COGNITIONS ABOUT COGNITIONS: THE THEORY OF METACOGNITION

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This paper proposes a theoretical review of the term 'metacognition'. It was introduced by John Flavell in the early 1970s based on the term 'metamemory' previously conceived by the same scholar (Flavell 1971). Flavell (1979) viewed metacognition as learners' knowledge of their own cognition, defining it as 'knowledge and cognition about cognitive phenomena'. Metacognition is often referred to in the literature as 'thinking about one's own thinking', or as 'cognitions about cognitions'. It is usually related to learners' knowledge, awareness and control of the processes by which they learn and the metacognitive learner is thought to be characterized by ability to recognize, evaluate and, where needed, reconstruct existing ideas. Flavell's definition was followed by numerous others, often portraying different emphases on or different understanding of mechanisms and processes associated with metacognition.

Introduction

Relating metacognition to developing one's self-knowledge and ability to 'learn how to learn' resulted in metacognition being awarded a high status as a feature of learning. The ground for developing such an interest proved particularly fertile, especially in view of a constantly changing technological world when not only it is impossible for individuals to acquire all existing knowledge, but it is also difficult to envisage what knowledge will be essential for the future. The subsequent calling for inclusion of metacognition in the development of school curricula, therefore, seems fully justified. Flavell (1987) proposed that good schools should be 'hotbeds of metacognitive development' because of the opportunities they offer for self conscious learning. Similarly, Paris and Winograd (1990) have argued that students' learning can be

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enhanced by becoming aware of their own thinking as they read, write, and solve problems in school, and that teachers should promote this awareness directly by informing their students about effective problem-solving strategies and discussing cognitive and motivational characteristics of thinking. Clearly sharing this view, Gunstone and Northfield (1994) took a step further and argued in favour of a central position of metacognitive instruction within teacher education. Borkowski and Muthukrishna (1992) similarly have argued that metacognitive theory has considerable potential for aiding teachers in their efforts to construct classroom environments that focus on flexible and creative strategic learning. Voices advocating the importance of metacognitive activity within educational contexts have resulted in placing metacognition high on educational research agendas.

Reasons for the growing interest in metacognition over the past three decades relate not only to the anticipated improvement in learning outcomes, through interventions that aim at developing students' metacognition, but also to the broader rise in interest in cognitive theories of learning. However, as Brown (1987) points out in a review of the origins of metacognition, 'processes metacognitive' have been recognized and advocated by educational psychologists (for example, Dewey 1910, Thorndike 1914) well before the emergence of the term 'metacognition', especially in the area of reading and writing. John Locke, for instance, used the term 'reflection' to refer to the 'perception of the state of our own minds' or 'the notice which the mind takes of its own operations' (Locke 1924). The importance of the concept of reflected abstraction to human intelligence was later discussed by Piaget (1976), who pointed out the need for making cognitions statable and available to consciousness, at which point they can be worked on and further extended (Campione 1987). Notably, the work of Piaget was introduced to many in the US by John Flavell (1963), maintaining a profound impact on Flavell's writings and the development of his notion of metacognition. 'Introspection', a technique used by early psychologists to find answers to psychological questions, was also a first sign of interest in metacognitive processes. The definition of 'introspection' as 'the reflection on one's own conscious experience' (Butler and McManus 1998: 4) makes such connection all too obvious.

In searching for the origins of metacognition others go far beyond the twentieth century. As Spearman points out: Such a cognizing of cognition itself was already announced by Plato. Aristotle likewise posited a separate power whereby, over and above actually seeing and hearing,

the psyche becomes aware of doing so. Later authors, as Strato, Galen Alexander of Aphrodisias, and in particular Plotinus, amplified the doctrine, designating the processes of cognizing one's own cognition by several specific names. Much later, especial stress was laid on this power of 'reflection', as it was now called by Locke (1923).

Hard as it might be to pinpoint the exact origins of metacognition, it is by far easier to reach agreement over the fact that recent attention in metacognition has resulted in the reawakening of interest in the role of consciousness, awareness or understanding in thinking and problem-solving (Campione 1987).

Following a review of the many different historical roots from which metacognition has developed, Brown (1987) warned that '… metacognition is not only a monster of obscure parentage, but a many-headed monster at that' (p. 105). The acknowledged complexity of the notion of metacognition is also successfully reflected in Flavell's (1987) remark that although metacognition is usually defined as knowledge and cognition about cognitive objects (i.e. about anything cognitive), the concept could reasonably be broadened to include anything psychological, rather than just anything cognitive. In his attempt to identify where metacognition fits in 'psychological space' Flavell (1987) suggested that concepts that may be related to metacognition include executive processes, formal operations, consciousness, social cognition, self-efficacy, self-regulation, reflective self-awareness, and the concept of psychological self or psychological subject. The diversity of perceived meaning and the multidimensional nature of metacognition are therefore without question, a conclusion that was reached by numerous studies in the past, and is discussed later in this paper. Before discussing further aspects of the nature of metacognition, it is important to address briefly the area of general thinking skills, which shares important links with metacognition.

Metacognition: definitions

Flavell (1978) was the first to define metacognition when he said it was "knowledge that takes as its object or regulates any aspect of any cognitive endeavor.” Brown and Baker (1984) further defined the idea of metacognitive knowledge by emphasizing a difference between *static* and *strategic* knowledge. Static knowledge, according to Brown and Baker, is what people are

able to verbalize about cognition; whereas, strategic knowledge consists of the strategies that people use to regulate a particular cognitive activity. These strategies consist of *planning*- figuring out how to begin or continue; *predicting* – estimating how much will be remembered or understood or how much time it will take to complete a particular cognitive task; *guessing* – hypothesizing an answer before reaching a complete cognitive solution; and *monitoring*- continually deciding how well progress is being made toward the accomplishment of some cognitive goal. Baker and Brown (1984) later modified their definition of metacognition claiming that it is "an awareness of what skills, strategies, and resources are needed to perform a task effectively; and the ability to use self-regulatory mechanisms to ensure successful completion of a task" (p. 345).Although, originally, Flavell used the term metacognition to describe the awareness "of knowing'' in relation to memory, more recently Babbs and Moe (1983), based on the preceding theoretical work of Flavell, Baker and Brown, have presented a model for metacognition related specifically to the reading task. They claimed that certain strategies have been traditionally taught as comprehension, critical reading, and study skills, but now are relabeled "as metacognitive skills because they can be consciously invoked by the reader to aid in focusing on the important content in monitoring comprehension" (p. 423)**.** These skills include the following acts by the reader: (1) consciously intending to control the reading act; (2) establishing the goal of the reading act; (3) focusing on metacognitive knowledge; (4) planning the regulation and monitoring of the reading act; and (5) periodically assessing reading success. Babbs and Moe (1983) claim the advantage in viewing these reading skills metacognitively is that the reader must assume more responsibility for this knowledge and control.

Perhaps the most straightforward definition of metacognition is that it is 'thinking about thinking' (Flavell, 1999; Bogdan, 2000; Metcalfe, 2000); however, this definition requires further elaboration, because metacognition also involves knowing how to reflect and analyse thought and how to draw conclusions from that analysis, and how to put what has been learned into practice. In order to solve problems, students often need to understand how their mind functions. In other words, they need to perceive how they perform important cognitive tasks such as remembering, learning and problem-solving. Paris and his colleagues (Paris and Jacobs 1984,

Cross and Paris 1988, Paris and Winograd 1990) identified two essential features in their definition of metacognition: 'self-appraisal' and 'self-management' of cognition. Self-appraisal of cognitions comprises reflections about learners' understanding, abilities and affective state during the learning process, while self-management refers to 'metacognitions in action'; that is, mental processes that help to 'orchestrate aspects of problem solving' (Paris and Winograd 1990: 8).

Kluwe (1987) refined the concept of metacognition by noting two characteristics: the thinker knows something about their own and others' thought processes, and the thinker can pay attention to and change their own thinking. This latter type of metacognition Kluwe calls 'executive processes'. Hacker (1998) points out the difference between 'cognitive tasks' (remembering things learned earlier that might help with the current task or problem) and 'metacognitive tasks' (monitoring and directing the process of problem-solving), stressing the importance of learning more about thinking. Cornoldi (1998) emphasizes the role of learners' beliefs about thinking, and makes the point that if students feel confident that they can solve problems, they tend to do better work. In defining metacognition as 'thinking about thinking' or 'second-order cognition', Weinert (1987) acknowledges that purpose, conscious understanding, ability to talk or write about tasks, and generalizability to other tasks are also important factors in determining whether a given task is metacognitive and this viewpoint is supported by Brown (1987), who agrees that metacognition requires the thinker to use and describe the process of mental activity. Many other researchers also make the point that metacognition is best defined by acknowledging that it is both knowledge about and control over thinking processes (Allen & Armour-Thomas, 1991).

Cognition and metacognition

Thinking takes place in a variety of ways. Where thinking is purposeful and is based on experiential data, we call it cognition. So where the objects of purposeful thinking are real objects (as perceived by the individual concerned) or are abstractions of real objects and their properties, then the thinking is cognition. In this sense, cognition mediates between the learner and the experiential world and the objects of cognition are real objects, ideas and abstractions. Hence learners can be engaging in cognition when they are working with parallel lines, whether or not a drawing of parallel lines exists in their sight.

Another form of purposeful thought, and one that is also involved with problem solving, is metacognition. Metacognition mediates between the learner and their cognition. While cognition can be considered as the way learners' minds act on the 'real world', metacognition is the way that their minds act on their cognition. This relationship is indicated in figure 1.

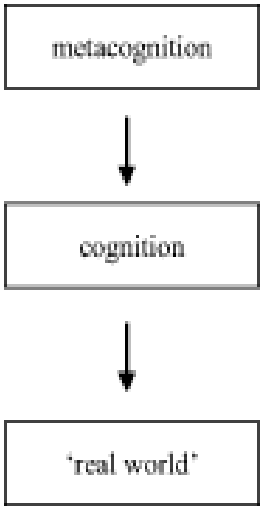

Figure 1. The relationship between metacognition, cognition and the 'real world'.

It is worth noting that metacognition comes into play when cognition becomes problematic. Metacognition becomes essential when tasks are more challenging. This may occur at any stage in a contemplative situation from the beginning to the end. Hence metacognition has been strongly linked with problem solving where problems are usually not of any standard type.

Metacognitions are second-order cognitions: thoughts about thoughts, knowledge about knowledge, or reflections about actions. However, problems arise when one attempts to apply this general definition to specific instances. These problems concern whether metacognitive knowledge must be utilized, whether it must be conscious and verbalizable, and whether it must be generalized across situations.

In an attempt to make such a distinction clear, Flavell (1976) suggested that cognitive strategies 'facilitate' learning and task completion, whereas metacognitive strategies 'monitor' the process. To use a clear-cut example by Flavell (1976), asking oneself questions about this article might function either to improve one's knowledge (a cognitive function) or to monitor it (a

metacognitive function), hence demonstrating co-existence and interchangeability of cognitive and metacognitive functions. For Forrest-Pressley and Waller (1984), cognition is referring to the actual processes and strategies used by the learner, whereas metacognition is referring to what a person knows about his/her cognitions and to the ability to control these cognitions. Watts (1998), on the contrary, views metacognition in a hierarchical relationship to cognition. It is a metalanguage, he says, which permits individuals to talk about what is happening in their first level of feedback-governed learning, representing second-order change.

An essential characteristic of metacognition as 'metalanguage' is that such 'talking about' should entail more than the simple description of previous thoughts or actions. Metacognitive reflection involves the critical revisiting of the learning process in the sense of noting important points of the procedures followed, acknowledging mistakes made on the way, identifying relationships and tracing connections between initial understanding and learning outcome. This is a key characteristic to be included on the list of features distinguishing between cognitive and metacognitive activity, for, although it is possible for cognitive activity (and consequently learning) to take place without a critical approach on behalf of the learner, the practice of non-critical metacognition is not possible. It is common experience, for instance, that learners often engage in the learning process in passive ways, reproducing information without scrutinizing it and following instructions or applying formulae without knowing what the purpose of their efforts is. No matter how unsophisticated or superficial such learning behaviour is, these learners successfully activate and engage in cognitive functions, in order to carry out their tasks, even in the absence of any critical thinking. What this is suggesting is that passive, non-critical learning, although limited, is possible. Metacognitive monitoring of the process of learning or task completion, on the contrary, entails more than passive observing. It requires an element of judgement that is essential in comparing, assessing and evaluating the content or the processes of one's learning (self-appraisal). This judgement-laden reflective feedback will later enable the metacognitive learner to take informed action for rectifying the situation (selfmanagement). Clearly such behaviour demonstrates that being critical is *sine qua non* for metacognition. Notably, engaging in critical self-appraisal is an endeavour that requires strong affective support for the learners, who should feel comfortable with the idea of identifying, acknowledging and reporting their errors, partial understandings, or personal routes towards learning. Attention

should therefore be given to establishing supportive class environments that will encourage learners to demonstrate such learning behaviour, in essence taking responsibility of their learning.

Components of metacognition

According to the classic models, metacognition primarily consists of metacognitive knowledge (a declarative component) and regulation (a procedural component). ***Metacognitive knowledge*** refers to the knowledge about cognitive tasks, strategies and knowledge learners possess about themselves and people (Flavell, 1979). ***Regulation*** refers to the monitoring and control of one's cognitive processes during learning (Nelson & Narens, 1990). In addition to these two prime components, recent findings show that metacognitive knowledge requires **competence** in using it (Corsale & Ornstein, 1980; Schneider, 1985). ***Use of learning strategies*** is certainly a necessary component. Another major component is ***evaluation of or reflection on the result of one's learning,*** and experience. This metacognitive activity is an overall judgement of the product of a learning experience. It provides feedback to the learner on the selection and use of strategies leading to the refinement of one's metacognitive knowledge (Flavell, 1979; Schunk & Ertmer, 1999).

Research shows that all these metacognitive components develop with age. Children show a developmental trend in understanding the effects of task difficulty and strategy use on memory performance and that, by age 11 or 12, knowledge of most facts about memory is well developed (see Schneider & Lockl, 2002). The capability in using cognitive strategies appears to develop by the age of 10 or 12 (Schneider, 1985). Children of 10 and 12 years old have been found to be more able to regulate their learning by devoting more time to studying hard items than easy items when compared to 6- and 8-year-old children (Dufresne & Kobasigawa, 1989). The 10-year-olds did better than 7-year-olds in judgements of learning (Pressley *et al.*, 1987) and ease of learning judgements improved from young to late elementary school years (Schneider *et al.*, 1990). The 11- to 12-year-olds were more likely to reflect on their own performance and evaluate or control their cognitive abilities compared to 7- to 8-year-olds (Schunk & Rice, 1987).

Although a whole host of research studies has shown the importance of metacognitive competencies in learning, it is widely accepted that metacognitive knowledge or regulation is not sufficient to promote student achievement. Students must also be motivated to use their metacognitive skills (e.g. Zimmerman, 1990; Bandura *et al.*, 1996). Koriat *et al.* (2001) found that although older children outperformed younger ones, young children (8-year-olds) could also produce an accurate record of past events when they were explicitly motivated to do the task. Similarly, Roebers *et al.* (2001) found that when motivation for accuracy was high, even the youngest children could perform very well, and clearly motivation is an important factor.

Newer models of metacognition include not only purely cognitive processes, but also motivational ones (Ames & Archer, 1988; Dweck & Leggett, 1989). The traditional cognitive-metacognitive approach has been integrated with the motivational-metacognitive approach to explain the development and success of learning in schoolchildren. Among the motivationally mediated metacognitive models, ***self-efficacy*** and ***value of learning*** have been closely examined. Studies show that students with high self-efficacy display better-quality learning strategies (Kurtz & Borkowski, 1984) and more self-monitoring of their learning outcomes than those with low efficacy (see Wigfield, 1994). For value of learning, studies show that students' interest in the materials enhances their comprehension of difficult materials and that task value is the best predictor of cognitive and regulatory strategy use (Wolters & Pintrich, 1998).

While research on cognitive-metacognitive competencies portrays a developmental trend from middle childhood to adolescence, these two motivational-metacognitive components (self-efficacy and value of learning) do not exhibit a similar increase. Children's perceptions of their academic abilities decline precipitously during school. Children enter school with positive views of their own competence, but by the age of 11 to 12, have lowered this self-perception of competence considerably (Nicholls, 1984). Junior high school children show a dramatic decline in ratings of self-perceived ability, probably because of changes in schools and peers that increase social comparisons (Pomerantz *et al.*, 1995). Children's value of learning also decreases with age, particularly during the transition from elementary to junior high school. Older children's preference for challenge, curiosity and independent mastery is much lower than that of the younger children and children's mean levels of value of academic task get lower when they grow older (Eccles & Midgley, 1989).

Gender differences have been found to exist in some metacognitive components. Zimmerman and Martinez-Pons (1990) found that girls showed higher levels of self-regulated learning than boys in grades 5, 8 and 11. In the study by Wolters and Pintrich (1998), 7th- and 8th-grade girls exhibited higher levels of cognitive strategy use than boys, while their level of regulatory strategy use was similar to that of boys. Research indicates that girls show a greater decline in self-perceived ability than boys when they enter junior high school (Eccles *et al.*, 1983). Phillips and Zimmerman (1990) also found that gender differences characterized students at the 9th grade rather than at 3rd or 5th grade as having a higher percentage of girls perceiving themselves of low competence. The study by Ladd and Price (1986) indicated that gender differences in perceptions of academic competence appeared in 3rd- and 5th-graders, while the studies by Eccles *et al.* (1983, 1989) did not reveal stable gender differences prior to junior high school. Other than the consistently found differences between boys and girls in competencies of regulation and self-efficacy in various studies, differences in other metacognitive competencies or between age groups have not been stable.

In sum, the literature shows that metacognitive knowledge, use of learning strategies, regulation of learning and evaluation of learning portray developmental trends connected to growing up, whereas the components of self-efficacy and value of learning show declining trends as age increases. Differences due to gender, however, have not been conclusive. The literature reveals an intriguing phenomenon: school students are increasingly competent in cognitive-metacognitive competencies but increasingly less competent in motivational-metacognitive competencies as they get older. This phenomenon contradicts researchers' hypotheses and studies about the causal and enhancing relationships between the motivational components and cognitive components in learning (Pintrich & De Groot, 1990; Chan, 1993; Bandura, 1997). The developmental patterns of metacognitive competencies certainly need further investigation, particularly with regard to the gaps shown in previous studies where only one or two metacognitive components were examined, or where discontinuous age groups were employed.

The most common distinction in metacognition separates metacognitive knowledge from skills. The former refers to a person_s declarative knowledge about the interactions between person, task, and strategy characteristics (Flavell, 1979), whilst the latter refers to a person_s procedural knowledge for regulating one_s problemsolving and learning activities (Brown &

DeLoache, 1978; Veenman, 2005). Metacognitive knowledge about our learning processes can be correct or incorrect, and this self-knowledge may be quite resistant to change. For instance, a student may incorrectly think that (s)he invested enough time in preparation for math exams, despite repeated failure (But the teacher made the exams so hard to pass...). Such misattributions prevent students from amending their self-knowledge. Metacognitive skills, on the other hand, have a feedback mechanism built-in. Either you are capable of planning your actions ahead and task performance progresses smoothly, or you don_t and your actions go astray. Or, you may be unsure of task performance status as metacognitive skills are developing. Failing metacognitive skills may render new metacognitive knowledge, but the process of skill acquisition takes time and effort.Researchers have distinguished many more specific components of metacognition,but they seem to disagree about the nature of those components. For instance,Metamemory is often merely studied from a declarative-knowledge perspective, while monitoring processes are heavily involved in generating this knowledge. Similarly, Feeling of Knowing and Judgment of Learning have been investigated as metacognitive processes or rather as product measures (i.e., the knowledge generated). Finally, conditional knowledge about what to do when_ is sometimes considered as metacognitive awareness and declarative knowledge (Alexander, Schallert & Hare, 1991; Desoete & Roeyers, 2003; Schraw & Moshman, 1995), or as being intrinsically part of metacognitive skills. Obviously, more precise taxonomies of metacognitive knowledge and skills are needed. Such extensive descriptions of metacognitive activities have been made for text studying by Pressley and Afflerbach (1995) and Pressley (2000). In the same vein, Meijer, Veenman, and Van Hout-Wolters developed a hierarchical model of metacognitive activities for both text-studying and problem-solving tasks in different domains. Additional to these taxonomies of components and subcomponents of metacognition, the relations amongst those components need further clarification. For instance, the work of Lockl and Schneider (2000) shows that advanced Theory of Mind leads to improved metamemory at a later stage. We endorse further research into the intricate relations between Theory of Mind, metamemory, metacognitive experiences and awareness,metacognitive knowledge, and metacognitive skills (Thorpe & Satterly, 1990). We view this state of affairs as healthy and inevitable, with the dynamic evolution of scientific knowledge fueled by diverse, related traditions of research inquiry.

Vadhan and Stander (1993) clearly distinguish between ordinary thinking and awareness and understanding of thinking, and this is a theme elaborated on by Hacker (1998), who divides metacognition into three types of thinking:

- ***Metacognitive knowledge*:** what one knows about knowledge.
- ***Metacognitive skill*:** what one is currently doing.
- ***Metacognitive experience:*** one's current cognitive or affective state.

Therefore, whilst cognition focuses on solving the problem, metacognition focuses on the process of problem-solving (Marchant, 2001).

In addition to the knowledge people have about how they use their thoughts and strategies (Brown, 1987), knowledge about how much they will be able to learn and what kinds of strategies they use (Gleitman, 1985; Weinert & Kluwe, 1987), people also possess a set of general heuristics. For example, how they plan, set goals and process feedback (Frese *et al*., 1987). The assumption is that these general heuristics can be either conscious or automatic (Brown, 1987; Flavell, 1987) and they may be highly generalized or specific.

Metacognition can be assessed in a number of ways but one of the most popular methods currently in widespread use in schools, colleges and universities worldwide is through the use of questionnaires which require students to report their perceptions about their thinking and problem-solving skills and strategies. It is generally accepted that most students who struggle at university could improve their performance considerably if they understood the learning process better. Weinstein and Palmer (1988) point out that poor grades begin to rebound when students learn the trick of pinpointing the key points in lectures, and assert that learning is more effective when we engage in thinking about the process of learning, thinking and problem-solving. As a result of Weinstein's work in the field of strategic learning at the University of Texas at Austin, she developed the *Learning and study strategies inventory* (LASSI), which is now one of the most widely used learning inventories (Weinstein, 1987). The LASSI measures students' perceptions of their study and learning strategies and methods. In other words, it is a measure of the students' thinking about their thinking or metacognition.

The tool consists of ten scales, and 80 items which provide an assessment of students' awareness about and use of learning and study strategies related to the skill, will and self-regulation components of strategic learning. Research has repeatedly demonstrated that these factors contribute significantly to successful study, and that they can be learned or enhanced through educational interventions such as learning and study skills courses (King, 1991; Letteri, 1992; Weinstein, 1994a, 1994b; Hanley, 1995).

The LASSI provides standardized scores for the ten different scales and provides students with a diagnosis of their strengths and weaknesses, compared to other students, in the areas covered. It measures three main areas of 'strategic learning', as follows.

The skill component

These scales examine students' perceptions (metacognition) of their learning strategies, skills and the thought processes related to identifying, acquiring and constructing meaning for important new information, ideas and procedures. The LASSI scales related to the skill component of strategic learning are:

- *Information processing*: the ability to process ideas by mentally elaborating on them and organizing them in meaningful ways.
- *Selecting main ideas*: the student's ability to identify the important information in a learning situation.
- *Test strategies*: the student's ability to prepare effectively for an examination and to reason through a question when answering it.

The will component

These scales measure students' perceptions of their receptivity to learning new information, their attitudes and interest in college, their diligence, self-discipline and willingness to exert the effort necessary to successfully complete academic requirements, and the degree to which they worry about their academic performance. The LASSI scales related to the will component of strategic learning are:

- *Attitude*: the student's perceived motivation and interest to succeed in his/her study, and willingness to perform the tasks necessary for academic success.
- *Motivation*: the extent to which the student accepts responsibility for performing academic tasks by using self-discipline and hard work.
- *Anxiety*: the degree of anxiety perceived by the student when approaching academic tasks.

The self-regulation component

These scales measure students' perceptions of how they manage, self-regulate and control the whole learning process through using their time effectively, focusing their attention and maintaining their concentration over time, checking to see if they have met the learning demands for a class, assignment or test, and using study supports such as review sessions, tutors or special features of a textbook. The LASSI scales related to the self-regulation component of strategic learning are:

- *Concentration*: the student's perceived ability to focus his or her attention, and avoid distractions, while working on school-related tasks like studying.
- *Time management*: the student's perception of the extent to which they create and use schedules to manage their responsibilities effectively.
- *Self-testing*: the student's awareness of the importance of self-testing and reviewing when learning material, and use of those practices.
- *Study aids*: the student's perceived ability to use or develop study aids that assist with the learning process.

There is a wealth of research, making use of the LASSI as a measure of metacognition, which identifies the value of learning to learn interventions in schools, colleges and universities (Loomis, 2000); however, few studies have tried to identify factors outside the learning institution that might impact upon the development of metacognitive skills in students.

The functions of metacognition

metacognition is used to refer to the awareness individuals have of their own thinking; their evaluation of that thinking; and their regulation of that thinking (Wilson, 2001). This

definition is consistent with existing literature but also extends that literature. These three functions of metacognition: awareness, evaluation and regulation require careful specification.

Metacognitive awareness relates to individuals' awareness of where they are in the learning process or in the process of solving a problem, of their content-specific knowledge, and of their knowledge about their personal learning or problem solving strategies. It also includes their knowledge of what needs to be done, what has been done, and what might be done in particular learning contexts or problem solving situations. Metacognitive awareness encompasses an individual's cumulative knowledge of acquired competencies and on-going knowledge of mental processes in progress.

Metacognitive evaluation refers to judgements made regarding one's thinking processes, capacities and limitations as these are employed in a particular situation or as self-attributes. For example, individuals could be making a judgement regarding the effectiveness of their thinking or of their strategy choice. Such an evaluative function assumes some awareness of the individual's thinking processes and anticipates the possible regulation ofthose processes.

Metacognitive regulation occurs when individuals make use of theirmetacognitive skills to direct their knowledge and thinking. Metacognitive regulation draws upon individuals' knowledge (about self and strategies, including how and why they use particular strategies) and uses *executive* skills (such as planning, self-correcting, setting goals) to optimise the use of their own cognitive resources. When thinking metacognitively, learners reflect on their existing knowledge or thought processes. Individuals may be aware of, evaluate and/or regulate their own thinking. While the completion of a mathematical task is basically a cognitive process utilising cognitive strategies (e.g., adding up or using percentages), metacognitive behaviour deals with the selection and use of these cognitive strategies (e.g., This strategy is not working; what do I know about the task to help me work it out?). It is acknowledged that metacognition is employed within a social context (for example, a classroom) that is personally experienced, and that other aspects of the individual's experience of this context, such as prior knowledge, abilities, preferred ways of learning, values and expectations, and volition (Corno, 1993) affect the process (and, therefore, the products) of learning and problem solving. The importance of such personal attributes is recognised but not addressed explicitly in this article. Such attributes may facilitate or hinder the metacognitive activity of the learner/problem solver or even provide the

focus for that activity. Seen in this light, these attributes are not active agents in that activity, but may provide the matter on which metacognitive activity is undertaken.

Conclusion

Scruggs *et al*. (1985) suggests that direct instruction in metacognitive strategies leads to increases in learning (e.g. Learning to learn courses), and that independent use of these strategies develops only gradually. Whilst there is a wealth of research in support of Scruggs (Hanley, 1995; Bogdan, 2000; Driscoll, 2004), it is also essential that educators do not neglect the crucial role of the student's experience outside of the classroom in the development of metacognitive skills. Independent use of metacognitive strategies is a by-product of coping with everyday new social contexts and cultures. It seems very likely from the data presented in this paper that the experience of moving away from home (and culture) creates a metacognitive environment which fosters the development of 'thinking about thinking' and provides students with more opportunities to become successful problem-solvers and lifelong learners. In our rapidly changing world, the challenge for teachers is to help undergraduate students develop skills that will not become obsolete. As such, metacognitive strategies are essential for the twenty-first century because they will enable students to successfully cope with new situations, and the challenges of lifelong learning. To return to Socrates, it is clear that moving away from home and culture into a new social context ensures that everyday life is examined, and this paper suggests that this examination promotes the development of metacognitive skills which go some way to equipping students for the demands of a worthwhile career in a rapidly changing world.

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