Assessing approaches to learning, attributional beliefs and strategic learning in specific subject domains: Scale development.

Hedy M Fairbarin, Phillip J Moore & Lorna K S Chan
Department of Education
The University of Newcastle


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Abstract

This paper reports on Study One of a three year project examining the changing pattern of the influence of motivation and strategic learning on school achievement across years of schooling from both a cross-sectional and longitudinal perspective. One of the specific aims of the project involves the examination of motivational orientations and strategic learning in specific domains and their relationship with generalised global measures of these constructs.

In this first study, three assessment scales used as global measure in previous research were refined and new scales were constructed for use in the specific subject domain of English/reading, mathematics and social science. These include three sets of four scales (generalised context and the three subject domains), each set developed from Biggs' (1987) Learning Process Questionnaire, Chan's (1994) Casual Attribution Scales and Youlden & Chan's (1994) Self-Regulated Learning Strategies Scale. Each scale includes a junior and senior version for primary and high school students. The scales were trialed using 185 students from Years 5 & 6, and 236 students from Years 7, 8 and 9. The construction of the scales in mathematics are reported in some detail as illustration of the methodology. Further, reliability estimates and factor analysis results are reported.

This paper reports on Study One of a three year project examining the changing pattern of the influence of motivation and strategic learning on school achievement across years of schooling from both a cross-sectional and longitudinal perspective. One of the motivation constructs under investigation in this project is causal attributions which refers to what students perceive as the cause of their successes and failures in school. Earlier research in attributions focused on ability, effort, and external
factors like task difficulty, significant others and luck as the major perceived causes of success/failure (Weiner, 1984, 1991). More recently attention has been drawn to the importance of strategy attributions in enhancing motivation to learn (Borkowski, Carr, Rellinger & Pressley, 1990; Chan, 1991a, 1992a; Clayton-Jones, Rodwell, Skehan, Archer, Chan & Moore, 1992). According to Weiner's theory (1984) attributions can be classified along three dimensions: locus, stability and controllability. For example, ability attributions have an internal locus, are stable but uncontrollable whereas effort and strategy attributions have an internal locus, are unstable (therefore can be changed) but are controllable. Students who perceive their failures as attributable to lack of ability are likely to develop a set for future failure because whatever they do is perceived to be dependent upon their ability which is unchangeable and out of their control. Indeed, in extreme instances such an attribution can lead to learned helplessness (Reid & Borkowski, 1987). On the other hand, students who perceive they have control over school successes or failures are likely to have higher expectations of success and are motivated because they realise that their effort and use of strategies are closely linked with their performance.

Perceptions of personal control (effort and strategy attributions) have been shown to relate positively to strategic learning (see Strategy Learning section) and subsequently, academic performance (Borkowski, Weyhing & Carr, 1988; Chan, 1991b, 1992a). More importantly, for the proposed research, the pattern of attributional beliefs appears to change across the years of schooling (Chan, 1992a; Clayton-Jones et al, 1992). In the Clayton-Jones' et al study, students from Grades 4, 6, 7, 9, 11 and TAFE classes were administered a general attribution scale incorporating ability, luck, effort and strategy attributions for success and failure. For the primary aged children, effort attribution for success was positively related to achievement in maths and English (a combined score) but at Grade 9, strategy attribution for success emerged as a positive predictor of achievement. Ability attribution for failure, however, was a pervasive negative influence across all grades, except Grade 4. This study was exploratory in nature, and further, did not consider the potentially different causal attributions that students might have for different academic subject domains, a question that will be addressed in the present proposed research.

The other motivation construct of importance to the current project emerges from the approaches to learning literature (Biggs, 1987; Biggs & Moore, 1993; Watkins & Hattie, 1990).
Three prototypical motivational intentions are identified: surface, deep, and achieving. Students with a surface perspective are extrinsically motivated, and do the least amount possible to succeed, whereas those with a deep motivation are intrinsically oriented and seek meaning from the materials they are learning. The essence of achieving motivation is ego enhancement. When these three are matched with appropriate surface, deep and achieving strategies, three approaches to learning are identified: surface, deep, and achieving. The rather extensive literature on approaches to learning and their relationships to learning show the surface approach to be negatively related to performance (Cantwell & Moore, 1990; Moore & Telfer, 1992; Ramsden & Entwistle, 1981). Deep approaches tend to lead to more complex responses (Biggs, 1987), better applications of complex knowledge (Moore, 1991a) and higher self-estimates of achievement (Watkins & Hattie, 1990) while the achieving approach also relates positively to achievement and self-perceptions (Watkins & Hattie, 1990).

Cross-sectional studies of the development of approaches to learning suggest increases in deep approaches with age while university faculty comparisons reveal a greater propensity for surface approaches as students move through science faculties (Biggs, 1987). The question arises, however, of the relative contribution that such approaches might make to achievement variance when taking other motivational constructs, such as attributions, into account. The Clayton-Jones et al (1992) study goes some way in addressing that issue. When attributions, approaches and goal orientations were all entered into regression analyses, only failure attributions made a significant unique contribution to achievement in maths and English (combined) for the primary aged students while both success and failure attributions made significant unique contributions at the secondary school level. It was only at the TAFE level that approaches to learning made a significant unique contribution to achievement variance.

The recent literature abounds with calls of enhancing student learning by teaching students critical thinking skills or learning strategies and getting students to become active, strategic, metacognitive, independent, self-directed or self-regulated learners (e.g. Paris & Winograd, 1990). Regardless of the term that is used, the emphasis is on how to think, how to learn and taking active control over one's own thinking and learning processes. Strategic learning is considered to involve two essential features of metacognition, self-appraisal and self-management of cognition (Paris & Winograd, 1990). Self-appraisal includes personal reflections.
about one's knowledge states and abilities while self-management refers to executive cognitive actions that help guide and coordinate thinking, such as planning, using a variety of strategies, monitoring, evaluating and regulating. That is to say, strategic learning emphasises awareness and executive management of our own thinking and learning.

The close relationship between strategic learning and achievement has been consistently demonstrated in beginning reading (e.g., Adams, 1990; Calfee, 1991; Perfetti, 1991; Stanovich, 1991; Vellutino, 1991), reading comprehension (e.g., Chan, 1991b, 1992a; Spedding & Chan, 1993), mathematics and science (e.g., Pintrich & De Groot, 1990; Zimmerman & Martinez-Pons, 1990) and general academic studies (Schneider, Borkowski, Kurtz & Kerwin, 1986; Youlden, 1993). Further evidence of this relationship comes from training studies designed to improve learning outcomes through strategy instruction. Strategy instruction has been found to be effective in improving performance and achievement in reading comprehension (e.g., Borkowski, Weyhing & Carr, 1988; Bruce & Chan, 1991; Chan, 1991c; Chan, Cole & Barfett, 1987; Chan, Cole & Morris, 1990; Moore, 1988; Woloshyn, Pressley & Schneider, 1992), content area reading (e.g., Mastropieri, Scruggs, Bakken & Brigham, 1992; Moore, 1991b, 1991c; Moore & Scevak, 1993; Scevak, Moore & Kirby, in press), mathematics (e.g., Hutchinson, 1992; Montague, 1992; Swing & Peterson, 1988; van Essen & Hamaker, 1990) and others.

Metacognition, and similarly strategic learning, is considered to be "embedded in cognitive development and represents the kind of knowledge and executive abilities that develop with experience and schooling" (Paris & Winograd, 1990, p.19). Indeed, research into the causal relations between phonological processing and acquisition of reading skills has provided strong support for a theory of reciprocal causation. It has been found that certain phonological processing abilities (involving awareness and executive control of cognitive processes, that is, strategic learning) play a causal role in learning to read, and learning to read plays a causal role in the subsequent development of certain phonological processing abilities. Evidence supporting this reciprocal relationship has come from longitudinal and training studies of children in early primary grades (Juel, Griffith & Gough, 1986; Perfetti, Beck, Bell & Hughes, 1987; Stanovich, Cunningham & Feeman, 1984; Wagner, 1988). Given the recent recognition of the interdependence of the cognitive, metacognitive and motivational aspects of academic learning (Borkowski, 1992; Borkowski, Carr, Rellinger & Pressley, 1990; Chan, 1991a; Paris & Winograd, 1990), the same
reciprocal causation can be hypothesised for the relationship between attributional beliefs, approaches to learning, strategic learning and school achievement.

As mentioned earlier, the interdependence of cognitive, metacognitive and motivational factors in academic learning has recently been highlighted. Borkowski and associates (Borkowski, 1992; Borkowski, Carr and Pressley, 1987; Borkowski, Carr, Rellinger & Pressley, 1990) propose that metacognitive theory is particularly suited for understanding more about the interface of motivation, attitudes and cognition. It is suggested that "strategy-based actions directly influence self-concept, attitudes about learning, and attributional beliefs about personal control. In turn, these personal-motivational states determine the course of new strategy acquisition and, more importantly, the likelihood of strategy transfer and the quality of self-understanding about the nature and function of mental processes" (Borkowski et al, 1990, p.54). For example, students must first believe in the worth and benefits of their strategic actions and effort before they will apply those strategies and efforts in situations that require strategic learning.

Likewise, Paris & Winograd (1990) maintain that self-appraisal and self-management, the two essential aspects of strategic learning and metacognition, "invite both cognitive and motivational explanations because skill and will are interwoven in reflections and explanations about learning" (p.19). It is argued that self-appraisal and self-management are personal assessments filled with affect and that engagement in strategic learning involves motivational dynamics as well as cognitive knowledge. Students use personally constructed knowledge about themselves (such as causal attributions for success and failure and expectations for success) and academic tasks (such as declarative, procedural and conditional knowledge of cognitive strategies) to marshall appropriate effort and cognitive strategies in their learning.

Most of the research in causal attributions and approaches to learning has been limited to general notions of learning rather than learning in specific subject domains. A focus on generality may not be particularly helpful, at least in terms of instructional implications, if students have different attributions and approaches to learning in different school subjects. Marsh, Cairns, Relich, Barnes and Debus (1984) maintained that there is good evidence for the separation of attributions according to academic subject domain, at least in the case of ability attributions. The results of their study suggest that attributional responses students make do not generalize across academic subject domain and two subject-specific dimensions (ability in mathematics and ability in...
reading) can be identified. It was suggested that ability attributions are specific to academic content, but effort attributions and particularly external attributions may not be subject-specific. Only two specific subject domains, mathematics and reading, and one grade level (Grade 5) were examined in their study. It is reasonable to expect that with more school experience, students may learn to perceive different cost-effectiveness for effort exerted in different subject domains. They may have been led to believe from experience, for instance, that effort (or the lack of it) is more likely to be the cause for their success/failure in English/reading and social studies subjects than in mathematics. Similarly, strategy attributions may also depend on subject domain.

Indications of different motivational influences operating in different school subjects can also be seen in two other recent studies. Pintrich & De Groot (1990) studied the relationships among intrinsic beliefs and cognitive and self-regulatory strategies in English, social studies and science. While they reported very few differences in these subject domains, their interview data, which discussed all school subjects, showed perceived motivational and strategic differences in mathematics. Young, Arbreton and Midgley (1992a, 1992b) also examined motivational orientation and cognitive strategy use in different subject domains. Their study of 6th and 7th graders included English, social studies, mathematics and science measures showing, among other findings, that science and mathematics were more learning focussed (mastery) than English and social studies. On the other hand, ability focussed orientations (performance rather than mastery) were highest in social studies. These findings clearly show that students do have different motivational orientations for different school subjects. However, it still leaves open the question of the relationship of this complex of variables to actual achievement. Nevertheless, such research provides rather compelling evidence to move to subject-specific assessments as well as global assessments of motivation and strategic knowledge.

The overall objective of the three-year project is to investigate the reciprocal relationship between motivational and metacognitive factors in school learning. Specifically, the interrelationships among causal attributions, approaches to learning, strategic learning and achievement in both generalised and subject-specific contexts will be examined. Developmental changes in the pattern of relationships across years of schooling from primary to secondary (Years 5 - 9) will be studied from both a cross-sectional and longitudinal perspective. Further, the effects of motivational and metacognitive
instruction of cognitive strategies on students' motivational dispositions and strategic behaviour, and subsequently achievement, will also be explored.

As Study One of the three year project, the specific aims of the study reported here were to refine and develop instruments for assessing approaches to learning, causal attributions and learning strategies in both generalised and subject-specific contexts. The specific subject domains include English/reading, mathematics, and social studies, the major areas of school learning.

The sample

Five schools from the Hunter region of New South Wales took part in Study One - two high schools and three primary schools, giving seven classes each from Years 5 and 6 and three classes each from Years 7, 8 and 9. This gave 185 primary and 236 secondary students, or a total sample of 421. Table 1 shows the breakdown of the sample by grade and sex.

Table 1: The sample population by grade and sex

<table>
<thead>
<tr>
<th>Grade</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 5</td>
<td>50</td>
<td>47</td>
<td>97</td>
</tr>
<tr>
<td>Grade 6</td>
<td>34</td>
<td>54</td>
<td>88</td>
</tr>
<tr>
<td>Total Primary</td>
<td>84</td>
<td>101</td>
<td>185</td>
</tr>
<tr>
<td>Grade 7</td>
<td>38</td>
<td>45</td>
<td>83</td>
</tr>
<tr>
<td>Grade 8</td>
<td>43</td>
<td>40</td>
<td>83</td>
</tr>
<tr>
<td>Grade 9</td>
<td>36</td>
<td>34</td>
<td>70</td>
</tr>
<tr>
<td>Total Secondary</td>
<td>117</td>
<td>119</td>
<td>236</td>
</tr>
<tr>
<td>Total Sample</td>
<td>201</td>
<td>220</td>
<td>421</td>
</tr>
</tbody>
</table>

Administration of the Questionnaires

Classes from Year 5 to Year 9 were visited four times each over a period of two to four weeks in third term of 1994. On each visit, a set of three questionnaires was given to each class - Learning Process Questionnaire, Casual Attribution Scale and Self-Regulated Learning Strategies Scale - covering either the generalised or one of the three subject domains. Due to the repetitive nature of the questionnaires, great care was taken to
avoid an order bias. This was achieved by:

randomising the order of the items or, for the Learning Process Questionnaire and the Casual Attribution Scale, groups of items for each subject domain but keeping the primary and secondary forms parallel. It was not necessary to randomise the order of the items on the Self-Regulated Learning Strategies Scale as the items, being largely subject-specific, were different for each subject domain and, in the case of mathematics in particular, the items were presented sequentially;

randomising the order in which the subject domains were presented over the four visits; and

randomising the order in which the three questionnaires was given on each visit.

Procedures were standardised for administering the questionnaires. Students were read the instructions and then completed the practice items for the first questionnaire. The items were read to Years 5, 6 and 7 while Years 8 and 9 completed the questionnaires at their own pace.

Development of the Self-Regulated Learning Strategies Scale for Mathematics

The Self-Regulated Learning Strategies Scale is a rating scale designed to assess students' awareness and regulation of learning strategies. The original scale developed by Youlden and Chan (1994) has 24 items, each describing a student using a particular self-regulated learning strategy identified by Zimmerman (1986). After each description, students are required to rate the strategy on two separate four-point scales in terms of how helpful they consider that strategy to be and how often they employ that strategy. Ratings on the two questions are then averaged separately, giving a "Knowledge" and a "Reported Usage" mean score, ranging from zero to four.

COGNITIVE STRATEGIES AND PROCESSES
(Specific problem-solving strategies)

1. READ (comprehension)
   Read the problem aloud

2. PARAPHRASE (translation)
   Give important information
   Repeat question aloud
   What is asked?  What am I looking for?
3. VISUALISE (transformation)  
   Draw a diagram

4. HYPOTHESESE (planning)  
   If I ... then ...
   How many steps?

5. ESTIMATE (prediction)  
   Round the numbers

6. COMPUTE (calculation)  
   Label
   Circle

7. CHECK (evaluation)  
   Check every step
   Check calculation
   Does the answer make sense?

Figure 1: Montague's model of mathematical problem solving strategies

Using this general version of the Self-Regulated Learning Strategies Scale as a model, a scale was developed specifically to measure students' knowledge and use of mathematical problem solving strategies. The items were theory-based, primarily derived from the mathematical problem solving models developed by Montague (1992), Montague and Boss (1986a, 1986b), Lester (1985), Schoenfeld (1985) and others. The items were designed to fit, very broadly, into the seven categories of the Montague model (Montague and Bos, 1986b; Montague, 1992) as shown in Figure 1.

A scale of 30 items was developed, comprising 18 strategies specific to mathematical problem solving and 12 general learning strategies adapted from the general version of the scale. The general items were included so that very specific comparisons of strategy knowledge and usage could be made between subject domains and between subject specific and the generalised domain. Also, the mathematics items referred specifically to mathematical problem solving tasks whereas inclusion of the general items, reworded to apply to mathematics, meant strategies used in the broader context of studying for test and quizzes, etc were included in the questionnaire.

The proposed items were discussed with experienced teachers to ensure their face validity and with a
group of students to ensure that the language and phrasing used was appropriate for the age group and that the intent of the questions was clear.

Two parallel versions of the scale were developed - a junior version for primary students and a senior version for high school students. While the aim was to make the items as relevant and meaningful as possible for each age group, the only flexibility possible was with item wording as the actual strategies described had to be consistent between the two forms. This was because firstly the same set of strategies applies to both primary and secondary school and secondly, to ensure that valid comparisons could be made between the junior and senior scales. Examples of senior and junior wording are:
Senior: After reading over a Maths word problem Allison restates the problem in her own words
Junior: After reading over a Maths word problem, Allison tries to put the problem in her own words.

Senior: When studying for a Maths exam, Lauren gets past exam papers to practice.
Junior: When studying for a Maths test, Lauren has her mother make up questions to ask her.

Two subscales, namely Knowledge of Strategies and Reported Usage of Strategies, were developed for both junior and senior versions. The scales statistics and correlation between the subscales are shown in Table 2.

While both junior and senior students reported that the strategies were, on average, "quite helpful", the mean of the senior Knowledge subscale (3.04) was significantly higher than that of the junior students (2.90) (univariate F-ratio=5.84, p <0.05). Since the strategies were the same on both forms of the scale, it is to be expected that senior students would have a greater knowledge of mathematical problem solving strategies, even if they did not make more use of them as the results indicate. Both the junior and senior students reported using the strategies, on average, "sometimes", there being no statistically significant difference between the means which were 2.30 and 2.23 respectively.

The subscale reliabilities were well above the accepted level of 0.80 (Oppenheim, 1992) being 0.94 for both the junior and senior Knowledge subscales and 0.91 for Usage subscales and the items within each sub-scale were uniformly reliable with virtually no variation between items.
Table 2: Self-Regulated Learning Scale for Mathematics
Scale statistics and correlations between subscales for Junior and Senior students
Original items

<table>
<thead>
<tr>
<th></th>
<th>Junior (n=185)</th>
<th>Senior (n=236)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>2.90</td>
<td>3.04</td>
</tr>
<tr>
<td>S.D.</td>
<td>0.56</td>
<td>0.50</td>
</tr>
<tr>
<td>No. of items</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Reliability</td>
<td>0.94</td>
<td>0.94</td>
</tr>
<tr>
<td>Usage</td>
<td>2.30</td>
<td>2.23</td>
</tr>
<tr>
<td>S.D.</td>
<td>0.52</td>
<td>0.50</td>
</tr>
<tr>
<td>No. of items</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Reliability</td>
<td>0.91</td>
<td>0.91</td>
</tr>
</tbody>
</table>

Correlation:
Knowledge
Usage
0.63**

Usage
0.59**

*p<0.05    **p<.01

The Knowledge and Usage subscales correlated at 0.63 and 0.59 (p<0.01) for junior and senior, respectively, indicating a positive and relatively high degree of relationship between the two subscales. This is an expected outcome: while students may not necessarily use the strategies very often even though they are familiar with them, as the scale means indicate, strategy knowledge must precede use.

A decision was made to shorten each version of the Self-Regulated Learning Strategies Scale to reduce the fatigue factor involved in answering three questionnaires at each of four sessions, if doing so maintained or improved subscale reliability. Each of the four versions was to be a uniform length of 20 items, so ten items had to be deleted from the mathematics version. Since subscale reliability could not be improved by deleting any items, deletion had to be based on other considerations. The main criteria were the face validity of the items, the number of items in each broad strategy category and the frequency distribution of the scores on the Usage subscale since this was the subscale which, it was anticipated, would be more influenced by the proposed strategy training in Year 3 of the study.

Six general items were deleted, four on the basis of distribution (lower standard deviations than similar items indicating more uniform responses) and the two environmental structuring items because it was felt this strategy was adequately covered by the general scale.
Four mathematical problem solving items were deleted, preference being given to those items covering the same strategy category which had a larger standard deviation and/or clearer and more concise wording and greater face validity. As a result of feedback from students during the pilot study, the wording of several of the remaining items was changed to give them greater face validity. For example:

Original: When Chad gets a good grade on Maths test, he treats himself to a movie with his friends.
Final: When Chad gets a good grade on Maths test, he rewards himself by doing something special.

Even though the reliabilities of each of the subscales fell slightly due to the reduced number of items in each scale, they remained very acceptable at 0.92 for the Knowledge subscales and 0.89 and 0.88 for the junior and senior Usage subscales, respectively.

The Appendix shows the final 20 items and the strategy category, based on the theoretical models, to which they belong. Table 3 gives the scale statistics and correlation between subscales for the final items.

Table 3: Self Regulated Learning Strategies Scale for Mathematics
Scale statistics and correlations between subscales for Junior and Senior students

<table>
<thead>
<tr>
<th>Final items</th>
<th>Junior</th>
<th>Senior</th>
</tr>
</thead>
<tbody>
<tr>
<td>n=185</td>
<td>n=226</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Knowledge</th>
<th>Usage</th>
<th>Knowledge</th>
<th>Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>2.82</td>
<td>2.24</td>
<td>3.0</td>
<td>2.25</td>
</tr>
<tr>
<td>S.D.</td>
<td>0.59</td>
<td>0.55</td>
<td>0.54</td>
<td>0.53</td>
</tr>
<tr>
<td>No. of items</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Reliability</td>
<td>0.92</td>
<td>0.89</td>
<td>0.92</td>
<td>0.88</td>
</tr>
</tbody>
</table>

Correlation:
Knowledge
Usage 0.63** 0.58**

*p<0.05  **p<0.01

These final 20 items became the version of the scale for use in subsequent studies of the project.

Development of the Causal Attribution Scale for Mathematics
As outlined in the introduction, one of the motivation constructs under investigation was causal attributions which refer to what students perceive as the cause of their success and failure at school. These attributions are measured using a scale developed by Chan (1994), and designed to assess a student's tendency to attribute general school success and failure experiences to the four likely reasons of effort, ability, strategy use and luck. Six items describe success incidents and the other six, failure incidents. For each item, the four different reasons are listed and students are required to rate each on a four-point scale to indicate how true they consider that particular reason to be for them. The ratings for each of the four types of reasons are then averaged across the six success and the six failure items respectively, thus giving eight subscale scores, each ranging from zero to four.

Based on this general version, a Causal Attribution Scale for Mathematics was developed. The only changes necessary to the original scale were to insert the word "Maths" or substitute it for "schoolwork". By doing this, not only for mathematics but also for the other two subject domains, all four versions of the scale had similar constructs referring their specific domain. A typical general item and its mathematics equivalent is:

Suppose you were given an award for schoolwork, it was likely because:

a. you are good at schoolwork
b. you had useful methods for studying
c. you worked hard that term
d. you were lucky that term

Suppose you were given an award for Maths, it was likely because:

a. you are good at Maths
b. you had useful methods for studying Maths
c. you worked hard on Maths that term
d. you were lucky that term

As with the Self-Regulated Learning Strategies Scale, parallel versions of the scale were developed for junior and senior students, making the wording relevant for primary students. For example:

Senior: When you got high marks for your Maths assignment, it was probably because
Junior: When you got high marks for your Maths homework, it was
probably because

Apart from these changes, the junior and senior items were the same, presented in the same order. Scale statistics for the Causal Attribution Scale for Mathematics are shown in Tables 4 and 5.

**Table 4: Causal Attribution Scale for Mathematics**
Scale statistics and correlations between subscales for senior students - original items
n=236

<table>
<thead>
<tr>
<th>Success</th>
<th>Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Luck Ability Effort Strategies</td>
<td>Luck Ability Effort Strategies</td>
</tr>
<tr>
<td>Mean 1.86 2.60 3.10 2.53</td>
<td>Mean 1.73 1.91 2.43 2.12</td>
</tr>
<tr>
<td>SD 0.66 0.73 0.71 0.69</td>
<td>SD 0.61 0.77 0.92 0.65</td>
</tr>
<tr>
<td>No of Items 6 6 6 6</td>
<td>No of Items 6 6 6 6</td>
</tr>
<tr>
<td>Reliability 0.80 0.87 0.85 0.83</td>
<td>Reliability 0.80 0.90 0.90 0.81</td>
</tr>
</tbody>
</table>

Correlation:
Luck
Ability 0.09 0.40**
Effort -0.25** 0.35** 0.04 0.31**
Strategies -0.14* 0.46** 0.64** 0.30* 0.48** 0.45**

* P<0.05  **p<0.01

**Table 5: Causal Attribution Scale for Mathematics**
Scale statistics and correlations between subscales for junior students - original items
n = 185

<table>
<thead>
<tr>
<th>Success</th>
<th>Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Luck Ability Effort Strategies</td>
<td>Luck Ability Effort Strategies</td>
</tr>
<tr>
<td>Mean 1.97 2.62 2.96 2.47</td>
<td>Mean 1.83 1.87 2.04 1.84</td>
</tr>
<tr>
<td>SD 0.78 0.84 0.72 0.73</td>
<td>SD 0.72 0.85 0.85 0.67</td>
</tr>
<tr>
<td>No of Items 6 6 6 6</td>
<td>No of Items 6 6 6 6</td>
</tr>
<tr>
<td>Reliability 0.84 0.87 0.78 0.84</td>
<td>Reliability 0.82 0.88 0.87 0.83</td>
</tr>
</tbody>
</table>

Correlation:
Luck
Ability -0.21* 0.46**
Effort -0.12 0.56** 0.34** 0.38**
Strategies -0.05 0.58** 0.56** 0.51** 0.67** 0.41**
Senior and junior students responded that while it was "sometimes true" that they attributed success in mathematics to luck, it was "often true" that they attributed it to ability, effort and use of strategies. They perceived lack of ability, effort and use of strategies as contributing less to their failure than to their success, responding that it was only "sometimes true" that lack of luck, ability effort, and use of strategies contributed to failure in mathematics. Overall, luck was the weakest attribution, indicating that students, by and large, felt that success and failure in mathematics was less likely to be attributed to luck relative to the other internal factors.

There was no statistically significant difference between the junior and senior responses on the success subscales but for the failure subscales, the senior students perceived lack of effort and use of strategies as contributing significantly more often to their failure than did junior students (univariate F-ratio=16.68 and 17.03 respectively, $p<0.01$).

Once again, learning from the experience of the pilot study, the decision was taken to shorten the scale to ten items - five success and five failure items. However, this was not as straightforward as it had been with the Self-Regulated Learning Strategies Scale for three reasons. First, the final four versions of the scale - general, mathematics, English and social science - had to contain the same items and the junior and senior forms had to be parallel, so across the eight versions, the same items had to be deleted. Secondly, since there had to be an equal number of success and failure items, one of each would have to be deleted. Thirdly, each item consisted of a stem and four attributions. This meant that an item must be deleted from all four subscales even though, in terms of reliability and/or factor analysis, it may have been preferable not to delete it from all four subscales.

The decision as to which items to delete was based on scale reliability, factor analysis and how students had related to the items during the pilot study, that is, their face validity. The decision had to be one which, over all versions, gave the most valid and reliable scales.

Deleting the item, If you were tested at the end of a Maths lesson on what had just been taught and you knew most of the answers, it would probably be because ... would improve the reliability of the success-ability subscale on all versions, junior and senior; while deleting the item, Suppose you were asked to be the team leader on a class project. It was probably because ... would improve the success-luck subscale for the senior English and social science and the success-effort subscale for junior social science. Despite the fact that, based on reliabilities alone, it was preferable to delete the first item, there were two other considerations.
It was learnt from talking with students during the pilot study that to be selected as a team leader is considered to be unlucky or a job that is volunteered for because no one else would do it. The item, therefore had little face validity. Secondly, the factor pattern indicated that a clearer factor pattern would result by deleting the second item due to cross-loading.

For the failure items, the deletion of any item would, for all scales except social science, mean lower subscale reliabilities. On the factor analysis however, two failure items were consistently cross-loading. Scale reliabilities were run, deleting each in turn. Deleting the item If you had trouble understanding what had been taught in a maths lesson, it was probably because ... consistently gave higher scale reliabilities than the deletion of the other and when this item was deleted from the factor analysis in conjunction with the success item previously selected, a better and clearer factor pattern resulted.

The final scale therefore had 10 items, five success and five failure. The scale statistics and subscale correlations are shown in Tables 6 and 7.

Table 6: Causal Attribution Scale for Mathematics
Scale statistics and correlations between subscales for senior students - final items
n = 236

| Luck  | Ability | Effort | Strategies || Luck  | Ability | Effort | Strategies |
|-------|---------|--------|------------|---------|---------|--------|------------|
| Mean  | 1.79    | 2.60   | 3.17       | 2.55    | 1.71    | 1.92   | 2.44       |
| SD    | 0.69    | 0.73   | 0.74       | 0.70    | 0.63    | 0.77   | 0.95       |
| No of Items | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Reliability | 0.80 | 0.81 | 0.83 | 0.81 | 0.79 | 0.87 | 0.90 |

Correlation:
| Luck Ability | -0.09 | 0.36** |
| Effort       | -0.22** | 0.31** | 0.03 | 0.32** |
| Strategies   | -0.08 | 0.42** | 0.60** | 0.25** | 0.48** | 0.43** |

* P<0.05  **p<0.01

Table 7: Causal Attribution Scale for Mathematics
Scale statistics and correlations between subscales for junior students - final items
n = 185

Success  Failure

| Luck  | Ability | Effort | Strategies || Luck  | Ability | Effort | Strategies |
|-------|---------|--------|------------|---------|---------|--------|------------|
| Mean  | 1.89    | 2.60   | 3.17       | 2.55    | 1.62    | 1.92   | 2.44       |
| SD    | 0.69    | 0.73   | 0.74       | 0.70    | 0.58    | 0.77   | 0.95       |
| No of Items | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Reliability | 0.80 | 0.81 | 0.83 | 0.81 | 0.79 | 0.87 | 0.90 |

Correlation:
| Luck Ability | -0.09 | 0.36** |
| Effort       | -0.22** | 0.31** | 0.03 | 0.32** |
| Strategies   | -0.08 | 0.42** | 0.60** | 0.25** | 0.48** | 0.43** |

* P<0.05  **p<0.01
Luck Ability Effort Strategies | Luck Ability Effort Strategies
--- | ---
Mean | 1.94 | 2.63 | 3.02 | 2.50 | 1.87 | 1.88 | 2.05 | 1.83
SD | 0.80 | 0.81 | 0.74 | 0.74 | 0.74 | 0.85 | 0.87 | 0.68
No of Items | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5
Reliability | 0.84 | 0.79 | 0.83 | 0.77 | 0.80 | 0.83 | 0.86 | 0.72

Correlation:

**Lucky** Ability  -0.22** | 0.43**
Effort  -0.12  0.46** | 0.36** 0.12
Strategies  -0.35** 0.55** 0.23** | 0.52** 0.23** 0.44**

* p<0.05  **p<0.01

The factor pattern (using total data sample) is shown in Table 8. An oblique rotation was employed to refine scale loadings, while recognising the correlation between the subscales.

**Table 8: Causal Attribution Scale for Mathematics**

Rotated factor matrix: oblique rotation
40 items n=421
Only factor loadings of 0.3 or more are shown

<table>
<thead>
<tr>
<th>Item</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
<th>Factor 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor 1: 6D</td>
<td>.76</td>
<td>4B</td>
<td>.81</td>
<td>1D</td>
</tr>
<tr>
<td>Failure-</td>
<td>10A</td>
<td>.76</td>
<td>12B</td>
<td>.81</td>
</tr>
<tr>
<td>Ability</td>
<td>12B</td>
<td>.73</td>
<td>4C</td>
<td>.73</td>
</tr>
<tr>
<td>3A</td>
<td>.71</td>
<td>3A</td>
<td>.71</td>
<td>2A</td>
</tr>
<tr>
<td>Factor 2: 4B</td>
<td>.81</td>
<td>10B</td>
<td>.79</td>
<td>11A</td>
</tr>
<tr>
<td>Failure-</td>
<td>12B</td>
<td>.81</td>
<td>6C</td>
<td>.79</td>
</tr>
<tr>
<td>Effort</td>
<td>10B</td>
<td>.79</td>
<td>3D</td>
<td>.76</td>
</tr>
<tr>
<td>Factor 3: 1D</td>
<td>.84</td>
<td>9B</td>
<td>.77</td>
<td></td>
</tr>
<tr>
<td>Success-</td>
<td>9B</td>
<td>.77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Luck</td>
<td>7B</td>
<td>.76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2A</td>
<td>.69</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11A</td>
<td>.61</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Factor 4: 7D</td>
<td>.72</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Success-</td>
<td>11D</td>
<td>.71</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effort</td>
<td>9D</td>
<td>.69</td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>----</td>
<td>-----</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1C</td>
<td>.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2C</td>
<td>.53</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Factor 5:
| Failure-Strategies | 4A | .81 |
|                   | 6A | .60 |

Factor 6:
| Success-Ability   | 7A | .86 |
|                   | 9A | .82 |

Factor 7:
| Strategy          | 1B | .76 |
|                  | 9C | .73 |

Factor 8:
| Luck             | 4D | .74 |
|                 | 3C | .74 |

% Variance      | 21.1 | 11.7 | 9.5 | 5.9 | 3.6 | 3.4 | 3.1 | 2.9 |
Eingenvalue     | 8.4  | 4.7  | 3.8 | 2.4 | 1.5 | 1.3 | 1.2 | 1.1 |
Reliability     | 0.87 | 0.88 | 0.82 | 0.81 | 0.81 | 0.83 | 0.81 | 0.78 |

### Development of the Learning Process Questionnaire for Mathematics

The Learning Process Questionnaire (LPQ) (Biggs, 1987), developed and normed for Australian secondary students, was "designed to assess the extent to which students endorse the more important approaches to learning and the motives and strategies comprising these approaches" (Biggs and Moore, 1993, p. 316). The Learning Process Questionnaire has 36 items, 18 on motives and 18 on strategies. Of the 18 items on each of the subscales there are six surface, six deep and six achieving items, yielding in all, six subscales, three for motives and three for strategies with a score ranging form zero to five. The Approaches scale score is found, therefore, by adding the motive and the strategy subscale scores. For the present project, only the 18 motive items were used, as learning strategies are measured by the Self-Regulated Learning Strategies Scale. The general version for senior students used in the pilot study was made up of the 18 motive items from the original Learning Process Questionnaire. A new...
version had to be developed for junior students, keeping the intent of the items the same but altering the wording to ensure the items were relevant and the meaning readily understood by fifth and sixth grade students.

Creating a version for mathematics then entailed taking both general forms and adapting them for mathematics. By and large this simply involved inserting “Maths” or substituting it for “schoolwork”. An example of the evolution of the mathematics version is given below.

Original and general - senior
I chose my present subjects mainly because of career prospects when I leave school, not because I'm particularly interested in them.

General - junior
Even though I am not particularly interested in schoolwork, I do it because it will help me get a job.

Mathematics - senior
Even though I am not particularly interested in Maths, I do not mind doing it mainly because it will help me get a job.

Mathematics - junior
Even though I am not interested in Maths, I do it because it will help me get a job.

On several items minor changes in wording were made but other items required more radical changes to ensure the intent was clear to primary students. For example

Senior: I see doing well in Maths as a sort of game, and I play to win.
Junior: I want to do better at Maths than others in my class.

The presentation of the form was also changed because the original Learning Process Questionnaire was designed for computer coding and therefore had a separate answer sheet. The version developed here, consistent with the other scales, provided a line marked with both the numerical and verbal response categories.

The scales statistics and correlations between subscales for the Learning Process Questionnaire for Mathematics are shown in Table 9.

For the junior students, the average response for the Surface and Achieving motives was "often true", though the Achieving motive was dominant. For the Deep motive the average response was "sometimes true". For the senior students, however, the Surface motive was dominant, the average response being "often true". There was a statistically significant difference (multivariate F-ratio=15.84, p<0.01) between the junior and senior motives. Univariate statistics indicated that, though both means lay within the "sometimes true" response category, the junior students had significantly stronger Deep motive (F-ratio=32.88, p<0.01) and stronger Achieving motive.
(F-ratio=5.62, p<0.05) than did the senior students.

Table 9: Learning Process Questionnaire for Mathematics
Scale statistics and correlations between subscales for junior and senior students original items

<table>
<thead>
<tr>
<th></th>
<th>Junior n=185</th>
<th></th>
<th>Senior n=236</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Surface Deep Achieving</td>
<td>Surface Deep Achieving</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>3.48  3.19  3.57</td>
<td>3.53  2.67  3.35</td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td>0.85  0.91  0.95</td>
<td>0.72  0.84  0.83</td>
<td></td>
</tr>
<tr>
<td>No of Items</td>
<td>6  6  6</td>
<td>6  6  6</td>
<td></td>
</tr>
<tr>
<td>Reliability</td>
<td>0.64  0.72  0.77</td>
<td>0.58  0.74  0.74</td>
<td></td>
</tr>
</tbody>
</table>

Correlations:
Surface
Deep                .56**                     0.42**
Achieving           .65**    .52**            0.49**   0.63**

*p<0.05  **p<0.01

The results of the pilot study indicated that the reliabilities of the three subscales could be improved by deleting items. One of the problems, however, as with the Causal Attribution Scale, was that the four forms — general, mathematics, English and social science had to be kept the same and the junior and senior version were to be parallel. In addition, if items were to be deleted, it was preferable that an equal number of items be deleted from each subscale.

The reliability analysis clearly indicated that, for all the senior subscales, two items should be deleted. For the mathematics version, the reliability of the Achieving subscale increased from 0.74 to 0.79 when the item: I like the results of tests to be put up publicly so I can see by how much I beat some others in my class was deleted. However, the deletion of this item reduced the reliabilities of the junior Achieving subscales for all but English, but the gain to the senior scales outweighed this.

Deleting the Surface item: I think that teachers shouldn’t expect students to study things which aren’t taught in class, increased the reliability of the Surface motive subscale on all senior forms, and for mathematics, from 0.58 to 0.64. Again, for the junior forms, there was an increase in the reliability of the English surface subscale, but the mathematics reliability fell from 0.64 to 0.62, general and social science remaining the same. Overall, therefore, a more reliable subscale was produced by deleting this item.

This meant that a Deep motive item had to be deleted also and the best candidate was the item: While I realise that others sometimes know better than I do, I feel I have to say what I think is right. Although the
deletion of this item meant that the reliability of the Deep motive subscale for mathematics fell from 0.74 to 0.73 for the senior version and from 0.72 to 0.68 for the junior version, for all other versions, the deletion of this item improved the subscale reliabilities.

The decision to delete the above items was supported by their poor face validity. For example, test and exam results are seldom publicly displayed in Australian classrooms nowadays. In fact, competition between students is actively discouraged, particularly at the primary school level with the growing emphasis on individual profiles and outcomes-based grading. The students' attitudes to the other two items were very poor during the pilot study.

A further refinement was made to the question wording based on the experience gained during the pilot study. For example, sample question above, for the junior form became: Even though I am not interested in Maths, I do it because it will help me get a job when I am older. Since employment is so far in the distance for 5th graders, the last phrase was added to make the question more relevant.

Although the factor analysis did not give a clear-cut factor pattern, the deletion of the above items did clarify the factor structure. The Deep item was cross-loading on surface, the surface item on Achieving.

The final form of the Learning Process Questionnaire for Mathematics had 15 items, five on each sub-scale. The subscale statistics and correlations between subscales are shown in Table 10.

Table 10: Learning Process Questionnaire for Mathematics
Scale statistics and correlations between subscales for junior and senior students
Final items

<table>
<thead>
<tr>
<th></th>
<th>Junior n = 185</th>
<th>Senior n = 236</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Surface</td>
<td>Deep</td>
</tr>
<tr>
<td>Mean</td>
<td>3.46</td>
<td>3.17</td>
</tr>
<tr>
<td>SD</td>
<td>0.88</td>
<td>0.94</td>
</tr>
<tr>
<td>No of Items</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Reliability</td>
<td>0.62</td>
<td>0.68</td>
</tr>
</tbody>
</table>

Correlations:
Surface
Deep               0.52**       0.41**
Achieving          0.61**       0.53**       0.57**  0.60**

*p<0.05  **p<0.01
Conclusion

This intent of this paper has been to illustrate the development of motivational and strategic knowledge/use scales for employment in a three year longitudinal study of the pattern of relationships among motivational, strategic and achievement variables in general schoolwork, as well as in English/reading, mathematics and social science. For illustrative purposes, the focus has been on the mathematics related scales. The results to date indicate reasonably reliable and valid instruments in the specific subject domains. The next phase of this research will involve tracking a large number of Year 5, 7 and 9 students for three years. During this time, the effects of combined motivation/strategic training will also be monitored.

Acknowledgment

Hunter Region High and Primary schools involved in this project are thanked for their co-operation. ARC funds supported this research.

Appendix: The final Items - junior version

1. After reading a Maths question, Fiona underlines the important words. Montague (1986, 1992): STATE THE PROBLEM

2. After reading over a Maths word problem, Allison tries to put the problem in her own words. Montague (1992): PARAPHRASE; Charles & Lester (1985)

3. After reading a Maths problem, Erik asks himself, "What is given in the problem and what do I have to find out?" Montague (1986): STATE THE PROBLEM

4. Before doing the sums for a Maths question, Peter tries to work out what information is needed, and what is not needed. Charles & Lester (1982): HELPING STRATEGY - ACTIVITY

5. When given a Maths question, Greg draws a picture to help him decide how to find the answer. Montague (1986): VISUALISE; Lester (1985) in Silver (1985); Schoenfeld (1985) - ANALYSIS

6. Lisa keeps a list of the questions she gets wrong in Maths tests so she can learn the correct way of doing them for the next test. Zimmerman (1989): KEEPING RECORDS & MONITORING

7. Before doing the sums for a Maths problem, Allen works out a plan for finding the answer.
8. To help prepare for a Maths test, Anne and her friends ask each other questions.
   Zimmerman (1989): REHEARSING & MONITORING

9. When solving word problems in Maths, Chad draws up tables and graphs to help him work out the answer.

10. When Susan gets a good mark on a Maths test, she treats herself to a movie with her friends.
    Zimmerman (1989): SELF-CONSEQUATING

11. Before doing the sums for a Maths problem, Mark decides what operations he should use to solve the problem.

12. Before doing the sums for a Maths question, David tries to guess what the answer is likely to be.
    Montague (1986): ESTIMATE

13. If Jamie has difficulty solving a Maths problem, he tries to see if the problem works using easier numbers.

14. If Sophie has trouble doing her Maths homework, she asks her friends to help her.
    Zimmerman (1989): SEEKING SOCIAL ASSISTANCE

15. After working out the answer to a Maths word problem, Tom asks himself if he has followed the steps in his plan.
    Polya (1990): LOOKING BACK; Schoenfeld (1985)

16. When studying for a Maths test, Sue has her mother make up questions to ask her.
    Zimmerman (1989): SEEKING SOCIAL ASSISTANCE

17. After doing the sums for a Maths puzzle, Martin always asks himself if his answer makes sense.

18. When Kelly has to remember something for a Maths test, she writes it down so she can study it before the test.
    Zimmerman (1989): REHEARSING & MONITORING
19. If Leanne does not know how to work out a Maths problem, she sees if it is like any problems she has done before.

20. When Martin has finished his Maths homework, he always checks his method and the sums.
   Montague (1986): SELF-CHECK

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