EFFECTIVE TEACHING

Evidence and Practice

4th Edition

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Theories of Learning and Intelligence

Key Points

In this chapter, you will learn about:

- the main elements of behaviourist learning theory
- what Piaget and Vygotsky had to say about learning, and its relevance today
- the meaning of IQ and traditional theories on intelligence
- Gardner's theory of multiple intelligences
- the main lessons from cognitive science.

Introduction

In this chapter, we will discuss the main theories on how children learn. This is of course an important issue in teaching, as to be effective we need to try and teach in a way that reinforces how people naturally learn. Theories of learning and intelligence are many and diverse, and we can't look at all existing theories in one chapter. What we will do instead, is focus on some of the theories that have been most influential in education over the years.

IQ Theory

One of the first theories on learning to gain widespread currency in education was IQ (Intelligence Quotient) theory.

IQ theory is mainly interested in the concept of intelligence, which is seen as determining people's ability to learn, to achieve academically and therefore to take on leading roles in society. IQ theorists, like William Stern, who was one of the developers of the theory in the early part of the twentieth century, claimed that core intelligence was innate. Many psychologists in the USA and Europe supported that conclusion and psychologists like Terman and Binet developed instruments specifically designed to test people's innate intelligence. These were analysed using the newest statistical methods such as factor analysis, developed by Thurstone and Spearman. These analyses showed that all the items (questions) in those tests essentially measured one big factor, called G, or 'general intelligence'. Therefore, the theory states that people have one underlying general intelligence, which will predict how well they are able to learn and perform at school (Howe, 1997).

A major point of discussion is whether intelligence as measured by IQ tests is innate or learned. The initial theories largely stressed the innate nature of intelligence, seeing it as an inborn property. Subsequent research has, however, clearly shown that IQ can be raised through educational interventions, which means that it cannot be totally inborn. The successful CASE programme in the UK, for example, does just that (Adey and Shayer, 2002). Another fact that points to the 'learnability' of IQ is that average IQ test scores have been increasing steadily over the past decades in all countries where they have been studied (Flynn, 1994). When we are testing someone's IQ, we are therefore testing his or her education level at least as much as whatever innate ability he or she may possess. These criticisms notwithstanding, there is increasing evidence that there is a genetic basis to how well we do in school, as we will discuss below.

As well as the issue of whether IQ is innate or learnt, the whole theory of IQ has been heavily criticized for many years now. These criticisms focus on a number of areas. The first of these is the methods used to measure intelligence, which produced G. While we don't want to go into a discussion of statistics here, it is fair to say that the factor analysis method these researchers developed was specifically designed to come up with one big underlying factor, and usually does. If you use different methods, you are likely to find far more factors. Therefore, in many ways, it is pre-existing theories which led to the development of methods designed to confirm these theories. The theory of intelligence also focuses on 'academic' intelligence, and so potentially disparages other skills and abilities. As we will see, some recent theories have taken a different approach on these matters (Gardner, 1983).

The idea that there is one measurable factor that distinguishes people has also been widely misused. One of the earliest uses of IQ tests was to look at differences in intelligence between particular groups in society, which were then said to be differently intelligent (and by implication more or less suitable to take on leading roles in society).

The findings of these studies tell us far more about the societies in which they were carried out than about the 'intelligence of different groups' (which as a matter of fact does not differ significantly). Thus, in the USA, research concentrated on finding differences between racial groups (whites scoring higher than blacks), in France on differences between genders (men scoring higher than women) and in the UK on differences in social class (the higher classes obviously coming out as more intelligent than the working class) (Blum, 1980; Gould, 1983).

Notwithstanding these criticisms, it would be wrong to reject IQ theory. There is evidence that an underlying general aptitude influences how well pupils perform in a variety of subjects. There is a far stronger correlation between pupils' performance in maths and English than is often realized, for example. Therefore, the evidence does suggest that such a thing as general intelligence may exist and is a significant predictor of pupil attainment and learning.

Multiple Intelligences

As we saw in the previous section, the theory of IQ stresses the existence of one overarching intelligence, a view that has become increasingly controversial over time. For many decades, however, no alternative theory was able to overcome the dominance of IQ theory whenever ability and intelligence were studied. This changed in the early 1980s, with the publication of *Frames of Mind* by Howard Gardner (1983), in which he set out his theory of 'multiple intelligences'.

Gardner takes a view that is very different from that of IQ theory. According to him, people do not have one general intelligence, but are characterized by a range of intelligences instead. So, rather than being globally intelligent, I may be particularly strong in certain areas, for example mathematics, while someone else may be particularly strong in another area, for example physical sports.

Gardner initially (1983, 1993) distinguished seven main types of intelligence:

1. *Visual/spatial intelligence*. This is the ability to perceive the visual. Visual/spatial learners tend to think in pictures and need to create vivid mental images to retain information. They enjoy looking at pictures, charts, movies and so on.
2. *Verbal/linguistic intelligence*. This is the ability to use words and language. These learners have highly developed auditory skills and are generally elegant speakers. They think in words rather than pictures. This is the ability that can be measured by the verbal part of IQ tests.
3. *Logical/mathematical intelligence*. This is the ability to use reason, logic and numbers. These learners think conceptually in logical and numerical patterns, making connections between pieces of information. They ask lots of questions and like to do experiments. The non-verbal portion of traditional IQ tests largely measures this intelligence.

4. *Bodily/kinaesthetic intelligence*. This is the ability to control body movements and handle objects skilfully. These learners express themselves through movement. They have a good sense of balance and eye–hand coordination. Through interacting with the space around them, they are able to remember and process information.
5. *Musical/rhythmic intelligence*. This is the ability to produce and appreciate music. These learners think in sounds, rhythms and patterns. They respond strongly to music and rhythm. Many of these learners are extremely sensitive to sounds occurring in their environment.
6. *Interpersonal intelligence*. This is the ability to relate to and understand others. These learners can empathize and see things from other people's point of view in order to understand how they think and feel. They are good at sensing feelings, intentions and motivations. Generally, they try to maintain peace in group settings and encourage cooperation. They can be manipulative.
7. *Intrapersonal intelligence*. This is the ability to self-reflect and be aware of one's inner states. These learners try to understand their inner feelings, dreams, relationships with others, and strengths and weaknesses. Their strength lies in the ability to be self-reflective (Gardner, 1983, 1993).

A misconception that exists about this theory is that one intelligence is necessarily dominant. This is not really the case, as all of us will possess all intelligences to some extent. It is also important to remember that doing something will usually require use of more than one intelligence.

To some, it might seem that this choice of different intelligences is somewhat arbitrary. Gardner's theories are sometimes seen as somewhat unscientific, a seemingly random selection of intelligences. This, according to Gardner, is a misconception. A number of criteria are used for defining an intelligence, taken from a variety of disciplines such as developmental psychology and cultural anthropology:

- *Isolation as a brain function*. A true intelligence will have its function identified in a specific location in the human brain. This can increasingly be determined using the latest brain-imaging techniques.
- *Prodigies, idiot savants and exceptional individuals*. In order to qualify as an intelligence, there must be some evidence of specific 'geniuses' in that particular area.
- *Set of core operations*. Each true intelligence has a set of unique and identifiable procedures at its heart.
- *Developmental history*. A true intelligence is associated with an identifiable set of stages of growth, with a mastery level which exists as an end state in human development.
- *Evolutionary history*. A true intelligence can have its development traced through the evolution of our species as identified by cultural anthropologists.
- *Supported psychological tasks*. A true intelligence can be identified by specific tasks which can be carried out, observed and measured by clinical psychologists.

- *Supported psychometric tasks*. Specifically designed psychometric tests can be used to measure the intelligence. A psychometric test is a standardized test used to measure a specific psychological facet, such as personality or intelligence.
- *Encoded into a symbol system*. A true intelligence has its own symbol system which is unique to it and essential to completing its tasks (Gardner, 2003).

These criteria have themselves, however, been subject to criticism, as they are seen as overly loose, and allowing for an almost infinite number of intelligences to be concocted, such as, in Willingham's (2004) example, humorous intelligence.

Focus on Research 1.1

Misuses of Gardner's Theory

Gardner's theory has proved both popular and controversial in education, and both views are closely linked. As often happens in education, psychological theories are taken on board by educators or commercial consultants who do not understand them well and produce a low-level vulgarized version for use in schools. Gardner has pointed to a number of misuses he sees of his theories in education:

1 Sometimes it is inferred that all subjects or concepts need to be taught using all seven intelligences. According to Gardner (1995), while most topics can be taught in a number of ways, it is usually a waste of time to try and teach a topic using all seven intelligences.
2 Going through the motions of using an intelligence does not in itself lead to learning. Gardner gives the example of some teachers getting children to run around as a way of exercising bodily/kinaesthetic intelligence.
3 Gardner (1995) also does not believe that the use of materials associated with a multiple intelligence as background (e.g. playing music in the classroom) will do anything to aid learners who are strong in that area.
4 Sometimes teachers claim they are exercising pupils' multiple intelligences (in this case musical/rhythmic intelligence) by getting them to sing or dance while reciting something like a times table. While this may help them remember it, Gardner (1995) describes such a use of multiple intelligences as trivial. What educators should encourage instead is thinking musically or drawing on some of the structural aspects of music in order to illuminate concepts in other fields (like maths).
5 The use of various measures or instruments that grade intelligences is seen by Gardner as being directly in opposition to his views of intelligence as something that occurs when carrying out activities within cultural settings.

While Gardner's theories have been widely influential in education recently (although, as mentioned above, not always in the most helpful way), they have also been subject to criticism. One criticism focuses on what is seen as a lack of testability of Gardner's theories. This is seen to result from an ambiguity of the theory, in that it is not clear to what extent the intelligences are supposed to operate separately or interconnectedly. The fact that the existence or not of an intelligence is not testable experimentally and cannot be accurately psychometrically assessed is also critiqued (Klein, 1997), although Gardner would argue that this critique misunderstands the theory which sees intelligences as operating in cultural action. Critics claim that Gardner doesn't provide a clear definition of intelligence and some authors state that what Gardner is studying are in fact cognitive styles rather than intelligences (Morgan, 1996). The criteria he uses have been described as somewhat arbitrary (White, 1998), and Gardner is seen as not providing a clear explanation as to why these and not other possible criteria were chosen (Klein, 1997). Furthermore, the continual addition of new intelligences by Gardner has to lead to doubts as to the rigour of this framework. A number of recent studies have also led to questions over the validity of this theory. Visser et al. (2006), for example, found that when tests were developed for each intelligence, there was evidence of a global G factor underlying them, as would be predicted by intelligence theory. This view is also supported by findings from neurological research that show significant overlap between neural pathways controlling different brain functions (Waterhouse, 2006). This, furthermore, would appear to be essential as many skills (as Gardner acknowledges) require the presence of more than one intelligence, meaning some overarching executive function would need to be present. In general, a lack of empirical evidence is a major problem with this theory, as over 25 years after its initial publication we should by now have been able to collect evidence to support it (Waterhouse, 2006). The practical use of the theory has also been questioned, as there is very little evidence of successful interventions that have been based on it (Willingham, 2004). In view of these problems in demonstrating both a scientific basis for the theory and real-world relevancy, we have to conclude that this theory is not supported.

Think Point 1.1

While the theory of multiple intelligences is not empirically supported, it nevertheless tries to address some major limitations of general IQ theory. What do you think those are?

Behaviourism

One of the earliest theories to focus explicitly on learning rather than on intelligence is called behaviourism. Behaviourism was developed in the 1920s and 1930s by psychologists such as Skinner, Pavlov and Thorndike. While obviously somewhat outdated now, this theory still has a strong relevance to educational practice.

Behavioural learning theory emphasizes change in behaviour as the main outcome of the learning process. Behavioural theorists concentrate on directly observable phenomena using a scientific method borrowed from the natural sciences. The most radical behaviourists, such as Skinner, considered all study of non-observable behaviour ('mentalism') to be unscientific (Hilgard, 1995; O'Donohue and Ferguson, 2001). In recent years, however, most researchers and psychologists in the behaviourist tradition, such as Bandura (1985), have expanded their view of learning to include expectations, thoughts, motivation and beliefs.

Learning, according to behaviourists, is something people do in response to external stimuli. This view was an important change over previous models, which had stressed consciousness and introspection, and had not produced many generalizable findings about how people learn. When they studied learning, behaviourists usually did so using experiments conducted with animals like dogs as well as humans. This is because, being against 'mentalism', behaviourists think that it is largely external factors which cause our behaviour. The basic mechanism through which this happens is conditioning. According to behaviourists, there are two different types of conditioning:

> *Classic conditioning* occurs when a natural reflex responds to a stimulus. An example of this comes from Pavlov's experiments with dogs. In order to process food, dogs need to salivate when they eat. As all dog owners will know, what happens is that dogs will start to salivate even before eating, as soon as they have smelt or seen food. So, the external stimulus of food will cause the dog to salivate. It has become a habit that is conditioned. When confronted with particular stimuli, people as well as animals will produce a specific response.
>
> *Behavioural* or *operant conditioning* occurs when a response to a stimulus is reinforced. Basically, operant conditioning is a simple feedback system: if a reward or reinforcement follows the response to a stimulus, then the response becomes more probable in the future. For example, if every time a pupil behaves well in class they get a reward, they are likely to behave well next time.

Rewards and punishments are an important part of behaviourist learning theory. Initial experiments with dogs and rats convinced these psychologists of the importance of the use of rewards and punishments to elicit certain desired behaviours, such as pushing a lever, in these animals. Over ensuing decades, these findings were further tested and refined with human subjects, and became highly influential in education. Pleasurable consequences, or *reinforcers*, strengthen behaviour, while unpleasant consequences, or *punishers*, weaken behaviour. Behaviour is influenced by its consequences, but it is influenced by its antecedents as well, thus creating the A(ntecedents)–B(ehaviour)–C(onsequences) chain. Skinner's work concentrated mainly on the relationship between the latter two parts of the chain (O'Donohue and Ferguson, 2001; Skinner, 1974), and these findings still form the basis of many behaviour management systems in schools, as well as much of the research on effective teaching (e.g. Muijs and Reynolds, 2003b).

While this movement remains highly influential, behaviourism has come to be seen as far too limited and limiting to adequately capture the complexity of human learning and behaviours. The idea that learning occurs purely as a reaction to external stimuli has been proved wrong. Activities such as recognizing objects (this is a ball), sorting objects (this is a rugby ball, this is a football) and storing information are clearly 'mentalist' activities – they occur in the head. While of course an external stimulus (perception of an object) is present, behaviourist theory cannot account for the information processing that occurs when we are confronted by stimuli. Behaviourism also cannot account for types of learning that occur without reinforcement – in particular, the way children pick up language patterns (grammar) cannot be explained using a behaviourist framework. Behaviourism also presents problems when the learner is confronted with new situations in which mental stimuli he or she has learnt to respond to are not present. The fact that behaviourism does not study the memory in any meaningful way (they only talk about acquiring 'habits') is another major problem if we want to explain learning. If we want to really understand how people learn, we have to be 'mentalists' and look at what is going on inside the brain as well as measuring reactions to external stimuli.

However, not all the criticism of behaviourism is justified. Some of it seems to emanate from a dislike of the findings rather than a close look at the evidence. Behaviourism has little place for the role of free will and human individuality. This is never a popular view, and as we have seen this determinism is clearly overdone in behaviourist theories. However, that does not mean that it is entirely inaccurate. While we always like to believe that we are entirely free, our behaviours can to an extent be predicted, in some cases by behaviourist models. That this is true is attested to by the continued usefulness of behaviourist methods in teaching, such as the use of rewards. Not liking certain research findings does not make them wrong, and it is not the job of research and science to simply tell us what we want to hear. Outside of education, many neo-behaviourist theories have become popular among scientists looking at the role of evolution in the way we behave. If you read the work of Richard Dawkins (1989), for example, there are clear links with behaviourist psychology.

Piaget and Vygotsky

Piaget and the stages of cognitive development

As well as the behaviourists like Skinner, two other pioneering psychologists who have had a continuing influence on how we view learning are Piaget and Vygotsky.

Jean Piaget was a Swiss psychologist, who started his important work on how children develop and learn before the Second World War. In contrast to the behaviourists, who developed most of their theories using laboratory experiments and rarely looked at the real-life behaviours of children, Piaget's theories were developed from the observation of children.

What these observations taught him was that in order to understand how children think, one has to look at the qualitative development of their ability to solve problems. Cognitive development, in his view, is much more than the addition of new facts and ideas to an existing store of information. Rather, children's thinking changes qualitatively; the tools which children use to think change, leading children of different ages to possess a different view of the world. A child's reality is not the same as that of an adult (Piaget, 2001).

According to Piaget, one of the main influences on children's cognitive development is what he termed *maturation*, the unfolding of biological changes that are genetically programmed into us at birth. A second factor is *activity*. Increasing maturation leads to an increase in children's ability to act on their environment, and to learn from their actions. This learning in turn leads to an alteration of children's thought processes. A third factor in development is *social transmission*, which is learning from others. As children act on their environment, they also interact with others and can therefore learn from them to a differing degree, depending on their developmental stage.

According to Piaget (2001), learning occurs in four stages.

The sensori-motor stage (0–2 years)

The baby knows about the world through actions and sensory information. He or she learns to differentiate him or herself from the environment. The child begins to understand causality in time and space. The capacity to form internal mental representations emerges.

The pre-operational stage (2–7 years)

In this stage, children take the first steps from action to thinking, by internalizing action. In the previous stage, children's schemes were still completely tied to actions, which means that they are of no use in recalling the past or in prediction. During the pre-operational stage, the child starts to be able to do this, by learning how to think symbolically. The ability to think in symbols remains limited in this stage, however, as the child can only think in one direction. Thinking backwards or reversing the steps of a task are difficult.

Another innovation that starts to take place during this phase is the ability to understand conservation. This means that the child can now realize that the amount or number of something remains the same, even if the arrangement or appearance of it is changed (for example, four dogs and four cats is the same amount). This remains difficult for children in this phase. Children here still have great difficulty freeing themselves from their own perception of how the world appears. Children at this age are also very egocentric. They tend to see the world and the experiences of others from their own standpoint.

The concrete operational stage (7–12 years)

The basic characteristics of this stage are: (1) the recognition of the logical stability of the physical world; (2) the realization that elements can be changed or transformed and still retain their original characteristics; and (3) the understanding that these changes can be reversed.

Another important operation that is mastered at this stage is *classification*. Classification depends on a child's ability to focus on a single characteristic of objects and then to group the objects according to that single characteristic (e.g. if one gives a child a set of differently coloured and differently shaped pens, they will be able to pick out the round ones). Pupils can now also understand seriation, allowing them to construct a logical series in which A is less than B is less than C and so on. At this stage, the child has developed a logical and systematic way of thinking which is, however, still tied to physical reality. Overcoming this is the task of the next phase.

The formal operational stage (12+)

In this stage, which is not reached by all people, all that is learned in previous stages remains in force but pupils are now able to see that a real, actually experienced situation is only one of several possible situations. In order for this to happen, we must be able to generate different possibilities for any given situation in a systematic way. Pupils are now able to imagine ideal, non-existing worlds. Another characteristic of this stage is adolescent egocentrism. Adolescents tend to incessantly analyse their own beliefs and attitudes, and often assume that everyone else shares their concerns and is in turn analysing them.

Piaget's theory has been hugely influential, but has been found wanting in a number of areas. His stages of learning are clearly too rigid. A number of studies have found that young children can acquire concrete operational thinking at an earlier age than Piaget proposed, and that they can think at higher levels than Piaget suggested. Piaget also underestimated the individual differences between children in how they develop, and the fact that some of these differences are due to the cultural and social background of the child. Piaget also did not take much notice of the way children can learn from others such as parents, other children or indeed teachers, seeing learning as largely dependent on their stage of development. Notwithstanding that, Piaget's theories have stood the test of time well, and are still a useful way of looking at children's development.

Vygotsky and the role of the environment in child development

Vygotsky was a Russian psychologist, who worked at around the same time as Piaget (although he died younger) and was influenced by Piaget's work. During his lifetime, he was not well known in the West, but after his death (in particular since the 1960s) he has become increasingly influential.

Vygotsky's main interest was the study of language development, which he believed initially develops separately from thought, but starts to overlap with thought more and more as the child grows up. According to Vygotsky, a non-overlapping part still remains later in life, some non-verbal thought and some non-conceptual speech existing even in adults (Moll, 1992; Vygotsky, 1978).

A major disagreement between Piaget and Vygotsky was that Vygotsky did not think that maturation in itself could make children achieve advanced thinking skills. Vygotsky, while seeing a role for maturation, believed that it was children's interaction with others through language that most strongly influenced the levels of conceptual understanding they could reach (Vygotsky, 1978).

Vygotsky strongly believed that we can learn from others, both of the same age and of a higher age and developmental level. One of the main ways this operates is through *scaffolding* in the *zone of proximal development* (ZPD). This latter concept, one of Vygotsky's main contributions to learning theory, refers to the gap between what a person is able to do alone and what they can do with the help of someone more knowledgeable or skilled than they are. It is here that the role of teachers, adults and peers comes to the fore in children's learning, in that they can help bring the child's knowledge to a higher level by intervening in the zone of proximal development. This can be done by providing children's thoughts with so-called scaffolds, which are no longer needed by the child once the learning process is complete. Not all children are as *educable* in this respect, some being able to learn more in the zone of proximal development than others.

Thus, for Vygotsky, it is *cooperation* that lies at the basis of learning. It is formal and informal *instruction* performed by more knowledgeable others, such as parents, peers, grandparents or teachers that is the main means of transition of the knowledge of a particular culture. Knowledge for Vygotsky, like for Piaget, is embodied in actions and interactions with the environment (or culture), but unlike Piaget, Vygotsky stresses the importance of *interaction* with a living representative of the culture.

While Piaget has been criticized for being too strongly focused on developmental learning, Vygotsky's work is seen as suffering from the opposite problem. Vygotsky wrote little about children's natural development and the relationship of that to their learning (Wertsch and Tulviste, 1992). Vygotsky's theories are also in many ways rather general and overarching, and have not been fully worked out (that Vygotsky died at the age of 37 is one reason for this). Vygotsky's contribution lies mainly in his attention to the social aspects of learning, which clearly need complementing by what current research is teaching us about brain functions.

This view of learning as socially constructed strongly influenced the so-called constructivist theories that have followed since then, and has influenced classroom practice. His ideas about pupils' learning in their zone of proximal development have been influential in the development of collaborative learning programmes.

Think Point 1.2

Behaviourist learning theory and the theories of Piaget and Vygotsky have been highly influential in the development of teaching. Can you think of some of the different implications each of these theories may have?

Learning Styles

Recently, a lot of attention has focused on differences in pupils' learning styles. While this concept is often evoked, what exactly is meant by different learning styles is not always clear.

Kolb's learning styles theory

One of the most clearly elucidated theories of learning styles is that of Kolb (1995), according to whom learning styles can be ranked along a continuum running from:

1. concrete experience (being involved in a new experience) through
2. reflective observation (watching others or developing observations about our own experience) and

3. abstract conceptualization (creating theories to explain observations) to
4. active experimentation (using theories to solve problems and make decisions).

As is clear from the above, Kolb saw these different styles as a cycle through which all learners should move over time. However, more recently, learning theorists have conceptualized these styles as ones which learners come to prefer and rely on, most learners thus preferring one of these four styles. Litzinger and Osif (1993) called these different types of learners *accommodators*, *divergers*, *convergers* and *assimilators*, and arranged them along Kolb's continuum as depicted in Figure 1.1.

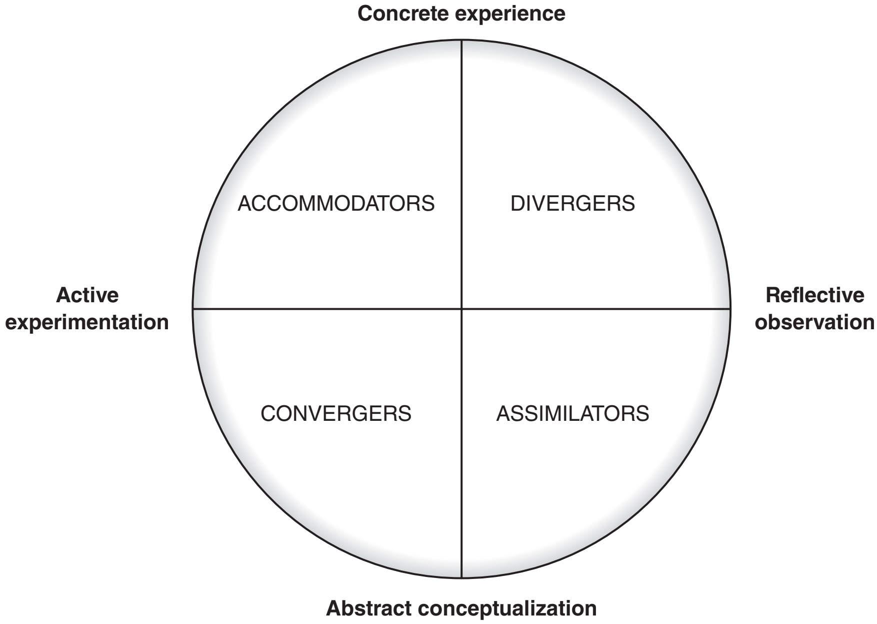

Figure 1.1 Kolb's learning styles (from Litzinger and Osif, 1993). Reprinted with permission from Pierian Press.

Accommodators prefer an active learning style. They tend to rely on intuition rather than on logic and like to connect learning to personal meaning and experiences. They enjoy applying their knowledge to real-life situations and don't like to analyse too much. When teaching these learners, it is recommended to encourage independent discovery and to let learners participate actively in their learning. Interpersonal aspects are important to accommodators, so they will tend to enjoy cooperative learning and group work.

Assimilators like accurate, organized delivery of knowledge and tend to respect the views of those they consider to be experts on the subject. They think logically and prefer abstract ideas. Logic is more important to them than a practical explanation. They will prefer lecture-style lessons or carefully prepared exercises which they will follow closely. However, they also enjoy independent analysis of data and research.

Convergers are mainly interested in the relevance of information. They want to understand in detail how something operates, so they can use it in practice. These learners prefer technical information and are not very interested in social and interpersonal issues. Lessons that suit these learners are interactive, and it can be useful to provide them with real-life problems to explore. Convergers will enjoy doing hands-on tasks, use manipulatives, etc.

Divergers are mainly interested in the 'why' of a system. They like to reason from concrete specific information and to explore what a system has to offer. They like to see things from a variety of viewpoints and like categorizing information. These learners like to use their imagination when solving problems. Divergers enjoy self-directed learning and like independent study, simulations and role play. Information should be presented to them in a detailed, systematic manner.

Kolb's theory is far from being the only learning styles classification in existence. Another classification looks at pupils' different sensory preferences. According to this theory, learners can be classified as preferring either visual, auditory or tactile/kinaesthetic learning (Benzwie, 1987; Dunn and Dunn, 1978), while others add print, interactive and olfactory learners to this typology, leading to the following typology:

- *Visual learners* learn best by looking at pictures, graphs, slides, demonstrations, films, etc. Colourful, bright graphics can help these learners retain information.
- *Auditory learners* like to learn through listening both to others speaking and to audio tapes. They will benefit, for example, from preparing listening tapes for review.
- *Tactile/kinaesthetic learners* learn best through touch and movement, and will therefore like to work with hands-on manipulatives. They will also like role plays and activities which employ body parts as a mnemonic device, such as hand-signals.
- *Print-oriented learners* prefer to learn through reading.
- *Interactive learners* enjoy discussions with other pupils in small groups or during paired work.
- *Olfactory learners* benefit from the use of smell during learning. Associating certain lessons to particular smells can benefit these learners.

The distinction between *inductive* and *deductive learners* has also been looked at by learning styles researchers (Hodges, 1994). Inductive learners begin with observations or data and then infer governing rules and principles from these observations. They work from particulars to general principles, and want to know: (1) What will the results to be derived help me know? (2) What are the results? (3) How do I derive them? Deductive learners begin with general principles, then deduce consequences and phenomena from these. They work from generalities to particulars and want to know: (1) What are the results to be derived? (2) How do I derive them? (3) How do I use them?

The concept of learning styles remains popular, and a plethora of different classifications have developed. A popular and still widely used distinction is that between *sequential* and *global learners*. Sequential learners learn one thing at a time. They function well with partial understanding, are good at analysis and convergent thinking, but may sometimes miss the big picture. Global learners, on the other hand, learn in large chunks, don't function well with partial understanding, are good at synthesis and innovation, but are fuzzy on details and may appear to learn more slowly, especially at the beginning of a topic (Felder and Silverman, 1988). Many educators in England still advocate a distinction between *visual*, *auditory* and *kinaesthetic* learners, who respectively prefer to learn from visual sources, through hearing or through movement (Rogowsky et al., 2015). More recently, Blazhenkova et al. (2011) distinguish between *verbalizers*, who prefer to represent information verbally, *spatial visualizers*, who prefer to schematically represent spatial relations and objects, and *object visualizers*, who prefer concrete and detailed images of objects.

The evidence on learning styles

As can be seen from the above, there are a whole number of learning styles, one study finding a total of 71 different learning styles frameworks (Coffield et al., 2004), and this in itself illustrates some of the problems with the whole idea. There are a number of commercial tools on the market designed to measure learning styles among pupils of various ages, such as the Learning Style Inventory (Dunn et al., 1985). However, while a number of these tips make intuitive sense, there is very little research that suggests that teaching to different learning styles actually aids pupils' achievement.

While some studies show a relationship between learning style and achievement (e.g. Burns et al., 1998; Uzuntiriyaki et al., 2003), in general there is very little evidence to support learning styles. In a large-scale review of the evidence, Coffield et al. (2004) found that learning styles had weak theoretical grounding and close to no empirical support. In one of the earliest relevant studies, Davis (1990) measured the learning styles of a group of second-grade pupils and changed the classroom environment to reflect their preferred learning styles. She found that a control group of pupils whose learning styles had not been taken into account outperformed the experimental group. Similar findings are reported by O'Sullivan et al. (1994), who found mixed effects of an intervention to help at-risk ninth graders through learning-style-based instruction. As well as a lack of evidence on the relationship of Kolb's learning styles to achievement, doubt has been cast on the validity of the concept, with Garner (2000), for example, finding no evidence of the existence of stable learning styles in his study using Kolb's Learning Styles Inventory. This lack of empirical support continues in recent studies. For example, Rogowsky et al. (2015) found no relationship between learning styles and instructional method used.

This does not, of course, mean that there are no differences in the ways that individuals learn, or prepare to learn, and it is possible to measure these differences, though the fact that people have come up with so many different styles suggests that it is not a well-developed concept. However, what is entirely lacking is any evidence that it makes sense to adapt teaching to different learning styles. As Pashler et al. (2009: 105) state in their review: 'there is no adequate evidence base to justify incorporating learning styles assessments into general educational practice'. In other words, it is not a useful idea to base teaching practice on.

It is also important to remember that even if we find that children and adolescents have different preferences or learning styles, the implications of that for teaching is not necessarily to 'give the pupil's what they want'. On the contrary, it might be far more useful to try and develop those areas where they are weaker.

Cognitive Science

Recently, cognitive science has started to have significant influence in education. Cognitive science, the study of how the mind works, combines research from a number of different fields, like psychology, neuroscience and computer sciences (in particular the study of artificial intelligence). Technological advances have led to major scientific discoveries in this area, and to great public interest, especially in the visually attractive presentation of brain imaging results. Cognitive science has led to significant breakthroughs in understanding the different functions of the brain and in starting to understand how specific processes such as visual processing work. All of this has implications for our understanding of learning, but has unfortunately also led to a lot of misconceptions and has provided further material for educational snake-oil salespeople. Translating data from the lab to the classroom is not straightforward, not least because while cognitive scientists typically study functions in isolation, in reality different functions interact with the environment in complex ways. Willingham (2008) gives the example of overlearning. Cognitive science suggests that learning is better retained when we continue to practice even after full mastery of a certain piece of content has been obtained. However, this may not have very positive effects on the motivation of our pupils! So in this section we will discuss some of the things we can learn from cognitive science, but also look at what we can't.

What many of the older learning theories (like behaviourism and the theories of Vygotsky) were not able to incorporate was any theory of how the brain works (due to limitations in research methods at the time). More recently, however, cognitive and neuroscience have progressed greatly, and are informing learning theory and education to an ever-greater extent. To some extent, these new methods are confirming theories that we discussed earlier, but they are also offering us important new insights.

One of the major insights from cognitive theory relates to the working of memory and cognitive information processing theory. Especially important in this theory is the role of memory in learning processes. The memory consists of three parts: the sensory buffer, the working memory and the long-term memory.

The memory works as follows: one's experiences (tactile, visual or auditory) are registered in the sensory buffer, and then converted into the form in which they are employed in the working and long-term memories (see Figure 1.2). The sensory buffer can register a lot of information, but can only hold it briefly. Some parts of the information in it will be lost, while other parts will be transmitted to the working memory. The working memory is where 'thinking gets done'. It receives its content from the sensory buffer and the long-term memory but has a limited capacity for storing information, a fact that limits human mental processes. The working memory contains the information that is actively being used at any one time.

The long-term memory has a nodal structure, and consists of neural network representations, whose nodes represent chunks in memory and whose links represent connections between those chunks. As such, nodes can be equated with concepts, and links with meaningful associations between concepts. Together these form schemata, or clusters of information. Activating one item of the cluster is likely to activate all of them (Best, 2000). This means that memorization and making connections are two crucial components of learning.

These structural characteristics of the brain have some important pedagogical consequences. In particular, if working memory is where information processing happens, the limitations of working memory are of great importance to learning. This, indeed, is the basic thesis of the so-called cognitive load theory, which suggests that the limited capacity of the working memory places a limit on the amount of information that can be processed at any one time. These limitations only apply to new information that has not been stored in long-term memory. This type of information can only be stored for a short period of time. This is not the case for information from the long-term memory, which can be retrieved for an indefinite time and in large quantities. Thus, it is important that learning tasks do not overload working memory, something that is often a problem with individual and discovery learning approaches (Kirschner et al., 2006). Rather, a structured approach, akin to mastery learning, or an approach whereby cognitive load is limited through collaborative group work (with different pupils taking on different parts of the load) may be more appropriate, and may account for the lack of effectiveness of discovery oriented approaches among pupils with lower levels of competence or prior knowledge as found in a lot of effective teaching research (Muijs et al., 2014).

The functioning of the short-term memory is itself not independent from the long-term memory. The more information about a specific area or skill that is contained in the long-term memory, the easier it will be for the working memory to retrieve the necessary information for quick processing. The processing of information in the working memory (or learning) is influenced by the extent and speed with which prior knowledge (in the broad terms defined here) can be accessed. Working memory processes are therefore part-determined by the extent of prior knowledge, as well as the extent to which prior knowledge is organized in a way that makes it easily accessible. These processes are open to change, and practice and learning can increase them,

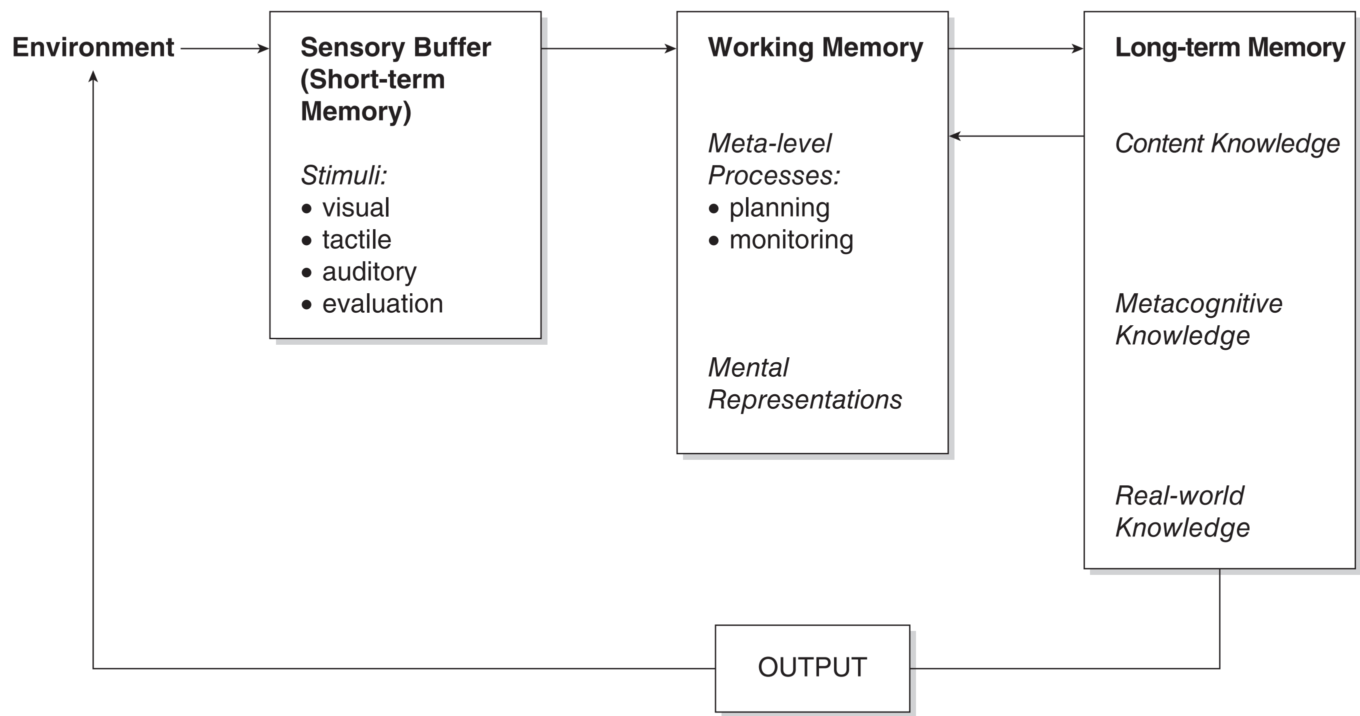

Figure 1.2 The structure of memory

which in turn is linked to achievement in maths and reading (little research exists on other subject areas) (Molfese et al., 2010). Of course, this potential for change means that common misconceptions on the actual number of chunks of information that can be processed are not very helpful.

The way memory works has been found to be somewhat different from what we intuitively expect. For example, repeatedly rereading a text or doing a lot of practice immediately after we have learnt something is not as effective as we think. We feel we are learning and memorizing, but actually we quickly lose what we have learnt. More effective strategies are spacing out practice of new skills or knowledge, or interleaving them with practice of a different skill, and testing ourselves on what we have learnt (Brown et al., 2014). The fact that learning proceeds through making connections in the long-term memory also means that we do in fact need a solid knowledge base, contrary to views that we do not need knowledge in the age of the Internet and ever accessible information (we will discuss this further in Chapter 6).

Another key finding from cognitive science relates to the importance of emotion in learning. Emotions can both help and hinder learning. On the positive side, emotions help us to recall information from the long-term memory, through allowing any information received through the sensory buffer to be perceived as positive or a threat. Research suggests that the brain learns best when confronted with a balance between high challenge and low threat. The brain needs some challenge to activate emotions and learning. This is because if there is no stress the brain becomes too relaxed and cannot actively engage in learning. Too much stress is also negative, however, as it will lead to anxiety and a 'fight' response, which are inimical to learning. A physically safe environment is particularly important in reducing overly strong levels of stress (Sousa, 1998).

As mentioned above, there are also a number of ideas that have been peddled as 'brain-based', but which do not stand up to empirical scrutiny. Learning styles, as mentioned above, is one such area. Other so-called 'neuromyths' include the idea that we can neatly distinguish left- and right-sided brain functions, the idea that we only use 10 per cent of the brain, and programmes such as the preposterous 'Brain Gym', which remains popular in some schools in the UK and Europe. Unfortunately, one recent (albeit small scale) study, found that such neuromyths were believed by almost 50 per cent of surveyed teachers (Dekker et al., 2012).

Cognitive science is a constantly developing research field, and it is highly likely that further developments will in future strongly inform our views on learning, and our teaching strategies. However, one caveat does apply: while we have presented a number of basic findings, this research area is diverse. Findings from different studies do not always agree with one another, and are usually far more subtle than we have been able to outline in this introductory text. Also, it is always dangerous to try and directly translate findings from brain research into the classroom. This type of research should clearly inform us, but we need to take into account that it has been conducted for very different purposes, and will always need to be matched to educational research findings on effective classroom teaching before it can be translated into effective classroom strategies.

Think Point 1.3

Research in cognitive science suggests that immediate intensive practice of new learning may be less effective than spacing out practice. What implications would this have for teaching?

The genetic basis for learning

Another recent development from psychological science is the growth in research on genetic components to learning. Findings from twin studies, which aim to disentangle genetic and environmental components determining human behaviour, have started to produce some striking findings on education. In their recent overview of research in this area, Asbury and Plomin (2013) summarize some of the key lessons. Firstly, the genetic component to attainment appears to be large, accounting for up to two thirds of variance between individuals, and this across subjects. Secondly, the genetic component is mainly correlated with the static component of attainment (our initial attainment levels), and whole environmental factors account more strongly for the growth component (the change in our relative attainment levels over time). Thirdly, the higher the quality of education received, and the more homogeneous this quality is, the greater the contribution of genetic factors to attainment. Fourthly, there is no such thing as a 'learning' gene. Rather, as has been found in other areas of genetic research, complex genetic interactions appear to account for differences found.

This research, though still in a relatively early phase of development, raises challenges to educational research. Asbury and Plomin (2013) suggest developing models of schooling that more closely align education to pupils' genetically determined aptitudes, for example through personalized education plans and broad curriculum choices.

It is, in our view, currently too early in the development of this area to draw overly firm conclusions for education, but the further development of genetic research is certainly something we need to keep an eye on as educators.

Summary

In this chapter, we have looked at some educationally influential theories of learning and intelligence.

IQ theory focuses on the concept of intelligence. According to IQ theorists, there is one underlying, general intelligence that determines our capacity for learning. More recently, Gardner developed his theory of multiple intelligences. Rather than just the one intelligence, Gardner claims that there are a number of different intelligences, such as musical and visual/spatial intelligence.

Behaviourism was mainly concerned with how we learn from external stimuli. Using experimental methods, behaviourists looked at how behaviour can be conditioned, for example by providing rewards and punishments.

Piaget used observation to come to his theories of learning. He was particularly interested in the ways children develop. This happens through *maturation*, whereby our genetic growth creates change, and through *activity*, whereby children act on their environment and learn from this. An important finding of Piaget's is that growing up does not just mean knowing more, it actually entails a change in how we think.

Vygotsky concentrated on the ways in which learning is a social process. We learn through interaction with others, both of the same age and of a higher age and developmental level. This process operates through *scaffolding* in the *zone of proximal development*. The ZPD is the gap between what a person is able to do alone and what he or she can do with the help of someone more knowledgeable or skilled than him or herself. Scaffolding refers to the way others can help us to bridge that gap.

Cognitive science is increasingly influential in our understanding of learning and is producing valuable findings for educators. Key lessons concern the importance of the structure of memory to learning, where we need to make sure that we encourage the making of connections in long-term memory and develop the necessary basis for learning through knowledge stored in the long-term memory. The important role of emotions in learning is also stressed.

Reflective Questions

1. Thinking about your own practice, in what ways do you think learning theories could influence the way you teach?
2. Thinking about your own learning, how well do you think the different learning theories describe how you learn?
3. What elements of behaviourist theories might influence how you teach?
4. What elements of cognitive science would influence how you teach?