The concepts of 'skill' and 'skilled performance' are central to major changes presently occurring in vocational education in Australasia. However, meanings are implicit and the concepts are seldom defined. Explicit definition of these concepts is vital for effective program design, teaching and research. Earlier attempts at skill classification reflecting the mind-body dichotomy and recent theory concerning the impact of social variables upon learning have contributed to confusion about the characteristics of skill learning and to the lack of adequate definition. Nine separate defining attributes of 'skill' and 'skilled performance' are advanced from a psychological perspective, which it is argued is the most valid in accounting for skill acquisition and performance by individuals. These defining attributes include the following: skill is learned; content knowledge and contextual knowledge are important; skilled performance is goal directed and requires motivation; schema existence is a prerequisite; problem solving relevant to the content and context is involved; skilled performance involves relative judgements with individual differences evident; standards of excellence are important; comparable replication is involved and considerable periods of time are required to reach high levels of skill and to improve beyond this. Some major implications of these defining attributes for skill acquisition and consolidation are considered from the perspectives of learners, teachers and administrators.

The need for adequate definition

The concepts of 'skill' and 'skilled performance' are central to major changes presently occurring in vocational education policies and practices. However, these concepts are seldom adequately defined, even in specialist references. Meaning is almost always implicit: as, for example, with the competency-based training movement, where all the heated debate over the remoulding of the post-compulsory education sector has produced little reference to skill-learning processes (Cornford 1993) and no attempts to define the underpinning skill constructs explicitly. Unfortunately, as Stevenson (1993a, p.1) has stated: 'assumptions about knowledge... are seldom made explicit or addressed when massive and far reaching changes in educational policies occur'.
Cautionary tales abound which support Stevenson’s arguments concerning the need for explicit statement of meaning in vocational education. It is difficult not to conclude that many of the practical problems currently being experienced with the implementation of competency-based programs in vocational education could have been avoided had there been attempts to define competency adequately. Well into the process of general implementation, the confusion surrounding competency and the essential characteristics of competency-based training still continues to bedevil reforms in vocational education (see Watson 1993; FitzGerald Report 1994).

Major Australian federal government training initiatives which are centred upon school-to-work transition programs for the better preparation of youth for occupations, workplace-learning programs which upgrade levels of skills of the workforce, and indeed the whole Australian Vocational Training System, will only achieve their potential if there is greater understanding of skill learning. The basis of this understanding must lie, in part, in more explicit definition of what constitutes skill and skilled performance.

Apart from the implications for practical teaching and effective policy implementation, adequate definition of concepts is also vitally important for research. Lack of adequate definition of ‘skill’ and ‘skilled performance’ underlies Wulf and Schmidt’s (1993) criticism that Annett’s (1991) coverage of skill learning does not adequately consider longer-term retention and transfer; and of the separation of skill learning and retention in Morrison’s (1991) important text on skill learning and performance. The definition attempted in this article will have relevance for research into skill learning. However, the focus is on increasing understanding of skill acquisition and consolidation by practitioners involved in everyday course design and implementation, and related policy formulation.

**Current limitations to understanding skill-related processes**

There appear to be several reasons why there has been little argument about skill learning and skill-learning processes, as opposed to delineation of content and standards of performance exemplified by competency standards. The major reasons centre around the lack of
understanding of skill learning evident in government, business, training and academic contexts. For example, there does not appear to be wide understanding of skill-learning phases and processes in the business training community. This is, perhaps, attributable to the low priority Australian business has placed upon training until recently. As regards the academic and research communities, as Fitts (1964) noted perceptively some time ago, skill learning has been only intermittently a major focus of research.

Despite current wide general usage of skill or skill-related terms in the literature on learning, teacher education and educational psychology—with frequent reference to cognitive, metacognitive and performance skills—skill and skill-learning processes are not adequately defined or described. Educational psychology texts, which are used in teacher education courses to assist teachers in understanding aspects of learning, are logically the most likely source of information on skill learning. Several years ago analysis of recently published educational psychology texts (Cornford 1992) revealed that, with rare exceptions, the vast majority did not have adequate coverage of skill theory and the learning of skilled performance, with many not having any coverage of skill learning at all. Examination by the author of a large range of newly published, similar texts in late 1995 revealed that the position had not changed substantially.

It is, perhaps, not too surprising that there is also an absence of attempts to adequately define skilled performance in educational psychology texts, given the absence of adequate coverage of skill-learning theories and practices in them. What is surprising, is that relatively recently published specialist skill-learning references edited by Colley and Beech (1989) and Morrison (1991) provide only working definitions and lack comprehensive definitions of ‘skill’ and ‘skilled performance’. This is despite their abundant coverage of theory and factors which affect skill acquisition and performance. The reasons for this may lie with the difficulty of adequately defining ‘skill’ as noted by Adams (1987), and the continuation of older views of skill learning involving classifications reflecting the mind-body dichotomy (see below), which have made satisfactory definition well-nigh impossible.

Recently Stevenson (1994) has made important steps in the definition of vocational expertise in the Australasian context. Characteristics
identified by Stevenson include conceptual understanding, higher-order procedural knowledge, and the capacity to generate original and worthwhile responses to complex and ill-defined situations. The factors which Stevenson identifies for expertise are important and relevant to skill learning, and indeed represent the long-term goals for effective skill learning. However, they do not necessarily constitute a comprehensive list of the salient characteristics relevant to skill learning occurring more generally at earlier and lower levels of attainment. Not everyone who works in a specialist trades or professional area attains levels of expertise or even proficiency (Cornford & Athanasou 1995). While research into the development of expertise and skill learning are complementary (Cornford 1993), skills are the essential building blocks. This is because increases in the number and quality of skills help explain movement through the stages in the development of expertise, and also from the periphery to the centre in terms of Lave and Wenger’s (1991) social contextual theory.

This article seeks to extend Stevenson’s (1994) work and increase understanding of skill learning. In so doing, it adopts a psychological perspective to make explicit the defining attributes of skill and skilled performance; and to indicate some of the implications these defining attributes have for skill acquisition and consolidation in teaching, learning and program development. Before doing this, it is necessary to consider briefly recent movements which have focussed upon social factors affecting skill acquisition and performance, and also previous attempts to classify skills based on the mind-body dichotomy. Through division and exclusion of relevant factors, these research movements have impeded effective definition and understanding of skill learning.

**Social factors and the study of skill**

A complication for those seeking to define skilled performance is that both psychological and social factors affect skill recognition and definition (Ainley 1993). Currently, a diverse group of social theorists centred around Lave (Chaiklin & Lave 1993; Lave & Wenger 1991) hold that knowledge is only comprehensible within actual social practice and cannot be separated from the social and cultural activity that surrounds the individual. Such a position is in direct conflict with reductionist and generalised views of learning (Billett 1994) and hence with definition
across both skills and contexts as attempted in this article. While not denying the importance of social and cultural factors in learning, it is considered that the critical elements in skill learning are psychologically based. This position is held because of the inability of the social theorists to account for the processes involved in individual learning or the structures created in the mind necessary for long-term retention. The reasons for maintaining this position are outlined briefly. Although fuller analysis is warranted, it is beyond the scope of this article.

It is accepted that social factors will help determine the values placed upon skills, and widespread adoption or rejection of particular skills or methods within a society. It will also assist the organisation of learning experiences and the structures for training which will be or not be established, as well as processes used for formal recognition. Social factors are also indisputably important in teaching, the passing on of wisdom accumulated over generations, and the development of standards of excellence (Ainley 1993). However, it also needs to be considered that social attitudes can be substantial impediments to advantageous change and skill development (see Niven 1994), that skills can develop despite this and also may be relatively uninfluenced by social factors.

It is possible for individuals to develop great inventions and skills in relative social isolation and without support or recognition. In fact, there are skills like tattooing which survive in Japan despite generally wide social condemnation. It is also the case that skills involving substantial innovation are generally developed in social surroundings which are in many cases socially neutral, if not outright hostile, with wider recognition and appreciation only coming later. An example would be the Australian Lawrence Hargrave's development of box kites to understand flight.

It is considered by this researcher that it is the self-regulatory and control factors within the individual that determine whether a skill is learned or not, or to what degree social influence is accepted, and whether there will be internalisation or rejection of standards. Acquisition and maintenance of skills are dependent upon cognitive factors largely controlled by the individual (see Bandura 1977); that is, psychological factors which are socially invisible to others except when the individual cares to reveal them through language or overt performance.
Recognition of the existence of these psychological factors within individuals is necessary to account for atypical behaviour and problems in learning during teaching and other socialisation processes. Even Billett (1994), a supporter of the social cognition movement, has come to acknowledge that this literature has failed to consider adequately the aspects of individual responses and processing.

It should be stressed that while insisting upon the importance of generalisable, psychological factors in skill learning it is not sought to develop a false dichotomy. Social factors are still recognised as important and are drawn upon to help explain some aspects of the defining attributes where appropriate.

**Previous classifications of types of skills and the mind-body dichotomy**

Reasons for the failure to explicitly and comprehensively identify defining attributes of skill and skilled performance may also be traced to researchers who have sought to classify skills into different categories, rather than examine elements common to all skills regardless of their most obvious features. Earlier attempts to classify skills, in apparent efforts to facilitate understanding, include such categories as cognitive, performance, perceptual, psychomotor, gross motor and fine motor skills and various other permutations and combinations such as closed and open loop, etc. (e.g. see Adams 1987). These efforts at classification generally reflect distinctions between mind and body. Recent specialist references on skill and skill learning by Colley and Beech (1989) and Morrison (1991) have retained a classification based upon cognitive and performance elements. These two recent, specialist volumes thus provide further evidence that western science and psychology continue to be bedevilled by the mind-body dichotomy (see Ainley 1993).

The mind-body dichotomy is not particularly useful in considering the defining attributes of skills, since there is so much overlap between so-called cognitive and performance skills (see Annett 1991). Several researchers (Fitts 1968; Colley 1989; Cornford 1993) have indicated that there are great similarities in the processes and acquisition of cognitive and performance skills. There is certainly evidence that both cognitive and performance skills follow the same Law of Practice (Newell &
Rosenbloom 1981). Cornford (1992, 1993) has argued that even so-called cognitive skills involve performance elements whenever there is any attempt to communicate in oral or written forms, or translate theory into practice.

Support for the importance of both cognitive and performance elements in skill acquisition and consolidation comes from a variety of positions and areas of research. At least one school of thought in the situated cognition movement (e.g. Brown, Collins & Duguid 1989) has as a central, underlying concept the interrelation of the theoretical and practical, and the importance of the physical world context in real-life learning. More recent conceptualisations of human intelligence specifically acknowledge performance activity and practical experience as constituting important factors in the development of ability and effective human functioning (see Gardner 1985; Sternberg 1985). Furthermore, strategic and system knowledge, which have been identified by Gott (1994) and others as important in effective problem solving with complex skills in real-world tasks, can only develop from the interaction of cognitive and practical performance knowledge.

The position taken here is that neither the cognitive-performance skill dichotomy, nor attempts to categorise skills upon the basis of senses involved or context, are useful or illuminating, since cognitive and behavioural elements are both inextricably involved in skill learning and performance. While different senses may be involved with different skills, and there are different social and physical contexts in which skill performance takes place, all skills appear to follow the same learning phases (see Fitts 1964, 1968; Anderson 1982) and appear to have the same defining attributes.

The defining attributes of skill and skilled performance

The Concise Oxford Dictionary defines skill as ‘expertness, practised ability, facility in doing something, dexterity’ and skilled as ‘having or showing skill, skilful’. While these do indicate some of the relevant issues, they are only a starting point for what are nine defining attributes of skilled performance. Throughout this article, the essential relationship between ‘skill’ and ‘skilled performance’ suggested by these dictionary definitions is maintained. That is to say that ‘skill’ is considered as an
ability and capacity which is possessed by individuals, inferences and judgements. The existence of 'skill' can only be made through the observation or experiencing of 'skilled performance', which is causally related to the possession of skill.

1 Skill is learned

The first defining attribute of skilled performance is that skill is acquired or learned and does not consist of innate, instinctive actions, simple actions or reflex reactions which everyone possesses (Annett 1991). Knowledge underpinning skilled performance involves a complex set of interrelated concepts and processes which have to be acquired, learned or constructed in the learner's mind. The complexity of this knowledge will vary, just as skills themselves vary in complexity and difficulty. They range for example, from relatively simple skills for normal individuals such as showering or making toast; to more difficult skills such as programming a computer or playing a musical instrument with proficiency. Different occupational groups recognise the differences in skill learning in terms of amount of on-the-job training required to attain reasonable levels of performance (see Athanasou, Pithers & Cornford 1993, pp.37-8).

With the acquisition of at least some skills, human genetic or developmental factors may be involved. For example, the language-learning explosion which occurs around age two may be related to genetic factors (see Gage & Berliner 1992). In other skills, physical maturity, muscular co-ordination and levels of strength stemming from physical maturation may be necessary for the development of satisfactory performance or even acquisition of basic subskill routines. Not only physical maturation may be involved. A number of theorists such as Piaget and Bruner see effective cognition as involving maturation and stage-related learning processes (Gage & Berliner 1992).

2 Skill involves motivation, purpose and goals

A second defining attribute is that skill learning and skilled performance are motivated, purposive (Bandura 1977; Shuell 1990) and goal directed (Gott 1994). A number of researchers see learning and skilled
performance as problem-solving behaviour (e.g. Anderson 1982; Annett 1991). With this last approach, problem identification implies motivation; that is, purposive behaviour first to identify the problem and then to engage in finding a solution. Moreover, motivation is important both for initial learning and subsequent practice to achieve levels of proficiency. Apart from issues of skill acquisition and consolidation, whether a skill will be performed well or poorly by an individual who has practised a skill to high levels and continues to possess the capabilities to perform that skill to those levels, is dependent upon motivation.

Incidental learning should be recognised as a real phenomenon. However, while this may occur, it is exceptionally rare if not non-existent for other than very simple or low-order skills to be acquired or exhibited at superficial levels without motivated practice. Associative learning appears to be involved in incidental learning, with the incidentally-learned elements acquired because of association with, or close proximity to, other elements which are recognised as important in the acquisition of a particular skill.

3 Schemas are prerequisite for skilled performance

The third defining attribute is that a mental plan or schema, which embodies at the very least components, processes, correct sequences of components and temporal elements, needs to exist in the mind of the individual before a skill can be performed (Colley 1989; Gott 1994), even with (so-called) motor skills (Chamberlin & Magill 1992).

Observation of skilled performance and analyses of skill tasks from both behavioural and cognitive perspectives clearly reveal that skilled performance consists of a series of linked steps with the sequencing and timing of the steps of vital importance. For example, it is necessary to undress and turn the water on before attempting to lather soap in order to shower. Effective skilled performance is, in fact, dependent upon a gradually learned blueprint being followed. Even where skill acquisition occurs reasonably easily through observation, there is still a need for a mental schema which has to be accurately constructed through coding and rehearsal, and refined through practice before performance can be replicated and effective (Bandura 1977).
Schemas would appear to embody and be constructed from a variety of different types of information. There is some disagreement concerning the nature of the types of knowledge involved. Anderson (1982), on the basis of analysing cognitive skills, indicates the need for declarative and procedural knowledge. Gott (1994) has argued that, in addition, device, system and strategic knowledge are required for problem solving in complex, real-world activities. Cornford (1993) has drawn a distinction between theoretical and practical performance procedural knowledge. The issue of different types of knowledge involved in schema construction awaits further analysis and clarification.

4 Skills require specific content and context knowledge and are performed and transferred in the presence of specific stimuli

There is growing evidence that learning and problem solving are content and context specific (see Brown et al. 1989) and there is little evidence that skills transfer easily or automatically (Berryman 1991; Anderson 1990; Detterman 1993).

Skills are performed in specific contexts in the presence of specific stimuli which come to signal to the skilled individual the appropriate time and circumstances to perform or apply the knowledge. Stimuli also serve as cues to indicate the appropriate next step in a skilled process. Effective skill training normally involves development of schemas for recognition of appropriate or inappropriate times and places to engage in skill performance. It also involves knowledge of alternative methods which need to be employed in certain contexts in response to different emerging stimuli. For example: the ability to translate theory into practice concerning the suitability of different types of paint in situations exposed to different conditions of moisture; and how to react to dry rot discovered while painting timber previously thought sound, are prerequisites for recognising a house painter as a skilled professional.

Transfer of learning occurs when there is any variation from the original context in which a skill was learned to where it is applied. While relatively simple differences such as time are taken for granted, changes in context make the identification of stimuli signalling the need for application of previously learned knowledge more difficult. Successful
transfer of knowledge is totally dependent upon the recognition of appropriate stimuli to indicate the need for transfer of previously-learned skills. Given research which indicates the difficulty of attaining transfer (see Anderson 1990; Detterman 1993), there are strong reasons for teachers and program designers to stop regarding transfer as a passive, naturally-occurring phenomenon (Stokes & Baer 1977).

One of the great challenges in vocational education is clearly establishing a knowledge of the stimuli that are required for performance of a skill. This is required in order to facilitate the generalisation and transfer of training from one specific context, usually a classroom or TAFE workshop, to the workplace or factory. The tradition of apprenticeship, of the more conventional or cognitive kind (Brown et al. 1989; Berryman 1991), reflects the need to educate for content, context, transfer and problem solving within a specialist domain.

5 Skills involve problem solving relevant to the context

The fifth defining attribute is that skilled performance involves elements of problem solving relevant to the particular context in which the skill is used. Some researchers, for example Anderson (1982) and Annett (1991), view skill learning and performance as problem-solving activity.

Problem solving itself is increasingly being seen as a matter of transfer (Stevenson 1993b); that is, application of previous learning to new situations. However, while all transfer may involve problem solving, not all problem solving appears to involve just transfer and application of previous learning. Distinction needs to be made between different types of transfer. The solution of problems from a learned repertoire involving relatively minor stimulus variation, such as length or weight, use of generic rules and principles in problem-solving skills which are not content and context specific, and problem solving which involves major, creative, novel transformations or applications of knowledge, appear to be involve distinctly different factors and skills.

Currently, there is much interest in the development of sophisticated transfer and problem-solving skills which involve considerable creativity and ill-defined problems (Stevenson 1994; Gott 1994). However, Detterman (1993) would see this as involving far transfer, which he and
others would argue occurs very rarely. Despite some movement to post-Fordist management principles, solid empirical data is lacking. It is uncertain how many individual workers in different occupational areas are required to generate original and worthwhile responses to complex and ill-defined situations. Any situation where an individual lacks knowledge and skills is likely to be perceived as ill-defined and complex, and it should be noted that Gott’s (1994) work revolves around avionics trouble shooting on F15 aircraft involving radically new technology.

Traditionally, training in problem solving in vocational education has been implicit and connected to the level of skilling desired and the demands of the particular occupational level. Within many trade and specialist areas, a de facto recognition of differences in ability and problem-solving skill exists (see Lave & Wenger 1991). There are both formal and informal hierarchies of social power and influence to help resolve any unusual problems which emerge. More experienced workers are frequently consulted in the normal work context. In many areas, for example plumbing, specialist consultants exist as part of the professional hierarchy for major problems outside those normally encountered on the job. In the medical profession, those problems which cannot be solved by general practitioners are referred to specialists.

Currently lacking in the literature are substantial analyses of the problem-solving demands of different occupations and occupational levels; different types of transfer and problem solving; and, very importantly, research on effective methods for promoting contextualised problem-solving ability. Further research is needed into all these issues. Differences in problem-solving skills per se, however, constitute an indicator of individual differences.

6 Skill involves relative judgements with individual differences in skilled performance evident

Another defining attribute of skill or skilled performance is that different levels of performance, that is individual differences, exist in the general community and among practitioners in any one specialist skill or sub-skill area. In fact, the concept of skill always involves relative excellence and can only exist by comparison with less and non-skilled, or more skilled, performance.
High levels of skilled performance are not attained by all who attempt to learn a skill (Cornford & Athanasou 1995). The quantity and quality of knowledge are fundamental determinants of observable individual differences. Differences in aptitude and ability help to explain differences in learning and the attainment of different levels of skilled performance, quite apart from the fact that there are considerable differences in rates of acquisition and retention. A range of levels of performance typically may be observed among even those who have been practising or performing the skill over considerable periods of time (see Berliner 1988). Differences in motivation, aptitude and treatments or training, or all in combination, may be the direct causes of this (Kanfer & Ackerman 1989).

Recent research into the development of expertise explicitly identifies individual differences in real-world skilled performance. There is a generally accepted classification in the development of expertise of novice, advanced beginner, competent, proficient and expert (Berliner 1988; Stevenson 1994). This is based upon differing levels of skilled performance and recognition of movement from tightly rule-governed behaviour to ability to engage in increasingly more difficult problem solving. In effect, the descriptions and classification of stages in the development of expertise are based implicitly upon standards of excellence of actual performance, as reflected through individual differences and stages in learning.

7 Standards of excellence

Standards of excellence are integral to judgements concerning skill existence and constitute a seventh defining attribute of skilled performance. Standards of excellence operate on both individual and interpersonal levels. Recognition of individual and interpersonal levels is necessary to explain the process of gradual learning of standards and of personal improvement in skilled performance. Frequently beginners, as in teaching, are unable to comprehend the complexity of the standards, with full appreciation of expert standards coming only after much experience (see Westerman 1991). In most specialist fields, direct teaching of standards and observation of superior models via apprenticeship (Brown et al. 1989; Berryman 1991) are involved.
Standards of excellence internalised by individuals are necessary in order for the individuals to be judged as skilled and to perform independently of parents, teachers, trainers or coaches. Moreover, standards of excellence are necessary to be able to solve problems. Without standards, it is not possible for the individual to judge that a performance is adequate and constitutes a skilled performance, or that a problem has been solved adequately. In addition, it is the existence in the minds of others, and the agreement over and sharing of most elements in a mental plan or schema, that allows judgments of relative worth of skill performance and standards to be made by others in specialist areas or the society generally. Most of the competency debate in Australasia has centred upon standards of excellence and the establishment of benchmarks which are to be maintained at an interpersonal level and transmitted to individual learners.

Knowledge of standards in and of itself does not guarantee maintenance of performance to satisfactory levels. Self-regulation is an important aspect of all learning (see Schunk & Zimmerman 1994), but particularly of skilled performance. Self-regulation is best considered as involving acquired regulatory and judgement skills and is closely linked to motivation and willpower. While the individual may possess self-regulatory skills, it will depend upon the motivation and persistence of the individual whether these are actively employed to maintain performance to the learned standards.

8 Skill involves comparable replication

Skill involves performance which can be comparably replicated or repeated to similar standards by the performer. Consistency of application over time is an important aspect of commonsense recognition of skilled performance. However, such replication is only possible if there has been an internalisation of consistent standards. While absolutely identical and exact replication may not be possible—consider, for example, the remarkable shots played by top tennis players or golfers—comparable levels of excellence can be achieved on other occasions under similar conditions. Performance is evidently under the control of the performer, it involves self-regulation, and the actions are not ‘one-off’ or chance occurrences.
The issue of consistency over time is an important consideration. Currently, competency-based approaches in practice often employ only single assessments, where one correct performance may be sufficient to gain a satisfactory assessment of competence. Single instances of assessment do not take into account the fact that the skill may not have been firmly enough established to ensure consistency over time and replication to a comparable standard at a later time.

9 Considerable periods of time are required to achieve high levels of skill

Very considerable periods of time are required for acquisition of a skill to high levels and for an individual to move through the various stages in the development of expertise. It is appropriate that time be explicitly recognised as a defining characteristic of skilled performance. Many formal certification procedures in highly-skilled professions, such as chartered accountancy or in the gaining of recognition of specialist ability in the medical profession, implicitly recognise the importance of time factors.

The more complex the patterns of thought or behaviour are involved in the development of skilled performance, the more time is likely to be required. Many researchers consider ten years a minimum for the development of expertise (see Ericsson & Smith 1991). There is ample evidence that even seemingly simple skills like stringing pearls or marching may require hundreds of thousands or even millions of practice efforts before high levels of skill performance can be reliably demonstrated (Kottke, Halpern, Easton, Ozel, & Burrill 1978). Likewise, basic academic skills for effective reading and writing develop over very long periods of time at primary, secondary and tertiary levels of education. In terms of practical, real-world learning, a recent survey of skilled workers found that 34 per cent of respondents indicated that four or more years of on-the-job training were required to achieve satisfactory levels of performance, with some 8 per cent of these indicating that ten or more years was needed (Athanasou et al. 1993).

Practice occurring over numerous occasions clearly involves time, as does the obtaining of feedback of an informative as opposed to an ego-enhancing kind (see Hattie 1993). The capacity restrictions of conscious
working memory would appear to be partially responsible for the time taken to construct and piece together important elements in skill schemas derived from practice and critical thinking (Sweller 1993). The accuracy and sophistication of schemas or mental models will be increasingly refined in the process, as episodic and case knowledge from atypical instances is accumulated and processed (Berliner 1988). Complex schemas are increasingly being seen as necessary for effective problem solving.

It is recognised that Bandura's (1977) work on observational learning established that learning can take place from one observation, where the necessary sub-skills are already in the individual's repertoire. However, such learning is atypical and there are few skills where one observation is sufficient to enable the production of a matching performance with a complex skill totally new to the individual (see Bandura's Model of Observational Learning, Bandura 1977, p.23). Even seemingly less complex social and language skills—for example a child acquiring and using a new word—typically require multiple observations and attempts at practice to refine the schema, before satisfactory levels of skilled performance can be attained. Explicit recognition of time as a defining characteristic of skilled performance may lead to the design and implementation of more realistic and effective skill-learning programs.

Summary of attributes and some overall implications

In summary, skilled performance involves purposive behaviour to achieve set goals to predetermined standards. Skilled behaviour is possible because of guiding schemas or mental models which are constructed and internalised over considerable periods of time by the individual learner. Levels of skill attained are dependent upon the ability of the learner, the internalisation of standards of excellence and the opportunities to learn and practise the skill effectively over extended periods of time. Feedback derived from performance is the critical variable in the refinement of schemas and the development of increasingly better skill standards. In the skill learning and performance processes, stimuli and context are important in providing clues as to if, when and how the skill should be performed or transferred to help solve problems. Maintaining levels of consistency in performance is dependent upon self-regulation, motivation and persistence.
Overall, these defining attributes focus attention upon both the factors within the learner which are necessary for effective skill learning, and opportunities which are created by a more experienced, proficient or expert teacher or trainer to assist in skill development. These defining attributes indicate the need to give recognition to the importance of the teaching or guiding role. This recognition stands in contrast to a number of theories of reflection that are currently popular. In contemporary terms, teachers or trainers need to be viewed as managers of learning, diagnosticians and intervenors, as models, instructors and monitors of cognitive processes and metacognition (Paris & Winograd 1990).

The defining attributes of skill and skilled performance provide a clear indication of the appropriate roles for learners, teachers/trainers and training providers, especially in relation to effective acquisition and consolidation of skills. At the same time, these attributes highlight deficiencies in current attitudes, practices and the present systems. The following section gives consideration to some of the desirable roles and responsibilities of relevant people in the light of these defining attributes. These people include the learner, the teacher/trainer, and the authorities responsible for provision of training programs for the development of skill and skilled performance. The chief focus in this following section is upon aspects affecting effective skill acquisition and consolidation.

**Implications for teaching and training: The individual learner**

A motivated individual is one of the keys to effective skill acquisition and development. Effective skill learning and performance are dependent upon the individual acquiring and understanding information relating to skill and performance processes, and the interrelationship between these theoretical and practical aspects. It is not possible for any teacher or trainer to learn for another individual. That individual must want to learn and engage in initial coding and rehearsal activities to ensure that initial information is retained as a schema and a basis for further development (Bandura 1977). Effective learning also involves a variety of cognitive skills which are centred around self-testing and actively relating new material to what is already stored in memory (Chi, Bassock, Lewis, Reimann & Glaser 1989). Engaging in
these cognitive skills will help the learner to construct appropriate schemas. However, it is important for the learner to know that these information-processing skills exist and how to employ them effectively. To date, at nearly all education levels, but especially in post-compulsory education, learning-to-learn skills have been neglected.

Employment of learning-to-learn strategies will enable the individual to construct schemas and mental models which will guide performance. However, for the performance to be recognised as appropriate and skilled, the individual must also be capable of self-regulation to recognise and adhere to the internalised standards of excellence which form part of the schemas. The acquisition of skill, monitoring and self-regulation all require motivation and the will power to actually engage in self-critical and self-regulatory behaviour (Schunk & Zimmerman 1994). Ultimately, skilled performers must take responsibility for their own performance and solve the problems they identify.

Numerous occasions of skill practice and performance are necessary to build up episodic and case knowledge (Berliner 1991) and informative feedback (Hattie 1993). These contribute to the development of sophisticated schemas, proficiency or expertise and high-level problem-solving ability. In this process, the learner must not only be active, but display perseverance and persistence which involve more than just motivation or wanting to do something. Without perseverance and practice, autonomous stages of skilled performance (Fitts 1964, 1968) will never be attained. Students engaged in vocational training need to be taught explicitly to recognise perseverance and persistence as vital qualities in effective skill learning and also the stages of learning described by Fitts. On account of the limitations of the novice learner (Shuell 1990; Berliner 1988), the teacher or trainer will always play a very substantial role in this and many other aspects of the skill-learning process.

Not all individuals have either the disposition suited to working in certain occupations or the prerequisite aptitude and abilities for reasonable success. Despite commendable government attempts to reduce unemployment statistics through vocational training, these facts need to be borne in mind. Nothing could be more cruel than to allow a person who has normal career aspirations, but does not have the
prerequisite aptitude and abilities, to persevere if it will not be possible to achieve at least competent performance. Both trainers and training providers need to be responsible for the sensitive screening out of those who lack the required aptitude and abilities or the readiness to engage in effective learning.

**Implications for teaching and training: Teachers/trainers**

The processes made more explicit by the defining attributes of skill and skilled performance indicate that instructors of skill learning need to know much more than how to perform the skill. Individual differences in aptitude and different rates of acquisition and retention demand that trainers and teachers need to be knowledgeable and able to plan sequences of practice with grades of difficulty. There is the need for teachers and trainers to engage in deliberate training for transfer and problem solving at different stages in the development of expertise over the longer term.

Clearly, teachers and trainers need to be able to identify the stage of development which a trainee is at. They also need to engage in the use of teaching strategies which are appropriate for a trainee's stage of skill development and level of understanding, and which will promote further development. In the light of all these sophisticated teaching demands, the duration of instructor training, the quality of teacher instruction programs and the quality of teachers and trainers need to be treated much more seriously than it is at present.

Shulman's (1986, 1987) analyses indicate that there are three distinct types of knowledge and associated skills which teachers need to possess. These are: subject content knowledge, which is essentially subject-matter content expertise; pedagogical knowledge, which is knowledge about teaching and learning; and pedagogical content knowledge, which is knowledge of how to teach the specialist content knowledge to make difficult content easily understood by the learners. While the use of the term 'pedagogical' refers to the education of children, and is unfortunate in a vocational education context, these three concepts do have relevance in the vocational education setting if 'pedagogical' is interpreted broadly to include adult learning.
Subject-matter proficiency is a critical factor in effective skill learning. High levels of skilled performance are only likely to result if learners are taught by teachers who have high levels of proficiency or expertise in the skill area themselves. Without high levels of subject matter, knowledge and proven skill teachers cannot act as models for students, with modelling being the most important means of learning complex skills (Bandura 1977). The development of high standards in a general workforce can only occur if learners are exposed to relevant examples which reveal the ultimate standards of work which can be achieved using modern equipment and techniques.

As well as personifying skilled models in their own specialty area, effective teachers and trainers need pedagogical content knowledge. This is important, because it enables them to explain difficult concepts and procedures and move beyond simply demonstrating. It fosters the broader understanding and perspectives necessary for effective problem solving, and the development of proficiency or expertise. Pedagogical content knowledge can only be developed over a long time as a result of interaction of subject specialty knowledge and teaching knowledge and skills.

The need for vocational educators to be more familiar with strategies relevant to general learning is not widely accepted. However, the need for coding and rehearsal (Bandura 1977), and other cognitive and metacognitive procedures to help ensure effective skill learning (Chi et al. 1989), indicates that teachers and trainers require knowledge of and skills relating to mnemonics, rules for mnemonic generation, self-instruction processes, cognitive mapping and the like (see Weinstein, Meyer & Van Mater Stone 1994). This moves vocational trainers and teachers well beyond simply instructing skill content, or even acting as appropriate role models.

Overall, the factors considered in defining skill and skilled performance point to a much more sophisticated and challenging role, with vocational educators becoming more diagnosticians of learning problems and designers of longer-term, effective teaching and practice programs.
Implications for teaching and training: Training management authorities

There is ample evidence that teachers and trainers themselves progress through a number of stages as they develop skills as teachers and trainers. They move from novice, to advanced beginner, to competent and finally, hopefully, to proficient and expert (see Berliner 1988, 1991). This indicates that there must also be on-the-job training provision and extended feedback for trainers and teachers in vocational education. As with other areas of teacher education, previously it has been assumed that a relatively short training course is all that is required. Patently, this is not so. The increasing complexity of teaching/training and changes within trade and professional areas, stemming particularly from the introduction of new technology and computing, indicate that the time and processes involved in teacher or trainer education need to be reconceptualised in radically different ways.

The relatively short time allocated to teacher training is just one specific example of a wider problem. Few formal training agencies provide programs which take into account the lengthy time and practice required for effective skill development. It has been invalidly assumed for many years that the bulk of skill learning can take place within formal courses provided by TAFE and similar training bodies. There is now growing recognition that application of theory in context in real-world settings is an important aspect of effective skill learning. The relationship between theory and practice and on- and off-the-job training providers is in the process of being radically reconceptualised.

As a matter of general policy, schemes for assessment over longer periods of time need to be established commensurate with the time required to acquire skills of a high order. This would avoid the farce of deciding upon competence from one, or a very limited number, of performance occasions. Comparative world best practice training, for example as in the French and German systems, is grounded on extensive, genuine assessment over longer time intervals. It is perhaps time that Australasian training authorities stopped deluding themselves over the effects of a product-oriented system and developed a system based upon both products and processes consistent with real-world human learning.
Unfortunately, TAFE-type courses have long been perceived as the dumping ground for those lacking in academic aspirations or abilities. While any society needs to retain educational equity, it is time that skill learning be perceived realistically as a complex and demanding undertaking, success in which demands appropriate aptitude and abilities. Selection processes to screen out those who are not suitably qualified need to be established to provide messages to the community concerning the seriousness of skill acquisition and to prevent continuing wastage of teaching resources. There also need to be formal mechanisms to assess learning-to-learn capacity and courses to teach learning-to-learn strategies. However, ideally, much of this work relating to lifelong learning should have been accomplished at primary and secondary levels. There is clearly the need for co-operative planning between compulsory and post-compulsory education sectors which focusses on this issue.

**Conclusion**

Explicit analysis and statement of the defining attributes of skill and skilled performance reveal a range of factors which. These point to the need for considerable change in attitudes, policy and practices for learners, teachers/trainers and administrators and policy makers in the post-compulsory sector. The two major issues emerging are recognition of the need for longer duration of skill development and the degree to which sophisticated cognitive skills are an essential part of effective skill learning and teaching. These have direct implications, not just for the basic skill training of the workforce, but also for the need for trainers and teachers to be supported so that they become truly proficient or expert. Simply recruiting those with the subject-matter knowledge and providing minimal teacher training is no longer appropriate, given the complexity of learning and teaching revealed by explicit statement of the defining attributes of skill and skilled performance.

**References**


The defining attributes of ‘skill’ and ‘skilled performance’


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