Concerns about the quality and quantity of students' knowledge about learning

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## Abstract

In any instance of learning a student uses both knowledge related to the topic being studied and knowledge about learning. Our observations of students' knowledge about learning show that it is often quite limited and poorly developed. Many students struggle to develop a detailed description of what happens when they learn. It is disconcerting that students are in this state when there is now available a body of detailed research-based knowledge about learning that has been shown to benefit student achievement. We consider the possibility that this situation is associated with an inappropriate reliance on the belief that appropriate knowledge about learning will be generated through experience. This view underestimates the complexity of the domain of knowledge about learning, complexity that necessitates sustained teaching and practice that parallels that provided for other knowledge domains.


## Introduction

It is a great pleasure to be able to contribute to a collection of papers honouring Professor J. P. Das who was the PhD supervisor of the first author. It was in Das's classes during graduate studies at the University of Alberta in 1974 that Mike Lawson encountered the constructs of metacognition in the work of Brown (1974) and executive functioning in research by Belmont and Butterfield (1971). These ideas have had enduring value for the study of both learning and teaching because they have drawn attention to the role of cognitive processes, knowledge about those processes, and the management of such processes during learning and problem solving. Cognitive strategies and their management by learners have also been central to the continuing work of Das and his colleagues (e.g., Das, 2002; Das, Naglieri & Kirby, 1994; Mahapatra, Das, Stack-Cutler & Parrila, 2010). Knowledge about these strategies and their use is critical for learning and it is the state of this knowledge that is the major concern in this chapter.

## The issue: The state of students' knowledge about learning

In a recent Australian study involving schools in suburban Melbourne, Griffin, Care, Francis, Hutchinson and Pavlevic (2012) examined growth in students' levels of reading comprehension and numeracy performance across Year Levels 3 to 6 (ages 8 -11 years). Along with evidence of growth, the authors noted that this growth in both areas diminished at the higher levels of student proficiency. Students in the upper quartile of the achievement distribution were not progressing at a rate that would be predicted on the basis of their previous performance. In following up this pattern of results Griffin et al. asked teachers whose students had shown the highest levels of improvement to recommend strategies for developing the skills of students at the different levels of proficiency. They found that:

> Teachers were proficient in recommending strategies for developing lower order skills among their students. However, they were unable to identify strategies at the top levels of the reading or mathematics continua. (p. 10).

The authors situated their discussion of these findings in the context of a recent plateau in the Program for International Student Assessment (PISA) results for students in Australia, which McGaw (2009) noted was associated with the fact that the high-achieving Australian students were not achieving as well as expected based on their previous PISA performance. A possible implication of the juxtaposition of the overall PISA performance profile and the findings arising from the teachers in the Griffin et al. (2012) study is that the teachers of high-achieving students need help with developing strategies for the more advanced literacy and mathematics problems being worked on by this group of students. One of the possible explanations that Griffin et al. considered for their results was that teachers did not have detailed knowledge about ways to facilitate the learning of higher ability students.

These findings related to the state of teacher knowledge about learning strategies sparked our interest because of their similarity to findings emerging from our observations of students' knowledge about learning and learning strategies in a different location in Australia. In many of the students we have observed, knowledge in the domain of learning is much less well developed than we had expected it to be. When we have involved school students and prospective teachers in discussions about learning, we have found that their knowledge about learning is often quite rudimentary when judged against the current state of research evidence about learning and instruction. Our findings and others including those of Griffin et al. (2012) raise the question of whether there should be greater concern with the state of knowledge about learning held by both teachers and students, in some Australian schools and universities and more widely (Dunlosky, 2013).

For researchers in this field it is disconcerting that our students have poorly developed knowledge about learning at a time when knowledge that would help them in their learning is readily available. We know from a wide body of strategy training research that if students at both school and university level are assisted to develop detailed, explicit knowledge about motivational, cognitive, and metacognitive strategies their performance in specific curriculum areas can be improved. Currently available textbooks like those by Bruning, Schraw, and Norby (2011) and Mayer (2008) set out the evidence showing that detailed training of specific learning strategies has practically significant impacts on students' performance. The meta-analysis by Hattie (2009) provides a large body of evidence of the substantial effect sizes associated with many of these learning strategy interventions (e.g., teaching students self-verbalisation strategies, metacognitive strategies and study skills all have effect sizes greater than 0.6). It is also relevant to note that for many commonly discussed strategies there is more detailed research work to be done to help teachers and students use these in effective ways (Dunlosky, Rawson, Marsh, Nathan, & Willingham, 2013). In this chapter we want to re-focus the attention of the research and teaching communities on the value that can be gained by helping students and their teachers develop better quality knowledge in the domain of learning. One part of the research that could be developed in this area could examine if the patterns of performance of high-achieving students noted by both Griffin et al. (2012) and McGaw (2008) could be influenced by better quality knowledge about motivational, cognitive, and metacognitive features of learning. Before we discuss some findings from our research we will consider why students need good quality knowledge about learning. In brief, our answer is that they need this knowledge to teach themselves.

**Students need to direct their own learning**

One source of evidence about the high level of responsibility placed upon students to build good quality knowledge about learning is made clear by observations of teacher-student interaction in classrooms. Research carried out in the United Kingdom (UK) (Black, 2004; Galton, Hargreaves, Comber, Wall & Pell, 1999) and in Hong Kong (Galton & Pell, 2012) indicates that, across classes of different sizes, many students spend a significant proportion of their time in solitary activity. In her observation of a Year 5 class (10-11 years) in the UK, Black found that for the average student across a set of 24 lessons there was about one individual interaction per lesson with a teacher. In their 1999 study in UK primary classes, Galton et al. observed that only 48% of teacher interactions in a typical class were with individual students, which is at a similar level to that noted by Buckingham (2003). When these interactions were spread across all the students in the period of a lesson there were not many minutes available in the lesson for teacher to have one-on-one interaction with each student.

In a more recent observational study in Hong Kong primary level classes (ages 6-8 years), Galton and Pell (2012) found a similar pattern of student-teacher interaction, with little difference in levels of interaction in classes that differed in size between around 38 students and those that had 20-25 students. Galton and Pell found that around 65% of the typical lesson involved whole-group teaching. When they looked at differences in patterns of behaviour among students they found that the largest groups of engaged students (43.8%) adopted what they termed a *solitary worker* approach, in which they

> *are on task for almost the entire lesson even when the teacher is engaged with other pupils elsewhere in the classroom. Although they sit in groups, for nearly 70% of the time they work on their own. Their contact with the teacher mainly involves being part of his/her audience when nobody in the class is in focus.* (p. 29.

It seems very likely that the patterns of teacher and student behaviour described in these studies would be found in many classrooms around the world. If this is the case, these findings point to two implications for teachers and students. First, even for students who show high levels of engagement in their lessons (like the solitary workers), what they do in class is mostly their own responsibility. They must direct most of their own learning about the subject-matter being studied because for most of the time they will have to work on their own. Less engaged students might use this time much less effectively.

A further implication of these observations of classroom life is that if students are to direct their learning in an effective manner they will need to develop a significant amount of good quality knowledge about learning. As Carr (2010) has argued, students who do not have well-developed capabilities to direct their own learning must rely more on others, especially on their teachers for such direction, teachers who may have little time to provide such direction.

It is also important to note that the knowledge that can be used for directing learning is distinct from the knowledge about the different topics of subject-matter content that students meet each day, though both sets of knowledge need to be used during learning. Even when they interact individually with the teacher, and especially when they are working on their own in the classroom and doing their own private study, students must decide how to approach and process what the content knowledge being presented to them. They must decide how they will represent themselves and how they will act in the learning situation. They must position themselves motivationally, decide what to attend to and what to select from the teacher's input or from the book or webpage, how to transform that selected information, and then how to organise it in memory in a way that will enable subsequent retrieval during problem solving. To expand this list of responsibilities we suggest that, to develop toward a state of high proficiency in learning, the students would need to have some knowledge about a range of features of learning, such as those listed in Table 1.

This account of the role of the student implies that whether they are learning in the classroom or outside it, students are to a significant extent, engaged in teaching themselves. Even when they are under the direct guidance of a teacher, students must make decisions about how to direct their learning. When learning is seen as self-teaching, students need a range of good quality knowledge that parallels what is described as teacher knowledge possessed by their teachers (e.g., Calderhead, 1996; Munby, Russell & Martin, 2001; Shulman, 1986). Students need their own pedagogical knowledge (Tran & Lawson, 2007). We now turn to a discussion of findings from investigations we have made about the state of students' knowledge about learning.

**Graduating university students' knowledge about learning**

In two studies we investigated the views of graduating Bachelor of Education students about what helped them to learn well in their university classes. In the Lawson and Askell-Williams (2001) study, the most frequent nominations of features that helped learning were class discussions and group work. Other high frequency responses referred to active learning, cognitive demands of set readings, personal qualities of teaching staff, supportive learning environments, critical thinking opportunities, and practical activities. Very few responses mentioned affective or motivational states of learners. These views were similar to those of the Belgian educational science university students studied by Elen and Lowyck (1999), and those expressed by students in Doyle's (1986) discussion of classroom organisation and management. In all of these studies, students reported explicit knowledge about a wide range of activities that helped their learning.

What we did not investigate in our 2001 study, and what was not examined in detail by the other researchers just referred to, was how well-developed the students' knowledge was about why these activities helped their learning. We could not say whether the students' explicit knowledge was at the level of mere familiarity with key ideas, or whether it was more elaborated, had greater complexity, or was well-developed. That is, we did not have any rating of the quality of that knowledge.

Table 1.

*Motivational, cognitive, and metacognitive learning features of learning*

| | |
|---|---|
| Motivational | • Beliefs about self, self-efficacy, ability and about the task<br>• Goal types<br>• Autonomy and control<br>• Interest<br>• Effort<br>• Causal attributional processes |
| Cognitive | • The role of context as a source of assistance, of possible cues for retrieval and of potential distractors<br>• Beliefs about knowledge<br>• Analysis and selection processes<br>• Attention, automaticity<br>• Sensory memory<br>• Working memory and cognitive load<br>• Reduction, elaboration and other transforming/encoding processes<br>• Role of practice and proceduralization, including rehearsal, mass and spaced practice, reminders and encoding variability<br>• Critical thinking<br>• Problem representation, situation models<br>• Activating relevant existing knowledge and problem-solving strategies<br>• Organisation of information for storage, including the nature of knowledge representation in long-term memory, memory networks<br>• Information integration processes, theory construction<br>• Retrieval processes, search<br>• Problem solving |
| Metacognitive | • Self-regulation of cognition<br>• Goal setting and planning<br>• Monitoring of progress, self-testing<br>• Evaluation of task achievement and awareness of possible biases of judgement<br>• Reflection on procedure, use of feedback |

Concerns about the quality of teacher education students' knowledge about learning had been voiced by other researchers (e.g., Elen and Lowyck, 1999; Rachal, Daigle &

Rachal, 2007; Woolfolk-Hoy & Tschannen-Moran, 1999). Woolfolk-Hoy and Tschannen-Moran noted that the prospective teachers they interacted with

> *lack understanding of the connections between teaching strategies and students' learning … our students have great difficulty explaining the mechanism of learning and how teaching influences these processes … Few students are able to connect the activity to cognitive processes that lead to learning, and few prospective teachers articulate what they want students to learn in ways that adequately represent academic content or cognitive outcomes (p. 280-281)*

Similarly, Elen and Lowyck found that their students lacked systematic vocabularies about instruction and did "not seem to have articulate conceptions about the way in which an instructional environment may support their cognitive processing and/or control activities" (p. 157).

In our 2003 study (Lawson, Askell-Williams & Murray-Harvey, 2003) we focused attention on the quality of final year Bachelor of Education students' knowledge about the features of learning that they found most helpful for their learning.  In one part of that investigation we interviewed nine students in order to seek detailed explanations about how the activity they nominated as most helpful for their learning did help their learning. In the interviews we 'pushed' the students as far as we could, using a sequential probing procedure to follow the linkages made explicit by students in their explanations. We stopped probing when they could add no more to their explanations. Our interest in doing this was to uncover the generativity, or generative power, of their explanations, which we consider to be a major dimension of the quality of knowledge (Lawson & Askell-Williams, 2012). More generative knowledge is, in Bruner's (1966) terms, more powerful because it provides a basis for wider transfer of knowledge.

In the 2003 study we rated each student's explanations on a four-point scale: from mere statement of a proposition about the learning activity at level 1 (*Discussion helps because it is good to hear other people's views*), through elaboration of a statement, to identification of an implication of discussion (*Um…because it helps me know what I've taken on board and what I can understand…the fact that I've disagreed with somebody means that I do have something there*), and finally to a statement that made a link with some element of theory of learning and instruction (level 4), even if that theory was oblique or stated in everyday terms (*When a piece of information is presented…I have a network or a filter or a structure of thought and I take that piece of information and place it in a mental process…I make sort of connections.*)[1]

Our analysis showed that only about 17% of the students' statements received the highest quality rating. For the remainder of their statements the students could not articulate an understanding that could be related to any component of contemporary theory of cognition and instruction. One student did not make any high quality explanations (level 4) and only two students had more than 30% of their statements at that level, where they made an explicit association with contemporary theories of learning and instruction. Four of the nine students had fewer than 50% of their statements rated in the top two categories of the scale. Across the body of the students' statements there was very little technical language from the domain of knowledge about learning.

In this group of prospective teachers, detailed probing of their knowledge about learning revealed that only a small proportion of their knowledge could be rated as showing an explicit association with some element of contemporary theories of learning and instruction, such as those in Table 1. The emphasis on explicit knowledge is important in the sense that explicit knowledge is conscious (Dienes & Perner, 1999), and is knowledge that

[1] For all ratings discussed in this paper, responses were coded by two independent raters, with level of agreement beyond 90%. Differences were then resolved through consensus.

can be inspected and discussed by both the individual and others (Karmiloff-Smith, 1992). Students (and teachers) who cannot access a body of good quality and explicit knowledge about learning will find it hard to engage in detailed discussions about ways to generate high quality learning actions.

In terms of their knowledge about the learning activity that was seen as most helpful to their learning, our students showed profiles similar to that described by both Woolfolk-Hoy and Tschannen-Moran (1999) and by Elen and Lowyck (1999). Although our students referred to a wide range of factors that influenced their learning, even when probed for detailed explanation they found it difficult to articulate powerful, coherent and detailed descriptions of how they learned. The difficulty experienced in trying to generate explicit knowledge about learning was stated clearly by one of our students:

> *I don't know what really helps me to learn…I don't know how that helps me to learn, it just does. It's just something I've never questioned, it just helps me…it's just the way I've learned to survive while I'm doing these things. But I don't know how.* (Student SG)

If these teacher-education students found it difficult to generate detailed accounts of how their own learning occurs, accounts that are based on a good quality network of knowledge about learning, we think it unlikely that they would be able to use that knowledge to generate effective ways to handle novel problems that might arise in their own learning. If this is so, then they would also be unlikely to develop the knowledge of their own students about learning to any major degree.

In the interviews, as we pushed our participants to say why a preferred activity helped their learning, we were asking them to solve problems involving theories of learning; using their knowledge related to theory in the domain of learning. Many struggled to solve these problems. This limited degree of success in problem solving in the domain of learning stands in contrast to successful problem-solving at a level appropriate for university graduates in their chosen study domains, such as mathematics, geography, or music. During teaching, their knowledge in these content domains would be expected to enable them to show their students how to solve the demanding problems that characterise the senior high school curriculum. Yet in the domain of learning, they struggled to explain what happens, say, when something “Gets incorporated into my thinking”, or what happens when a class discussion “Helps me through bouncing-off thoughts”. We think it likely that there is an imbalance in the extent and degree of development of their knowledge in their undergraduate major subjects compared to their knowledge about the domain of learning. More recently, we have been observing the knowledge about learning of students who could possibly have our Bachelor of Education graduates as their teachers.

## Senior high school students’ advice to students about how to learn well

In part of a recent survey we received responses from 240 Year 12 students (ages 16-18 years) to two questions that drew upon their knowledge of learning. These students were in the final term of their studies prior to graduating from a high school in suburban Adelaide that has a strong academic focus, with most graduating students undertaking tertiary level study. First we asked them to offer advice to fellow students about how to learn well in the subject they judged to be their ‘best’ subject. The second question asked students to advise their teachers on how to better support their learning. We examined responses to both questions for students’ explicit use of knowledge about learning and coded the responses using the four-point scale discussed in the previous section. This knowledge is significant because the knowledge the students accessed in responding to the survey can be argued to be accessed either because it is strongly encoded or because it is in a high state of activation (Anderson, 2000), and as such is functionally available for immediate use by the student

(Askell-Williams & Lawson, 2007). It is this functionally available knowledge that is likely to be used most frequently when engaged in learning.

In the advice to fellow students, about two-thirds of the responses focussed on the following categories: Making effort (14.2%), paying attention (9%), practice (7.5%), revising work (6%), asking teachers for help (5.6%), time management (4.9%), being interested (4.5%), making notes (4.1%), reading (4.1%), and using a wide range of resources (4.1%). Lower frequency response categories included knowledge transforming, problem solving, using feedback from drafts, checking work, being confident, setting goals, persistence, analysis, using diagrams, working in a group and spaced repetition. Of the total of 255 responses that were coded, only 10 described some form of transformation of presented information, two referred to ways of remembering, two referred to an affective state, one referred to working in a group and one suggested the use of diagrams.

When considered as a total set, this advice identifies learning practices that would likely be useful for other students. However, two features of the responses were of note. First, there was relatively little explicit knowledge of some of the key strategies identified in Table 1, such as attributional processes, selection of information, activation of prior knowledge, organisation for storage, or integration strategies. Instead most of the student advice was very general in nature, akin to an everyday theory of learning. Very little of the advice was specific and in the overall body of responses there was a lack of use of any technical vocabulary of learning.

The second feature of this set of advice was that it did not show evidence of being well-developed in terms of quality. The responses were coded using the scale of generative power noted in the previous section, with the results being shown in Table 2. Most of the students' statements were coded in the first two levels of the scale, as mere statements or elaborated statements. Just 9% of statements contained extensions that identified implications of actions for a student's motivational, cognitive, or metacognitive state, or made a connection to an element of theory of learning and instruction. For the level 4 responses, it was possible to identify links that could be made with spaced repetition, linking new information with prior knowledge, paraphrasing, variable encoding, or problem representation, though such technical descriptions were not used by students. As in the responses from the group of graduating university students described in the previous section, in the graduating high school students' responses evidence of good quality knowledge about learning was not widespread.

Table 2:

*Frequency of generative power codes for Year 12 students' advice to fellow students.*

| Level | Frequency (%) | Examples |
|---|---|---|
| 1 | 75 | *Listen to what is said in class*<br>*Study. Put time in to it, that's about it.* |
| 2 | 16 | *Ask the teacher if you don't understand a concept.*<br>*If you don't understand something, make a note about it and look it up on the web after school.* |
| 3 | 4.5 | *Consistently being open minded to new things helps improve the interest within the subject.*<br>*Keep reading what you've learnt, even days or weeks after you've studied it, so you don't lose that knowledge close to tests.* |
| 4 | 4.5 | *Link it to a real world application that you have an interest in. This will help you to be interested and apply more effort.*<br>*Researching topics that are both related to the student's interest and to the topic in question provides a bridge between the knowledge and interest that can improve motivation.* |

**Senior high school students' advice to teachers about supporting learning**

The second survey question answered by the graduating high school students, about how teachers could better support their learning, drew on students' knowledge about learning using a retrieval path different from that used in their responses to our first question about advising students how to learn well. To respond to this second question students needed to access their knowledge about how learning could be facilitated by the actions of an external agent, a teacher. Their suggestions about such facilitation reflect their understanding of how a teacher's actions could influence their learning. Table 3 shows the results of our categorisation of the content of the students' responses to this question.

The responses were grouped into the six broad content categories listed in the left column, with more specific sub-categories listed in the middle column of the table. The most frequent subcategories are listed individually for each of the six broad categories, with the subcategories that each had a frequency of less than 2 per cent being grouped together. Like the university students, the high-school students attributed influence on their learning to a wide range of factors, from the broad approaches taken by teachers, the attitudes the teachers held, the manner in which they prepared for and organised their teaching, the way they presented content and had students engage with that content, and the manner of social interactions among teachers and peers set up within classes. Indeed if we view the listing in Table 3 as a set of elements of a collective everyday, or informal, theory of what influences learning, it covers many relevant topics. As a group, these students suggest that learning can be facilitated by teachers who, to use just the most frequent sub-categories:

- arrive at class with suitable approaches to teaching and learning
- espouse positive and supportive attitudes and show high levels of interest in the topic
- have well-prepared and interesting lessons
- organise the lessons effectively using appropriate tasks and materials

- check student understanding and give effective explanations
- provide effective feedback
- are readily approachable and set up conducive social interactions in the class and with students

Table 3.

*Content categories of students' responses about how teachers could better support their learning.*

| Major category (% frequency) | Focus | Frequency (%) |
|---|---|---|
| Process (30%) | Checking understanding | 10.7 |
| | Explanation | 8.0 |
| | Feedback | 5.7 |
| | Different ways of presenting; use of examples; allowance of learning style; use of questions; use of diagrams; listening; teaching ways of remembering and ways of learning; use of writing | each < 2.0 |
| Organisation (21%) | Being prepared and organised | 11.1 |
| | Assessment procedures; providing choice; managing class; giving notes; resources; homework; revision; independent work; amount of content; pace of presentation; variety in presentation; teacher involvement | each < 2.0 |
| Tasks (17%) | IT-based activities | 13.4 |
| | Practical activities; class materials; discussion | each < 2.0 |
| Affect (16%) | Teacher attitude | 5.7 |
| | Individual and task interest | 5.3 |
| | Encouragement; enjoyment; enthusiasm; disposition; motivation | each < 2.0 |
| Social (14%) | Individual teacher attention | 6.9 |
| | Approachability | 3.1 |
| | Teacher-class interaction | 2.7 |
| | Peer interaction; teacher support | each < 2.0 |
| Teacher approach (2%) | Assumptions; goals; degree of challenge; innovation | each < 2.0 |

The broad propositions of this collective informal theory are very similar in terms of content to common discussions of teaching set out in many texts on teaching methods (e.g., Barry & King, 1998). In this respect the students' knowledge is wide-ranging.

Our next concern was with how well developed this knowledge was and for that purpose we coded the responses using the same generative power scale described earlier. The results of this coding are shown in Table 4.

Table 4**.**

*Frequency of generative power codes for Year 12 students' advice to teachers*

| Level | Frequency (%) | Examples |
|---|---|---|
| 1 | 40.4 | *Be more approachable*<br>*Ask students more about what they want to learn* |
| 2 | 45.8 | *Please understand that some students are having trouble in understanding the things they say*<br>*I think teachers could explain what we are learning a bit better and give us more detailed feedback.* |
| 3 | 11.9 | *Treat the students with the respect you expect to receive and ask them how they are going in case they need extra attention.*<br>*To ensure that they thoroughly explain the course work or whatever we are working on, even if the material is clear to some. This is important because some other students may be afraid to raise the issue.* |
| 4 | 1.9 | *Teachers seem to be focused on the content of the lessons. If teachers were more focused on changing a student's disposition to be more passionate about the subject then a lot more learning would be achieved.*<br>*Think about your thinking to determine how well you actually understand the logic behind what you are doing.* |

As was the case with their advice to students, the majority of the students' advice to teachers was coded in the first two levels of the scale, with students either merely making a statement or elaborating on that statement without identifying any implications of the advice for their cognitive or affective states, or making suggestions that could be seen as including a reasonable link to theories of learning and instruction. Although it might be suggested that the survey format did not encourage detailed responses, it is still the case that the knowledge that these students accessed was very general and non-technical in nature, being closely similar in this respect to that of the university students who participated in the interviews discussed earlier, in which detailed probing of their views was used. One noticeable difference between the results of the analyses for the two survey questions answered by the senior high school students was the higher frequency of level 3 statements in the response set for the second question, which identified implications for the teachers' awareness of their students' knowledge state. In particular, in the responses to the second question there was more frequent concern that teachers check the level of understanding of students before they moved on to a new topic. The importance of such checking is noted in one of the level 3 statements in Table 3 and in statements such as the following:

> *I think they could check more on our work because many times we don't really know what to do but we don't know what to ask either and other times we think we understood but we are doing it wrong.*

When considered alongside the data from graduating teacher education students, the findings emerging from the survey responses of the graduating high school students related to advice they would give fellow students, and advice they would give their teachers, show a similar broad profile. In both cases there is evidence that the students have explicit knowledge about many of the key elements included in contemporary theory of learning and instruction. Yet this knowledge is not detailed or elaborated and relatively little of it shows evidence of being embedded in a reasonably generative network of knowledge about learning. In terms of quality, this knowledge about learning is not well developed. It is not powerful in the sense that it could not be expected to generate new and useful techniques for effectively handling problems that arise during learning as these students necessarily engage in self-teaching. Like the university teacher education students, the high school students do not use the technical language associated with the domain of learning, which may well indicate that such language has not been used in their lessons.

**Student use of strategy knowledge across time**

A further source of evidence that feeds our concern about the state of students' knowledge about learning comes from collecting data about learning strategy knowledge from two other groups of students across five years of high school. These students came from a different part of suburban Adelaide in two schools with lower socioeconomic ratings than the school involved in the survey just discussed. Data were available for all five years for a sample of 107 students from School A and 111 students from School B. The outcomes of the analyses in these two schools were of interest to us because in both schools we had undertaken small-scale interventions with groups of students, focussing on use of strategies for selection, relating and organisation of task knowledge and the checking of levels of understanding (SROC). Findings related to these interventions are described in Askell-Williams, Lawson and Skrzypiec (2012). In subsequent discussions with staff at School B, we learned that the school administrators had decided to expand our SROC intervention to a larger cohort of students in the year after we completed our intervention. We had no direct involvement with students in this expanded use of the intervention, but did initially provide some advice and material resources. There was no similar extension of our intervention at School A. In the analysis below we were interested in trajectories of change in students' reports from both schools about their use of effective cognitive and metacognitive strategies during their high school years.

From a review of the literature (e.g., Lawson, 1984; Weinstein & Mayer, 1986; Nelson, 1996; Schraw & Dennison, 1994) we selected 11 cognitive and metacognitive strategies that are consistently identified as key contributors for good quality learning. Examples of items are, "*I discuss what I am doing in this subject with others", "I draw diagrams or pictures to help understand this subject", "When I have finished an activity in this subject I look back to see how well I did"* and "*I make a note of things that I don't understand very well in this subject, so that I can follow them up*". Questionnaires requiring responses on 7-point Likert scales (Strongly Disagree to Strongly Agree) about the participants' tendency to use each of the 11 strategies were administered to students at the end of each academic year from 2007 to 2011. In 2007, the students were in Year 7 or 8, and by the end of the study they were in Year 11 or 12.

Principal components analysis of the 11 questionnaire items (conducted separately for each year of data collection) consistently identified a Learning Strategies Factor[2]. Students were classified into four Groups (Low to High) based upon their initial Learning Strategy Factor scores [3] in 2007. In order to provide results that maintained a connection with the meaning of the original Likert scale scores, in the next section we report analyses based on students' averaged Learning Strategies scale scores (analyses using averaged Learning Strategies scale scores and factor scores were substantively similar). Regression to the mean (RTM) has been identified as a possible threat to validity in designs that examine the repeated performance of participants categorised according to their score on the first data collection occasion, though the impact of RTM is likely to be reduced when there are five occasions of measurement (Barnett, van der Pols, & Dobson, 2005). To take possible RTM into account,

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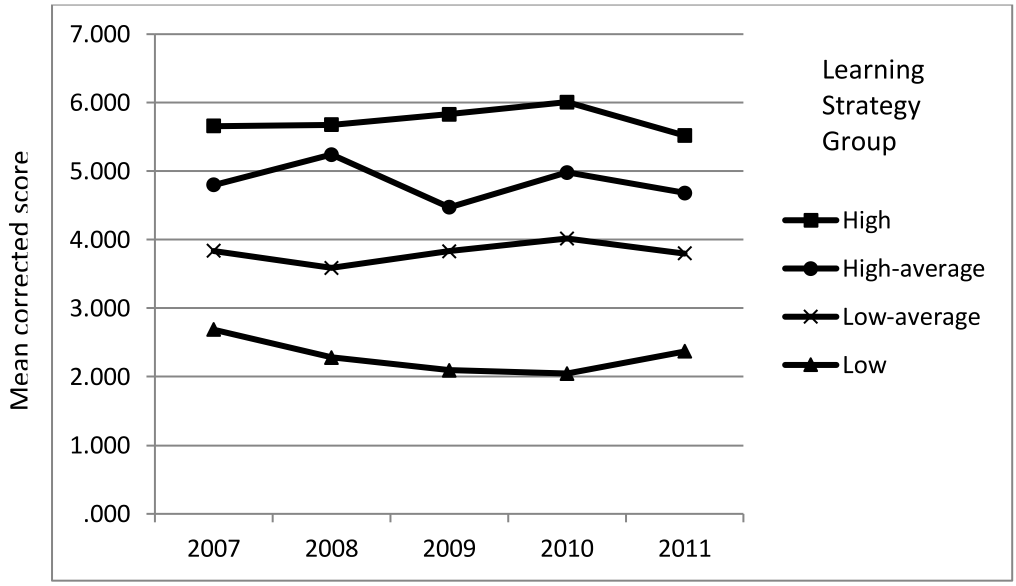
[2] Kaiser-Meyer-Olkin valuesfor each year were above 0.9; accounting for 42.2% of the variance in 2007 to 50.5% of the variance in 2011; with all item weightings above 0.4

[3] Low = < -1SD below Mean; Low-average = -1SD to Mean; Average-High = Mean to +1SD; High = > +1SD above Mean.

students' corrected averaged Learning Strategies scores for 2008 to 2011 were generated based on the procedure proposed by Nielsen, Karpatschof, and Kreiner (2007).

Figure 1: School A students' corrected Learning Strategies scores over five years of high school.



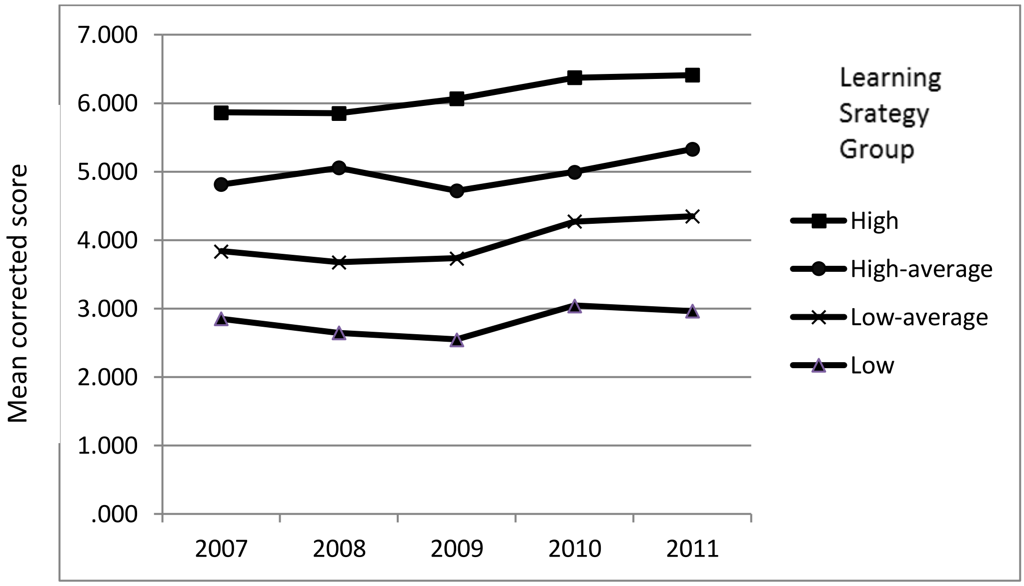

The pattern of response for students in School A is shown in Figure 1. A mixed design ANOVA found a main effect for Learning Strategy Group, with students in higher learning groups having scores (in each year) that were significantly higher than students in the lower groups $F$ (3,103) = 64.12, $p$ <.001, $\eta^2$ = .65. Pairwise comparisons, corrected using a Bonferroni adjustment, indicated that the differences were significant between all Learning Strategy groups (all $p$ < .001). Neither the main effect for Time nor the Learning Strategy Group x Time interaction was significant. These findings suggest that for these students the reported frequency of use of productive learning strategies did not increase over five years of secondary schooling. Feedback to us from the participants' teachers included a suggestion that whereas primary school teachers *do* provide an explicit focus on learning strategies, secondary school teachers tend to focus more on subject-matter content. If this were the case for these students, then they might just maintain rather than develop their levels of strategy use. The trajectories for the groups largely run in parallel: The scores of the students in the lower groups never catch up to the students in the higher groups.

A parallel analysis was carried out on the data from students in School B. The pattern of corrected scores for the groups is shown in Figure 2. A mixed design ANOVA showed that students in the higher Learning Strategies groups had scores (in each year) that were significantly higher than students in the lower groups $F$ (3,107) = 68.55, $p$ <.001, $\eta^2$ = .66. Pairwise comparisons, corrected using a Bonferroni adjustment, indicated that the differences were significant between all Learning Strategy groups (all $p$ < .001). However, in the case of School B, the effect of Time was also significant, $F$ (3.2, 344.21) = 6.74, $p$ <.001, $\eta^2$ = .059. Tests of within-subjects contrasts showed that a significant effect occurred between 2009 and 2010, $F$ (1, 107) = 13.73, $p$ < .001. Pairwise comparisons showed that for the whole group, final Learning Strategies scores in 2011 were significantly higher than at baseline in 2007 ($p$ < .05). In the case of students at School B, there was increase in their reported use of learning strategies over the five years. However, the separation between the Learning Strategy groups was maintained and the Learning Strategy Group x Time interaction was not significant. Notably, in both School A and in School B, the lowest group's average scores did not approach the mid-point of the scale.

The findings from this longitudinal study raise different concerns to those noted in the interview and survey studies discussed above and suggest areas for further research. In designing and administering this survey, one of our expectations was that strategy use would be quite frequent for students, based on the assumption that the complex problem solving that students would undertake across their high school classes would require them to also employ many of the learning strategies that were included in the survey. A further expectation was that we would see an increase in frequency of strategy use across the groups of students.

Underlying this assumption are findings from research that suggest that: (1) Learning of subject-matter content requires use of subject-matter content and learning strategies (e.g., Dunlosky, 2013); (2) By the end of high school at least some students have knowledge of and report use of both specific and general learning strategies (e.g., Leutwyler, 2009; McCormick, Dimmitt, & Sullivan, 2013); and (3) If students are taught to use new learning strategies the learning of subject-matter content can be improved (e.g., Hattie, Biggs & Purdie, 1996; Schraw, 1998).

Figure 2: School B students' corrected Learning Strategies scores over five years of high school.




However, it might be that part of our reasoning was unsound, namely, that as they moved through high school students would develop new knowledge of learning strategies through involvement in more complex problem solving, or through observation of peers and teachers, or through explicit instruction by teachers. For the group of students in School A the pattern of results in Figure 1 suggests that frequency of use of the identified strategies did not show the expected pattern of growth across time. We do not have evidence that allows us identify what lies behind this. Perhaps the students did not observe frequent use of the strategies by their peers or teachers, or were not taught new strategies. For these students the advantages associated with frequent use of powerful learning strategies may well be unknown, and may also not be known by their teachers. If this is the case then we as researchers face a serious challenge in convincing students and teachers that it is worth their while to develop more detailed knowledge about learning. The research by Dunlosky et al. (2013) noting students' continued use rereading and highlighting adds weight to the argument that there is a need for a more direct approach to spreading knowledge about good quality learning strategies. Such strategies would be able to be related explicitly to a well-developed theory of learning.

We make two further points about our findings from School A and B above. First, the results shown in Figure1 suggest that there are significant groups of students, like those in the Low and Low-Average groups in School A, who do not report frequent use of powerful learning strategies across the period of their high school education. On the basis of the literature noted in this chapter these students could be expected to benefit from increased knowledge and use of learning strategies. The situations of the Average-high and Low-average groups are also of concern and there may be a connection between their situations and the students referred to in Griffin et al. (2012) earlier in this paper. The pattern of use we observed for the High and Average-high groups in School A was similar to that observed for use of metacognitive strategies in Swiss high school students by Leutwyler (2009). Although in that study only two time points were observed, there was no observed increase of students' self-reported use of metacognitive strategies during the final years of secondary school.

Second, there are some students who do report increased frequency of use of learning strategies, like those in School B, and this more frequent use *may* have been associated with explicit learning strategy instruction by teachers, although again we have no evidence to support such a claim. The gain in students' reported strategy use was apparent at a time when teachers in School B were discussing explicit use of learning strategies in lessons. On the basis of our research we can only speculate that the observed change in frequency of strategy use was associated with the teachers' use of the SROC intervention, although there is a body of research by others that suggests that such an association is possible (e.g., McCormick et al., 2013).

**The quality and quantity of students' knowledge about learning**

The findings just reviewed point to issues of both the quality and quantity of students' knowledge about learning. Although the knowledge reported by our university and high-school student groups covers a wide range of relevant topics, we do not see evidence that many students' knowledge about learning is complex or generative. Given the current state of knowledge about learning generated from research studies, we think students in all levels of education should be able to discuss in detail, and make more frequent use of the detailed knowledge of learning that is currently available.

There is also an issue that is more quantitative. Despite the wide range of topics described by the students in our studies, there are important topics listed in Table 1 that are poorly represented in our student data. There is relatively little concern with issues such as causal attributions and self-efficacy, or varied and more elaborative encoding procedures, or knowledge organisation, or schema activation and knowledge integration, all of which could benefit students' learning across the curriculum.

Before we close we want to give some consideration to factors that might inhibit improvement in the quantity and quality of students, and teachers, knowledge about learning. We suggest that three such factors might be influential and areas for further investigation.

**Knowledge about learning will develop naturally?**

One possibility is that learning is seen by some teachers and students as something 'natural', something that is to an appreciable extent automatic, that will happen as students do the tasks, or imitate the processes modelled by their teachers or other students, or as a result of 'telling' by the teacher as the student moves through school. Bruner (1996, p. 55) pointed out that parents often believe that they are sending their children to study under the care of teachers who "have the knowledge" themselves, or who have access to books and computers that store the knowledge. In this case, it may be that parents and students, and perhaps even teachers, believe that this knowledge will be acquired through the students' involvement in classrooms and laboratories. Bruner referred to such beliefs as instances of 'folk pedagogy', powerful beliefs that have intuitive credibility but which are largely implicit and unexamined. A strong implication of such a view is that students will gradually pick up or absorb the quantity and quality of knowledge about learning they need to work effectively in a classroom. Yet the data we and others have gathered from students who have many years of experience in school and university classrooms does not support the view that good quality knowledge in the domain of learning emerges automatically from experience.

We place emphasis on the "good quality" knowledge about learning because we see that such knowledge is relatively infrequent in our data. We and others have shown that students do have a body of knowledge about learning at the end of high school and in university. Lehmann and Hasselhorn (2007) observed spontaneous changes in memory strategy development and strategy use but also showed that the path of development is not a simple incremental one. Other researchers have found that the pattern of metacognitive knowledge is not uniform in US college students (Hofer, Yu, & Pintrich, 1998; McCabe, 2011) and that these students may lack knowledge of key strategies (Justice & Dornan, 2001).

Neuenhaus, Artelt, Lingel, and Schneider (2011) also reviewed evidence that although metacognitive knowledge develops during schooling, even in adulthood explicit declarative metacognitive knowledge is not guaranteed to be available. Rachal, Daigle, and Rachal (2007) provided some of the detail of areas in which US college students themselves report learning difficulties that indicate problems of knowing about learning.

The pattern of findings from such research suggests to us that it is unwise to expect that good quality knowledge of learning will develop naturally as students attend school and university. Rather we suggest that it would be wiser to make explicit provision for the teaching of key components of knowledge about learning.

**Teacher knowledge about learning**

It is implied in our previous argument that teacher knowledge about learning is also a factor that needs to be considered in bringing about growth in student knowledge about learning. In this chapter we have not reported data related to teacher knowledge, but the findings of other research suggest that it is an area for further attention. Veenman, van Hout-Wolters and Afflerbach (2006) have argued that many teachers lack sufficient knowledge about metacognition and find it difficult to provide well-developed accounts of this key component of learning. Wilson and Bai (2010) have also found a number of practicing teachers who did not know what metacognition was and that teachers did not report the active teaching of metacognition. The anecdotal reports we received from teachers involved in our longitudinal study, indicating that high-school teachers focus mostly on teaching subject-matter content, also find a parallel in the research by van Velzen (2012) and Dunlosky (2013) who have suggested that high school teachers are focussed mostly on the cognitive features of subject-matter content. These findings suggest that teachers would also be a key target for interventions concerned with the development of good quality knowledge about learning.

**The status of learning as a domain of knowledge**

A third and related factor that we suggest as being influential in this area is the conceptualisation of learning as a domain of knowledge. There are some topics in school curricula that are regarded as more difficult for students to understand, like rational numbers (Vamvakoussi & Vosniadou, 2004) or parts of physics (Slotta & Chi, 2006). Recognition of these as difficult areas, or even as areas where some students will struggle to make any significant progress, might be taken to imply that most other learning is relatively straightforward. To caricature this position, if the student puts in the effort on most topics then the learning will occur. However, the precise nature of that effort, which should be seen to include the deliberate application of appropriate learning strategies, is largely left unspecified. In this section we do not want to deny the role of effort or make any claims about the difficulty of learning in any specific area of the curriculum. Rather we want to draw attention to the complex nature of the act of learning and to the complex nature of many of the processes involved in learning, including processes identified in Table 1.

As noted earlier, in every class, students must use a wide range of knowledge about learning at the same time as they are engaged in acquisition of subject-matter knowledge. Winne (1991) made a similar argument point in his discussion of the constant interaction of motivational and task knowledge during learning. However, his argument needs to be extended to include the motivational, cognitive, and metacognitive knowledge features of learning listed in Table 1 and summarised in models of learning and instruction such as the account of Bransford, Derry, Berliner, Hammerness, and Beckett (2005), Mayer's (1996) motivational-cognitive-metacognitive model, Schunk and Zimmerman's (2013) model of self-regulated learning, Efklides' (2011) further development of the SRL model, or Boekaerts and Corno's (2005) model of self-regulated learning. A further feature of the complexity of the domain of learning is that knowledge in that domain also comprises declarative, procedural, and conditional aspects. During any learning event, whether under the guidance of a teacher or alone, students need to decide, when and how to use specific declarative knowledge about learning. The complex nature of this knowledge domain needs to be given due recognition.

One possibility that might be a rewarding direction for future research is to consider to what extent teachers and students believe that knowledge about learning is as important as we have argued here, and what lies behind their views on this issue. Our experience in classrooms suggests that some teachers have a very low degree of belief in many of the central assumptions made by researchers in the field of cognition and instruction like us. Perhaps for these teachers and their students the idea of learning as transmission is much more powerful than a view of learning as construction involving a major component of detailed knowledge about learning. An interesting research program could be mounted to see if this was the case and what might bring about conceptual change in such teachers.

## Conclusion: The need for sustained teaching about learning

The arguments in this paper do not move too far from the themes that attracted one of us (Lawson) when he studied with Das in the 1970s. Against the background of behaviourist psychology, the idea of a cognitive strategy was quite novel. It has proved to be a powerful idea that continues to demand investigation, so those classes with Das were quite influential. The arguments we have made for more explicit teaching about learning are also ones that have continued to be reflected in the work of Das and his colleagues (Mahaptra et al., 2010). Like Das we believe that the strategies used in learning can be taught and learned and that such learning will have major benefit for students.

The need for greater focus on explicit teaching about learning was summarised concisely by Schneider (2010), when he noted that "Most of memory development is not so much a matter of age but of education and practice" (p. 71). Rather than seeing growth of high quality knowledge about learning as a natural consequence of schooling or development, such knowledge should be the topic of more explicit teaching across the period of formal education (also see Kirby & Lawson, 2012). Teaching related to the key interacting components of learning discussed in this paper should be undertaken at all levels of education. The work in doing this has already started, though it is often focussed on limited areas of knowledge about learning. School-based programs include those such as Literacy Gains (2009), the South Australian TfEL materials (Department of Education and Children's Services, 2010) and the PEEL program associated with Monash University in Melbourne (Mitchell, 2009) that has been in operation for over 25 years. Examples of more laboratory-based programs include those of Kiewra (2002), Lin (2001), Ornstein, Grammer and Coffman (2010), Roll, Aleven, McLaren and Koedinger (2007), and Spörer and Brunstein, (2009).

For those of us who educate teachers, an uncomfortable implication of the findings reviewed here is that our teachers and students do not develop detailed explicit knowledge of learning simply because they do not engage in detailed study of learning. This was also the broad argument made for university students by Weinstein (1994), Entwistle (2012) and Dunlosky (2013). Inspection of the time allocated to study of learning in our own degrees and teacher training programs suggests that this is a quite likely possibility. We need to change this and also consider taking our teaching about learning into schools in what Roediger (2013) described as a task of educational translation.

Berliner (2004) made a strong case for the serious development of teaching expertise, noting that in a field such as sport, one of the generators of expertise is good coaching. He also noted that beyond the period of initial teaching experience the incidence of coaching of teachers as they learn to be teachers is very low. Through professional learning programs for teachers we have the possibility of generating greater expertise in the domain of learning through the coaching of students and teachers.

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