# Learning for life in the 21st Century

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*"As we enter the 21st century… life success depends increasingly on the mastery of… processes such as goal setting, planning, organizing, prioritizing, memorizing, initiating, shifting, and self-monitoring. Beginning in the elementary grades, teachers now require students to complete lengthy reading and writing assignments, as well as long-term projects, both of which rely heavily on these… processes. Students are also expected to become proficient at note taking, studying, and test taking, all tasks that require the simultaneous organization and synthesis of multiple subprocesses. Academic success is thus dependent on students' ability to plan their time, organize and prioritize materials and information, distinguish main idea from details, shift approaches flexibly, monitor their own progress, and reflect on their work. Nevertheless, [the underlying] processes are not taught systematically in schools and are not a focus of the curriculum.... Furthermore, classroom instruction generally focuses on the content, or the what, rather than the process, or the how, of learning and does not systematically address metacognitive strategies that teach students to think about how they think and learn. As a result, a large gap separates the skills and strategies taught in school from the… processes needed for success there and in the workplace. Both these settings now require individuals to take greater responsibility for their independent learning and to organize and integrate an ever-changing body of information that is available through the Internet and other web-based media."*

(Meltzer, 2007)

# 1. Change

## The changing world

There is little doubt that the world is changing at an increasingly fast pace (e.g. Kurzweil, 2005; OECD, 2008) and the contexts within which young people live and learn are very different to those experienced a generation ago. The environments in which today's young people will find themselves in the future will be different again. This constant change has profound effects both on the students themselves and the skills they will need for social and economic participation and prosperity. When today's students enter the workplace and/or undertake further education the knowledge and skills that will be valued will no doubt differ from those we currently give significance. As Richard Riley, the US Secretary for education famously said in 1999:

> *We are preparing our students for jobs that don't exist, using technologies that have not been invented, to solve problems that we haven't even considered yet.*

There is evidence of this phenomenon in relatively recent years; longitudinal studies show that academic skills correlated best with earning power at 30 years old for those born in 1958. However, for those born in 1970, "non-cognitive" skills are better predictors of earnings (see from page 16). This difference demonstrates the need to strategically consider the skills students will require to adequately equip them for lifelong learning and adaptability (within a particular cultural context) from one year to the next.

## The changing nature of students

The development of the characteristics of young people is in turn dependent on the characteristics of the environments in which they find themselves. As the world changes, so these environments change and there is a knock-on effect to the ways in which young people think, behave and learn (OECD, 2009). For example, some computer games create an environment that demands a high degree of visual attention from the players. Perhaps unsurprisingly, people who spend time in these environments develop significantly higher capacity for such visual attention making these individuals more able to quickly take in information from the scene before them (Green & Bavelier, 2003). However, this same capacity may lead to increased distractibility in environments of low visual richness. The interaction with specific characteristics of the environment (created by the game in this example) changes the way that individuals within that environment think and behave.

There is much comment about the changing nature of young people and categorisation such as GenY and even GenZ can be an unhelpful simplification. If anything, one of the aspects of the environment that has changed over the last few decades is the diversity of the contexts to which

young people now have access, necessarily resulting in a diversity of influences on the nature of students thinking.

**The changing nature of teaching and learning**

There is little doubt that the changing world has presented

> *…opportunity to shift discussion about schooling from a narrow focus on skills and specific areas of knowledge to the broad range of needs for the future*
> (Teaching Australia, 2008)

This opportunity has been realised through changes in the expression of the purpose of education. There has been a move towards the development of the student such that young people are equipped

> *with the knowledge, understanding, skills and values to take advantage of opportunity and to face the challenges of this era with confidence.* (MCEETYA, 2008)

Placing the student at the centre of education, with recognition of their prior (informal and formal) learning has been a fundamental part of moving away from the didactic "chalk and talk." (OECD, 2007a) The learning environments and experiences of young people today are very different to those experienced by their parents and grandparents. Again, this difference in the environment brings about differences in the way that young people think, behave and learn.

The shift to a more student-centred approach helps to meet the widening diversity of learning that will be needed in the 21st century whilst literacy and numeracy *"remain the cornerstone of schooling for young Australians"* (MCEETYA, 2008). However, the same shift has had some unintended consequences on the nature of young people's learning skills. The repercussions are felt across all subjects and are exemplified by Roditi and Steinberg (2007) in mathematics education:

> *Back in the 1960s and 1970s, when math curricula reflected a rote instructional paradigm, teachers provided math rules, algorithms, and step-by-step procedures using direct instruction. They often stood up in front of the class, lecturing and writing the steps for math problem solving on the board. They assigned worksheets for homework and, the following day, reviewed the homework with the class, problem by problem. Then they collected the homework, graded it, and wrote comments on each student's paper. The teachers developed their own tests that mimicked the skills and strategies that they taught directly in class. In these traditional math classrooms, the teachers acted as the executives, providing math instruction in a structured, systematic way within highly organized classroom environments. Therefore, it is not surprising that students were not identified as having… difficulties [with underlying attention, organising, planning, prioritising, and strategising processes] at that time.*

> *Currently, students are expected to be "reasonably computationally fluent" (Russell, 2000), and, at the same time, they must learn how to apply these computational skills to solve higher-level mathematical problems. Within a constructivist paradigm, students who have difficulties with [underlying attention, organising, planning, prioritising, and strategising processes] are more vulnerable than others to experiencing difficulty in discovering their own mathematical conjectures as well as remembering and internalizing all the steps necessary for meaningful problem solving. These students have difficulty organizing knowledge for themselves because they need scaffolds and templates to help them learn how to learn. If they struggle for too long in the math classroom, they begin to develop "learned helplessness" (Diener & Dweck, 1978) and no longer have the motivation to engage in learning mathematics. This is, they no longer have what Moran and Gardner (2007) describe as the "will" or "skill" to go up the "hill". Therefore, a major challenge facing math teachers today is how to provide an open structure for meaningful problem solving and, at the same time, the systematic, strategic scaffolds necessary for students with [underlying attention, organising, planning, prioritising, and strategising] processes who struggle to learn in the math classroom.*

The changing nature of the world, of the student and of teaching and learning, conspire to change the thinking processes of young people and the value of different cognitive processes and underlying learning skills. In section 2 contemporary expressions of important skills in learning will be explored and the underlying process will be drawn out. However, before that it is important to consider a further factor to consider when determining important learning skills; namely the emerging research evidence from the cognitive and neurosciences on thinking and learning.

**The changing understanding of learning**

The neuroscience of learning is an emerging field and the interaction between the expertise of educators and neuroscientists is proving to be particularly fertile (e.g. Howard-Jones, 2007; teachers.tv, 2008).

It is well established that the brain changes in response to environmental demands (e.g. Blakemore and Frith, 2005), forming and strengthening some connections between brain cells whilst weakening and eliminating others (a characteristic called plasticity). While the formation of these connections occurs at prodigious rate in infancy, the process continues throughout childhood, maturity and old age.

The findings from early neuroscience research was often stretched and distorted resulting in unhelpful conceptions such as:

- distinction between “left-brain” and “right-brain” thinkers or thinking
- only 10% of brain capacity is ever used
- windows of opportunity when learning must take place
- a universal difference between the brains of males and females

It is important to avoid making the same mistake with the use of findings from contemporary neuroscience research and to resist over-interpretation and over-claiming. However there are some well-established insights into learning from neuroscientific perspective that educators have used to influence their thinking about teaching and learning (e.g. Blakemore and Frith, 2005; Howard-Jones, 2007; teachers.tv, 2008) For example, there are "sensitive periods," particularly during the early years when specific aspects of development take place most effectively. One such aspect is the ability to hear and process sounds and then to make speech sounds usually develops early and in a relatively short period whereas vocabulary acquisition can be learned throughout life (even if it does generally do so at a decreasing rate) (Blakemore and Frith, 2005)

A second important developmental phase is during adolescence, when neurological change accompanies the familiar hormonal, physical, emotional and developmental changes that occur. In particular, an increase in the speed of transmission of nerve impulses and a significant increase in the rate at which some connections between brain cells are pruned away (Choudhury *et al.*, 2008). Development of the (pre-) frontal cortex associated with some of the processes underpinning self-control, decision making and social-cognitive abilities continues through adolescence leading to a combination of emotional immaturity and high cognitive potential characterised as "high horsepower, poor steering" (OECD, 2007b).

Overall, the traditional view treats cognitive development as a ladder that individuals climb one rung at a time reaching progressively higher cognitive stages in a linear fashion (e.g. a single stage of logic in Piaget's theory (1983)). In this model, an individual progresses from one stage to another across domains. For example, a junior primary student would be expected to exhibit the same (pre-operational) stage of cognitive development in arithmetic and social understanding while a senior secondary student would exhibit a different (formal operational) stage across both domains.

Students do not exhibit this extent of consistency.

> *On any particular task, a person acts at a wide variety of levels, ranging from the functional, or typical level to the optimal level (what can be done with contextual support). The role of the supportive environment in causing variation... has been widely documented for tasks as diverse as telling a story about social interactions or predicting whether objects will sink or float.*
>
> *Children demonstrate rapid changes in performance in specific age regions for optimal conditions in familiar domains – changes that have some of the properties of stages.*
>
> (Fischer & Daley, 2007)

In domains such as reflective judgment (the reasoning about the basis of knowing and developing concepts particularly when there are conflicting

arguments in support of an idea) the rapid changes, or spurts occur for the optimal level when appropriate contextual support is in place (see Figure 1). A more slow and smooth development is seen at the lower functional level. Students show one developmental level (functional) when they act in a spontaneous context and a much higher developmental level (optimal) when they act in a socially supportive context. This developmental range has some consistency with Vygotsky's Zone of Proximal Development (1978).

Teachers are familiar with individual students performing at a relatively high level one day and dropping back the next, a variation that they may be able to predict/rationalise depending on context which might be something as mundane as the day of the week or, for example, the student's emotional state.

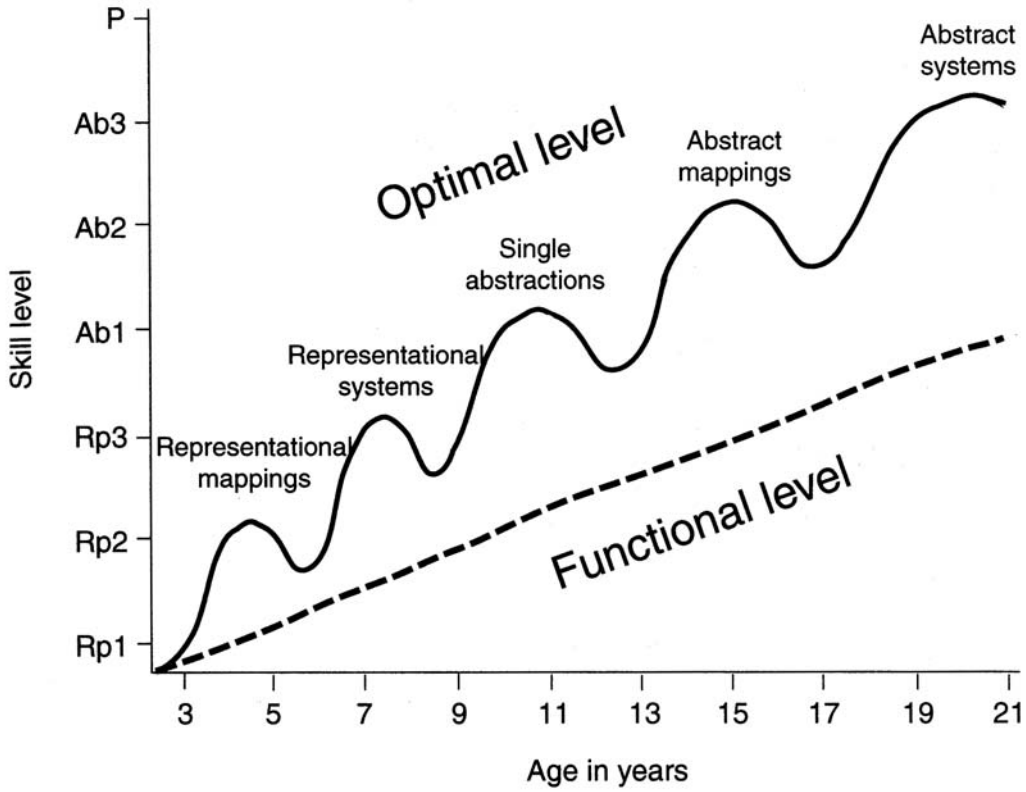


**Figure 1:** Graphical representation of the accessible skill level, changing gradually over time for the functional level and in spurts for the optimal level. From Fischer and Daley (2007) See below for description of the skill levels.

Longitudinal research suggests that reflective judgments develop according to the stages outlined in the table below. (Fisher *et al.,* 1993)

**Table 1: Stages of development of reflective judgment**

| ***Skill level*** | ***Stage of reflective judgement*** | **Potential relevance** |
|---|---|---|
| *Level Rp1: Single representations* | *Stage1: Single category for knowing: To know means to observe directly without evaluation.* | Early years & primary |
| *Level Rp2: Representational mappings* | *Stage 2: Two categories for knowing: People can be right about what they know, or they can be wrong.* | Primary |
| *Level Rp3: Representational systems* | *Stage 3: Three categories for knowing: People can be right about what they know, or they can be wrong, or knowledge may be incomplete or temporarily unavailable. The status of knowledge may differ in different areas.* | Primary |
| *Level Rp4/A1: Systems of representational systems, which are single abstractions* | *Stage 4: Knowledge is uncertain: The fact that knowledge is unknown in several instances leads to understanding knowledge as an abstract process that is uncertain.* | Primary & junior secondary |
| *Level A2: Abstract mappings* | *Stage 5: Knowledge is relative to a context or viewpoint; it is subject to interpretation. Thus it is uncertain in science, history, philosophy, etc. Conclusions must be justified.* | Junior & senior secondary |
| *Level A3: Abstract systems* | *Stage 6: Knowledge is uncertain and subject to interpretation, but it is possible to abstract some justified conclusions across domains or viewpoints. Knowledge is an outcome of these processes.* | Senior secondary & beyond |
| *Level A4: Systems of abstract systems, which are principles* | *Stage 7: Knowledge occurs probabilistically via inquiry, which unifies concepts of knowledge. Knowledge can be reached with various degrees of certainty depending on justifications and evidence.* | Senior secondary & beyond |

(After, Fisher *et al.,* 1993; Fischer & Daley 2007)

Students' development of concepts maybe influenced by these stages but for the individual, their access to different levels at different times and the uncertainty about the exact age at which they show a spurt in their optimal level means that any staging can only be a broad framework. Performance varies from moment to moment up and down a developmental scale as a function of degree of contextual support for high-level functioning.

> *Traditional conceptions of competence and performance fail because they treat competence as a fixed characteristic of the child, analogous to a bottle with a fixed capacity. Performance factors are seen as somehow interfering with this capacity.*
>
> *The property of separation of levels allows children to function at a high level when the context demands it while at the same time keeping lower levels of functioning open to new learning from experience. In this kind of system, there is no single fixed competence like that of a [bottle] but a dynamic range of competences reflecting the complexity of human behavior and experience.*
>
> (Fisher *et al.,* 1993)

A student's development of concepts will follow the ebb and flow of their optimal level of performance that can be accessed when the contextual, social support is available.

Table 1 and Figure 1 give insight into the way that students' development of reflective judgement influences their understanding of concepts over time. More complexity and sophistication may be built into a concept as a student moves through the stages. When operating at the optimal level, students are capable of undergoing a spurt in the level of their thinking and understanding, though as outlined above this can drop back significantly when operating at the functional level. This suggests that concepts need to be continually developed over several years across schooling.

The developmental range increases with age (an important difference with Zone of Proximal Development (Vygotsky, 1978)) highlighting the importance of maintaining a supportive context in educational environments.

The accumulating evidence from neuroscience and the wider cognitive sciences, in conjunction with the expertise and experience of education professionals, can give some new insights (and reinforce existing views) into learning and the processes that underpin the development of a range of characteristics and outcomes. These insights may influence what are considered to be the cross-curricular learning skills that are required for successful learning and the realisation of culturally desired characteristics and capabilities including, but not limited to, literacy, numeracy, collaboration, creativity, and resourcefulness.

# 2. Skills in 21st Century Australia

## Skills in 21st Century Australia

The skills required for participation and prosperity in the changing world are the subject of ongoing consideration. The Melbourne Declaration on Educational Goals for Young Australians (MCEETYA, 2008), The Employability Skills for the Future (DEST, 2002) and the Australian Core Skills Framework (DEEWR, 2008) serve to provide a snapshot of the current position in Australia. In the articulation of these skill sets there is a mix of skills, abilities, activities, capabilities and characteristics. The underlying processes required to achieve these desired outcomes are rarely elucidated but often hinted at or implied (and neither do the statements set out to do so). A consideration of these three documents and the National Curriculum discussion paper (NCB, 2008) is set out below with a view to bringing out the underlying learning skills contained within each publication.

In the Melbourne Declaration on Educational Goals for Young Australians (MCEETYA, 2008), the second of the two goals is "All young Australians become: Successful learners; Confident and creative individuals; Active and informed citizens" [*sic*]. This goal is further elucidated by broad statements about the behaviours, characteristics, abilities and positioning displayed by such learners, individuals and citizens.

In particular, "successful learners":

- *develop their capacity to learn and play an active role in their own learning;*
- *have the essential skills in literacy and numeracy and are **creative** and productive users of technology, especially ICT, as a foundation for success in all learning areas;*
- *are **able to think deeply and logically**, and obtain and **evaluate evidence in a disciplined way** as the result of studying fundamental disciplines;*
- *are **creative**, **innovative** and **resourceful**, and are **able to solve problems** in ways that draw upon a range of learning areas and disciplines;*
- *are **able to plan** activities independently, **collaborate**, **work in teams** and **communicate** ideas;*
- *are able to make sense of their world and think about how things have become the way they are;*
- *are on a pathway towards continued success in further education, training or employment, and acquire the skills to **make** informed learning and employment **decisions** throughout their lives;*
- *are **motivated** to reach their full potential.*
  (MCEETYA, 2008)

As would be expected, within this declaration literacy and numeracy are clearly and explicitly valued. The adjectives and abilities used to characterise "successful learners" have been highlighted here to give some indication of

the intended nature of outcomes when learning skills are applied. The actual learning skills and the underlying processes are not developed in the declaration.

Similarly the statement of Employability Skills by the ACCI and BCA (2002), following the reports from Finn (AEC, 1991) and Mayer (AEC, 1992), draw out some general areas:

- *communication skills that contribute to productive and harmonious relations between employees and customers;*
- *team work skills that contribute to productive working relationships and outcomes;*
- *problem-solving skills that contribute to productive outcomes;*
- *initiative and enterprise skills that contribute to innovative outcomes;*
- *planning and organising skills that contribute to long-term and short-term strategic planning;*
- *self-management skills that contribute to employee satisfaction and growth;*
- *learning skills that contribute to ongoing improvement and expansion in employee and company operations and outcomes; and*
- *technology skills that contribute to effective execution of tasks.*

The elements that constitute each of the areas are elucidated in the report. Learning skills *per se* are treated in a rather limited way, the elements essentially all pointing to the value and application of lifelong learning, namely:

- *managing own learning;*
- *contributing to the learning community at the workplace;*
- *using a range of mediums to learn – mentoring, peer support, networking, IT, courses;*
- *applying learning to technical issues (e.g. learning about products) and people issues (e.g. interpersonal and cultural aspects of work);*
- *having enthusiasm for ongoing learning;*
- *being willing to learn in any setting – on and off the job;*
- *being open to new ideas and techniques;*
- *being prepared to invest time and effort in learning new skills; and*
- *acknowledging the need to learn in order to accommodate change.*

However, given the wider context of the skills areas (communication, team-work, problem-solving, initiative, planning and organising, self-management), abilities emerge throughout the report that resonate with those highlighted above in the description of “successful learners” from the Melbourne Declaration such as innovation, resourcefulness, problem-solving, decision-making, planning, organising, etc. As with the Melbourne Declaration, the employability skills report did not set out to develop the fundamental skills and underlying processes that lead to the desired outcomes.

The Australian Core Skills Framework (ACSF) (DEEWR, 2008) has a particular focus on vocational and adult learning and sets out five core skills

"essential for people to participate in our society", namely learning, reading, writing, oral communication and numeracy. The ACSF recognises that:

> *It is likely that each new role and responsibility we take on will require new or enhanced core skills. Therefore we need a range of strategies to adapt to changing circumstances and new challenges including strategies to help us learn.*

Each of the skills is given detailed consideration based on some research evidence. For learning, a number of "critical factors… that influence development of expertise as a learner" are identified:

- *The concept of self as a learner, including self-esteem, awareness of one's strengths, weaknesses and preferences*
- *The degree of motivation and engagement in learning and the stage of the learner in a particular context*
- *The degree of conscious management of the learning process (metacognition)*
- *The ability to actively reflect on one's performance and learn from it*
- *Learning dispositions, or habits of mind, such as transferring prior knowledge and skills, persistence and taking responsible risks*
- *Knowledge and application of practical strategies to facilitate learning, including thinking techniques*
- *Social interaction as a critical component of situated learning, including the role of mentoring and coaching and skills to participate in formal teams.*

The ACSF is broadly in line with the desired outcomes of the Melbourne Declaration or the employability skills (and an explicit mapping of the latter appears within the framework document). With the "critical factors" there are a few areas where the emphasis could be changed in the light of recent research findings (e.g. habits of mind and learning preferences Howard-Jones, 2007). Nevertheless, the ACSF adds consideration of the nature of the learner and hints at the underlying learning skills.

In the National Curriculum discussion paper (NCB, 2008) the "solid foundation in skills and knowledge for further learning" sets out the importance of ongoing learning in literacy and numeracy but goes no further in identifying the other foundational learning skills that predict successful outcomes for students.

In the "deep knowledge and skills" section, consideration quickly turns to content and the need to maintain "rigourous, in depth-study" whilst dealing with an over-crowded curriculum. The need for a balance between domain-specific processes and content knowledge is articulated (paragraphs 27 & 28) but the underlying learning skills are not elucidated.

The "general capabilities" section in the Melbourne Declaration and the Employability Skills are drawn upon and extended. Problem-solving is considered to be domain specific and of course "experts moving outside their domain of expertise become novices in a new domain." (Paragraph 39) However, it has been demonstrated that the cognitive and even the non-

cognitive processes that underpin successful problem solving, or create barriers to doing so, can be taught so as to change students' educational trajectories (see below). Creativity (paragraph 40) and collaboration (paragraph 41) are treated in similar ways.

**Technology skills**

Skills in Information and Communication Technologies are widely valued and deserve specific consideration.

The Melbourne Declaration states that:

> *Rapid and continuing advances in information and communication technologies (ICT) are changing the way that people share, use, develop and process information and technology. In this digital age, young people need to be highly skilled in the use of ICT.*
> (MCEETYA, 2008)

The ACCI and BCA (2002) elucidate the "technology skills that contribute to effective execution of tasks" as:

- *applying IT as a management tool*
- *using IT to organise data*
- *being willing to learn new IT skills*
- *having the occupational health and safety knowledge to apply technology*
- *having the appropriate physical capacity*

The ACSF deals with technology skills in a similarly mechanistic way and in the mapping of the Employability Skills onto the framework, only "using IT to organise data" is picked up and mapped onto ACSF numeracy skills.

The National Curriculum Board moves beyond the simple use of technological tools, recognising that:

> *ICT competence are as much about information management as about the use of technology so an important aspect of the competence is the ability to evaluate the source, reliability, accuracy and validity of information that abounds in cyberspace and is readily retrievable. This set of capacities will be represented in each curriculum area in ways appropriate to that area.*

This adds what might be called information literacy or ICT literacy to the curriculum.

However, in the early 21st century the often unintended influence of technology on interpersonal interactions, thinking, learning, creativity and productivity are of increasing concern across education, business and wider society (for example see IIIP). Appropriate contemporary and future learning will need to include the ongoing development of a sophisticated skills set to deal with these emerging aspects of technology (for example see Sobel Lojeski & Riley, 2008). It could be

claimed that the communication sections of the Australian documents considered here cover some of these issues but there are significant specific issues relating to the use of technologies that will have a profound effect on the social and economic prosperity of individuals, of business and of wider society.

The underlying cognitive and non-cognitive processes that are required for effective learning, including within a technological environment, are described in section 3. As such these processes can be defined as **learning skills** because they can be taught and, as will be seen, the degree to which they are mastered correlates with an individual's educational, social and economic outcomes.

# 3. Learning Skills

Sections 1 and 2 briefly summarised the changes that led to a reconsideration of what might be viewed as the learning skills underpinning effective learning and capabilities such as literacy, numeracy, creativity, etc and the employability skills. In this section, an evidence base cutting across education, neuroscience and the broader cognitive science is used to elucidate the nature of those cross-curricular learning skills.

**What are the learning skills that underpin learning outcomes?**

There are group of complex processes that serve our ongoing goal directed behaviours. This group may be considered to be the learning skills that underpin successful outcomes and includes:

– sustaining and appropriately switching attention (required for multitasking)
– goal setting
– planning (including the modification of priorities)
– prioritising (including the modification of priorities)
– devising, switching and modifying of strategies
– implementation of strategies and plans
– inhibition of responses/impulses (e.g. of habits, temptations or distractions)
– error correcting
– working memory (mentally holding/using information; required for creativity)
– organising behaviour
– flexibility and adjusting to change
– self-regulation
– anticipation and prospective memory (intention to act in the future and to do so appropriately e.g. to post a letter when you pass the post box or make a phone call at the appropriate time)

These terms might be expressed in different ways and could be called energy, direction or even metacognition. There is much overlap and interdependence between each point. Whatever the nomenclature, this list contains some of the underlying processes that are generally agreed to fall under an umbrella entitled **executive functions**.

Of all these functions, since the 1980s there has been much concern and emphasis on attention. It has taken a lead position in educational literature and is now understood to mean more than the common parlance of "concentration span." This change in perception is due to the increasing number of young people diagnosed as having difficulty with appropriately directing and sustaining attention (Barkley, 1997).

Many students develop some or all of learning skills listed above without strategic intervention, allowing them to become independent learners and flexible thinkers. They can more easily bypass their weaknesses and use their strengths to learn efficiently and effectively so they can learn how to learn (Meltzer, 2007). These are the students characterised as "successful learners" in the Melbourne Declaration. For other students these executive function learning skills need to be taught otherwise the desired education outcomes will not be realised. For example, young lower-income children have disproportionately poor executive function skills (Noble, 2005, 2007) with the result that they fall progressively farther behind in school each year (O'Shaughnessy *et al*., 2003). As noted on page 3 this need for the student to develop these learning skills is made more cogent because teachers are less likely to play the role of the executive (e.g. organising the learning process for the student) than they were in the past.

**Examples from the evidence base**

There is a growing body of evidence (e.g. Meltzer, 2007; Margo & Dixon, 2006, Mind, Brain and Education, 2008) showing that the extent to which students can demonstrate their command of executive function learning skills correlates with their educational, social and economic outcomes. For example, in Walter Mischel's classic delayed gratification experiments 4 year olds were given a number of marshmallows and asked not to eat them until the researcher returned after a short absence. If they could not wait (i.e., could not inhibit their impulse) the children were allowed to eat just one marshmallow, forfeiting the rest of the treats. In a follow-up study of a sample of these children, those 4 year olds that had waited longest grew up to be more academic and socially competent, were able to concentrate more, to plan, to think ahead. They were considered more competent, skilful and able to cope with stress more maturely than those who were more impulsive children. The number of seconds of delay time in that pre-school environment was significantly related to their scores in the Scholastic Aptitude Tests at aged 19 (the standard academic scores for US university entrance).

Similarly, the learning skills associated with executive functions are more strongly associated with school readiness than IQ or entry-level literacy or numeracy (Blair & Razza, 2007; McClelland et.al., 2000) and in fact the learning skills of working memory and inhibition of impulses independently predict mathematics and reading scores in preschool through high school [e.g., (Blair & Razza, 2007; Bull & Scerif, 2001; Gathercole et.al., 2005).

Allied to the learning skills, each student's view of themselves as a learner has a profound effect on their trajectory and learning outcomes. On initial consideration, this may not seem to qualify as a learning skill or to warrant mention in a curriculum document. However, given the findings that a student's view of their own intelligence can be developed through teaching so that it improves not only their learning outcomes but also their level of potential earnings in the future is deserves some attention.

In middle school students, often hold different "theories" about the nature of intelligence (Dweck and Leggett, 1988; Dweck, 1999). Some believe that their intelligence is malleable and can be developed whilst others see intelligence as being fixed, a "thing" of which they have a little or a lot. When dealing with academic tasks, there are significant differences in the behaviour and learning of each group (see Table 2).

**Table 2: Characteristics associated with students' theory of intelligence**

| Students who hold intelligence as being **malleable:** | Students who hold intelligence as being **fixed:** |
|---|---|
| Focus on **learning goals** (goals aimed at increasing their ability) | Focus on **performance goals** (goals aimed at documenting their ability) |
| Believe in **utility of effort** given difficulty or low ability | Believe in **futility of effort** given difficulty or low ability |
| Make **low-effort, mastery-oriented attributions for failure** (e.g. *"I didn't try hard enough, but I can try something else")* | Make **low-ability, helpless attributions for failure** (e.g *"I'm not smart enough, it's not my fault"*) |
| Display **mastery-oriented strategies** (effort escalation or strategy change) **in the face of setbacks** | Display **helpless strategies** (effort withdrawal or strategy perseverance) **in the face of setbacks** |

(Dweck & Leggett, 1988; Hong *et al.,* 1999; Henderson & Dweck, 1990; Robins & Pals, 2002; Blackwell *et al.,* 2007)

Perhaps unsurprisingly, a student's belief that intelligence is malleable predicts an upward trajectory in academic grades in contrast to a belief that intelligence is fixed which predicts a flat trajectory in those grades (regardless of their starting level of performance). The student's view of intelligence causes the direction of their academic trajectory. Research has shown that students can be taught about their own learning and malleability of intelligence, resulting in positive change in classroom motivation and a reversal of falling or unchanging grades to increasingly positive results.

The British Cohort Study followed a group of children born in 1970 and that detailed analysis of the data allows for the identification of the childhood and adolescent experiences that influenced outcomes in later life (Blanden et al., 2006; Feinstein, 2000; Margo & Dixon, 2006). The relative importance of cognitive factors, such as IQ, and ability in copying, mathematics and reading, have been compared to the importance of non-cognitive factors such as "**application**" which included estimations of "the child's concentration and perseverance and his/her ability to understand and complete complex tasks"; all closely related to the executive function learning skills listed above. The second main non-cognitive factor was the "**locus of control**" capturing the

degree to which students perceived events to be within their control and their sense of personal agency. Both application and locus of control are closely related to and dependent upon executive functions.

One of the measures used in the study was the strength of the correlation between earnings at age 30 and a large number of education-related variables. The authors noted that:

> *The strongest association with earnings among the cognitive variables are for copying at age 5 and maths at age 10. The results suggest that a standard deviation increase in the copying score at age 5 is associated with 4.2% increase in earnings, whilst for the maths score this is 5.4%. The application and locus of control scores at age 10 and anxiety at age 16 have the largest earnings returns among the noncognitive variables, at 4.7%, 3.0% and -3.4% respectively extra earnings associated with a one standard deviation increase.*
> (Blanden *et al.,* 2006)

Comparing the size of these effects with the 1.3% increase in earnings associated with a standard deviation increase in the reading score at age 10, demonstrates that the "non-cognitive" executive function learning skills are comparable in importance to literacy and numeracy.

Comparing the data from the 1970 cohort with a similar study of individuals born in 1958 reveals how the relative importance of cognitive and non-cognitive factors have changed over time (Blanden *et al.,* 2006; Feinstein, 2000; Margo & Dixon, 2006)

> *The non-cognitive factors became 25% more important in determining earnings later in life between 1958 and 1970 cohort while cognitive factors became 20% less important.*
> (Margo & Dixon, 2006)

It goes without saying that earning power is just one measure that can be used to interrogate the outcomes from education and the learning skills that inform those outcomes. However, these studies clearly exemplify not only the importance of the executive function learning skills (including theory of intelligence) as cornerstones of future learning and social and economic prosperity but also their increasing value in a changing world. Two data points (from the 1958 and 1970 cohort studies) do not constitute a trend, but the changes in the educational and workplace context over the period of these studies has continued, and if anything accelerated. The expectation is that the importance of the executive function learning skills (the non-cognitive factors) may be even more important to the children of the 21st century.

In addition to the educational and economic outcomes that are facilitated by executive function learning skills, there is a significant influence on social equity that cannot be overlooked.

> *The key idea here is that as pathways through education to work became*

> *less structured (and often less oppressive), making the right decision, having long-term plans and being able to see them through became more important in shaping success. The decline of educational and economic structures that traditionally shaped young people's lives was the inevitable result of deeper, underlying shifts in the domestic and global economy. This was in many ways a positive development. But the gradual removal of the constraints of traditional pathways meant that those with the capacity to take advantage of formal opportunities had unprecedented chances to succeed in education and the emerging labour market.*
> (Margo & Dixon, 2006)

The ability to recognise an opportunity, see the benefit of that opportunity and then to grasp it and realise the potential depends upon the executive function learning skills. Sustaining attention to the information or situation at hand, identifying goals and making a strategic plan to achieve those goals is just the beginning of the process. Initiating the strategy in the light of the opportunity, organizing behaviour, adjusting to any changes that may occur and inhibiting distractions whilst holding the opportunity, goal and strategy in mind are all required.

For many (young) people any number of the skills required to achieve these processes may not be in place and it is more likely that they do not have these skills if they are operating within contexts characterised by low socio-economic status (Noble, 2005, 2007). A study of 5000 young people in the UK and Germany found that unemployed people tend to see education and qualifications as more important in influencing life chances, but were less likely than other groups to stress the importance of interest, long-term goals, choice and planning and were much more likely to attribute success or failure to chance (Evans, 2002). In contrast, young people with jobs tended to attribute their success to their own plans and efforts.

In the context of the changes outlined in section 1,

> *life course events that were once normatively structured by 'traditional' institutions (early marriage, established gender roles, religious beliefs and clear, if oppressive, career paths), were increasingly left to individuals to decide on their own, leaving them to take on new responsibilities for living with the consequences of their actions. For those with the capacity to take advantage of these changes, typically the affluent, expanding opportunities led to improved outcomes, but for those without, events left them further behind than ever.*
> (Margo & Dixon, 2006)

Whilst social inequity in Australia is a complex problem, influenced by a large number of factors, a lack of executive function learning skills contributes a significant disadvantage that persists thorough generations and communities. Even when opportunities are available, young people without these skills are essentially unable to turn them to their advantage. A strategic approach to the

teaching of executive function learning skills will be required if students are to be equipped

> *with the knowledge, understanding, skills and values to take advantage of opportunity and to face the challenges of this era with confidence."*
> (MCEETYA, 2008)

Many of the executive function learning skills are already valued by teachers and students are often given the opportunities to practice and learn these skills across all subjects. However, the opportunities to learn these skills have until now been a secondary effect, almost a happy accident. Given the changes outlined in section 1, the desired outcomes summarised in section 2 the evidence of the nature of the skills that make a difference in this section, and the development of the national curriculum, the opportunity exists as never before to strategically equip students with learning skills for life in the 21st century.

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