Transitions and the development of expertise

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This paper explores the relationships between the development of expertise and transitions. It sets out what we know about the development of expertise, changes in the brain as expertise develops, and how transitions between different learning contexts and the challenges that they present may impact on developing expertise. It sets out a series of propositions concerning the way that transitions may impact on expertise, the evidence supporting the propositions, and the educational implications.

Learning as the development of expertise

THE WAY THAT learners increase their knowledge and skills in a domain can be conceptualised as the development of expertise. Research on the development of expertise is characterised by exploration of the ways in which individuals acquire specific skills and knowledge in a domain and how thinking and learning processes change as expertise develops. The study of expertise has taken two main forms, the study of exceptional people, for instance, Mozart and Einstein, and the study of experts in comparison with novices. The relative approach assumes that expertise is a level of proficiency that novices can achieve providing that they persist over a sufficiently long time in an appropriately conducive environment. Within this framework the level of expertise attained can be assessed in relation to such indicators as academic qualifications, seniority, years performing the task, or consensus among peers. The acquisition of expertise can be viewed as development along a continuum, although some have seen it in terms of a series of phases through which the individual passes. For instance, Hoffman (1998) suggests progression from naive (one who is totally ignorant of a domain) through novice (someone who has minimal exposure to the domain), initiate (an individual who has been through an initiation ceremony and begun introductory instruction), apprentice (one who is immersed in the domain), journeyman (one who can work unsupervised although needing goals to be set), expert (distinguished or brilliant journeyman), and finally to master (one of an elite group).

Expertise is domain specific. Individuals rarely reach an elite level in more than a single area of study (Ericsson & Lehmann, 1996; Glaser & Chi, 1988). A person highly skilled in one domain cannot automatically transfer their skills to another because their expertise relies on the acquisition of a large body of specific knowledge (e.g. Gobet & Charness, 2006). The skills developed in problem solving and performance are influenced by domain specific acquired patterns and associated actions which influence basic cognitive skills (Newell & Simon, 1972; Pellegrino & Glaser, 1982a, 1982b). For instance, conceptual knowledge about numbers affects performance in number analogy and number series tasks. Even within domains transfer of skills can be problematic. For instance, Sudnow (1978), a highly skilled, adult, professional, classical musician, documented how tedious, effortful, frustrating and time consuming was the experience of acquiring expertise in jazz improvisation.

The expertise paradigm challenges accepted notions that high-level achievement depends on inherited ability

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suggesting instead that the length of time engaged in activities is a better predictor of the level of expertise attained (Ericsson & Chase, 1982; Hallam, 1998). Developing even moderate levels of expertise in any field of study requires considerable time. Chase and Simon (1973) suggest that to attain masters' level, chess players typically spend 10,000 to 20,000 hours engaged exclusively with chess. In music up to 16 years of practice are required to achieve levels which will lead to international standing in playing an instrument. The individual usually begins to play at a very early age with increasing amounts of practice being undertaken up to as much as 50 hours a week by adolescence (Sosniak, 1985). Equally long periods of learning are necessary to acquire high levels of expertise in a variety of domains, for example, in sporting activities, as a master chef, gaining doctoral level qualifications or professional status in medicine or the law.

As expertise develops, processing in the expert domain changes, enabling experts to generate the best solutions to problems and to do this faster and more accurately than non-experts (de Groot, 1965; Klein, 1993). Across a range of domains a number of common characteristics of expert performance have been identified (Chi, 2006; Glaser & Chi, 1988). These are considered below.

Expertise involves the development of automaticity. Operations that are initially slow, serial and demand conscious attention become fast, less deliberate and can run in parallel with other processes (Schneider & Shiffrin, 1977; Schnieder, 1985). Automaticity is central to the development of expertise and it is through practice that automaticity develops and the character of cognitive operations changes (Posner & Snyder, 1975). Speed and smoothness are improved, cognitive demands are reduced releasing attention for higher order or other functions (Ericsson, 2006). For instance, expert typists can type and recite nursery rhymes at the same time (Shaffer, 1975). After one hour of practice a day for six weeks college students could read unfamiliar text while simultaneously writing words read by an experimenter without any reduction in reading speed or comprehension (Spelke et al., 1976). Automaticity of basic skills is crucial to enable attention to be focused on higher level skills, for instance, decoding needs to be automated before reasoning, comprehension, inference, and monitoring of text can be carried out effectively (Lesgold & Resnick, 1982; Logan, 1985). Once developed, automatic processes are relatively resistant to disruption by reduced cognitive capacity and to a limited degree are largely resource insensitive (Schneider & Fisk, 1982).

In addition to automaticity, experts acquire an extensive body of domain knowledge. This enables them to perceive large meaningful patterns in their field (Akin, 1980; Egan & Schwartz, 1979). They organise perceptually available information in their working environment into larger units which makes processing faster and easier. This has been demonstrated in many domains (see Ericsson et al., 2006).

In their field, experts have superior short- and long-term memory. The automaticity that they develop in relation to many of their skills frees up working memory for other tasks. For instance, deGroot (1966) studied chess masters, experts and novices, and found relatively few differences in the thinking of fair chess players and chess masters. The key difference seemed to be in memory for chess positions. The master chess players could reproduce almost all the pieces on a chess board after a five-second exposure with few errors. The performance of expert and novice players was poorer. The masters' superior memory was specific for meaningful chess positions. Memory for meaningless positions was considerably less (Chase & Simon, 1973).

Experts see and represent problems in their domain at a deeper level than novices. The conceptual categories which experts adopt in problem solving are semantically and principle based whereas those of novices are syntactically or surface feature oriented. For instance, in physics, experts use principles of mechanics to organise categories whereas novices build their problem categories around literal objects stated in the problem (Chi et al., 1981). Expert programmers sort problems according to solution algorithms whereas novices sort them according to areas of application, for example, whether the programme is to create a list of employees' salaries or to keep a file of current user identification (Weiser & Shertz, 1983).

Experts spend a great deal of time analysing a problem qualitatively before attempting a solution (Simon & Simon, 1978; Voss et al., 1983). They try to understand the problem, build a mental representation from which they can infer relations, define the situation and add constraints to the problem. This is particularly evident when problems require creativity. For instance, Collins (2005), studying a single composer, demonstrated that at the outset a clear mental picture of the composition was in place which acted as a loose framework throughout the process. Problem proliferation and successive solution implementation occurred not only in a linear manner but also recursively. Moments of Gestalt creative insight were observed which related to problem restructuring, some were seen to overlap in real time with others indicating an element of parallelism in thinking. There were no clear boundaries between the various stages. For each problem arising, solutions themselves were conjectured, implemented or deferred.

A key element in expert performance is self-monitoring. Experts have well developed meta-cognitive and self-monitoring skills (Hallam, 1995, 2001a; Larkin, 1983). They are better able to detect errors and the status of their own comprehension. They know why they make errors, why they fail to comprehend, when they need to check their solutions, and what they need to do next. They are better than novices in judging the difficulty of a problem and selecting appropriate strategies to solve it (Chi et al., 1982; Hallam, 1995, 2001a; Larkin et al., 1980) and can retrieve relevant domain knowledge and strategies with minimal cognitive effort (Alexander, 2003). They are also more opportunistic making use of whatever sources of information are available while solving problems (Gilhooly et al., 1997).

Limitations of expertise

Expertise is not without its limitations. Experts can be over confident. Glenberg and Epstein (1987) found that experts in physics and music overestimated their comprehension of a physics or music text. Novices were far more accurate.

Although experts excel in understanding and remembering the deep structure of a problem they may fail to recall the surface features and overlook details that are less relevant (Voss et al., 1980). They also tend to rely on contextual cues. For instance, in medicine, experts use tacit enabling conditions of a situation for diagnosis, for example, age, sex, drug use, previous diseases, occupation. These are often related to particular diseases and such relationships are learned through clinical practice (Hobus et al., 1987). Expert skills have been shown to be context dependent in many studies. For instance, experienced waiters cannot indicate the correct surface orientation of liquid in a tilted container despite their experience in the context of wine glasses (Hecht & Profitt, 1995).

Bias is one of the most serious handicaps of experts. Greater domain knowledge can create mental set or functional fixedness and lead to problems in devising creative solutions (Wiley, 1998). Experts can be inflexible and have trouble adapting to changes in problems that have a structure that deviates from those that usually apply. Sternberg and Frensch (1992) found that expert bridge players suffered more than novice players when the game's bidding procedure was changed. Even where the nature of the domain itself is creative and the expertise is adaptive in nature (Hatano & Inagaki, 1986), many creative artists, having developed a distinctive style early in their career, tend to maintain it throughout their work, although there are exceptions.

From an educational perspective one of the most serious limitations of experts is that they may be unable to assess the future performance of novices. Hinds (1999) found that in general the greater the level of expertise the worse experts were in predicting how quickly novices could perform a task such as using a cell phone. They seemed unable to take the perspective of the novice accurately. This is a serious problem for teachers in any context.

The development of expertise and neurophysiological research

Although our knowledge of the way the brain works is in its infancy some of the fundamental processes involved in learning have been established. The human brain contains approximately 100 billion neurons a considerable proportion of which are active simultaneously. Information processing is undertaken largely through interactions between the neurons, each having approximately 1000 connections with other neurons. When we learn there are changes in the growth of axons and dendrites and the number of synapses connecting neurons, a process known as synaptogenisis. When an event is important enough or is repeated sufficiently often synapses and neurons fire repeatedly indicating that this event is worth remembering (Fields, 2005). In this way changes in the efficacy of existing connections are made. As learning continues and particular activities are engaged with over time myelinisation takes place. This involves an increase in the coating of the axon of each neuron which improves insulation and makes the established connections more efficient. Pruning also occurs, a process which reduces the number of synaptic connections, enabling fine-tuning of functioning. Through combinations of these processes, which occur over different time scales, the cerebral cortex self-organises in response to external stimuli and learning activities (Pantev et al., 2003).

Permanent and substantial reorganisation of brain functioning takes considerable time. Much practice is associated with an increase in neuronal representation specific for the development of particular areas of expertise. In taxi drivers the posterior hippocampi (the brain regions which store spatial representation of the environment) have been found to be significantly larger relative to those of controls, the longer the time spent as a taxi driver the greater the extent of change (Maguire et al., 2000). Similarly, in relation to the processing of the tones of the musical scale, the largest cortical representations are found in musicians playing instruments for the longest periods of time (Pantev et al., 2003; Sluming et al., 2007).

The brain develops in very specific ways in response to particular learning activities and the extent of change depends on the length of time engaged with learning. Processing of pitch in string players is characterised by longer surveillance and more frontally distributed event-related brain potentials (ERP) attention. Drummers generate more complex memory traces of the temporal organisation of musical sequences and conductors demonstrate greater surveillance of auditory space (Munte et al., 2003). Compared with non-musicians, string players have greater somatosensory representations of finger activity, the amount of increase depending on the age of starting to play (Elbert et al, 1995; Karni et al., 1995; Pantev et al., 2003).

Changes in brain networks have been observed as motor skills develop. When participants practised five-finger exercises on the piano over as short a period as five days there was evidence of enlargement of the cortical representation area targeting the long finger flexor and extensor muscles (Pascuel-Leone et al., 1994). Where practice continued over further weeks, the cortical maps obtained after the weekend rest showed a small change from baseline with a tendency to increase in size over the course of the study (Pascual-Leone, 2003). Over a four-week period there was evidence of the beginnings of the process of brain re-organisation.

The changes in the brain reflect not only what has been learned but also how it is learned. Particular methods of approaching problem solving are reflected in subsequent brain activity. When students (aged 13 to 15) were taught to judge symmetrically structured musical phrases as balanced or unbalanced using traditional instructions about the differences (including verbal explanations, visual aids, notation, verbal rules, playing of musical examples), or participating in musical experiences (singing, playing, improvising or performing examples from the musical literature), activity in different brain areas was observed. The music processing of the traditionally trained group produced increased activation of the left fronto-temporal brain regions, probably reflecting inner speech and analytical, step-by-step processing. In contrast, the musically trained procedural group showed increased activation of the right frontal and bilateral parieto-occipital lobes indicating a more global way of processing and also visuo-spatial associations (Altenmuller et al., 1997). Taken together, the evidence suggests that the brain substrates of processing reflect the 'learning biography' and developed expertise of each individual (Altenmuller, 2003, p.349).

Experts demonstrate increased neurophysiological efficiency. Jausovec (1996) showed increased alpha EEG power in experts indicating less cognitive effort on a task than a normal cohort. Several studies support this (e.g. Grabner et al., 2006; Neubauer et al., 2005). Neuro-imaging studies have revealed an anterior-posterior pattern of activation differences between high and low performance (e.g. Rypma et al., 2006). Frontal activation is related to a more controlled, effortful and energy consuming cognitive activity, i.e. working memory, while posterior activation is related to more automatic perceptual processing. Experts are more efficient in their particular domain because they can recruit more neuronal resources for automatic processing. Working memory is, therefore, more efficient because it has more available resources.

Further evidence for brain changes as a result of developing expertise relate to aging. As ageing occurs the accuracy and speed of memory processes as well as most types of cognitive-motor performance undergo systematic decline starting as early as age 30 (Kaufman, 2001). Older adults typically need much longer to process the same tasks as young adults (see Krampe, 2002). These effects are more pronounced if tasks require complex processing. These changes should lead to a reduction in expert performance but in work settings the relationship between age and productivity is near zero or slightly positive in cross-sectional studies (for meta-analyses see McEvoy & Cascio, 1989; Waldman & Avolio, 1986). Knowledge and experience compensate, structured expert knowledge perhaps protecting working memory function decline (Mireles & Charness, 2002).

Proposition 1: In developing expertise learners need to negotiate a wide range of different types of transitions

In the modern world where employment demands flexibility and mobility individuals experience many transitions as they develop and maintain expertise. Transition routes have become increasingly individualised and frequently involve elements of individual choice, taking many forms with varying degrees of impact (Evans, 2002; Giddens, 1996; Glastra et al., 2004). As individuals adapt to transitions they go through a process of cognitive restructuring. In developing high levels of expertise they may experience transitions involving:

- learning environments, either between or within institutions;
- teachers and facilitators;
- pedagogical practices;
- peer and friendship groups;
- expectations of performance and types of assessment;

- changes in required skills;
- conceptual understanding;
- perceptions of the nature of knowledge itself;
- ways of thinking about learning; and
- ways of thinking about self and identity.

Proposition 2: Developing expertise requires transition through three phases from conscious and effortful processing to automatisation

To develop expertise in a domain requires much effort and practice. Three main stages have been identified. In relation to procedural skill development, in the cognitive-verbal-motor-stage the learner understands what is required and carries it out while consciously providing self-instruction. Learning is supported when the learner has a clear mental representation of both the process and the goal of learning and feedback is available, either directly from the environment or from observers. In the associative stage the learner begins to put together a sequence of responses which become more fluent over time. Errors are detected and eliminated and feedback from others or self-monitoring continues to be important. In the final autonomous stage the skill becomes automated, is carried out without conscious effort, and continues to develop each time it is used, becoming quicker and more fluent. As complex skills are learned some elements will be automated while others are at early stages. As automaticity develops the component processes become unavailable to conscious inspection and the learner has difficulty in explaining his/her actions to others (Fitts & Posner, 1967).

In relation to knowledge acquisition, three stages have also been proposed (Alexander, 1997; VanLehn, 1996). Firstly, in the acclimation phase, there is development of an understanding of the scope of the knowledge domain where the learner is introduced to specific facts, rules, terminology or conventions, definitions, simple concepts and principles. Simple links between the component parts of the knowledge domain are made. More complex interrelationships are established in the intermediate or competence phase where the knowledge base is expanded and refined so that it can be used to solve problems. In the final phase, the knowledge domain is secure and the aim is to improve speed and accuracy (proficiency/expertise). As in the learning of procedural skills, automaticity can be developing in one area while new knowledge is being acquired in another.

Although the development of procedural skills and the acquisition of knowledge have been described separately, in practice, in most domains, the two are inextricably intertwined. Knowledge-based mental representations of appropriate outcomes are required to check for errors, to select possible strategies and monitor progress (Hallam, 1995, 2001a, 2001b). These principles apply in relation to creative and routine tasks. While there may be some transfer of meta-cognitive or self-regulatory strategies the impact of these may be limited because of the lack of relevant knowledge. An individual may have a wide range of strategies for developing understanding and supporting learning, for instance, rehearsal, summarising, elaboration, organisation, repetition, but these will be of limited use unless the individual has sufficient prior knowledge in the domain to apply them. Executive strategies relating to planning, monitoring and evaluating also require extensive domain knowledge, although strategies for managing concentration, reducing distraction and managing motivation may be more successfully transferred within and between domains.

At any of the three stages of skill or knowledge development there is the potential for difficulties. In the early stages instructions may not be understood, feedback may not be sufficiently clear and misunderstandings may occur either in relation to knowledge or skill development. Learners may not be given sufficient opportunities for active engagement in the domain and automaticity may not develop.

Proposition 3: Inability to negotiate conceptual transitions can limit the level of expertise attained

The term conceptual change was introduced by Kuhn (1962) to indicate that concepts embedded in a scientific theory change their meaning when the theory (paradigm) changes. An inability to negotiate conceptual change at the individual level, when prior conceptual understanding is inaccurate may limit expertise development particularly as some concepts are pivotal to overall understanding in particular domains (Meyer & Land, 2003).

There are a number of theoretical approaches to understanding how concepts are grouped and why change can be difficult. One approach suggests that the knowledge system of novices consists of an unstructured collection of many simple elements known as phenomenological primitives (P-prims) that originate from a superficial interpretation of physical reality. P-prims are organised in a conceptual network and are activated through a mechanism of recognition that depends on the connections that P-prims have to other elements of the system. According to this approach the process of learning science is one of collecting and systematising the pieces of knowledge into larger wholes. This happens as P-prims change their function from relatively isolated, self-explanatory entities to become part of a larger system of complex knowledge which experts possess (diSessa, 1993, p.114). In the novice, P-prims are unstructured or loosely organised and through instruction come together into larger structures. It is this which constitutes the major change from intuitive to expert understanding. From this perspective, where naive and scientific conceptions are compatible they are relatively easy to learn (Carey, 1985). However, where concepts are inaccurate radical conceptual change is needed. This requires the re-assignment of a concept to a different ontological category, the creation of new ontological categories or the differentiation or coalescence of concepts. These are more complex processes which prove difficult for many people (Carey, 1991).

Where students hold misconceptions they can constitute a barrier to effective learning (Bishop & Anderson, 1990; Zaïm-Idrissi et al., 1993). Concepts which are incompatible with naive conceptions are often not acquired even after college level instruction (McCloskey et al., 1980). This tends to occur when naive conceptions are:

- robust (initial beliefs are held firmly and difficult to overcome by instruction);
- consistent over time and situations (the same misconception is displayed by the same student over different times and contexts);
- persistent across different ages and schooling levels (there is no developmental trend);
- homogenous among different students;
- recapitulated across historical periods (medieval scientists and contemporary naive students tend to hold the same conceptions); and
- systematic (the misconceptions conform to a coherent theory, they are not fragmented) (Chi & Slotta, 1993; Chi et al., 1994).

Vosniadou et al. (2008) argue that inability to successfully learn counterintuitive knowledge relates to the absence of critical thinking, knowledge fragmentation, lack of transfer, and misconceptions. They suggest that where new evidence conflicts with existing concepts students assimilate the new information into existing but incompatible models using enrichment type mechanisms which result in internally inconsistent approaches or in the formation of synthetic models (Vosniadou & Brewer, 1992, 1994. Vosniadou et al, 2007). Enrichment mechanisms cannot produce radical conceptual change (Carey, 1991; Spelke, 1991).

To facilitate understanding of how to bring about conceptual change, Chi (2008) proposes three conceptual levels: belief revision, mental model transformation and categorical shift. Beliefs are proposed as being at the grain size of single ideas. They can be missing, incomplete or false. Missing or incomplete beliefs can be added to and gaps filled. Incorrect beliefs can usually be changed by instruction that refutes them (Broughton et al., 2007). At a mental model level incorrect prior knowledge may appear coherent but, nevertheless, be flawed. The inaccuracy of the model depends on the number of critical false beliefs not the overall number of false beliefs. Here, conceptual change can be achieved by refuting multiple false beliefs, particularly those which are critical to understanding. The cumulative effect of such belief revisions will transform a flawed model. At this level, refutational texts are a powerful means of promoting understanding (Alvermann & Hynd, 1989; Diakidoy et al., 2003; Guzzetti et al., 1993). For misconceptions that are categorically misassigned between lateral branches or ontological trees, conceptual change requires categorical shift. This requires the learner to be aware that such a shift is needed and the correct category to be available. Conceptual change at the categorical level is the most complex. While it is not a difficult learning mechanism in everyday life it occurs rarely. We do not often have to re-categorise. The rarity of category mistakes in everyday life reinforces the strength of commitment to the original category to which a concept is assigned as well as the boundary between lateral categories. If a categorical shift is required the learner needs to be made aware of the need for change (Chi, 2008) and must unlearn the inaccurate conception which involves dismantling existing neural networks and creating new ones. The new concept will have to be learned as if it was a previously unknown one. This will inevitably take time and effort and requires conscious initiation and regulation of cognitive, meta-cognitive and motivational processes (Pintrich et al., 1993; Sinatra & Pintrich, 2003). Where learners are not motivated and are strongly committed to existing beliefs these will be extremely resistant to change (Chinn & Brewer, 1993). If learners are unable to make the conceptual shifts required in a domain to develop deep understanding, their progression to expertise in that domain is going to be limited.

Proposition 4: Inability to negotiate conceptual transitions relating to understanding the nature of knowledge can limit the level of expertise attained

There is considerable evidence that an individual's beliefs about knowledge (their personal epistemology) are related to academic performance. Where knowledge is seen as absolute, simple, stable and transmitted by authority, academic performance is lower. Where knowledge is perceived as complex, uncertain, and derived from reason, performance level is higher (e.g. Mason, 2000; Qian & Alverman, 1995; Sinatra et al., 2003; Windschitl & Andre, 1998).

Individuals spontaneously develop sets of mental representations about the mind, knowledge and its processes of acquisition and transmission. Beliefs about the mind and about knowledge influence the ways in which people learn, teach, and interpret their ways of knowing and those of others (Hofer & Pintrich, 2002; Kember, 2001; Vosniadou, 2008).

In 1970, Perry identified a series of positions or stages through which learners progress as they gradually acquire ways of thinking about academic discourse from dualistic thinking (a right answer) through relativistic reasoning, in which students accept uncertainty and use evidence and logic to test alternatives, to a firm, evidentially based commitment to a particular interpretation or perspective. Subsequent research has largely confirmed the developmental trend identified by Perry suggesting that individual personal epistemology evolves until contextual, constructivist and evaluative perspectives of knowledge and knowing are acquired (Hofer, 2002; Hofer & Pintrich, 2002), although there is some evidence that students can regress in their epistemology as well as progressing (Schommer-Aikins, 2002).

Epistemological beliefs mediate cognitive functions in the process of intentional conceptual change (Sinatra & Pintrich, 2003). Where students believe that knowledge is simple and certain they are less likely to reason effectively and experience conceptual change (Qian & Alvermann, 1995). This may be related to relatively consistent characteristics concerning seeking or avoiding closure (Kruglanski, 1989). Dualists have poorer text comprehension (Ryan, 1984), and naive beliefs about the structure of knowledge can have a negative effect on the interpretation of controversial evidence (Kardash & Scholes, 1996). Students who believe that knowledge is absolute and certain tend to draw inappropriate absolute conclusions from tentative text (Schommer, 1990).

The development of expertise itself may change beliefs about the nature of knowledge. Alexander and Sinatra (2007) argue that as an individual develops expertise in a domain they come to see knowledge in that domain as complex and nuanced, although this may not transfer to other domains.

Proposition 5: Inability to negotiate conceptual transitions relating to the nature of learning and understanding can limit the level of expertise attained

The way that individuals conceptualise learning and understanding will impact on the way that they learn. Saljo (1979) established a series of categories relating to conceptions of learning that differentiated broadly between learning as reproducing knowledge and learning as seeking meaning. A further category was later identified, learning as personal change (Marton et al., 1993). Adults who think about learning in a more sophisticated way recognise a variety of different learning processes and understand that effective learning depends on finding the most appropriate ways of tackling a particular task for a specific purpose in a given context (Saljo, 1982). Similar conceptions are evident in relation to teaching which can be seen as the transmission of knowledge or as the encouragement of conceptual development (Kember, 1998; Prosser et al., 1994; Van Driel et al., 1997).

A related body of research has considered the way that learners approach learning. Marton and Saljo (1976) identified surface approaches where the learner concentrates on words and information, and deep approaches where they pay careful attention to how well the evidence supports the conclusions. Subsequent research has reinforced this distinction (Entwistle & Ramsden, 1983; Richardson, 2000), also identifying a strategic approach (Biggs, 1987) and application directed and undirected approaches (Vermunt, 1998, 2005). These findings indicate that learners approach tasks in different ways which are related to their motivation in specific contexts.

There has been considerable debate about the extent to which these approaches are consistent or variable between different domains and teaching contexts (Thomas & Bain, 1984). There is some evidence of consistency in individual approaches (Biggs, 1993; Entwistle & McCune, 2004) and an element of stability across teaching contexts (Entwistle et al., 2007) suggesting that teachers do make a difference but students have to be both alert and ready to take advantage of encouragement to adopt a deep approach (McCune, 2004). Vermunt and Verloop (1999) suggest that there can be constructive and destructive friction in the effects of teaching-learning environments on student learning. Congruence occurs when students' learning strategies and teachers' teaching strategies are compatible, friction occurs when this is not the case. Friction may be necessary to stimulate students to develop skills in the use of learning and thinking activities that they are not inclined to use on their own, although it may also cause a decrease in learning or thinking skills when existing skills are not called upon or potential skills are not developed.

Changes in the way the curriculum is delivered can affect approaches to learning and the extent of self-regulation (Boyle et al., 2003; Van der Veken et al., 2009; Vermetten et al., 1999). Ensuring that students have appropriate prior knowledge relating to what is to be learned is important as is the nature of assessment. Short questions and multiple choice options lead to surface approaches (Thomas & Bain, 1984). Biggs (1993) advocates constructive alignment as a way of thinking about the relationships between learning, teaching and assessment to facilitate the adoption of the deep approach which is necessary for high levels of expertise to be attained.

Proposition 6: Inability to develop metacognitive and self-regulatory skills can limit the level of expertise attained

In addition to having appropriate beliefs about the nature of knowledge and learning, approaching learning with a view to developing a deep understanding, and being intrinsically motivated learners need to know and understand their own learning and be able to regulate it. Metacognition is defined as 'cognition about cognition', or 'knowing about knowing' (Flavell, 1976, 1979) and refers to personal knowledge concerning one's own cognitive processes or anything related to them (Brown, 1987). Metacognition involves executive management (planning, monitoring, evaluating and revising) and strategic knowledge (what, when, why and how). Both are needed to self-regulate thinking and learning (Hartman, 2001). There are also distinctions between general metacognitive knowledge and that which is specific to particular subjects. Metacognition also involves self-regulation, including maintaining motivation to complete a task, sustaining effort and avoiding distractions. Internal regulation involves controlling the balance between cognitive, affective and metacognitive processes, while external regulation includes the particular approaches adopted, instructional materials and computer-based learning systems (see Entwistle & McCune, 2004; Lonka et al., 2004; Pintrich, 2004; Richardson, 2000; Vermunt & Vermetten, 2004).

Proposition 7: Self-beliefs can limit or promote the development of expertise

As individuals develop expertise their relative success in doing so depends on their self-beliefs. This may include beliefs about the nature of their intelligence, their ability to complete tasks and their self-concept. Lack of progression or decline in attainment is related to changes in students' concepts of themselves as learners (e.g. Eccles & Wigfield, 1993; Wigfield et al., 1991).

Beliefs about the nature of intelligence can influence motivation to engage with challenging tasks (Dweck & Bempechat, 1983). Children with an incremental theory of intelligence (intelligence as malleable and improved through effort) tend to be mastery oriented, those with an entity theory (intelligence as fixed and not subject to change) tend to be performance oriented, choosing tasks where they can demonstrate their abilities. As students approach adolescence entity views tend to increase with less emphasis on effort (Nicholls & Gardner, 1999), perhaps as a result of inferences made from interactions with teachers. Given the importance of accepting challenge in order to develop high levels of expertise this is likely to be a limiting factor.

High self-efficacy has been linked with high attainment and positive emotional approaches to learning (Schunk & Pajares, 2005), although it could limit conceptual change if an individual is so confident in their thinking that they believe they are right even when the evidence suggests otherwise (Pintrich et al., 1993; Pintrich, 1999). Transitions between different learning environments can lead to a reduction in self-efficacy as pupils re-evaluate their perceived competences in a new context (Harter et al., 1992).

New learning environments provide a different frame of reference for self-perceptions. Marsh (1987) describes this as the Big-Fish-Little-Pond Effect. Those moving to environments with higher levels of attainment may develop lower academic self-concepts than those where attainment levels are lower (Marsh, 1991; Marsh & Rowe, 1996), for instance, pupils participating in programmes for the gifted and talented experience a decline in academic self-concept (Kulik & Kulik, 1982; Marsh et al., 1995). Other grouping arrangements also have an impact. McManus (2007) found that students who were allocated to ability groups on starting secondary school changed their perceptions of themselves as learners in a negative way if they were allocated to a low or middle group. General school self-concept and self-esteem are also influenced by the amount of structured ability grouping in a school, the more ability groups the greater the effect (Ireson & Hallam, 2001). Overall, the effects of the Big-Fish-Little-Pond Effect are strongest in highly competitive settings in which students follow a fixed curriculum and are normatively assessed in relation to common tasks. These situations increase social comparisons (Marsh & Peart, 1988). Being in a more competitive environment, of itself, can also lead to reduction in self-esteem (Wigfield et al., 1991).

As individuals make transitions between learning environments they may develop an ideal self of themselves in the new environment (Markus & Nurius, 1986). Ideal selves can produce discomfort if they are seen as being markedly different from actual selves leading to feelings of depression and dejection (Higgins et al., 1985), although they can also lead to positive motivational outcomes (Cantor et al., 1986). The cognitive strategies that are adopted to cope with transitions are very important in determining which of these applies. Cantor et al. (1987) found that optimists set realistic expectations that were congruent with past performance, while pessimists set their expectations very low. Two distinctly different but effective strategies were identified. Defensive pessimistic strategies emphasised the negative as part of attempts to gain control, manage anxiety, and motivate, while optimistic strategies led to more positive appraisals of achievement tasks and those adopting them were motivated and successful to the extent that they maintained their positive appraisal. Optimists and pessimists did well in their academic work and better than aschematics who adopted neither strategy.

Proposition 8: Motivation is crucial in the development of expertise and is affected by transitions

Motivation is complex and inextricably linked to self-perceptions and identity (see Hallam, 2005). While intrinsic motivation may be generated by interesting tasks in the short term, that interest must be internalised and become part of the individual's identity for motivation to be sustained over long periods of time. Motivation is crucially important in the development of expertise because of the considerable investment of time and effort that is required. It is also important in relation to conceptual change. Learners experiencing conceptual change referred to cognitive effort more than any other strategy including intrinsic (understanding) and extrinsic (wanting to pass an exam) motivations (Hynd et al., 2000).

Goal orientation describes the goals that learners choose and the methods that they use to pursue those goals. Dweck (1986) established two distinct patterns of goal oriented behaviour, mastery and performance. Mastery goals are associated with better learning, self-regulatory behaviour and positive affect, while performance goals are associated with superficial learning, low self-regulation and negative affect (Dweck & Leggett, 1988; Smiley & Dweck, 1994). Mastery goals have been linked to higher levels of academic engagement (Pintrich, 2000; Pintrich & Schrauben, 1992), students who are task focused performing better in tasks requiring deeper processing (e.g. Elliott et al., 1999; Graham & Golan, 1991). These findings have been demonstrated across a range of subjects, although not all of the evidence supports the importance of mastery goals. For instance, Linnenbrink and

Pintrich (2002) found that while mastery goals did support conceptual change, performance goals did not inhibit it, while Elliot (2005) found that performance and mastery goals together were the most effective. The nature of the learning environment may be an important mediator here (Maehr & Midgley, 1991). Task and mastery focussed instructional practices seem to reduce the negative shifts in motivation which can occur following transitions between learning environments (Midgley et al., 1989).

Individual interest in a particular subject is a relatively stable student characteristic, although topic interest can be both individual and situational (Hidi, 2000), the latter generated by certain conditions and or environmental stimuli such as novelty and intensity (Schraw & Lehman, 2001). Interest has been related to comprehension (Alexander et al., 1994); recall of ideas, elaborations, and main ideas independent of prior knowledge (Schiefele, 1996); increased resources being devoted to learning (Schiefele & Rheinberg, 1997); and more effective use of those resources (Voss & Schauble, 1992).

Interest plays a major role in conceptual change generating motivation to understand and also enhance skills (Andre & Windschitl, 2003; Pintrich et al., 1993). Where learners are interested they provide richer answers about conflicting perspectives in text than disinterested learners (Mason & Boscolo, 2004) and are more likely to change incorrect conceptions when presented with refutational texts (Mason et al., 2008), although some students with high topic interest may be resistant to change (Dole & Sinatra, 1998; Murphy & Alexander, 2004).

The highest levels of motivation occur where the individual's identity becomes inextricably linked to the domain. Research on the personalities of young musicians has shown that those who emerged as the most highly accomplished appeared to be self-motivated almost to the point of obsession, as if they were unable to separate their developing self-perception from that of being a musician (Kemp, 1996). This level of commitment sustains the individual even when bullying or loss of popularity occurs as a result of their involvement in music (Howe & Sloboda, 1991).

Why do individuals develop particular interests? In music interest depends on the extent to which engaging with it satisfies internal motives and provides personal fulfilment. This may include the desire for achievement (Gellrich et al., 1986) and satisfying curiosity and self-actualisation (Motte-Haber, 1984). Music also induces emotions, provides opportunities for positive social responses to performance, may allow the exploration of aggressive drives through its requirement for the development of motor skills, and provides opportunities for some degree of exhibitionism (Nagel, 1987). Overall, musicians seem to derive considerable personal fulfilment from the act of making music, the balance of motives related to particular musical environments and also changing over time as individuals progress through their musical careers (Harnischmacher, 1997; Manturzewska, 1990; Sosniak, 1985). In other domains different factors may contribute to the development of interest.

Proposition 9: Transitions can pre-empt decisions about the areas of expertise to be developed

Transitions between learning environments may offer new opportunities for learners which can lead to a loss of motivation to continue pursuing existing areas of expertise, the break in continuity providing an opportunity for discarding domains where the individual has lost interest or feels that they are making insufficient progress. In fields where students have control over their participation, for instance, playing a musical instrument, several phases in the development of expertise have been identified (e.g. Harnischmacher, 1997; Manturzewska, 1990; Sosniak, 1985, 1990). Broadly, these suggest that learners move from musical participation being fun and playful, to formal instruction with designated practice time, until finally, they commit to pursuing activities on a full-time basis.

Research on choosing to take GCSE music as an option supports this showing that the key factors in opting for music are already playing an instrument and seeing music as a possible career (Little, 2009). Early on, the influence of warm and sympathetic teachers is important in developing interest and self-efficacy (Sloboda & Howe, 1991; Sosniak, 1985) with later teachers providing high status role models with whom young people can identify and emulate (Manturzewska, 1990). Those who choose to stop playing report perceiving themselves as less musically able, receiving less family encouragement, and feeling musically inadequate. They tend to turn to other leisure activities (Frakes, 1984) viewing continuing to play as demanding too great a time cost for the rewards (Hurley, 1995). They have insufficient personal interest to sustain them (Hallam, 1998).

Proposition 10: Emotions are crucial in determining the way that transitions between or within learning environments are negotiated

Transitions between learning environments are often viewed with mixed emotions. There may be sadness about leaving some things behind alongside positive anticipation of new activities, accompanied by a degree of apprehension. For instance, foundation level children report looking forward to moving to Year 1 but are anxious about being given hard work (Fisher, 2009). Students transferring to secondary school are generally positive about the move believing that the work will be more challenging and interesting, and that there will be opportunities to make new friends and learn new subjects (Yates, 1999). Anxiety about transfer tends to focus on five main issues:

- the size and complex organisation of the new environment;
- new forms of discipline and authority;
- new demands relating to academic work;
- the prospect of being bullied; and
- the possibility of losing friends (Measor & Woods, 1984).

Some learners have particular concerns about their personal safety (Wylie & Chalmers, 1999), while transitions from rural areas to urban boarding schools can be particularly anxiety provoking as there is the additional stress of leaving home (Baills & Rossi, 2001; Walsh, 1995).

Anxiety prior to transfer declines during the first year (Delamont & Galton, 1986) to be replaced by more long-term concerns about schooling (Delamont & Galton, 1987; Ward, 2000). The length of the period of adjustment depends on the child's approach, the coping strategies adopted and having adequate information (Cotterell, 1986). The personal and social effects of transition may be less significant now than they once were because more support is now offered by receiving institutions.

Proposition 11: Transitions between different learning environments frequently lead to a decline or no progress in the development of expertise

Transitions between different learning environments can lead to a worsening or no progress in the development of expertise. At transfer between primary and secondary school achievement declines (Ofsted, 2002; National Centre for Educational Studies, 1995; Galton et al., 1999, 2003). Galton and Willcocks (1983) found that 40 per cent of pupils scored less on basic skills' tests at secondary school than they had in the term before transition, while Galton et al. (1999, 2003) found that seven per cent of 11-year-olds showed a deterioration in reading, mathematics and language skills in their first secondary year, their marks dropping by a third in standardised tests compared with their final primary year. Any transition may cause a drop in achievement regardless of the age at which it takes place (Suffolk LEA, 1997). Where students make two transitions through middle school to secondary school the drop in attainment seems to occur twice (Alspaugh, 1998; Felner et al., 1981). Even within school progress can be variable for whole groups of children. Ofsted (2002) reported that students made insufficient progress between Years 6 and 9 and there are declines in reading, spelling and mathematics performance between children in Key Stage 1 and Key Stage 2 (Galton et al., 1999, 2003; Minnis et al., 1998).

Reported declines on transfer between schools may be related to the lack of opportunities to practice skills in the summer break. Cooper et al. (1996) in a meta-analysis found that the summer was particularly detrimental for performance in mathematics and spelling. This may be because these are less practised than reading during the holidays.

An additional factor in transfer to secondary school is the level of disillusionment at the lack of academic challenge (Green, 1997; Kirkpatrick, 1997; Ofsted, 2002). A QCA report supported this stating that pupils were held back by a 'dumbing' down of the science curriculum in the first year of secondary school (Thorton, 1999). Scottish students found that the secondary school workload was lower than many had expected including less homework (Fouracre, 1993), while in Australia, Green (1997) found a similar lack of challenge.

Most children adjust to a new school within six months and many regain losses in performance by their second year (Mertin et al., 1989; Sebba, 2000). Preparation for transfer may be important. Some students suggest that they would cope better if they had been given more challenging work in their previous school and had been taught more strategies for working independently (Green, 1997; Mizelle & Mullins, 1997).

Proposition 12: Discontinuity in curricula and pedagogy can disrupt the development of expertise

When transitions between and within institutions occur there tends to be discontinuity in the curriculum even when measures are taken to prevent this, for example, the introduction of national curricula (Gorwood, 1991; Hargreaves & Galton, 1999; Huggins & Knight, 1997; Kruse, 1995; Lee et al., 1995; Sutherland et al., 1996; Weston et al., 1992). Where pupils are required to study things that they believe they already know this can lead to boredom (Yates, 1999). How the curriculum content is organised and taught can also be challenging. At secondary level teaching is mainly subject based with different teachers for each subject. This represents a major change from primary school. An integrated curriculum can enhance grades in the first year of transfer although this enhancement tends to disappear in the following year (Campbell, 2001). Other changes in teaching approaches including an over-reliance on text books, lack of student collaboration and active learning, little reflection on the learning process, and an assumption that all students will benefit from the same thing at the same time can impact on student learning (Kruse, 1996).

Proposition 13: Learners may be distracted from a focus on the development of expertise during transitions between different learning environments

Transitions can distract learners from a focus on their developing expertise. Adjusting to a new environment, losing old friends, making new friends, and coping with a variety of teachers and their expectations about work all have to be coped with during transition in addition to learning about the new physical environment (Bates, 1998; Galton et al., 1999, 2003; Measor & Woods, 1984). Transitions require the acquisition of tacit knowledge about the new situation. Learning new rules and procedures takes time and cognitive effort (Delament & Galton, 1986; Hargreaves & Galton, 1999; Measor & Woods, 1984; Youngman, 1978) and reduces the time that could be spent in expertise development.

Some educational transitions also coincide with other changes. The move to secondary school in early adolescence may be influenced by transition to puberty (Anderman & Maehr, 1994), although this occurs at different ages for different children, as do transitions (McGee et al., 2003). During early adolescence learners have a developing sense of autonomy, independence, and self-determination and place more importance on social interactions (Eccles & Midgley, 1989; Simmons & Blyth, 1987). The way that schools respond to this may be important in maintaining progression, although in Australia where children report that they continue to be treated as children (Yates, 1999) and in the US where students report greater teacher respect and support (Murdock et al., 2000) transitions still impact on academic attainment.

One focus on transferring to a different learning institution is friendships (Day, 1996; Hargreaves, 1996). Disruption of existing friendships can interfere with success (Barone et al., 1991; Felner et al., 1981) and students may feel isolated during their first year after transition (National Center for Education Statistics, 1995). This applies on transition to higher education as well as secondary education (Hays & Oxley, 1986). In the transfer from foundation stage to Year 1 being with a friend was perceived as more important than any other positive factor, although having an older sibling already in the new environment helped. Young children also have concerns about social interactions in the playground (Fisher, 2009). At secondary school allocation to different ability groups can disrupt friendship groups, although this may be advantageous to attainment if it breaks associations that are not conducive to academic work (Schiller, 1999).

As learners progress through compulsory schooling motivation declines, particularly after transfers, even though learners report being excited about the possibility of new types of work (Anderman & Maehr, 1994; Eccles & Midgley, 1989; Galton & Willcocks, 1983; Hadden & Johnston, 1983; Roderick & Camburn, 1999; Spector & Gibson, 1991; Wigfield et al., 1991). Receiving schools tend to have lower expectations than contributing schools which may impact on motivation (Eccles & Wigfield, 1993; Galton & Wilcocks, 1983; Ofsted, 2002). The more impersonal, evaluative, formal, competitive and comparative environment of secondary schools may contribute to a decline in intrinsic motivation and commitment to learn (Harter et al., 1992). Attitudes to individual subjects, science, mathematics and English become less positive following transition (Hargreaves & Galton, 1999; Speering & Rennie, 2006; Suffolk LEA, 1997). Even pupils who do well in science do not appear to enjoy it (Shrigley, 1990). The decrease in interest in academic activities parallels an increase in interest in non-academic activities, including sport (Eccles & Wigfield, 1993). This may be because there are more opportunities to engage in a wider range of activities and because there is increased engagement with peers (Seidman et al., 2006).

Proposition 14: Failure to successfully negotiate transitions in learning environments can disrupt the development of expertise and lead to drop out

Difficulties in transitions are strongly related to the likelihood of school dropout (Roderick & Camburn, 1999). Lack of motivation to attend school and to learn effectively in formal education is an increasing problem in the developed world. In the UK, the formal curriculum for children aged 14 to 16 years is dominated by the need for success in General Certificate of Secondary Examinations (GCSE). However, a continuing minority of students fail to achieve any GCSE passes (DCSF, 2009a) some seeming to regard GCSEs as inappropriate or lacking relevance. This can lead to disaffection, under-achievement and truancy (Bayliss, 1999; Cullen et al., 2000). The latter is evidenced in high levels of unauthorised absence, in 2007/08 1.49 per cent, while persistent absentees (those having more than 63 sessions of absence during the year) in secondary schools accounted for 5.6 per cent of enrolments. The average rate of overall absence for persistent absentees in 2007/08 was 35 per cent, over five times the rate for all pupils (DCSF, 2009b). Not all children express their disaffection through non-attendance. Some behave in ways which lead to their exclusion from school either for a fixed term or permanently, the highest rates being for boys, pupils with Special Educational Needs, and some minority ethnic groups. There is also a positive relationship between eligibility for free school meals and exclusion rates, although there is variability between schools (DCSF, 2009c).

There are similar concerns about disaffection elsewhere in the Western world. For instance, in the US there are high levels of student boredom and disaffection and high drop-out rates in urban areas (National Research Council & Institute of Medicine, 2004). Students report viewing school as boring or as a mere grade game where they try to get by with as little effort as possible (Burkett, 2002) with motivation declining particularly in the higher grade levels (Eccles et al., 1984; Fredricks & Eccles, 2002).

Proposition 15: Some individuals are more at risk during transitions than others

Some children are vulnerable throughout their educational careers and particularly at times of transition. These include summer-born children, boys, those eligible for free school meals, those with Special Educational Needs, those less fluent in English, and some minority ethnic groups (Fisher, 2009; Minnis et al., 1998). Similar characteristics of at risk students have been identified internationally (Kleese & D'Onofrio, 1994; Lehr et al., 2004; Presseisen, 1991; Redick & Vail, 1991; Steinberg et al., 1992). A review of data from 15 countries in Europe found that pupils with emotional, social and/or behavioural difficulties were regarded as presenting the greatest challenge (Meijer, 2001).

Educational implications

Learners have to negotiate a wide range of transitions as they go through the process of developing expertise. These transitions not only relate to changes in learning environments but also to changes in thinking: in particular domains; about knowledge itself; the nature of learning and understanding; and self-beliefs. Educational systems can be structured so as to support learners as they negotiate these transitions and minimise disruption to the development of expertise. Frequently they are not.

Studies of the development of expertise have tended to focus on the individual. Many of the domains studied fall outside or are on the periphery of formal compulsory education, for instance, music, ballet, sport, motor skills, chess, exceptional memory. Other domains have been studied at professional levels, for example, medicine, writing, software design, history. Where the domain is a central focus of mainstream education, for example, mathematics, the individuals studied have tended to be those exhibiting exceptional skills. There has been little longitudinal or cross-sectional research focusing on the development of expertise within a mainstream educational context over the long term. The focus has tended to be on attainment in the short term relative to particular educational phases. There is clearly potential for research taking a longer perspective.

A key characteristic of developing expertise is automaticity. Increasing automaticity depends on practice. This is particularly important in relation to the basic skills which underpin much other learning. For automaticity to develop individuals need to spend a great deal of time engaging with these activities. Encouraging engagement with literacy, numeracy and ICT skills as hobbies in their own right or as contributing to other hobbies is, therefore, important.

The provision of formative feedback has long been acknowledged as important in the development of expertise. Recently there have been attempts to raise the profile of this in formal education through the 'Assessment for Learning' programme based on the work of Black and Wiliam (1998). The programme assumes that learners learn best when: they understand clearly what they are trying to learn, and what is expected of them; are given feedback about the quality of their work and what they can do to make it better; are given advice about how to go about making improvements; and are fully involved in deciding what needs to be done next, and who can give them help if they need it. An evaluation of the 'Assessment is for Learning' programme in Scotland found that it enhanced pupil learning by changing teaching and giving learners more responsibility for their own learning. The effects were particularly marked for students with lower levels of expertise relative to their peers. Those with higher levels had frequently already developed the necessary metacognitive skills themselves (Hallam et al., 2004).

Other programmes have focused more directly on teaching thinking skills (McGuiness, 1999), for instance, the 'Instrumental Enrichment' programme (Feuerstein et al., 1980), the Philosophy for Children programme (Lipman, 1991), and the CASE programme (Cognitive Acceleration Through Science Education) developed by Adey and Shayer (1994). All of these have been shown to have a positive impact on the quality of thinking. The CASE programme, in particular, has shown long-term benefits with far transfer from science where it was implemented to attainment in mathematics and English (Adey, 2005).

Conceptual change, particularly where it involves re-categorisation, can be particularly problematic. Considered within an expertise framework previously learned material has to be unlearned requiring the construction of new neural connections and the dismantling of existing ones. One way to avoid this would be to introduce scientific concepts in such a way that these changes were not necessary. This might be achieved by introducing concepts early so that naive conceptions had little opportunity to develop while also avoiding oversimplification leading to misunderstandings. This would require teachers to have high levels of expertise themselves. In science, even at secondary school, particularly in physics, where the greatest difficulties occur, this is not always the case. Where concepts have been misunderstood, the evidence suggests that explaining to students that they have to make radical changes in their thinking alongside the use of refutational materials is effective.

Individuals who exhibit the highest levels of expertise show an almost obsessive interest in the domain from a very early age (see Ericsson et al., 2006). Butterworth (2006) considering exceptional calculators found that they had an obsession with numbers from the time that they could count, including counting the number of free drinks bought and the number of grains of corn fed to chickens. Interestingly one calculator became de-motivated at school because the teacher did not explain the concepts in ways that he could understand. Interest can arise from activities that exist within the family. If this is not the case the family frequently support activities once interest becomes apparent. This is particularly important where specialist training and resources are required. We know relatively little about what engenders interest in young children and why some children do not seem to develop any specific interests in academic or other domains. This is clearly an area which requires more research. If all children developed an interest to which they became committed, at which they could succeed, and which supported the development of a range of metacognitive and regulatory skills and increased self-confidence and motivation, this might have more general benefits across the whole curriculum. In the UK, some Government initiatives have been developed to address this issue, for instance, 'Find your Talent'. A range of voluntary organisations also offer opportunities to disaffected young people. For such initiatives to be successful the individual has to be sufficiently engaged for the activity to become part of their identity a 'serious leisure' pursuit to which time and resources are committed. For the greatest benefit, such activities would need to be identified early in educational trajectories with commitment made before transfer to secondary school.

Transitions can become problematic if an identity in one context does not transfer to another. Having to reconstruct an identity can disrupt a viable way of being and this can make transitions stressful and demotivating (Lam & Pollard, 2006; Osborn et al., 2006; Pollard & Filer, 1999). Agency, a means of taking control, requires self-direction, self-efficacy, opportunities to exercise autonomy and a desire to shape the future. Developing agency, it could be argued should be one aim of education. Enabling children to learn more about themselves and the ways that they interact with others can contribute to a developing sense of agency. In the UK, the Social and Emotional Aspects of Learning (SEAL) programme is a curriculum resource for use in schools which aims to develop the underpinning qualities and skills that help promote self-awareness, managing feelings, motivation, empathy and social skills. The materials promote understanding another's point of view, working in a group, sticking at things when they get difficult, resolving conflict and managing worries. They are organised into seven themes: New Beginnings; Getting on and falling out; Say no to bullying; Going for goals!; Good to be me; Relationships; and Changes. This programme has been successful in primary schools in promoting well-being and engendering a more positive school climate (Hallam et al., 2006). It remains to be seen if the early success of the programme is maintained in the long term and whether it has an impact on the extent to which participants feel increased agency with regard to their futures.

The home environment has been identified as a key source of support in the development of high levels of expertise and in supporting transitions. Where the student's home environment is aligned with that of the school transition is more effective and in the long term students achieve more (Catterall, 1998; Falbo et al., 2001; Rice, 2001). The importance of parents showing interest in their children's education has long been recognised (Desforges & Abouchaar, 2003) and a number of initiatives have been developed to encourage it. The difficulty is that the children who need the most support often have parents who are least able to give it. This is the issue that needs addressing.

The decline in levels of attainment following transitions between institutions may in part be due to the preceding vacation period, although there are clear issues relating to curriculum continuity. Those teaching in receiving institutions are frequently faced with a group of learners who have different levels of expertise. There is, therefore, a tendency for teachers to begin from a point where they are confident that all learners have prior knowledge and move on from there. At secondary school, this issue is often resolved by testing students soon after transfer and allocating them to highly structured ability groups based on this assessment. This can be counterproductive in the short and long term if it leads to a passive acceptance of the limits of what can be attained for those who are not in the top ability groups (see McManus, 2007). The best option seems to be the implementation of setting in a limited number of subjects where progress crucially depends on building on prior knowledge, for example, mathematics.

As learners make transitions between different educational environments they lose focus on learning and can become distracted by coping with the new environment, making new friends and engaging in new social interactions. This is to some extent inevitable but receiving institutions need to try to redress the balance and make the curriculum exciting and challenging. What motivates learners is inspiring teaching and teachers who are enthusiastic and interested in their subject (Day et al., 2008). This would seem to be crucially important at transition points. In addition, schools need to monitor each student's progress carefully to ensure that the development of expertise is not disrupted. If progression is not being made then steps need to be taken immediately to address any underlying problems. Ideally, each student needs to agree individual targets and progress towards these needs to be monitored. If they are not being met a discussion needs to take place with the learner to explore the reasons for this, and a set of interventions put in place to address the problems. This may involve drawing on resources within the school, for instance, learning support, or outside agencies, for instance, social services (see Hallam, 2007).

Research within the expertise paradigm has often neglected consideration of what leads individuals to discontinue their pursuit of particular areas of expertise. There are some exceptions to this. Research on drop out in instrumental music suggests that the causes are similar to those leading to drop out from mainstream education including lack of perceived success in the domain, greater success elsewhere and diminishing interest. These are often associated with other factors, for instance, low socio-economic status, lack of general educational success, and minority status. Additional support needs to be available to children in these vulnerable groups to assist them where their circumstances are not conducive to developing high levels of expertise and to prevent drop out either through not attending or through the expression of frustration in poor behaviour leading to exclusion. Pupils at risk are increasingly being identified in Western educational systems and a range of countries have developed programmes that address their needs (Chapman & Sawyer, 2001; Holmes, 2000; McElroy, 2000). In the UK, the key elements of good practice in the support of pupils at risk during the transition process from primary to secondary school include: beginning the intervention prior to transition; involvement of the primary school SENCO and effective liaison with the secondary school SENCO; effective transfer of information and understanding of the pupils' needs so that support structures are in place from the start in the secondary school; continuing the transition programme in the secondary school to allow time for the pupil to settle in; and the use of learning support facilities (Hallam & Rogers, 2008). Pupils at risk of dropping-out or being excluded are amongst the most vulnerable in society and although there have been increasing attempts to provide support for them during transitions these initiatives do not address the fundamental systemic problems. Educational systems need to be more responsive to the needs of all children. This requires consideration of the curriculum and its appropriateness and changing systems which by their very nature send out negative messages to some groups of learners.

Overall, the solution to ensuring the more effective development of expertise and negotiation of the transitions required to achieve it is to adopt a more individualised approach to learning. This is possible and has been adopted with highly successful results in the past in relation to the teaching of geography (see Hughes, 1993). Currently available technologies can also facilitate this. In the UK, moving in this direction, the Government introduced the idea of personalised learning. *The Teaching and Learning in 2020 Review* (Gilbert et al., 2006) focused on a pedagogy of personalised learning with nine key features: high quality teaching and learning; target setting and tracking; focused assessment; intervention; pupil grouping; the learning environment; curriculum organisation; the extended curriculum; and supporting children's wider needs. Research considering the implementation of a smaller number of the elements of 'personalised learning' (assessment for learning, effective learning and teaching, curriculum entitlement and choice, school as learning organisation and beyond the classroom) (Sebba et al., 2007) indicated that elements of the programme had been implemented in some schools but that the implementation had not radically changed the way that schools operated.

It may be that children themselves are the ones who have a better vision of how personalised learning might operate in the future. An international project, *Developing Visions of the School of the Future* brought together 70 students from 12 countries to generate ideas (British Council, 2009). Their conclusions focused on a number of key issues which are set out below. Their vision for social cohesion suggested that:

- schools should be multicultural and multiregional, with equal opportunities for everyone, with classes meeting the needs of all students;
- classes should be mixed in relation to social background, race and religion. Students with special educational needs should be integrated;
- learning should be international providing opportunities for learning different languages and about different cultures;
- there should be international schools to promote international understanding and cross-cultural awareness.

The students stressed the importance of technology, relevance and flexibility in relation to learning and teaching:

- challenge should be seen as normal and not to be feared;
- learning should be possible through virtual environments providing a balance between technological and face-to-face teaching with a greater use of technology in school settings;
- learning should take place in and out of school, in school to learn to co-operate, interact, build up social skills and manage time, out of school with e-learning and multimedia available at any time in any place alongside visits, trips, exchanges, field work, work experience, and project work;
- there should be more technology-based independent learning freeing up teachers to support students;
- classes should be small and based on levels of expertise, with flexibility, choice and learning of academic and non-academic skills;
- assessment should enable students to feel confident about what they have achieved and to see how to improve;
- parents should be educated on how to support learning with clearer and better communication between parents and teachers.

The students wanted to be viewed as customers with the opportunity to contribute to decisions about curricula, pedagogy and the design of the school. They wanted space to be used better to enable students to integrate and relax in a secure eco-friendly environment and suggested that the resources of other agencies should be involved in education to deal with issues such as bullying, drugs, and personal support. They recognised that teacher training would need to change to enable teachers to change their perceptions of learning, with a greater emphasis on psychology, learning to learn, personalised learning and catering for students with different needs.

The challenge is how to move towards this vision which more truly individualises educational provision providing support for the development of expertise and successful negotiation of transitions. This will not be easy given that existing systems were developed to meet the needs of industrialised societies not those which are globalised and multicultural with high levels of technological development. This transition will require radical conceptual change within the education community, much unlearning of previously held assumptions and practices, and the development of radical new approaches.

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References

Adey, P. (2005). Issues arising from the long-term evaluation of the Cognitive Acceleration Programme. *Research in Science Education, 35*, 2–22.

Adey, P. & Shayer, M. (1994). *Really raising standards: Cognitive intervention and Academic Achievement.* London: Routledge.

Akin, O. (1980). *Models of architectural knowledge.* London: Pion.

Alexander, P.A. (1997). Mapping the multidimensional nature of domain learning: The interplay of cognitive, emotional and strategic forces. In M.L. Maehr & P.R. Pintrich (Eds.), *Advances in motivation and achievement* (Vol. 10, pp.213–250). Greenwich, CT: JAI Press.

Alexander, P.A. (2003). The development of expertise: The journey from acclimation to proficiency. *Educational Researcher, 32*(8), 10–14.

Alexander, P.A., Kulikowich, J.M. & Schulze, S.K. (1994). The influence of topic knowledge, domain knowledge, and interest on the comprehensive of scientific exposition. *Learning and Individual Differences, 6*, 379–397.

Alexander, P.A. & Sinatra, G.M. (2007). First steps: Scholars' promising movements into a nascent field of inquiry. In S. Vosniadou, A. Baltas & X Vamvakoussi (Eds.), *Reframing the conceptual change approach in learning and instruction* (pp.221–236). Amsterdam: Elsevier.

Alspaugh, J.W. (1998). Achievement loss associated with the transition to middle school and high school. *Journal of Educational Research, 92*(1), 20.

Altenmuller, E.O., Gruhn, W., Parlitz, D. & Kahrs, J. (1997). Music learning produces changes in brain activation patterns: A longitudinal DC-EEG-study unit. *International Journal of Arts Medicine, 5*, 28–34.

Altenmuller, E.O. (2003). How many music centres are in the brain? In I. Peretz & R. Zatorre (Eds.), *The cognitive neuroscience of music* (pp.346–356). Oxford: Oxford University Press.

Alvermann, D. & Hynd, C. (1989). Effects of prior knowledge activation modes and text structure on non-science majors' comprehension of physics. *Journal of Educational Research, 83*, 97–102.

Anderman, E.M. & Maehr, M.L. (1994). Motivation and schooling in the middle grades. *Review of Educational Research, 64*(2), 287–309.

Andre, T. & Windschitl, M. (2003). Interest, epistemological belief, and intentional conceptual change.In G.M. Sinatra & P.R. Pintrich (Eds.), *Intentional conceptual change* (pp.173–193). Mahwah, NJ: Erlbaum.

Baills, L. & Rossi, T. (2001). The transition from isolated, rural contexts to boarding school: Can school physical education and sport play a part? *Journal of Physical Education New Zealand, 34*(1), 40.

Barone, C.A., Guire-Deandeis, A.I. & Trickett, E.J. (1991). Mean-ends problem solving skills, life stress, and social support as mediators of adjustment in the normative transition to high school. *American Journal of Community Psychology, 19*(2), 207–225.

Bates, P.J. (1998). *Multimedia in education: The transition from primary to secondary schools.* PJB Associates, UK for STOA, European Parliament, Luxembourg.

Bayliss, V. (1999). *Opening Minds: Education for the 21st century. The final report of the RSA Project: Redefining the curriculum.* London: RSA.

Biggs, J.B. (1987). *Student approaches to learning and studying.* Hawthorn, Victoria: Australian Council for Educational Research.

Biggs, J.B. (1993). What do inventories of students' learning processes really measure? A theoretical review and clarification. *British Journal of Educational Psychology, 63*, 3–19.

Bishop, B.A. & Anderson, C.W. (1990). Student conceptions of natural selection and its role in evolution. *Journal of Research in Science Teaching, 27*(5), 415–427.

Black, P. & Wiliam, D. (1998). *Inside the Black Box: Raising standards through classroom assessment.* London: Department of Professional Studies, King's College.

Boyle, E.A., Duffy, T. & Dunleavy, K. (2003). Learning styles and academic outcome: The validity and utility of Vermunt's Inventory of Learning Styles in a British higher education setting. *British Journal of Educational Psychology, 73*, 267–290.

British Council (2009). *Developing visions of the school of the future.* International Conference, 1–3 March, Budapest.

Broughton, S.H., Sinatra, G.M. & Reynolds, R.E. (2007). *The refutation text effect: Influence on learning and attention.* Paper presented at the Annual Meeting of the American Educational Researchers Association, Chicago, Illinois.

Brown, A. (1987). Metacognition, executive control, self-control, and other mysterious mechanisms. In F. Weinert & R. Kluwe (Eds.), *Metacognition, motivation, and understanding* (pp.65–116). Hillsdale, NJ: Erlbaum.

Burkett, E. (2002). *Another planet: A year in the life of a suburban high school.* New York: Harper Collins.

Butterworth, B. (2006). Mathematical expertise. In K.A. Ericsson, N. Charness, P.J. Feltovich & R.R. Hoffan (Eds.), *The Cambridge handbook of expertise and expert performance* (pp.553–569). Cambridge: Cambridge University Press.

Campbell, H. (2001). Easing the transition to high school. *The Education Digest, 67*(1), 12–18.

Cantor, N., Markus, H., Niedenthal, P. & Nurius, P. (1986). On motivation and the self-concept. In R.M. Sorrentino & E.T. Higgins (Eds.), *Motivation and cognition: Foundations of social behaviour* (pp.96–164). New York: Guilford Press.

Cantor, N., Norem, J.K., Brower, A.M., Niedenthal, P.M. & Langston, C.A. (1987). Life tasks, self-concept ideals, and cognitive strategies in a life transition. *Journal of Personality and Social Psychology, 53*(6), 1178–1191.

Carey, S. (1985). *Conceptual change in childhood.* Cambridge, MA: MIT Press.

Carey, S. (1991). Knowledge acquisition: Enrichment or conceptual change? In S.Carey & R. Gelman (Eds.), *The epigenisis of mind: Essays on biology and cognition.* Hillsdale, NJ: Erlbaum.

Catterall, J.S. (1998). Risk and resilience in student transition to high school. *American Journal of Education, 106*(2), 302–333.

Chapman, M.V. & Sawyer, J.S. (2001). Bridging the gap for students at risk of school failure: A social work-initiated middle to high school transition programme. *Children and Schools, 23*(4), 235.

Chase, W.G. & Simon, H.A. (1973). Perception in chess. *Cognitive Psychology, 4*, 55–81.

Chi, M.T.H., Feltovitch, P.J. & Glaser, R. (1981). Categorisation and representation of physics problems by experts and novices. *Cognitive Science, 5*, 121–125.

Chi, M.T.H., Glaser, R. & Rees, E. (1982). Expertise in problem solving. In R. Sternberg (Ed.), *Advances in the psychology of human intelligence* (Vol. 1, pp.17–76). Hillsdale, NJ: Erlbaum.

Chi, M.T.H. & Slotta, J. (1993). The ontological coherence of intuitive physics: Commentary on diSessa's 'Toward an epistemology of physics'. *Cognition and Instruction, 10,* 249–260.

Chi, M.T.H., de Leeuw, N., Chiu, M.H. & La Vancher, C. (1994). Eliciting self-explanations improves understanding. *Cognitive Science, 5*, 121–152.

Chi, M.T.H. (2006). Two approaches to the study of expert characteristics. In K.A. Ericsson, N. Charness, P.J. Feltovich & R.R. Hoffman (Eds.), *The Cambridge handbook of expertise and performance.* Cambridge: Cambridge University Press.

Chi, M.T.H. (2008). Three types of conceptual change: Belief revision, mental model transformation and categorical shift. In S. Vosniadou (Ed.), *International handbook of research on conceptual change* (pp.61–82). London: Routledge.

Chinn, C.A. & Brewer, W.F. (1993). The role of anomalous data in knowledge acquisition: A theoretical framework and implications for science instruction. *Review of Educational Research, 63*, 1–49.

Collins, D. (2005). A synthesis process model of creative thinking in composition. *Psychology of Music, 33*(2), 193–216.

Cooper, H., Nye, B., Charlton, K., Lindsay, J. & Greathouse, S. (1996). The effects of summer vacation on achievement test scores: A narrative and meta-analytic review. *Review of Educational Research, 66*(3), 227–268.

Cotterell, J.L. (1986). The adjustment of early adolescent youngsters to secondary school: Some Australian findings. In M.B. Youngman (Ed.), *Middle schooling transfer: Problems and proposals.* London: NFER Nelson.

Cullen, M.A., Fletcher-Campbell, F., Bowen, E., Osgood, J. & Kelleher, S. (2000). *Alternative education provision at Key Stage 4.* Slough: NFER/LGA.

Day, J. (1996). School friendship groups and their impact on learning. *Education 3-13, 24*(1), 51–58.

Day, C., Sammons, P., Kington, A., Regan, E., Ko, J., Brown, E., Gunraj, J. & Robertson, D. (2008). *Effective classroom practice: A mixed method study of influences and outcomes: Full Research Report, ESRC End of Award Report, RES-000-23-1564.* Swindon: ESRC.

De Groot, A. (1965). *Thought and choice in chess.* The Hague: Mouton.

DeGroot, A. (1966). Perception and memory versus thought: Some old ideas and recent findings. In B. Kleinmuntz (Ed.), *Problem solving* (pp.19–50). New York: Wiley.

Delamont, S. & Galton, M. (1986). *Inside the secondary classroom.* London: Routledge & Kegan Paul.

Delamont, S. & Galton, M. (1987). Anxieties and anticipations: Pupils views of transfer to secondary school. In A. Pollard (Ed.), *Children and their primary schools: A new perspective* (pp.236–251). London: Falmer.

Department for Children, Schools and Families (2009a). *GCSE and equivalent results in England: 2008/09.* London: DCSF.

Department for Children, Schools and Families (2009b). *Pupil absence in schools in England including pupil characteristics: 2007/08.* London: DCSF.

Department for Children, Schools and Families (2009c). *Permanent and fixed period exclusions from schools and exclusion appeals: England 2007/08.* London: DCSF.

Desforges, C. & Abouchaar, A. (2003). *The impact of parental involvement, parental support and family education on pupil achievement and adjustment: A literature review.* London: Department for Education and Skills.

Diakidoy, I.N. Kendeou, P & Ioannides, C. (2003). Reading about energy: The effects of text structure in science learning and conceptual change. *Contemporary Educational Psychology, 28,* 335–356.

diSessa, A. (1993). Toward an epistemology of physics. *Cognition and Instruction, 10*(2/3). 105–223.

Dole, J.A. & Sinatra, G.M. (1998). Reconceptualising change in the cognitive construction of knowledge. *Educational Psychologist, 33*(2/3). 109–128.

Dweck, C.S. & Bempechat, J. (1983). Children's theories of intelligence. In S. Paris, G. Olsen & H. Stevenson (Eds.), *Learning and motivation in the classroom* (pp.239–256). Hillsdale, NJ: Erlbaum.

Dweck, C.S. (1986). Motivational processes affecting learning. *American Psychologist, 41,* 1040–1048.

Dweck, C.S. & Leggett, E.L. (1988). A social cognitive approach to motivation and personality. *Psychological Review, 95*(2), 256–373.

Eccles, J.S., Midgley, C. & Adler, T.F. (1984). Grade-related changes in school environment: Effects on achievement motivation. In J.G. Nicholls (Ed.), *Advances in motivation and achievement* (pp.283–331). Greenwich, CT: JAI Press.

Eccles, J.M. & Midgley, C. (1989). Stage/ environment fit: Developmentally appropriate classrooms for young adolescents. In R. Ames & C. Ames (Eds.), *Research on motivation in education.* Orlando, FL: Academic Press.

Eccles, J.M. & Wigfield, A. (1993). Negative effects of traditional middle schools on students motivation. *Elementary School Journal, 93*(5), 553–574.

Egan, D.E. & Schwartz, B.J. (1979). Chunking in recall of symbolic drawings. *Memory and Cognition, 7,* 149–158.

Elbert, T., Pantev, C., Wienbruch, C. Rockstroh, B. & Taub, E. (1995). Increased cortical representation of the fingers of the left hand in string players. *Science, 270,* 305–306.

Elliott, A.J. (2005). A conceptual history of the achievement goal construct. In A.J. Elliott & C.S. Dweck (Eds.), *Handbook of competence and motivation* (pp.52–72). New York: Guilford Press.

Elliott, A.J., McGregor, H.A. & Gables, S. (1999). Achievement goals, study strategies, and exam performance: A meditational analysis. *Journal of Educational Psychology, 91,* 549–563.

Entwistle, N.J. & McCune, V. (2004). The conceptual bases of inventories measuring study strategies in higher education. *Educational Psychology Review, 16,* 325–346.

Entwistle, N.J. & Ramsden, P. (1983). *Understanding student learning.* London: Croom Helm.

Entwistle, N.J., Hounsell, D., Anderson, C., Beaty, L., Bromage, A., Counsin, G., Day, K., Hounsell, J., Land, R., Litjens, J., McCune, V., Meyer, E., Nisbet, J. & Reimann, N. (2007). *Learning and teaching at University: The influence of subjects and settings – TLRP Research Briefing 31.* London: TLRP.

Ericsson, K.A. (2006). The influence of experience and deliberate practice on the development of superior expert performance. In K.A. Ericsson, N. Charness, P.J. Feltovich & R.R. Hoffan (Eds.), *The Cambridge handbook of expertise and expert performance* (pp.683–703). Cambridge: Cambridge University Press.

Ericsson, K.A., Charness, N., Feltovich, P.J. & Hoffan, R.R. (Eds.) (2006). *The Cambridge handbook of expertise and expert performance.* Cambridge: Cambridge University Press.

Ericsson, K.A. & Chase, W.G. (1982). Exceptional memory. *American Scientist, 6,* 607–612.

Ericsson, K.A., Krampe, R.T. & Tesch-Romer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review, 100*(3), 363–406.

Ericsson, K.A. & Lehmann, A.C. (1996). Expert and exceptional performance: evidence on maximal adaptations on task constraints. *Annual Review of Psychology, 47,* 273–305.

Evans, K. (2002). Taking control of their lives? Agency in young adult transitions in England and the new Germany. *Journal of Youth Studies, 5,* 245–269.

Falbo,T., Lein, L. & Amador, N.A. (2001). Parental involvement during the transition to high school. *Journal of Adolescent Research, 16*(5), 511–529.

Felner, R.D., Primavera, D. & Cauce, A.M. (1981). The impact of school transitions: A focus for preventative efforts. *American Journal of Community Psychology, 9*(4), 449–459.

Feuerstein, R., Rand, Y., Hoffman, M. & Miller, R. (1980). *Instrumental enrichment: Redevelopment of cognitive functions in retarded performers.* New York: University Park Press.

Fields, R.D. (2005). Making memories stick. *Scientific American*, February, 75–81.

Fisher, J.A. (2009). We used to play in Foundation, it was more funner: Investigating feelings about transition from Foundation Stage to Year 1. *Early Years, 29*(2), 131–145.

Fitts, P.M. & Posner, M.I. (1967). *Human performance.* Belmont, CA: Brooks Cole.

Flavell, J.H. (1976). Metacognitive aspects of problem solving. In L.B. Resnick (Ed.), *The nature of intelligence* (pp.231–236). Hillsdale, NJ: Erlbaum.

Flavell, J.H. (1979). Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry. *American Psychologist, 34*(10), 906–911.

Fouracre, S. (1993). *Pupils' expectations of the transition from primary to secondary school.* Research in Education, Edinburgh, The SCRE Centre: Research Briefing no. 53.

Frakes, L. (1984). *Differences in music achievement, academic achievement, and attitude among participants, drop-outs and non-participants in secondary school music.* PhD Thesis, University of Iowa.

Fredricks, J.A. & Eccles, J.S. (2002). Children's competence and value beliefs from childhood to adolescence: Growth trajectories in two 'male-typed' domains. *Journal of Developmental Psychology, 38*, 519–533.

Galton, M., Gray, J. & Rudduck, J. (1999). *The impact of school transitions and transfers on pupil progress and attainment. Research Report 131.* London: The Stationery Office.

Galton, M., Gray. J. & Rudduck. J. (2003). *Transfer and transitions in the middle years of schooling (7–14): Continuities and discontinuities in learning. Research Report 443.* London: DfES.

Galton, M. & Willcocks, J. (1983). Changing teachers and changing schools. In M. Galton & J. Wilcocks (Eds.), *Moving from the primary classroom.* London: Routledge & Kegan Paul.

Gellrich, M. Osterwold, M. & Schulz, J. (1986). Leistungsmotivation bei Kindern im Instumentalunterricht. Bericht uber eine erkundungsstudie (Children's performance motivation in instrumental teaching). *Musikpsychologie, 3*, 33–69.

Giddens, A. (1991). *The consequences of modernity.* Cambridge: Polity Press.

Gilbert, C., August, K., Brooks, R., Hancock, D., Hargreaves, D., Pearce, N., Roberst, J., Rose, J. & Wise, D. (2006). *2020 Vision: Report of the teaching and learning by 2020 Review Group.* Nottingham: DfES Publications.

Gilhooly, K.J., McGeorge, P., Hunter, J., Rawles, J.M., Kirby, I., Green, C. & Wynn, V. (1997). Biochemical knowledge in diagnostic thinking: The case of the electrocardiogram (ECG) interpretation. *European Journal of Cognitive Psychology, 9*, 199–223.

Glaser, R. & Chi, M.T.H. (1988). Overview. In M.T.H. Chi, R. Glaser & M.J. Farr (Eds.), The nature of expertise (pp.xv–xxviii). Hillsdale, NJ: Erlbaum.

Glastra, F. Hake, B. & Schedler, P. (2004). Lifelong learning as transitional learning. *Adult Education Quarterly, 54*, 291–307.

Glenberg, A.M. & Epstein, W. (1987). Inexpert calibration of comprehension. *Memory and Cognition, 15*, 84–93.

Gobet, F. & Charness, N. (2006). Expertise in chess. In K.A. Ericsson, N. Charness, P.J. Feltovich & R.R. Hoffan (Eds.), *The Cambridge handbook of expertise and expert performance* (pp.523–538). Cambridge: Cambridge University Press.

Gorwood, B. (1991). Primary-secondary transfer after the national curriculum. *School Organisation, 11*(3), 283–290.

Grabner, R.H., Neubauer, A.C. & Stern, E. (2006). Superior performance and neural efficiency: The impact of intelligence and expertise. *Brain Research Bulletin, 69*, 422–439.

Graham, S. & Golan, S. (1991). Motivational influences on cognition: Task involvement, ego involvement, and depth of processing. *Journal of Educational Psychology, 83*, 187–194.

Green, P. (1997). Moving from the world of the known to the unknown: The transition from primary to secondary school. *Melbourne Studies in Education, 38*(2), 67–83.

Guzzetti, B.J., Snyder, T.E., Glass, G.V. & Gamas, W.S. (1993). Promoting conceptual change in science: A comparative meta-analysis of instructional interventions from reading education and science education. *Reading Research Quarterly, 28*, 117–159.

Hadden, R.A. & Johnston, A.H. (1983). Secondary school pupils' attitudes to science: The year of erosion. *European Journal of Science Education, 5*(3), 309–318.

Hallam, S. (1995). Professional musicians' orientations to practice: Implications for teaching. *British Journal of Music Education, 12*(1), 3–19.

Hallam, S. (1998). Predictors of achievement and drop-out in instrumental tuition. *Psychology of Music, 26*(2), 116–132.

Hallam, S. (2001a). The development of metacognition in musicians: Implications for education. *British Journal of Music Education, 18*(1), 27–39.

Hallam, S. (2001b). The development of expertise in young musicians: Strategy use, knowledge acquisition and individual diversity. *Music Education Research, 3*(1), 7–23.

Hallam, S., Kirton. A., Peffers, J., Robertson, P. & Stobart, G. (2004). *Final Report of the Evaluation of Project 1 of the Assessment is for Learning Development Programme: Support for Professional Practice in Formative Assessment.* Edinburgh: Scottish Executive.

Hallam, S. (2005). *Enhancing learning and motivation through the life span.* London: Institute of Education.

Hallam, S. Shaw, J. & Rhamie, J. (2006). *Evaluation of the Primary Behaviour and Attendance Pilot. Research Report 717.* London: Department for Education and Skills.

Hallam, S. (2007). Alan Roach. In National College for School Leadership: The Teaching Awards. *Inspiring Minds: Ten case studies of teaching award headteachers* (pp.35–41). London: NCSL.

Hallam, S. & Rogers, L. (2008). *Improving behaviour and attendance at school.* Maidenhead: McGraw Hill/Open University Press.

Hargreaves, A. (1996). Revisiting voice. *Educational Researcher, 25*(1), 12–19.

Hargreaves, A & Galton, M. (Eds.) (1999). *Moving from the primary classroom: 20 years on.* London: Routledge.

Harnischmacher, C. (1997). The effects of individual differences in motivation, volition, and maturational processes on practice behaviour of young instrumentalists. In H. Jorgensen & A. Lehman (Eds.), *Does practice make perfect? Current theory and research on instrumental music practice.* Oslo: NMH publikasjoner 1997, 1, Norges musikkh gskole.

Harter, S. (1985). Competence as a dimension of self-evaluation: Toward a comprehension model of self-worth, In R. Leahy (Ed.), *The development of the self.* New York: Academic Press.

Harter, S., Whitesell, N.R. & Kowalski, P. (1992). Individual differences in the effects of educational transitions on young adolescent's perceptions of competence and motivational orientation. *American Educational Research Journal, 29*, 777–807.

Hartman, H.J. (Ed.) (2001). *Metacognition in learning and instruction: Theory, research and practice.* Dordrecht, The Netherlands: Kluwer Academic.

Hatano, G. & Inagaki, K. (1986). Two courses of expertise. In H. Stevenson, H. Azmuma & K. Hakuta (Eds.), *Child development and education in Japan* (pp.262–272). New York: WW Freeman & Co.

Hays, R.B. & Oxley, D. (1986). Social network development and functioning during a life transition. *Personality and Social Psychology, 50*(2), 305–313.

Hecht, H. & Proffitt, D. (1995). The price of expertise: Effects of experience on the water-level task. *Psychological Science, 6*, 90–95.

Hidi, S. (2000). An interest researcher's perspective: The effect of instrinsic and extrinsic factors on motivation. In C Sansone & J.M. Harackiewicz (Eds.), *Intrinsic and extrinsic motivation* (pp.309–339). San Diego, CA: Academic Press.

Higgins, E.T., Klein, R. & Strauman, T. (1985). Self-concept discrepancy theory: A psychological model for distinguishing among different aspects of depression and anxiety. *Social Cognition, 3*, 51–76.

Hinds, P.J. (1999). The curse of expertise: The effects of expertise and debiasing methods on prediction of novice performance. *Journal of Experimental Psychology: Applied, 5*, 205–221.

Hobus, P.P.M., Schmidt, H.G., Boshuizen, H.P.A. & Patel, V.L. (1987). Context factors in the activation of first diagnostic hypotheses: Expert-novice differences. *Medical Education, 21*, 471–476.

Hofer, B.K. (2002). Personal epistemology as a psychological and educational construct: An introduction. In B.K. Hofer & P.R. Pintrich (Eds.), *Personal epistemology: The psychology of beliefs about knowledge and knowing* (pp.3–14). Mahwah, NJ: Erlbaum.

Hofer, B.K. & Pintrich, P.R. (Eds.) (2002). *Personal epistemologies: The psychology of beliefs about knowledge and knowing.* Mahwah, NJ: Erlbaum.

Hoffman, R.R. (1998). How can expertise be defined? Implications of research from cognitive psychology. In R. Williams, W. Faulkner & J. Fleck (Eds.), *Exploring expertise* (pp.81–100). New York: MacMillan.

Holmes, G. (2000, October). Education Connect: An innovative approach to transition. *Principal Matters, 45*, 2–5.

Howe, M. & Sloboda, J. (1991). Young musicians' accounts of significant influences in their early lives. 2. Teachers, practising and performing. *British Journal of Music Education, 8*(1), 53–63.

Huggins, M. & Knight, P. (1997). Curriculum continuity and transfer from primary to secondary school: The case of history. *Educational Studies, 23*(3), 333–348.

Hughes, M. (1993). *Flexible learning: Evidence examined.* Stafford: Network Educational Press Ltd.

Hurley, C.G. (1995). Student motivations for beginning and continuing/discontinuing string music tuition. *The Quarterly Journal of Music Teaching and Learning, 6*(1), 44–55.

Hynd, C., Holschuh, J. & Nist, S. (2000). Learning complex scientific information: Motivation theory and its relation to student perception. *Reading and Writing Quarterly: Overcoming learning difficulties, 36*(1), 23–58.

Ireson, J. & Hallam, S. (2001). *Ability grouping in education.* London: Sage Publications.

Jausovec, N. (1996). Differences in alpha EEG activity related to giftedness. *Intelligence, 23*, 159–173.

Kardash, C.M. & Scholes, R.J. (1996). Effects of pre-existing beliefs, epistemological beliefs and need for cognition on interpretation of controversial issues. *Journal of Educational Psychology, 88*, 260–271.

Karni, A., Meyer, G., Jezzard, P., Adams, M.M., Turner, R. & Ungerleider, L.G. (1995). FMRI evidence for adult motor cortex plasticity during motor skill learning. *Nature, 377*, 155–158.

Kaufman, A.S. (2001). WAIS-III IQS Horn's theory and generational changes from young adulthood to old age. *Intelligence, 29*, 131–167.

Kember, D. (1998). Teaching beliefs and their impact on students' approach to learning. In B. Dart & G. Boulton-Lewis (Eds.), *Teaching and learning in higher education: From theory to practice* (pp.1–25). Melbourne: Australian Council for Educational Research.

Kember, D. (2001). Beliefs about knowledge and the process of teaching and learning as a factor in adjusting to study in higher education. *Studies in Higher Education, 26*(2), 205–221.

Kemp, A.E. (1996). *The musical temperament: Psychology and personality of musicians.* Oxford: Oxford University Press.

Kirkpatrick, D. (1997). What's the point? Changes in students' beliefs about academic work in transition from primary to secondary school. *Set: Research Information for Teachers, 1.*

Kleese, E.J. & D'Onofrio, J.A. (1994). *Student activities for students at risk.* Reston, VA: National Association of Secondary School Principals.

Klein, G.A. (1993). A recognition primed decision (RPD) model of rapid decision making. In G.A. Klein, J. Orasanu, R. Calderwood & C.E. Zsambok (Eds.), *Decision-making in action: Models and methods* (pp.138–147). Norwood, NJ: Ablex.

Krampe, R.T. (2002). Ageing, expertise and fine motor movement. *Neuroscience and Biobehavioural Reviews, 26*, 769–776.

Kruglanski, A.W. (1989). *Lay epistemics and human knowledge: Cognitive and motivational bases.* New York: Plenum.

Kruse, D. (1995). Transition and beyond: The Northcote network of schools year 5–8 curriculum project. *Idiom, 30*(1), 35–43.

Kruse, D. (1996). Transition and change: Early adolescence and the role of education. *Learning Matters, 1*(2), 59.

Kuhn, T. (1962). *The structure of scientific revolutions.* Chicago: Chicago Press.

Kulik, C-L.C. & Kulik, J.A. (1982). Effects of ability grouping on secondary school students: A meta-analysis of evaluation findings. *American Educational Research Journal, 19*, 415–428.

Lam, M. & Pollard, A. (2006). A conceptual framework for understanding children as agents in the transition from home to kindergarten. *Early Years, 26*, 123–141.

Larkin, J.H. (1983). The role of problem representation in physics. In D. Gentner & A.L. Stevens (Eds.), *Mental models* (pp.75–100). Hillsdale, NJ: Erlbaum.

Larkin, J.H., McDermott, J., Simon, D.P. & Simon, H.A. (1980). Models of competence in solving physics problems. *Cognitive Science, 4*, 317–345.

Lee, B., Harris, S. & Dickson, P. (1995). *Continuity and progress 5–16: Developments in school.* Slough: NFER.

Lehr, C.A., Johnson, D.R., Bremer, C.D., Cosio, A. & Thompson, M. (2004). *Essential tools: Increasing rates of school completion.* Minneapolis, MN: National Center on Secondary Education and Transition. Retrieved 30 January 2007, from: www.ecs.org/html/Document.asp?chouseid=6649

Lesgold, A.M. & Resnick, L. (1982). How reading difficulties develop: Perspectives from a longitudinal study. In J.Das., R. Mulcahey & A. Wall (Eds.), *Theory and research in learning disabilities* (pp.155(30 Jan. 2007).187). New York: Plenum Press.

Linnenbrink, E.A. & Pintrich, P.R. (2002). The role of motivational beliefs in conceptual change. In M. Limon & L. Mason (Eds.), *Reconsidering conceptual change: Issues in theory and practice* (pp.115–135). Dordrecht, The Netherlands: Kluwer Academic.

Lipman, M. (1991). *Thinking in education.* New York: Cambridge University Press.

Little, F. (2009). *An exploration into the uptake rates of GCSE music with a focus on the purposes of music in school.* EdD thesis, University of Durham.

Logan, G. (1985). Skill and automaticity: Relations, implications and future directions. *Psychological Review, 95*, 492–527.

Lonka, K., Olkinuora, E. & Makinen, J. (2004). Aspects and prospects of measuring studying and learning in higher education. *Educational Psychology Review, 16*, 301–323.

Maehr, M.L. & Midgley, C. (1991). Enhancing student motivation: A school-wide approach. *Educational Psychologist, 26*, 399–427.

Maguire, E.A., Gadian, D.G., Johnsrude, I.S., Good, C.D., Ashburner, J., Frackowiak, R. & Frith, C.D. (2000). Navigation-related structural change in the hippocampi of taxi drivers. *Proceedings of the National Academy of Sciences of the United States of America, 97*(8), 4398–4403.

Manturzewska. M. (1990). A biographical study of the lifespan development of professional musicians. *Psychology of Music, 18*(2), 112–139.

Markus, H. & Nurius, P. (1986). Possible selves. *American Psychologist, 41*, 954–969.

Marsh, H.W. (1987). The Big-Fish-Little-Pond effect on academic self-concept. *Journal of Educational Psychology, 79*, 280–295.

Marsh, H.W. (1991). The failure of high ability high schools to deliver academic benefits: The importance of academic self-concept and educational aspirations. *American Educational Research Journal, 28*, 445–480.

Marsh, H.W., Chessor, D., Craven, R.G. & Roche, L. (1995). The effects of the gifted and talented programme on academic self-concept: The Big Fish strikes again. *American Educational Research Journal, 32*, 285–319.

Marsh, H.W. & Peart, N. (1988). Competitive and co-operative physical fitness training programmes for girls: Effects on physical fitness and on multidimensional self-concepts. *Journal of Sport and Exercise Psychology, 10*, 390–407.

Marsh, H.W. & Rowe, K.J. (1996). The negative effects of school-average ability on academic self-concept: An application of multi-level modelling. *Australian Journal of Education, 40*(1), 65–87.

Marton, F. & Saljo, R. (1976). On qualitative differences in learning – 1. Outcome and process. *British Journal of Educational Psychology, 46*, 4–11.

Marton, F., Dall'Alba, G. & Beaty, E. (1993). Conceptions of learning. *International Journal of Educational Research, 19*, 277–300.

Mason, L. (2000). Role of anomalous data and epistemological beliefs in middle students' theory change on two controversial topics. *European Journal of Psychology of Education, 15*, 329–346.

Mason, L. & Boscolo, P. (2004). Role of epistemological understanding and interest in interpreting a controversy and in topic-specific belief change. *Contemporary Educational Psychology, 29*(2), 103–128.

Mason, L., Gava, M. & Boldrin, A. (2008). On warm conceptual change: The interplay of text, epistemological beliefs, and topic interest. *Journal of Educational Psychology, 100*(2), 291–309.

McCloskey, M., Caramazza, A. & Green, B. (1980). Curvilinear motion in the absence of external forces: Naive beliefs about the motion of objects. *Science, 210*, 1139–1141.

McCune, V. (2004). The development of first-year students' conceptions of essay writing. *Higher Education, 47*, 257–282.

McElroy, C. (2000). Middle school programmes that work. *Phi Delta Kappan, 82*(4), 277–279.

McEvoy, G.M. & Cascio, W.F. (1989). Cumulative evidence of the relationship between employee age and job performance. *Journal of Applied Psychology, 74*, 11–17.

McGee, C., Ward, R., Gibbons, J. & Harlow, A. (2003). *Transition to secondary school: A literature review.* New Zealand: Ministry of Education.

McGuiness, C. (1999). *From thinking skills to thinking classrooms.* London: DFEE.

McManus, J. (2007). *The perpetuation of early disadvantage through the use of KS2 data to group pupils by ability.* Paper presented at the Annual Conference of the BPS Education Section, 9–11 November, Staffordshire University.

Measor, L. & Woods, P. (1984). *Changing schools: Pupil perspectives on transfer to a comprehensive.* Milton Keynes: Open University.

Meijer, C.J.W. (2001). *Inclusive education and effective classroom practices.* European Agency for Development in Special Needs. Education. Retrieved 12 September 2009, from: www.european-agency.org/site/info/publications/agency/ereports/docs/05docs/ie_effectivecp.doc

Mertin, P., Haebich, E. & Lokan, J. (1989). Everybody will be bigger than me: Children's perceptions of the transition to high school. *Australian Educational and Developmental Psychologist, 6*(2), 2–5.

Meyer, J.H.E. & Land, R. (2003). Threshold concepts and troublesome knowledge (1): Linkages to ways of thinking and practising within the disciplines. In C. Rust (Ed.), *Improving student learning: Theory and practice.* Oxford: Oxford Centre for Staff and Learning Development.

Midgley, C. Feldlaufer, H. & Eccles, J.S. (1989). Student/teacher relations and attitudes toward mathematics before and after the transition to junior high school. *Child Development, 60*, 981–992.

Miller, E. (1994). Intelligence and brain myelination: A hypothesis. *Personality and Individual Differences, 17*, 803–832.

Minnis, M., Seymour, K. & Schagen, I. (1998). *National results of Years 3, 4, and 5 optional tests.* Slough, NFER.

Mireles, D.W. & Charness, N. (2002). Computational explorations of the influence of structured knowledge on age-related cognitive decline. *Psychology and Ageing, 9*, 134–148.

Mizelle, N.B. & Mullins, E. (1997). Transition into and out of middle school. In J.L. Irvin (Ed.), *What current research says to the middle level practitioner.* Columbus, OH: National Middle School Association.

Motte-Haber, H. (1984). Die Bedeutung der Motivation fur den Instrumentalbericht (The significance of motivation in instrumental reports). *Zeitschrift fur Musikpadagogik, 51*, 51–54.

Munte, T.F., Nager, W., Beiss, T. Schroeder, C. & Erne, S.N. (2003). Specialisation of the specialised electrophysiological investigations in professional musicians. In G. Avanzini, C. Faienza, D. Minciacchi, L. Lopez & M. Majno (Eds.), *The neurosciences and music* (pp.112–117). New York: New York Academy of Sciences.

Murdock, T.B., Anderman, L.H. & Hodge, S.A. (2000). Middle-grade predictors of students motivation and behaviour in high school. *Journal of Adolescent Research, 15*(3), 327–351.

Murphy, P.K. & Alexander, P.A. (2004). Persuasion as a dynamic, multidimensional process: A view of individual and intraindividual differences. *American Educational Research Journal, 41*, 337–363.

Nagel, J.J. (1987). *An examination of commitment to careers in music: Implications for alienation from vocational choice.* Unpublished doctoral dissertation, University of Michigan, Ann Arbor.

National Center for Educational Statistics (1995). *Digest of education statistics.* Washington, DC: US Government.

National Research Council & Institute of Medicine (2004). *Engaging schools: Fostering high school students' motivation to learn.* Washington DC: National Academy Press.

Neubauer, A.C. Grabner, R.H., Fink, A. & Neuper, C. (2005). Intelligence and neural efficiency: Further evidence of the influence of task content and sex on the brain – IQ relationship. Brain research. *Cognitive Brain Research, 25*, 217–225.

Newell, A. & Simon, H.A. (1972). *Human problem solving.* New York: Prentice Hall.

Nicholls, G. & Gardner, J. (1999). *Pupils in transition: Moving between key stages.* London: Routledge.

Ofsted (2002). *Changing schools: Evaluation of the effectiveness of transfer arrangements at age 11.* London: Ofsted.

Osborn, M., McNess, M. & Pollard, A. (2006). Identity and transfer: A new focus for home-school knowledge exchange. *Educational Review, 58*, 415–433.

Pantev, C., Engelien, A., Candia, V. & Elbert, T. (2003). Representational cortex in musicians. In I. Peretz & R. Zatorre (Eds.), *The cognitive neuroscience of music* (pp.382–395). Oxford: Oxford University Press.

Pascuel-Leone, A. (2003). The brain that makes music and is changed by it. In I. Peretz & R. Zatorre (Eds.), *The cognitive neuroscience of music* (pp.396–412). Oxford: Oxford University Press.

Pascuele-Leone, A, Grafman, J. & Hallett, M. (1994). Modulation of cortical motor ouput maps during development of implicit and explicit knowledge. *Science, 263*, 1287–1289.

Pellegrino, J.W. & Glaser, R. (1982a). Improving the skills of learning. In D.K. Detterman & R.J. Sternberg (Eds.), *How much and how can intelligence be increased?* Norwood, NJ: Ablex.

Pellegrino, J.W. & Glaser, R. (1982b). Analysing aptitudes for learning: Inductive reasoning. In R. Glaser (Ed.), *Advances in instructional psychology Vol. 2* (pp.269–345). Hillsdale, NJ: Erlbaum.

Perry, W.G. (1970). *Forms of intellectual and ethical development in the college years: A scheme.* New York: Holt, Rinehart & Winston.

Pintrich, P.R. (1999). Motivational beliefs as resources for and constraints on conceptual change. In W. Schnotz, S. Vosniadou & M. Carretero (Eds.), *New perspectives on conceptual change* (pp.33–50). Amsterdam, The Netherlands: Pergamon.

Pintrich, P.R. (2000). The role of goal orientation in self-regulation learning. In M. Boekaerts, P.R. Pintrich & M. Zeidner (Eds.), *Handbook of self-regulation: Theory, research and applications* (pp.451–502). San Diego, CA: Academic Press.

Pintrich, P. (2004). A conceptual framework for assessing motivation and self-regulated learning in college students. *Educational Psychology Review, 16*, 385–408.

Pintrich, P.R., Marx, R.W. & Boyle, R.A. (1993). Beyond cold conceptual change: The role of motivational beliefs and classroom contextual factors in the process of conceptual change. *Review of Educational Research, 63*, 167–199.

Pintrich, P.R. & Schrauben, B. (1992). Students' motivational beliefs and their cognitive engagement in classroom academic tasks. In D. Schunk & J.Meese (Eds.), *Student perceptions in the classroom* (pp.149–183). Hillsdale, NJ: Erlbaum.

Pollard, A. & Filer, A. (1999). *The social world of pupil career: Strategic biographies through primary school.* London: Cassell.

Posner, M. & Snyder, C. (1975). Attention and cognitive control. In R.L. Solso (Ed.), *Information processing and cognition: The Loyola symposium.* Hillsdale, NJ: Erlbaum.

Presseisen, B.Z. (1991). At-risk students: Defining a population. In K.M. Kershner & J.A. Connolly (Eds.), *At-risk students and school restructuring* (pp.5–11). Washington, DC: Office of Educational Research and Improvement.

Prosser, M., Trigwell, K. & Taylor, P. (1994). A phenomenographic study of academics' conceptions of science learning and teaching. *Learning and Instruction, 4*, 217–232.

Qian, G. & Alvermann, D. (1995). Role of epistemological beliefs and learned helplessness in secondary school students' learning science concepts from text. *Journal of Educational Psychology, 87*, 282–292.

Redick, S.S. & Vail, A. (1991). *Motivating youth at risk.* Gainesville, VA: Home Economics Education Association.

Rice, J.K. (2001). Explaining the negative impact of the transition from middle to high school on student performance in mathematics and science. *Educational Administration Quarterly, 37*(3), 372–400.

Richardson, J.T.E. (2000). *Researching student learning.* Buckingham: SRHE and Open University Press.

Roderick, M.R. & Camburn, E.M. (1999). Risk and recovery from course failure in the early years of high school. *American Educational Research Journal, 36*(2), 303–343.

Ryan, M.P. (1984). Monitoring text comprehension: Individual differences in epistemological standards. *Journal of Educational Psychology, 76*(2), 248–258.

Rypma, B., Berger, J.S., Prabhakaran, V., Bly, B.M., Kimberg, D.Y., Biswal, B.B. & D'Esposito, M. (2006). Neural correlates of cognitive efficiency. *Neuroimage, 33*, 969–979.

Saljo, R. (1979). *Learning in the learner's perspective. 1. Some common-sense conceptions (Report 76).* Gothenburg: University of Gothenburg, Department of Education.

Saljo, R. (1982). *Learning and understanding: A study of differences in constructing meaning from text.* Gothenburg: Acta Universitatis Gothoburgensis

Schiefele, U. (1996). Topic interest, text representation and quality of experience. *Contemporary Educational Psychology, 12*, 3–18.

Schiefele, U. & Rheinberg, F. (1997). Motivation and knowledge acquisition: Searching for mediating processes. In M.L. Maehr & P.R. Pintrich (Eds.), *Advances in motivation and achievement* (Vol. 10, pp.251–301). Oxford Elsevier Science.

Schiller, K.S. (1999). Effects of feeder patterns on students' transition to high school. *Sociology of Education, 72*(4), 216–233.

Schneider, W. (1985). Training high performance skills: Fallacies and guidelines. *Human Factors, 27*(3), 285–300.

Schneider, W. & Fisk, A. (1982). Concurrent automatic and controlled visual search: Can processing occur without resource cost? *Journal of Experimental Psychology, 8*, 261–278.

Schneider, W. & Shiffrin, R.M. (1977). Controlled and automatic human information processing: 1. Detection, search and attention. *Psychological Review, 84*, 1–66.

Schommer, M.A. (1990). Effects of beliefs about the nature of knowledge on comprehension. *Journal of Educational Psychology, 82*(3), 498–504.

Schommer-Aikins, M.A. (2002). An evolving theoretical for an epistemological belief system. In B.K. Hofer & P. Pintrich (Eds.), P*ersonal epistemology: The psychology of knowledge and knowing* (pp.103–118). Mahwah, NJ: Erlbaum.

Schraw, G. & Lehman, S. (2001). Situational interest: A review of the literature and directions for future research. *Educational Psychology Review, 13*(1), 23–52.

Schunk, D.H. & Pajares, F. (2005). Competence perception and academic functioning. In J.Elliott & C.S. Dweck (Eds.), *Handbook of competence and motivation* (pp.85–104). New York: Guilford Press.

Sebba, J. (2000). *The trouble with transition.* London: DfES.

Sebba, J., Brown, N., Steward, S., Galton, M. & James. M. (2007). *An investigation of personalised learning approaches used by schools. Research Report RR843.* London: DfES.

Seidman, E., Aber, L., Allen, L. & French, S.E. (2006). The impact of the transition to hight school on the self-system and perceived social context of poor urban youth. *American Journal of Community Psychology, 24*(4), 489–515.

Shaffer, L.H. (1975). Multiple attention in continuous verbal tasks. In P.M.A. Rabbitt & S. Dornic (Eds.), *Attention and performance V.* New York: Academic Press.

Shrigley, R.L. (1990). Attitude and behaviour are correlates. *Journal of Research in Science Teaching, 27*(2), 97–113.

Simmons, R.G. & Blyth, D.A. (1987). *Moving into adolescence: The impact of pubertal change and school context.* New York: Aldine De Gruyter.

Simon, D.P. & Simon, H.A. (1978). Individual differences in solving physics problems. In R. Seigler (Ed.), *Children's thinking: What develops?* (pp.325–348). Hillsdale, NJ: Erlbaum.

Sinatra, G.M. & Pintrich, P.R. (Eds.) (2003). *Intentional conceptual change.* Mahwah, NJ: Erlbaum.

Sinatra, G.M., Southerland, S.A., McConaughty, F. & Demastes, J. (2003). Intentions and beliefs students' understanding and acceptance of biological evolution. *Journal of Research in Science Teaching, 40*, 510–528.

Sloboda, J.A.. Davidson, J.W., Howe, M.J.A. & Moore, D.G. (1996). The role of practice in the development of performing musicians. *British Journal of Psychology, 87*, 287–309.

Sluming, V., Brooks, J. & Howard, M. (2007). Broca's area supports enhanced visuospatial cognition in orchestral musicians. *Journal of Neuroscience, 27*, 3799–3806.

Smiley, P.A. & Dweck, C.S. (1994). Individual differences in achievement goals among young children. *Child Development, 65*, 1723–1743.

Sosniak, L.A. (1985). Learning to be a concert pianist. Developing talent in young people. In B.S. Bloom (Ed.), *Developing talent in young people* (pp.19–67). New York, Ballantine.

Sosniak, L.A. (1990). The tortoise and the hare and the development of talent. In M.J.A. Howe (Ed.), *Encouraging the development of exceptional skills and talents.* Leicester: British Psychological Society.

Spector, B.S. & Gibson, C.W. (1991). A qualitative study of middle school students' perceptions of factors facilitating learning in science. *Journal of Research in Science Teaching, 28*(6), 467–484.

Spelke, E., Hirst, W. & Neisser, U. (1976). Skills of divided attention. *Cognition, 4*, 215–230.

Spelke, E. (1991). Physical knowledge in infancy: Reflections on Piaget's theory. In S. Carey & R.Gelman (Eds.), *Epigenesis of mind* (pp.133–170). Hillsdale, NJ: Erlbaum.

Speering, W. & Rennie, L. (2006). Students' perceptions about science: The impact of transition from primary to secondary school. *Research in Science Education, 26*(3), 283–298.

Steinberg, L., Dornbusch, S.M. & Brown, B.B. (1992). Ethnic differences in adolescent achievement. *American Psychologist, 47*(6), 723–729.

Sternberg, R.J. & Frensch, P.A. (1992). On being an expert: A cost-benefit analysis. In R.R. Hoffman (Ed.), *The psychology of expertise: Cognitive research and empirical AI* (pp.347–354). Hillsdale, NJ: Erlbaum.

Sudnow, D. (1978). *Ways of the hand: The organisation of improvised conduct.* London: Routledge & Kegan Paul.

Suffolk Local Education Authority (1997). *A report on an investigation into what happens when pupils transfer into their next schools at the ages of 9, 11 and 13.* Ipswich: Inspection and Advice Division, Suffolk Education Department.

Sutherland, A., Johnstone, L., & Gardner, J. (1996). *A report for the Northern Ireland Council for Curriculum, Examinations and Assessment.* Belfast: Queen's University.

Thomas, P.R. & Bain, J.D. (1984). Contextual dependence of learning approaches: The effects of assessments, *Human Learning, 3*, 227–240.

Thorton, K. (1999). Secondary boost for summer's children. *Times Educational Supplement, 4338*, 6.

Van der Veken, J., Valcke, M., De Maeseneer, J. & Derese, A. (2009). Impact of the transition from a conventional to an integrated contextual medical curriculum on students' learning patterns: A longitudinal study. *Medical Teacher, 31*, 433–441.

Van Driel, J.H. Verloop, N., Van Werven, H.I. & Dekkers, H. (1997). Teachers' craft knowledge and curriculum innovation in higher engineering education. *Higher Education, 34*, 105–122.

VanLehn, K. (1996). Cognitive skill acquisition. *Annual Review of Psychology, 47*, 513–539.

Vermetten, Y.J., Lodewijks, H.G. & Vermunt, J.D. (1999). Consistency and variability of learning strategies in different university courses. *Higher Education, 37*, 1–21.

Vermunt, J.D. (1998). The regulation of constructive learning processes. *British Journal of Educational Psychology, 68*, 149–171.

Vermunt, J.D. (2005). Relations between student learning patterns and personal and contextual facrors and academic performance. *Higher Education, 49*, 205–234.

Vermunt, J.D. & Verloop, N. (1999). Congruence and friction between learning and teaching. *Learning and Instruction, 9*, 257–280.

Vermunt, J.D. & Vermetten, Y.J. (2004). Patterns in student learning: Relationships between learning strategies, conceptions of learning, and learning orientations. *Educational Psychology Review, 16*, 359–384.

Vosniadou, S. (2007). Personal epistemology and conceptual change: an introduction. In S. Vosniadou, A. Baltas & X Vamvakoussi (Eds.), *Reframing the conceptual change approach in learning and instruction.* Amsterdam: Elsevier.

Vosniadou, S. (2008). Conceptual change research: An introduction. In S. Vosniadou (Ed.), *International handbook of research on conceptual change* (pp.xiii–xxviii). London: Routledge.

Vosniadou, S. & Brewer, W.F. (1992). Mental models of the earth: A study of conceptual change in childhood. *Cognitive Psychology, 24*, 535–585.

Vosniadou, S. & Brewer, W.F. (1994). Mental modles of the day/night cycle. *Cognitive Science, 18*, 123–183.

Vosniadou, S., Baltas, A. & Vamvakoussie, X. (Eds.) (2007). *Reframing the conceptual change approach in learning and instruction.* Oxford: Elsevier.

Vosniadou, S., Vamvakoussi, X. & Skopeliti, I. (2008). The framework theory approach to the problem of conceptual change. In S. Vosniadou (Ed.), *International handbook of research on conceptual change* (pp.3–34). London: Routledge.

Voss, J.E., Greene, T.R., Post, T. & Penner, B.C. (1983). Problem solving skill in the social sciences. In G. Bower (Ed.), *The psychology of learning and motivation* (pp.165–213). New York: Academic Press.

Voss, J.F. & Schauble, L. (1992). Is interest educationally interesting? An interest-related model of learning. In K.A. Renninger, S.D. Hidi & A. Krapp (Eds.), *The role of interest in learning and development* (pp.101–120). Hillsdale, NJ: Erlbaum.

Voss, J.F., Vesonder, G. & Spilich, H. (1980). Text generation and recall by high knowledge and low knowledge individuals. *Journal of Verbal Learning and Verbal Behaviour, 19*, 651–667.

Waldman, D.A. & Avolio, B.J. (1986). A meta-analysis of age-differences in job-performance. *Journal of Applied Psychology, 71*, 33–38.

Walsh, M.E. (1995). Rural students transitions to secondary school: Culture curriculum and context. *Curriculum Journal, 6*(1), 115–127.

Ward, R. (2000). Transfer from middle to secondary school: A New Zealand study. *International Journal of Educational Research, 33*, 365–374.

Weiser, M. & Shertz, J. (1983). Programming problem representation in novice and expert programmers. *Instructional Journal of Man-Machine Studies, 14*, 391–396.

Weston, P., Barrett, E. & Jamison, J. (1992). *The quest for coherence: Managing the whole curriculum 5–11.* Slough: NFER.

Wigfield, A, Eccles, J., MacIver, D., Reuman, D. & Midgley, C. (1991). Transitions during early adolescence: Changes in children's domain-specific self-perceptions and general self-esteem across the transition to junior high school. *Developmental Psychology, 27*(4), 552–565.

Wiley, J. (1998). Expertise as mental set: The effects of domain knowledge in creative problem solving. *Memory and Cognition, 26*, 716–730.

Windschitl, M. & Andre, T. (1998). Using computer simulations to enhance conceptual change: The roles of constructivist instruction and student epistemological beliefs. *Journal of Research in Science Teaching, 35*, 145–160.

Wylie, C. & Chalmers, A. (1999). *Future schooling in Palmerston North: Views and experiences of parents, students, principals, teachers and trustees. Report to the Ministry of Education.* Wanganui, New Zealand: Ministry of Education.

Yates, L. (1999). Transitions and the year 7 experience: A report from the 12 to 18 project. *Australian Journal of Education, 43*(1), 24–41.

Youngman, M. (1978). Six reactions to school transfer. *British Journal of Educational Psychology, 48*(4), 280–289.

Zaïm-Idrissi, K., Désautels, J. & Larochelle, M. (1993). The map is the territory! The viewpoints of biology students on the theory of evolution. *Alberta Journal of Educational Research, 39*(1), 59–72.