check and Link (12.4%)</td>
</tr>
<tr>
<td>Factor 3 (2, 3#, 4, 15)</td>
<td>1.45 Discovering (11.7%)</td>
</tr>
<tr>
<td>Factor 4 (14, 25)</td>
<td>1.35 Autonomous Action (10.9%)</td>
</tr>
<tr>
<td>Factor 5 (7, 12, 19)</td>
<td>1.19 Validating (9.6%)</td>
</tr>
<tr>
<td>Factor 6 (27)</td>
<td>1.05 Finding Out for Oneself (8.4%)</td>
</tr>
<tr>
<td>Factor 7 (26)</td>
<td>0.81 Teacher Showing (6.5%)</td>
</tr>
<tr>
<td>Factor 8 (1 and 10)</td>
<td>0.68 Seeking Help (5.5%)</td>
</tr>
</tbody>
</table>
The 8 factors relate to two distinct theoretical constructs. Factors 1, 7 and 8, explaining 19% of total variance, were all regarded as aspects of First Order Cognitive Holding Power. Factors 2, 3, 4, 5 and 6, explaining 22% of the total variance were regarded as aspects of Second Order Cognitive Holding Power. The inter-relationships between the factors for each theoretical construct and embedded activities are depicted in Table 2.

Table 2: (a) Inter-relationships among First Order Factors (Items with Factor Loadings greater than 0.30)

<table>
<thead>
<tr>
<th>Item</th>
<th>Being Shown by (17, 18, 26a, 30)</th>
<th>Being Told (1, 10, 23*a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Teacher Showing)</td>
<td>(5, 8, 10, 16, 23a, 24, 28) Copying</td>
<td>(6, 9, 20)</td>
</tr>
<tr>
<td>7 (Seeking Help)</td>
<td>Linking (22#*)</td>
<td></td>
</tr>
</tbody>
</table>

(b) Inter-relationships among Second Order Factors (Items with Factor Loadings greater than 0.30)

<table>
<thead>
<tr>
<th>Item</th>
<th>Trying Out (2a)</th>
<th>Trying Out (2a, 19) Embedded Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Checking (7, 12)</td>
<td>Checking (21, 29) Finding Out (4, 15)</td>
<td>Linking (3a, 22a)</td>
</tr>
<tr>
<td>3 Operating Validat</td>
<td>Finding Out (27)</td>
<td>Autonomously (14, 25)</td>
</tr>
<tr>
<td>4</td>
<td>Linking (3a, 13a, 22a#)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Independently</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Discover Information</td>
<td></td>
</tr>
</tbody>
</table>
theoretical constructs. One exception was Item 22 which, while loading substantially on two factors relating to second order cognitive holding power, also loaded substantially on a factor relating to first order cognitive holding power. To check further the alignment of factors with the constructs, a principal factor analysis, with varimax rotation, was conducted again, but forcing a 2 factor solution. The results are given in Table 3, along with the results of similar factor analyses of data gained from subsequent administration of the instrument as follows:

Group A: 278 students in 22 different classes across all courses at a single College of TAFE
Group B: 7 groups of automotive, fitting and machining students in two colleges each taught three times by two teachers (automotive students in one college taught by only one teacher) (325 observations)
Group C: 6 classes of 187 students undertaking welding and electrical courses in three colleges
Group D: Groups A, B and C combined (49 classes involving 706 observations)

There was strong agreement in the factoring of each set of data, and each factor also contained items referring to both student and teacher activities. For each set of data, the two factors matched the constructs of First and Second Order Cognitive Holding Power. For the combined data (n = 706), the two factors explained 29% of the total variance.

From the factor analyses, several items (10, 14, 25) had substantial loadings on both factors. Items 14 and 25 comprised a sub-scale, autonomous action, identified in the original 8 factor solution. These items were eliminated from the measurement of Second Order Cognitive Holding Power because they are more likely to be individual characteristics than characteristics of the learning setting. Item 10 was eliminated as ambiguous because it could be interpreted to refer either to a press from the teacher for students to involve the teacher unnecessarily in checking or to a student desire to check results following second order processing. The items selected, then, to measure cognitive holding power were as follows:

First Order Cognitive Holding Power (FOCHP): 5, 6, 8, 9, 16, 17, 18, 20, 23, 24, 26, 28, 30
Second Order Cognitive Holding Power (SOCHP): 1, 2, 3, 4, 7, 11, 12, 13, 15, 19, 21, 22, 27, 29

Table 3: Factor Loadings with a Two Factor Solution

<table>
<thead>
<tr>
<th>Group A (n = 278)</th>
<th>Group B (n = 321)</th>
<th>Group D (A+B+Ca) (n = 706)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor 1</td>
<td>Factor 2</td>
<td>Factor 1</td>
</tr>
<tr>
<td>1</td>
<td>0.15</td>
<td>0.51</td>
</tr>
<tr>
<td>0.62</td>
<td>0.09</td>
<td>0.62</td>
</tr>
<tr>
<td>0.63</td>
<td>0.07</td>
<td>0.48</td>
</tr>
<tr>
<td>0.43</td>
<td>5</td>
<td>0.64</td>
</tr>
<tr>
<td>0.68</td>
<td>0.02</td>
<td>0.71</td>
</tr>
<tr>
<td>0.10</td>
<td>0.60</td>
<td>0.05</td>
</tr>
<tr>
<td>0.51</td>
<td>0.01</td>
<td>9</td>
</tr>
<tr>
<td>0.32</td>
<td>0.34</td>
<td>0.27</td>
</tr>
<tr>
<td>0.05</td>
<td>0.67</td>
<td>0.00</td>
</tr>
<tr>
<td>0.09</td>
<td>0.56</td>
<td>13</td>
</tr>
</tbody>
</table>
CONCLUSIONS Cognitive Holding Power (CHP) is a characteristic of learning settings which can be conceptualised in terms of the degree to which the setting presses students into the utilisation of First or Second Order Cognitive Procedures (FOCHP and SOCHP). An instrument has been developed with acceptable reliability in measuring these two dimensions in Colleges of TAFE. The reliability remained acceptable when the instrument was administered to students in different technical courses and across several TAFE colleges. The instrument also has face validity in that the items which load on each factor relate directly to the theoretical constructs.

Through theoretical synthesis and factor analysis, some components of FOCHP and SOCHP have been identified. From these analyses, CHP is conceptualised as depicted in Figure 1.

Figure 1: Conceptualisation of Cognitive Holding Power
More work is needed to determine if the instrument differentiates classes expected to have different degrees of FOCHP and SOCHP. The applicability of the instrument in other settings also needs to be examined.

The conceptualisation and measurement of CHP have implications for research and instructional design. Recently reported research has identified a number of factors involved in the development of problem-solving abilities. Teaching methods which emphasise discovery develop greater learner independence in handling the unfamiliar problems required in far transfer (Stevenson, 1986b). On the other hand, Ward and Sweller (1990) argue that reliance on means-ends strategies in discovery learning can interfere with learning, and have demonstrated that well structured worked examples reduce demands on working memory and facilitate the development of problem-solving skills. McDaniel and Schlager (1990) contributed to reconciliation of such research by differentiating transfer problems which involve re-application of strategies learned in training, but with new move sequences (specific procedures), from those which require the discovery of a new strategy. They demonstrated that discovery of strategies (second order procedures) was better than provision when a new strategy had to be generated to solve a transfer problem.

The measurement of CHP in such research would contribute to an analysis of the results, answering questions concerning the role of the learning setting in developing abilities for different kinds of transfer. The concepts explained in the current article indicate that the teaching of problem-solving through worked examples would be characterised by learning environments of high FOCHP, appropriate for near transfer. On the other hand, teaching through discovery would involve high SOCHP, appropriate for far transfer. Consideration of relationships between CHP learners’ abilities to transfer within and beyond specific content areas may also contribute to understanding the extent to which problem-solving ability is restricted to particular domains of knowledge (Glaser, 1984; Royer, 1986).

Measurement of cognitive holding power will also help to increase teachers’ awareness of the kinds of cognitive activity in which learners are engaging and the kinds of cognitive structures which are being developed. Such awareness will enable evaluation of instructional strategies and assist further instructional design.


Scandura, J.M. (1981). Problem solving in schools and beyond: transitions from the naive to the neophyte to the master. Educational Psychologist, 16(3), 139-150.


