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Appendix 3

Components of the Science Curriculum Course

1. Basic Science

Each topic includes

i. science knowledge
ii. practical work for school science
iii. a pedagogical dimension.

Process skills: measurement

Energy	Light
Materials	Forces
Electricity	Electronics
Senses	Technology
Life processes	Earth science
Particles	Earth in space
Pollution	

2. Other Topics included in the science course

Approaches to teaching science	Mathematics and science
Safety in science	Assessment in science
Health education	Teaching about the history
Computers in science	and nature of science
Bilingual learners in science	Teaching biology, chemistry or physics to advanced level
Childrens' learning in science	Use of museums in teaching

TECHNOLOGY, SCIENCE AND THE ENGLISH TRADITION OF LIBERAL EDUCATION

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INTRODUCTION

The challenges posed to the Australian Education System by economic and industrial change have been discussed in a recent paper by John Mathews and colleagues (1988). An interesting feature of this paper is that it is premised on the proposition that 'flexible skill formation and the development of technological literacy' are '*the preconditions of any citizen to be active in the democratic system*'. This assertion supplies a very new answer to a very old question, namely that of identifying the basic elements of the education of a free citizen. Questions about the nature of a 'liberal education' were formulated and answered, according to his lights, by Aristotle. Pride of place in Aristotle's scheme were given to music and gymnastics, learning about technology being excluded *a priori* as intrinsically degrading. Given the chasm in time and circumstances separating classical Athens from modern Melbourne, it is hardly a surprise that both Aristotle's preconceptions and prescriptions differ so markedly from those of his Australian successors. What is genuinely surprising, however, is the durability in the English speaking world, of the Aristotlean categories of 'liberal' and 'illiberal'.

John Dewey (1913), in a famous essay written early this century, reviewed the shifting conceptions of a liberal education which accompanied the political, economic and intellectual evolution of western societies. More recently, Sheldon Rothblatt (1976) has published a detailed study of this process as it occurred in 18th and 19th century England, where many factors combined to sow confusion about educational aims and methods. The eighteen-sixties, the decade of the Second Reform Bill was a period of particular turbulence. Matthew Arnold's (1868) *Culture and Anarchy* bears eloquent testimony to the social, political and religious ferment of those times. It also came to be accepted as a classic reformulation of the aims of liberal education in terms of the attainment of 'culture'. Arnold's notion of culture was crisply summarized by his friend and adversary Thomas Huxley (1893) in the following terms:

> *... a criticism of life is the essence of culture ... literature contains the materials which suffice for such a criticism.*

Although the near monopoly of classical language and literature in the curriculum of schools for the English upper classes was not seriously challenged in practice for many years, this particular version of the liberal curriculum was, at the time of *Culture and Anarchy*, under attack from several quarters. The slow process which would open up the curriculum to 'modern' subjects had already begun. Engineering subjects, for example, had gained acceptance at a number of university level institutions. A broad account of these developments has been given by Eric Ashby (1958).

The purpose of this paper is to discuss the terms on which scientific and technical subjects were incorporated into the English educational system. The most important theme, and one which is almost unavoidable in any discussion of English educational history, is that of class stratification. The work of Rothblatt and Ashby, although valuable and interesting, can be criticised for largely neglecting the class dimension. No such criticism, however, can be levelled at Dewey, whose essay begins by drawing attention to the extent to which Aristotle's conceptions of liberal education were rooted in the particular class relations of classical Athens, and is generally concerned with the relationship between ideas of liberal education and ideas of class.

Class and Education are currently both in the mainstream of political debate in the U.K. All political parties aspire, at a rhetorical level at least, to banish class divisions and 'classlessness' has become a badge of political respectability. The education system, widely regarded as inadequate, is the object of remorseless political scrutiny. There are particular worries about Science and Technology education. The Royal Society (1991) has recently published an authoritative report on post-16 education in the light of 'future scientific, mathematical and technological needs of the U.K.' In their opinion:

> *The education system of England and Wales does not compare favourably with that of other countries. Of major concern ... is the extremely high proportion of young people who leave education at the age of 16 : far higher than that of many of our European trading partners. Many of those who do stay on are expected to specialize to an extent that restricts their future career choices.*

Significant weaknesses in the system arise from a long-standing preoccupation, amounting almost to a fixation, with the education of elites. This preoccupation is essentially an English phenomenon; Scotland still retains, despite English rule, some of the features of a distinct, more democratic educational tradition. The dominant assumption within the English tradition, has been that the most important education questions were concerned with the education of the most important people. Educational arrangements have both expressed and helped to perpetuate class divisions. There is now widespread agreement that mass under-education, particularly in respect of science and technology, has been a major factor in the economic vulnerability of the U.K. and there is a growing realization of a necessary link between the deconstruction of the class system and the reconstruction of the economy.

In the Victorian era, links between technical education and economic performance were also recognised. The disposition of the governing elite, challenged by nascent working class movements, was to defend the rigid class distinctions which characterised Victorian life. The English Victoria reformers who constructed the framework of modern science and technology education were, by and large, as class-bound in their conception of society as the educational conservatives who opposed them.

The Legacy of Aristotle

Rothblatt (1976) observes that although:

> *... the idea of a liberal education ... has changed beyond recognition in the past 150 years ... no single purpose, or idea associated with some aspect of liberal education has ever been permanently discarded.*

For this reason it is important to go back initially to the origins of the concept. The importance of Aristotle's ideas of liberal education lie more in what they exclude than in what they prescribe and their historical significance within the English tradition derives from their resonance with the attitudes of educationalists from the mid-19th century onwards.

In his *Politics* Aristotle is concerned with identifying the best form of political organization for the city state. It is the manner in which the artisan class figures in his discussions which is of particular interest to the historian of technical education. According to Aristotle, the artisan (or mechanic) *ho banausos* belongs to one of the four chief divisions of the common people (1321a 6) and is a member of a class 'without which the city could not exist' (1291a 1). In some cities, artisans are slaves, and the question of citizenship does not arise, but in others they are free men; should they therefore share in the government of the state (1277b 5)? Aristotle does not actually exclude this possibility (1278a 21).

> *In oligarchies, the qualification for office is high and therefore no labourer can ever be a citizen, but a mechanic may, for an actual majority of them are rich*

but his own preferences are clear (1278a 3):

> *We cannot consider all those to be citizens who are necessary to the existence of the state ... The best form of state will not admit [the artisan class] to citizenship ... but if they are to be admitted, then our definition of the virtue of a citizen will not apply to every citizen ... no man can practise virtue who is living the life of a mechanic.*

Towards the end of *Politics* Aristotle speaks directly about the content of a liberal education (1337b 8).

> *There can be no doubt that children should be taught those useful things that are really necessary ... but not all useful things; for occupations are divided into liberal and illiberal. Any occupation that makes the body soul or mind of a free man less fit for the practice and exercise of virtue, is vulgar; wherefore we call those arts vulgar which tend to deform the body ... likewise all paid employments which absorb and degrade the mind.*

This passage appears to imply the following:

- only members of a leisured class can aspire to virtue
- a connection between physical and moral deformity.

The first sentiment is the archetype of the sort of aristocratic special pleading which doubtless found echoes in 19th century debates on electoral reform. It is useful to recall that the Second Reform Bill (1967) extended the franchise to adult males of the artisan class. The second idea points backward in time, recalling the myth of Haephestus the Smith, the most necessary and useful of the Gods, who was also the only physically deformed member of the Greek Pantheon. This may also shed new light on the frequent characterization of a technical education as 'lop-sided' by its liberal opponents.

In Aristotle, one and the same word *banausia* denotes 'handicraft' and 'vulgarity'. This corresponds to the pejorative usage of the word 'mechanical' between the 16th and 19th centuries. In A Midsummer Night's Dream Shakespeare scarcely needed to identify his (Athenian!) 'mechanicals' as 'rude' - in those times mechanicals were rude by definition. In the mid-19th century the word *banausic* was coined for 'illiberal' studies and pastimes. The word has little currency now, but recently one finds the classicist R.M. Ogilvie (1964) referring to 'banausic studies such as Russian and Electronics'.

Enter the Natural Sciences

In 18th century England, the aims of a liberal education were virtues such as 'taste' and sociability. It was held that these would accrue from the study of classical literature wherein lay the most uplifting moral sentiments and examples of distinguished literary style. A different emphasis emerged in the 19th century in the promotion of 'mental training' in 'habits of accuracy', which led to an increasing domination of classical teaching by grammar and language work. For most pupils, study of the classics came to mean little more than a tedious form of mental gymnastics, devoid of moral or aesthetic overtones. Appreciation of the aesthetic qualities of classical literature was supposed to have been fostered by Latin and Greek verse composition, but these were arts which few properly mastered. An Eton master in 1843, rebuked an idler in the following terms:

> *....Stephen Major.....if you do not write good longs and shorts, how can you ever be a man of taste? If you are not a man of taste, how can you ever be of use in the world?*

This quotation prefaces Herbert Spencer's (1861) essays on Education. Spencer, one of the earliest and most celebrated of the educational reformers, was writing from outside the clerical and classical establishment. Internal criticism was first crystallized in the collection of *Essays on a Liberal Education* edited by the clergyman Frederick Farrar in 1867. The most trenchant contribution to what is generally a fierce document is Farrar's own piece on Greek and Latin verse composition as a branch of Liberal Education. Recalling that he was:

> *...taught as a schoolboy that a false quantity makes a man ridiculous and sticks to him for life...*

he advocates:

> *the immediate abandonment of Greek and Latin verse writing as a necessary or general element of liberal education*

describing them as:

> *...gilded and fantastic chains....forged in an age of logomachy and tightened in an age of artificiality and retrogression.*

As for the defenders of an exclusively classical education:

> *....For many years they have spoken of educational reformers as 'mechanical' and 'utilitarian'.....incapable of forming any high conception of the ends and aims of intellectual culture.*

Farrar goes on to recommend that:

> *....hours now devoted to 'composition' should be assigned to other studies.....foremost in the weight of its claims is the study of Science, a study so invaluable as a means of intellectual training.....that the long neglect and strange suspicion with which it has been treated can only be regarded as a fatal error and a national misfortune.*

It must be emphasised at this point that Farrar is solely concerned with the education of the upper classes and in speaking of 'long neglect' is ignoring, or choosing to ignore, the fast growing network of government sponsored 'Organized Science Classes'. This system, set up in 1859, was explicitly intended for 'the Industrial Classes', and was based on night school instruction. Science, particularly in its 'application to trade' was recognised as useful albeit 'illiberal'. There could be no particular controversy, therefore, about its suitability for artisans.

In the event, it would be many years before the gilded and fantastic chains would be significantly loosened. The English 'public' school 'tradition' was at this very time in process of being invented. A rapid expansion of fee-paying boarding schools coincided fairly closely with the rapid expansion of imperial interests and sentiment. The ideological baggage which accompanied soldiers and administrators to the four corners of the earth was assembled in these schools. Classics formed an integral and indispensable part of this package. The new Britannia was supposed to re-embody the military and moral 'Grandeur that was Rome' along with the cultural and philosophical 'Glory that was Greece'. It was not just mental training and 'habits of accuracy' which were promoted by the countless hours spent translating sentences such as 'the wise consul has ordered that the barbarian prisoners be put to death'. The swelling pageantry of the imperial circus served largely to marginalise the curriculum reformers. Spencer (1861) had likened the position of Science with respect to Latin and Greek to that of Cinderella and the ugly sisters. For many years thereafter, it was not clear whether she would ever be invited to the ball, nor whose ball it might turn out to be.

It was necessary, in order for Science to be accepted into the liberal canon, to make the aims of Science teaching seem congruent with currently fashionable liberal notions. In the course of time Science was able to qualify, on more than one count, as a sufficiently edifying pursuit to be worthy of notice by the upper classes. The development of British universities in the 19th century, much influenced by German models, lent increasing prominence to the production of new knowledge, prefiguring their modern function as research factories. The 'disinterested' pursuit of knowledge became a legitimate liberal objective and at university level therefore, Science could be represented as a broad new avenue for truth-seekers. Before the end of the century, as noted by Sviedrys (1973), several university principals were physicists. Matthew Arnold (1882), in response to Huxley's goadings, conceded that the thoughts and sayings of scientists could be counted among 'the best that has been thought and said in the world'.

It has been the growing status of the universities and the status and legitimacy of Science within the universities, that has eventually enabled Science to cross over from being a low status to being a high-status sector of the school curriculum. One of the conditions for this cross over however, was that it should largely shed its connections with the merely useful and necessary. The reports of the British Association for the Advancement of Science (B.A.A.S.) Committee on Chemistry teaching, published in 1888 and 1889, throw light on the beginning of this transitional period. A questionnaire sent out in 1888 produced replies from 86 schools including 'the majority of the largest public schools in Great Britain'. Of the 23,350 pupils in this sample, 36% received instruction in Chemistry. One particular response reveals clearly how far short of the traditional liberal mark the new subject was deemed to be falling at this time:

> *Too much weight may easily be attached to the objection often urged against chemical teaching (and indeed against the study of other branches of natural science) that it fails to cultivate good taste and good style....(however) .....papers shown up by those.....trained in "the humanities" are composed in much better style than the productions of boys.....who, from their dulness(sic) in other subjects are considered to be exactly fitted for learning natural science.*

In the 1889 report, recommendations are made on teaching methods. In the preamble to these, the following strong statement can be found:

> *It cannot be too strongly insisted that elementary physical science should be taught from the first as a branch of mental education and not mainly as useful knowledge.*

A corollary of science moving up within the hierarchy of knowledge was its disappearance from the curriculum of working class schools. This development is chronicled in considerable detail by Brian Simon (1965). In spite of vigorous campaigning by Huxley and others, the Department of Education never created the conditions which would have enabled Science to take root in the Elementary School curriculum. The exact circumstances of this failure are reviewed in successive reports of the B.A.A.S. Committee on Science teaching in Elementary Schools, from 1882 onwards. The Department of Science and Art, however, as already noted, more influenced by the professors in the Government funded Science Colleges in South Kensington and Greenwich, financed its large network of Science evening classes and, towards the end of the century, day school teaching in Higher Elementary and Organised Science Schools. Around the turn of the century, first the Department of Science and Art, and then many of the activities it supported, were swept away. This came about as a result of a series of administrative

changes enacted by the Conservative governments which held office at this time. In 1897, the specific reference to 'the industrial classes' was removed from the mission statement of the Department of Science and Art. Shortly thereafter, the Department lost its separate identity by absorption into the Board of Education. The Education Act of 1902 formalised the division between 'elementary' and 'secondary' education (i.e. education for the masses) in a manner which specifically excluded any serious exposure to science. Prior to these changes, working class children had access to free instruction in subjects still largely absent from the curriculum of many of the fee-paying schools to which middle class children were sent. After 1902, public funds supporting science education were largely devoted to building up secondary and higher education, sectors to which few working class children had access.

Technical Education

The starting point for this paper was the article by Mathews *et al.* (1988) in which are advanced the claims of 'technological literacy' as an essential objective for the education of a free citizen. A key passage in this article elaborates the concept of technological literacy and also gives a thumb-nail sketch of the location of technology within the Australian education system:

> *A concept of 'technological literacy' should broaden the liberal notion of the arts and sciences as being the passport to economic and democratic participation in the wider society.*
>
> *By technological literacy we refer to a capacity on the part of citizens to comprehend the essentials of technological design and the motives for change. Such a literacy is a means of empowering them to play a meaningful role in the extensive processes of restructuring and reconstruction that lie ahead. Such a notion is radically opposed to the view, deeply rooted in our education system, that knowledge of science and technology is only needed by an elite, while others should rest content with a technology-free notion of 'humanities', and the bulk of the population should survive on a few narrowly imparted vocational skills.....this conventional approach in practice disenfranchises people from any form of participation in the key issues which affect their livelihood and, ultimately, their social involvement.*

While the reasons for parallels and convergences between the two systems cannot be pursued here, the situation in the UK is broadly similar. The most common access route to full time higher education in engineering involves specializing in Maths and Physical Science at age 16. In a certain sense, Mathematics and Physics have taken the place formerly occupied by Greek and Latin, enjoying high academic prestige while being intellectually narrow. A relatively small minority of students are enabled, or feel inclined, to travel this road. Another pathway leads through a sequence of vocational qualifications, originally devised for intending technicians and until fairly recently only available through part-time study (evening classes or day release). Beyond this, or in terms of status, below this, lies the narrowly occupational system of craft training.

The framework for this tripartite system was constructed in the late 19th century, the most significant decade being the 1880's. The early years of this decade saw the founding of the City and Guilds of London Institute (CGLI) and the activities of the Royal Commission on Technical Education. A Technical Instruction Act was passed in 1889 which authorised local authorities to finance the establishment of Technical Institutes out of local taxation.

These developments were preceded by several years of lobbying on behalf of technical education. The movement to promote technical education arose partly out of the perception that the Organized Science Classes of the Department of Science and Art were failing in their original purpose of giving a scientific underpinning to manufacturing activities. Controlled largely by Science academics, they had settled into an abstract and bookish mode of operation, dominated by syllabuses, written examinations and rote-learning. This process was part of a widening rift between pure and applied science within the educational system.

Huxley (1893), although himself one of the new breed of professional academic scientists, and a champion of the Department of Science and Art, was nevertheless a supporter of the technical education lobby. An address delivered in 1877 sets out his conception of an education suitable for the 'handicraftsman', and makes clear that his notion of educational reform is uncomplicated by any vision of social reform:

> *....no scheme of technical education is likely to be seriously entertained which will delay the entrance of boys into working life, or prevent*

them from contributing towards their own support, as early as they do at present....

....those who have to live by labour must be shaped to labour early....

During the school years, therefore, an essentially liberal curriculum is called for:

...the earlier....the handicraftsman has to enter into the actual practice of his craft, the more important it is that he should devote the precious hours of preliminary education to the things of the mind which have no....immediate bearing on his branch of industry....

Huxley (1893) declares that 'The workshop is the only real school for a handicraft' but suggests that what is needed otherwise, as a preparation for an essentially practical pursuit, whether that of the artisan or the anatomist is:

.....a good education with more attention to physical science, to drawing and to modern languages than is common....(with)....nothing specially technical about it....

and since there were elements in this prescription beyond what could practically be offered in an elementary school, the artisan would have to acquire these extras 'after working hours'.

The essentially static social backdrop to Huxley's (1893) educational ideas is well conveyed by his image of the education system as:

....a ladder, reaching from the gutter to the university, along which every child in the three kingdoms should have the chance of climbing as far as he(sic) was fit to go....

The ladder would evidently not need to be a very wide ladder since:

Mr. Galton tells us that not more than one in four thousand may be expected to attain distinction, and not more than one in a million some share of ....genius.

....the most important object of all educational schemes is to catch these exceptional people.

In fact, a ladder of sorts already existed in the form of Whitworth and other scholarships offered for the most successful examination candidates from the Organized Science Classes. In the 1870's, however, the university-level engineering education to which it gave access was still rather limited, consisting of a small number of small departments which concentrated mainly on mechanical engineering. The foundation of the CGLI in 1880, financed by the city livery companies, added two significant institutions in the form of Technical Colleges at Finsbury and South Kensington. These were staffed by some of the best scientists and teachers of the day and broke new ground by incorporating chemical and electrical departments. The Finsbury institution was relatively short-lived, but under Sylvanus Thompson, achieved considerable renown. The South Kensington foundation has constituted, since 1907, the engineering faculty of Imperial College London, under the name of City and Guilds College. Apart from a trickle of scholarship holders from working-class backgrounds, recruitment into City and Guilds College has, right from its inception, been mainly from better-off backgrounds. A number of women students were recruited in the 1800's but, in the ensuing century, pitifully few.

The lasting legacy of City and Guilds to the artisan class has been, in accordance with Huxley's specification, a framework for 'after-hours' craft training. This system has long outlasted the Organized Science classes, and CGLI is still the most significant national body for the accreditation of occupational skills.

The end of the 19th century also saw the incorporation of 'practical subjects' (housewifery for girls, workshop practice for boys) into the elementary school curriculum. When elementary schools disappeared after the 1944 Education Act, these subjects continued as a little regarded component of the secondary school curriculum. Attempts to establish a form of school technology teaching which would bridge the gap between Science and Craft teaching and which would thereby be more closely related to the activities of science-based industry were largely fruitless. A detailed account of this episode by McCulloch, Jenkins and Layton (1985) makes it clear that elitism on the part of Science teachers was a significant factor in this failure. A very brief description of the evolution of school Craft teaching into 'Craft, Design and Technology' (CDT) and the subsequent incorporation of the practical subjects into the recently established National Curriculum has been given by the present author.

An aspect of the development of technology related education in the UK which requires further comment is the very coming into existence of university level engineering departments in a country whose ruling class was so prejudiced against 'base and mechanical' occupations. These prejudices were most frequently voiced by Anglican clerics teaching in the ancient universities, acting as spokesmen for a traditional establishment. Many of the university colleges founded in the 19th century were created, explicitly or implicitly, in opposition to this establishment. University College London, which housed the most distinguished and influential of the university engineering departments in the 1870's, was a secular foundation set up by 'utilitarian' thinkers in 1828. The important civic universities of the North and Midlands were endowed by wealthy manufacturers and businessmen. This newly rich class, while they might send their children away to be classically educated in the revived public schools, would scarcely ignore the claims of engineering in their own industrial backyards. In Cambridge however, an engineering department was on the agenda of reformers from the mid-century onwards, but it was not until 1893 that engineering was recognised as a degree subject.

Summary

The main focus of this paper has been on educational developments in mid-to-late 19th century England, the period during which scientific and technical subjects first made their appearance. The inadequacies of the systems set up at that time and which have been insufficiently reformed in the intervening years, are still apparent. They contribute significantly to the current economic and educational ills of the UK. They are a price that the country has had to pay for being governed at that time by a classically educated elite, more in tune with ancient Athens than contemporary Sheffield, and who shared the contempt of the Athenian elite for the merely necessary members of society.

For a subject to lodge itself in the mainstream of the school curriculum, it was necessary that it should establish its 'liberal' credentials. Science, represented as an academic pursuit ('pure' Science), was eventually able to do this. Technology was admitted as handicrafts, a low status activity, but never as applied Science. A number of significant dislocations appeared, therefore, as a result of Science and Technology having to run the gauntlet of a 'liberal' educational ideology.

- The separation of pure and applied Science.
- The exclusion of applied Science from schools.
- The separate development of school Science and school Craft teaching.
- The isolation of higher education in Technology from the rest of the educational system.
- The over-reliance on part-time instruction in the delivery of intermediate level Technology education.

These dislocations, which have become deeply entrenched in institutional structures over the last hundred years, present a daunting agenda to present day reformers.

Postscript

Does the English tradition of liberal education have anything to offer to curriculum planners who, whether in Britain or Australia, are once more confronting the age-old problem of specifying an education appropriate to a free citizen? There must be a suspicion that an idea which has admitted of so many diverse and contradictory interpretations is now too ill-defined to be of much use. Rothblatt (1976), after devoting thirteen chapters to tracing its trajectory towards ambiguity and confusion, is somewhat unconvincing in claiming to discern, at the very last, an essential thread of continuity. It is difficult to see, in the light of the history of the English tradition, that the liberal idea can be consistently expressed in other than negative terms e.g. that liberal education is non-vocational education. Silver and Brennan (1988) draw attention to the 'deep....confusion surrounding the vocational and the liberal...in this century' having already stated that:

what the vocational is has no stable meaning, and it cannot be established by simply listing things it is not.

Towards the end of his survey Dewey (1913) wipes the social and historical slate clean by affirming that in modern democratic conditions:

Liberal education becomes a name for the sort of education that every member of the community should have

and goes on to suggest that:

....it has a value as a limiting concept to criticize various educational schemes.

This begs the question of *which* limiting concept, which cake to choose from among the highly assorted confections on the liberal cakestand.

There is, in fact, at least one element of the liberal tradition which could be valuable in criticizing current educational arrangements in the UK. Premature specialization and over-specialization have long characterized English secondary and higher education. This is related to the fact that the Victorians, while embracing the anti-vocationalism of the Aristotelean tradition, chose to ignore another element of that tradition, namely a presumption against excessive specialization. It is open to our generation, in furtherance of a different social and political agenda, to pick and choose our own limiting concepts, just as our predecessors did.

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BOOK REVIEWS

Evans, G. (Ed.) *Learning and teaching cognitive skills*. ACER, Melbourne, 1991.

This collection of readings developed from papers presented at the ACER International Symposium on Intelligence in 1988 looks at the issues associated with the teaching and learning of cognitive skills. As a result of this there is a strong emphasis on research findings and their application to the learning environment. The basic assumption of the ideas presented here is that thinking and learning can be taught and the learner takes an active role in selecting and using appropriate strategies to tackle new tasks, learn new skills and solve problems. The writings focus on teaching and learning in formal situations across the range of ages from children to adult learners. A variety of issues are addressed within the context of current thought in the field of cognitive studies.

The introductory chapter by Glen Evans provides a useful theoretical overview presenting current thought and research in the area of cognitive studies. Evans raises the major issues that are addressed in the chapters of this book and makes valuable links between the issues presented.

The book represents all of the major approaches to the area covering research issues, domain specific and general strategies and approaches to teaching these strategies to students of all ages. A number of the chapters take a developmental perspective investigating factors that may facilitate development or the examination of the process of development of specific strategies. The teaching of learning strategies is approached from a variety of philosophical perspectives, explicit instruction in strategies in subject specific and generic environments and the spontaneous generation of strategies for particular tasks. Within this there are suggestions for practice.

Chapter One provides a useful discussion of the range of methods available for the investigation of cognitive skills. The major issues related to the collection of data and the assessment of thought processes are discussed. The findings presented in subsequent chapters result from the use of a variety of the methods discussed.

This is a thorough coverage of research in the area with a particularly Australian focus. The findings presented cover a broad range of perspectives of the field, both methodologically and philosophically.

Biggs, J. (Ed.) *Teaching for learning: the view from cognitive psychology*. ACER, Melbourne, 1991.

The writings collected in this text take a constructivist view of knowledge, that is that the learner constructs knowledge rather than the teacher imparting knowledge to the learner. The focus of the research and the writing is clearly on the learner and the role of the learner in the educational experience. Emphasis is placed on the role of metacognition and the process of learning how to think and problem solve.

There is a strong focus on the Australian educational setting, only one chapter presents research derived from a non-Australian context. The initial chapters focus on the role of learning in the school context, followed by the role of cognitive and metacognitive processes as they apply to student learning. Subsequent chapters consider specific aspects of metacognitive processes including planning, discussion of the links between psychology and instruction and specific problem solving skills for mathematics and learning from reading. Also included are studies that have provided suggestions about the nature of metacognitive strategies and those things that teachers can do to teach in a way that facilitates the development of such strategies. Several of the chapters present details and results of specific programs such as PEEL (Project for the Enhancement of Effective Learning) and SPELT (Strategy Program for Effective Learning/ Thinking). Chapter Five by Swellings questions some widely accepted ideas about cognition and the links between cognition and instruction. This chapter in particular provides plenty of scope for debate. The final chapter focuses on implementation issues at classroom, school and community levels.

This book presents relevant theory and strategies in the field of cognitive and metacognitive