# Teaching Materials for Educational Psychology

# (English Group)

Educational Psychology

Raquel Cerdán Otero

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# SEARCHING FOR THE ESSENCE OF EDUCATIONAL PSYCHOLOGY: CONTENTS, MAIN DEBATES, AND FUTURE CHALLENGES

In this section we review the main contents of educational psychology in the modern era, outline the main achievements, and delimit its areas of influence as a discipline. We review the main debates that have arisen regarding the status of educational psychology as a science and its links to professional practice. We then address the main challenges for the future of educational psychology and propose evidence-based practice as the way forward for the relationship between educational psychology as a science and professional practice.

## 1.1. Main contents of educational psychology in the modern era: from 1960 to the present day

### *1.1.1. Educational psychology at the end of the 20th century and the beginning of this century*

We first detail the state of educational psychology at the end of the twentieth century and the beginning of this century by synthesising a review by Pressley and Roehrig (2003). These authors analysed two sources of evidence that are illustrative of the type of research being conducted by educational psychologists. Pressley and Roehrig initially reviewed the contents of three recent volumes that address current issues in educational psychology. They then analysed the contents of the 1997 and 1998 volumes of one of the most prestigious research journals in the discipline – the *Journal of Educational Psychology*.

### *1.1.2. Volumes reflecting contemporary educational psychology (main contents)*

In recent years, at least three impactful volumes have been published in the field that bring together the leading research in educational psychology. In each, specialised scholars detail the diverse nature of educational psychology.

#### Handbook of Educational Psychology (1996 edition)

The first edition of the Handbook of Educational Psychology (Berliner and Calfee, 1996) was sponsored by Division 15 of the American Psychological Association (educational psychology). At least eight significant themes emerge from an analysis of the contents (Pressley and Roehrig, 2003).

1. *Cognition*. Ideas about cognition appear primarily throughout the chapters, especially in the chapters entitled ‘Cognition & Learning’ and ‘Problem-solving transfer’. Cognition is also present in chapters devoted to individual differences, development, individual differences in cognition, and gender development. Discussion of cognition also appears in chapters on school curriculum, including chapters on teaching history, science, mathematics, literacy, and second-language instruction. Cognitive themes are also strong in chapters on teaching and instruction (learning to teach, teachers' beliefs and knowledge, teaching in a classroom, situated social practice & instructional design, technology & education, group processes in the classroom). An inevitable conclusion to be drawn from this analysis is that contemporary psychology is largely a cognitive psychology of education, with a great deal of work devoted to analysing the cognition and cognitive development of different types of students and teachers.
2. *Sociocultural perspectives*. Some authors argue that cognitive thinking and development occur in a social and cultural context and are better conceived of as sociocultural rather than simply cognitive. The cognitive perspective emphasizes processes within the individual learner, rather than processes that occur between people. It is striking that, although the handbook refers to sociocultural theoretical perspectives, little research is cited in relation to this perspective. This contrasts with the large volume of research cited related to the remaining topics covered in the volume.
3. *Development*. Development theory and research is present in most chapters. There are two chapters on development and much research is also referenced in other chapters.
4. *Motivation*. In addition to two specific chapters on motivation (one on theories and the other relating to instruction motivation), motivation also appears in two chapters focused on development and in three chapters on the analysis of individual differences. Motivation is particularly present in chapters devoted to teaching and instruction. In summary, the handbook considers the factors that affect student motivation, including school organisation.
5. *Individual differences*. The section of the handbook devoted to the analysis of individual differences is the longest section. In addition, concerns about individual differences appear in many other chapters (including in the chapters on bilingualism and curriculum development). The chapter on teacher beliefs looks at how teachers differ in their cognitive processes. By the late twentieth century, educational psychologists had largely addressed how people differ and the consequences of these differences for educational achievement.
6. *Psychological foundations of curriculum*. The handbook includes chapters on teaching history, science, mathematics, literacy/reading, and second-language learning. This demonstrates that psychological analyses have an impact on curriculum research.
7. *Teaching and instruction*. The handbook includes seven chapters on teaching and instruction, with teaching also included in chapters focused

on curriculum. A chapter on informal curriculum discusses how instruction sometimes conveys implicit messages that can affect students. The nature of teaching is also considered in the chapters on individual differences, especially in the chapters on exceptionality and gender.

8. *Research and evaluation methods*. An entire section is devoted to a discussion of research and assessment methods. Discussion of assessment also appears in the chapters on cognition and learning, exceptionality, mathematics instruction, reading, and informal curriculum.

From the review of the contents of the handbook, we could conclude that current educational psychology consists of theory and research on the following topics: *cognition; sociocultural perspectives; development; motivation; individual differences; psychological foundations of curriculum; teaching and instruction; and research and evaluation methods*. This list does not seem exhaustive and excludes, for example, behavioural psychology applied to education, education research, and new technologies.

The most recent changes in the discipline are reflected in the first and second editions of the Handbook of Educational Psychology. The table of contents of the HBEPII (Handbook of Educational Psychology, 2006) shows important changes from the previously revised first edition. In the first edition, the editors began the initial chapters on cognition and motivation, and left the foundations of the discipline for the end of the handbook. The methodological chapters were also relegated to the final chapters. In the second edition, the historical and philosophical foundations of the discipline take priority and become the first chapters of the manual. New entries on sociocultural issues and neuroscience are added. Cognition and motivation appear in the middle of the volume and the content had been substantially revised when compared to the first edition. A chapter on methodology with a special emphasis on experimental designs again ends the volume.

In the second edition of the manual, cognition continues to be the dominant paradigm. But its approach and style have changed significantly from the first edition. In the second edition, there is an increased interest in metacognitive components based on Vygotskian-type analyses. In general, there is increased interest in the analysis of individuals in context *('the self in social context'*). Motivation had also emerged as a relevant area in educational psychology, both conceptually and empirically, and the development of the concept of self-regulation emerges as a crucial field of study for understanding academic motivations.

The third edition of the Handbook of Educational Psychology is sponsored by Division 15 of the American Psychological Association (APA). In this volume, 30 chapters address new developments in theory and research methods while honouring the field's legacy. A diverse group of recognised scholars from within and outside the United States provide integrative reviews and critical syntheses of

developments in the substantive areas of psychological research in education; functional processes for learning; learner preparation and development; knowledge construction and subject matter expertise; and the learning environment and task. New chapters in this edition cover topics such as learning science research; latent variable models, data analysis; neuropsychology; emotion-motivation-volition relationships (EMOVO); scientific literacy; sociocultural perspectives on learning; dialogic instruction; and networked learning. Discussion of relevant individual differences, underlying processes, and new research on subject acquisition had been expanded.

**International Encyclopedia of Developmental and Instructional Psychology (2nd Edition)**

The International Encyclopedia of Developmental & Instructional Psychology, 2nd ed. (De Corte & Weinert, 1996) consists of 171 articles organised in 17 sections – with the first seven sections focusing on development and the final ten sections focusing on instructional psychology. It is on these latter sections that we focus for the analysis presented below. While the eight topics covered in the handbook also appear in the encyclopedia, the instructional psychology section of the encyclopedia includes substantive work on other topics.

1. *Behavioural learning*. Includes coverage of operant conditioning, feedback, behavioural modification, programmed instruction, behavioural goals, and mastery learning.
2. *Social relations and education*. The encyclopedia includes chapters on family environment, peer relationships, school social environments, communication, social interactions, and teacher expectations.
3. *Educational multimedia*. An entire section is devoted to computers, media, and learning. Studies on the effects of multimedia technology on learning were conducted in the late 1990s and have become part of educational psychology.

Thus, the encyclopedia addresses the following topics: *cognition; behavioural learning; sociocultural perspectives; social relations and education; development; motivation; individual differences; psychological foundations of curriculum; teaching and instruction; educational multimedia; and research and evaluation methods*. These subfields are not mutually exclusive but overlap and depend on each other.

**Advanced Educational Psychology (AEP) for Educators, Researchers and Policymakers:**

Pressley and McCormick (1995) edited a handbook that sought to comprehensively synthesise the field of educational psychology and document the most relevant research contributions. The authors cover the main lines of research represented in the major journals. The contents are the same as those outlined above for the handbook and encyclopedia.

**Synthesis of volume analysis:**

The three above sources (*Handbook, Encyclopedia, and AEP*) provide us with a complete picture of the current state of educational psychology, at least as it was conceived by its major leaders. However, these volumes do not fully reflect what is currently happening in educational psychology. To do this, it is necessary to review the major journals. Given that there is a clear connection between the discipline's recent past and the research currently being published, it is expected that the 11 themes identified in the volumes would appear in the more recent literature (Pressley and Roehrig, 2003).

*1.1.3. Publications in journals reflecting contemporary educational psychology*

**Journal of Educational Psychology: 1997-1998**

Pressley and Roehrig attempted to match the 11 categories identified in the previous volumes with articles published in the 1997 and 1998 volumes of the *Journal of Educational Psychology*. Each article was reviewed and classified into one of the categories identified above. Nearly two-thirds of articles published in the journal in 1997-1998 fit into the following categories: *cognition, motivation, and individual differences*. What is striking is that most articles were related to the field of cognition (including most of the articles identified as motivation and individual differences studies), despite this apparently not being the focus.

Therefore, by the end of the 20th century, the *Journal of Educational Psychology* could be classified as a journal with a strong cognitive orientation. Another striking result is that most of the papers identified as cognitive studies focused on the area of reading and literacy. For example, 17 articles were found related to comprehension processes, and another 12 focused on students with reading and writing difficulties. The only category not represented in the journal was the category identified in the analysis as behavioural learning. This shows that the cognitive approach was not a major area in educational research at the end of the twentieth century.

There was little in the journal primarily related to sociocultural analysis. Sociocultural scholars believe that there are qualitative differences between cultures with consequences for academic achievement, and these scholars prefer to employ qualitative rather than quantitative analysis. In contrast, educational psychology is a predominantly quantitative science, with only a few qualitative articles published in the journal in the period 97-98. Only a small portion of the articles focused on the relationship between education and technology. In part, this is due to the existence of specialised journals (i.e., *Journal of Educational Computing*) and because during 1997-1998 educational psychologists had not focused on analysing student performance in multimedia environments. Clearly this situation must have changed.

In conclusion, the 11 categories of research identified from the content analysis of the volumes in educational psychology are also reflected in the publications of the *Journal of Educational Psychology* during the decades 1997-1998. Some categories are stronger than others (cognitively oriented studies, analysis of individual differences, and motivation). Other smaller categories are beginning to emerge, such as socio-cultural analyses of academic achievement and studies on learning and new technologies (in other words, educational media).

It seems clear that educational psychology is heavily influenced by the broader field of psychology. The cognitive revolution in educational psychology seems part of and is influenced by the larger cognitive revolution in psychology. Similarly, the impact that the topics of motivation and individual differences have had parallels the interest that these topics have aroused in general psychology. At the end of the 20th century, educational psychology appears as a multifaceted subdiscipline of psychology.

### *1.1.4. Educational psychology in 1960*

Pressley and Roehrig (2003) identified books (in the absence of volumes like those reviewed in the 1990s) that revealed the content of educational psychology in the 1960s. An analysis of these volumes enabled comparisons between the current content in educational psychology and that of the 1960s, thus providing an insight into the progression of content in the discipline. These were the main educational psychology textbooks used by graduate students.

#### Educational Psychology according to Cronbach (1962) and Klausmeier (1961)

Two of the most respected handbooks on educational psychology were *Educational Psychology* (Cronbach, 1962) and *Learning and Human Abilities: Educational Psychology* (Klausmeier, 1961). To learn more about educational

psychology research in the 1960s these volumes were reviewed to determine if the 11 categories previously identified also appeared in these handbooks.

Except for the psychological foundations of the curriculum, all of the topics that make up contemporary educational psychology were represented in Cronbach's and Klausmeier's manuals. While cognition is the most prevalent field in contemporary educational psychology, behavioural approaches were predominant in 1960. Another difference lies in the differing prominence of theory and research in the main publications for each period (the 1990s versus the 1960s). There are citations to the major authors and theories in the 1960s volumes, while the manuals of the 1990s are much more research oriented.

**Journal of Educational Psychology (1960-1961)**

Articles published in the JEP in 1960 and 1961 were also analysed with respect to the 11 categories previously identified. All the articles seem to fit these categories. Some categories have a similar percentage of articles in 1960-61 as in 1997-1998 (sociocultural perspectives, social relations and education, development, individual differences, and education and media). Some categories, such as cognition and motivation, have much less representation in the early 1960s than in the late 1990s. Others such as behavioural learning, teaching and instruction, and research/assessment methods are more prevalent in the 1960s than in the 1990s.

Articles in the 1960s were much shorter than those published today, with 2500-word articles being not uncommon. The brevity of the introductions and discussions in 1960 is also striking. There was much less research to frame the studies and relate the main results. The increased length of introductions and discussions is thus a clear reflection of the accumulation of conceptual and empirical knowledge that has occurred during the modern era.

**Synthesis and content analysis of educational psychology from 1960 to 1990**

Current articles are longer and conceptually more complex, and it is also noteworthy that there are many more educational psychology journals in the late 1990s than in the 1960s. This greater number of publications indicates that there have been many significant contributions to educational psychology in the modern era.

*Table 1* shows authors cited at least four times in manuals of the 1960s and 1990s. Notably, twice as many names appear in the 1990s list than in the 1960s list, reflecting a greater number of educational psychologists active at the turn of the twentieth century. Benjamin Bloom and B.F. Skinner are the only two authors

appearing on both lists, reflecting their early and influential careers. In general, distinguished authors of the 1960s are barely cited in modern volumes.

| Cited four times in Cronbach (1962) and Klausmeier (1961) | Cited four times in Handbook (1996), Encyclopaedia (1996) and AEP | |
|---|---|---|
| B.S. Bloom | J.R. Anderson | M.R. Lepper |
| W.A. Brownell | A. Bandura | R.E. Mayer |
| L.J. Cronbach | C. Bereiter | J.G. Nicholls |
| H.B. English | B.S. Bloom | A.S. Palincsar |
| H.J. Klausmeier | J.E. Brophy | D.N. Perkins |
| J.P Guildford | A.L. Brown | P.L. Peterson |
| W.J. McKeatchie | J.C. Campione | J. Piaget |
| G. Murphy | C.S. Dweck | M. Pressley |
| S.L. Pressey | E. Fennema | M. Scardamalia |
| H.H. Remmers | H. Gardner | A.H. Schoenfeld |
| B.F. Skinner | R. Glaser | H.A. Simon |
| L.M. Terman | J.G. Greeno | B.F. Skinner |
| G.G. Thomson | W. Kintsch | R.E. Slavin |
| | L.S. Vygotsky | B.J. Zimmerman |

*Table 1. Educational psychologists cited. Adapted from Pressley and Roehrig (2003).*

Several aspects should be highlighted about the most outstanding authors of the 1990s. At least a quarter of the sample consists of major theorists whose contributions to educational psychology have been primarily theoretical: *J.R. Anderson, Albert Bandura, Howard Gardner, Lawrence Kohlberg, Herbert A. Simon, B.F. Skinner, and Lev S. Vygotsky*. Most of the others have also made important theoretical contributions, but stand out for their research in specific areas: *Carl Bereiter* in primary education and writing processes; *Richard Mayer* for work on the cognitive analysis of educational problems and learning processes; *Alan Schoenfeld* for his conceptualisations of cognition and mathematics education; *Barry Zimmerman* for research on observational learning and self-regulation; and *Walter Kinstch* for research on cognitive reading processes.

Thus, a large majority of contemporary scholars have made their most distinguished contributions to the cognitive psychology of education, reflecting the clear cognitive trend in educational psychology today. More than a quarter of the authors have worked on educational motivation. Most of the authors in the modern list were students when the modern era began. Interestingly, many of them did not

pursue their doctoral studies in educational psychology, but in related areas (for example, *Ann. L. Brown* in developmental psychology; *Annemarie Palincsar* in special education; and *Robert Slavin* in sociology). These authors found obvious connections between education and psychology, which is evidence that educational psychology both interacts with and is stimulated by broader areas of study and especially psychology.

### *1.1.5. Cognitive transformation of educational psychology in the modern era*

This section discusses elements that have shaped the field of educational psychology in the modern age. They are drawn from interviews, letters, and other documentation obtained from Pressley and Roehrig's (2003) interaction with leading educational psychologists. In turn, these elements can mostly be related to cognitive psychology and classified into one of the 11 categories defined for the analysis of educational psychology in the preceding decades.

## Cognition. Development of the major cognitive theories and research programmes

Psychology has generally undergone a cognitive revolution in the last 40 years, and educational psychology has been involved in this revolution. One of the books that had greatest impact on educational psychologists in the modern era was Miller, Galanter, and Pribram's (1960) *Plans and the Structure of Behavior*. It was an accessible text written in a very understandable style. Miller et al. argued in this text that with the advent of computers it would be possible to specify in detail the characteristics of the human internal processor to explain decision-making and other complex behaviours. Thus, concepts such as intentions, plans, and images were scientifically valid and constituted potential explanations for human decision-making and behaviour.

Most of the new research in cognitive psychology addresses memory. There were several nonbehavioral conceptions of memory that were studied in the late 1950s, with notable authors such as *Benton Underwood* and *Leo Postman*. They worked on internal E-R mediation. Many scientists contributed to the volume edited by Tulving and Donaldson (1972) entitled *Organization of Memory*, where it was specified that memory was based on categorical associations between bits of information. The first evidence for this was the finding that categorically organised lists of words were better remembered than lists of unrelated words. A second example of this stream of cognitive psychology and memory is Paivio's publication *Mental Imagery and Verbal Processes* (1971), where he argued that mental imagery mediated a large part of mental processes.

As evidence, Paivio explained how lists of words linked to specific referents were better remembered than lists of words linked to abstract referents, how pictures were better remembered than words, and how instructions for constructing mental images of words generally facilitated memory. This publication had a significant impact on educational psychologists, and several important studies were published on how mental imagery affected learning and memory. These studies appeared in volumes of the *Journal of Educational Psychology* in the 1970s and 1980s. In short, educational psychologists were influenced by basic cognitive theory from its first appearance. A significant number of educational psychologists conducted research that closely resembled basic cognitive psychology. The *Journal of Educational* Psychology published a significant number of articles on basic memory processes, conceptual development, and problem solving.

**Behavioural learning. Behaviourism has been transformed into cognitive behaviourism**

B.F. Skinner always refused to acknowledge the importance of cognitive analyses of behaviour. However, other behavioural psychologists were more open to cognitive theory and transformed behavioural psychology into cognitive-behavioural psychology.

At the beginning of the modern era, behavioural psychology was flourishing, in part due to the successful application of behavioural principles to applied problems, including problems in education. Behavioural modification was frequently applied in classrooms. While most behaviour modification was purely behavioural (reinforcement and punishment processes), several behavioural psychologists began to experiment with cognitive (imagery) techniques that could be used with the more purely behavioural techniques. All this work was well reflected in Bandura's (1969) *Principles of Behavior Modification*.

Bandura gained great fame through his work on observational learning, which is primarily a cognitive work. In his 1977 book, *Social Learning Theory*, Bandura devoted at least 20% of the book to cognitive explanations of observational learning, especially how observers represent what they see and how these representations have consequences for subsequent behaviours. The book included detailed discussions of the attentional, memory, visual, and linguistic processes underlying behaviour. This important work was complemented the following year by Rosenthal and Zimmerman's book (1978) *Social Learning and Cognition*. This book extensively reviewed all existing work relating social learning and cognition variables, including extensive sections on current topics in developmental psychology, such as conservation and moral judgments.

Interventions that brought together behavioural and cognitive mechanisms were strongly advocated in the 1970s. One notable volume was Donald

Meichenbaum's (1977) *Cognitive Behavior Modification,* which was replete with theory and data on treatments that involved students talking to themselves to regulate their own behaviour, imagining themselves performing behaviours, and reinforcing themselves for successfully completing a behaviour. Another significant volume detailing how people could direct their thoughts in ways that influenced their behaviour was Mahoney's (1974) *Cognition and Behavior Modification*.

These books were read and followed by an entire generation of educational psychologists, so that many educational interventions were designed to include behavioural and cognitive techniques (i.e., Meichenbaum and Biemiller, 1998). Teachers were encouraged to reinforce the adaptive behaviours of students and stimulate thoughts that guide self-regulation in learning tasks (such as encouraging students to believe what they can achieve if they make enough effort). Thus, good teachers teach their students to reinforce themselves when actively learning, for example, when developing a strategic plan to solve a specific task.

In summary, although there were prominent behavioural psychologists who never accepted cognitivism, others who began their journey in behavioural analysis discovered the possibility of combining cognitive and behavioural principles. A significant number of educational psychologists developed cognitive-behavioural approaches to teaching essential competencies that schooling was intended to develop (such as reading, writing, and problem solving).

**Sociocultural perspectives. Schooling can shape cognition**

At the beginning of the new era, it was recognised that cross-cultural studies could help understand the effects of schooling on development, especially cognitive development. Cultures vary in the amount and type of schooling. If schooling had an impact on cognitive development, then thinking skills should vary as a function of schooling practices. If schooling is relevant to shaping children's minds, then children who go to school should think differently than those who do not have that opportunity.

Consistently, schooling has been shown to matter. The cognitive skills that children show when memorising, reading texts, and solving problems vary as a function of the amount and type of schooling. Particularly noteworthy in this research were the contributions of *Michael Cole, Daniel Wagner, Jean Mandler, and Barbara Rogoff*. The cross-cultural data showed that education had an essential impact on cognitive development through schooling and related variables (such as instruction). The fact that the culture surrounding a developing child was crucial in the formation of the mind was a central idea in Vygotsky's thinking, as it appears in the 1978 translation of *Mind in Society*.

From Vygotsky's emphasis on the importance of interpersonal relationships between adult and child as precursors of higher cognitive skills in the child, instruction was reconceptualised. Thus, teaching would stimulate children to think as a support for the child to find the solution path on his own rather than to teach it directly. In a key article, Jerome Bruner and his collaborators (Wood, Bruner and Ross, 1976), referred to these actions as *scaffolding*. As the child becomes more competent in his or her interactions with adults, the scaffolding can be removed, and thus the child assumes greater cognitive responsibility for the solving process.

Possibly the most influential instructional intervention conceived from Vygosky's proposal was *reciprocal teaching*, an approach to developing comprehension skills in students with difficulties (Palincsar and Brown, 1984). With this approach, an adult teacher introduces students to a set of skills relevant to comprehension (making predictions, elaborating questions, seeking explanations, and synthesising). The teacher provides support, but only when strictly necessary. Consistent with Vygostky's theory, skills learned in groups are internalised by students, with improved comprehension of texts (Rosenshine and Meister, 1994).

Thus, many schools reformulated classroom interaction so that teachers interact with students like coaches with learners (Rogoff, 1990). The connections made between culture and psychological development (*Ann L. Brown, Anmarie Palincsar, Barbara Rogoff*) based on Vygostky's theory continue to have an impact on educational practices.

## Social relationships and education. Parents and peers influence cognitive development

During the modern era, it became evident that relationships with family and friends have consequences for educational progress. Researchers such as Kathyrn Wentzel (1991a, 1991b, 1993) established clear relationships between social competence and academic competence in middle schools, with socially competent schoolchildren being those who are also academically competent. Important analyses of the relationships between family environment and achievement were made, for example, in the work of Robert Hess (Hess and Shipman, 1965) and Luis Laosa (1978, 1980). A recurring theme in all these works is that social relationships and cognitive development were closely related, and this literature complements existing literature on the relationship between education and cognitive development.

## Development. Cognitive developmental theorists and researchers study education

Cognitive developmental psychologists had a special impact on the field of educational psychology. Psychologists working in the 1960s always mention the impact of Jerome Bruner's works: (1960) *The Process of Education* and *Toward a Theory of Instruction* (1966). They were also influenced by Joseph McVicker Hunt's (1961) *Intelligence and Experience*, which, for many, constituted an introduction to Piaget. But undoubtedly, one of the contributions that most popularised Piaget's work among educational psychologists of the time was John Flavell's (1963) *The Developmental Psychology of Jean Piaget*. Many studies on Piaget's phenomena (i.e., conscientisation) were conducted in the 1960s and 1970s, including several investigations by educational psychologists (Brainerd, 1978).

Possibly due to the prevalence of research on adult memory, as well as the obvious connection between memory and learning, the areas of children's memory and the development of memory caught the attention of educational psychologists. Of particular interest was what strategies could be taught to children that would improve memory. These questions inspired the pioneering work of Flavell and colleagues (Flavell, 1970), cited in much research on memory strategy instruction. Educational psychologists who studied children's memory in the first half of the modern era included *John Borkowski, Ann. L. Brown, Joseph Campione, John Hagen, Dan Kee, Joel Levin, Barbara Moely, Scott Paris,* and *Michael Pressley*.

Several relevant findings emerged from the work on memory development (Schneider and Pressley, 1997). The first is that children became more strategic as they develop. The second is that strategies can be taught, and this has very positive consequences on children's memory. A third result is that taught strategies very often did not transfer. This third result inspired developmental psychologists to think about metacognition as a mediator in the self-regulated use of memory strategies. Important work established that the use of strategy partially depends on the child's understanding of when, where, and how to apply the strategies they learn (Borkowski, Carr, Rellinger & Pressley, 1990).

**Motivation. The theory of academic motivation has become cognitive**

In the early modern era, motivation in education was entirely oriented from a behavioural perspective. Those theorists interested in the intersection between personality and motivation prompted the consideration of internal states and academic engagement. For example, several distinguished educational psychologists considered how individual differences in anxiety influenced student engagement and performance. Despite this, modern conceptions of educational motivation have developed more as cognitive theories than as theories of personality psychology. Thus, cognitive theories of motivation emerged in the 1970s and began to be applied in educational settings.

Bernard Weiner (1979) suggested that the impact of student successes and failures on their motivation depended largely on how students explained successes

and failures to themselves. They might view successes and failures as reflecting skill, luck, or level of task difficulty. These attributions may have consequences for future performance. Finally, if the success or failure of a given task largely depends on intelligence or skill, which is beyond the students' control, one might question the point of attempting it in the future. Similarly, if success or failure depends on luck or the difficulty of the test or task, it may seem pointless to expend additional effort in the future. Conversely, if students attribute success or failure to the effort expended, there would be motivation to work hard in the future. Weiner's theory and the research that supported it prioritised students' cognition as a significant motivational force.

Another influential conception of academic motivation emerged in the early 1980s. According to goal theory (Ames and Archer, 1988) student perceptions of their classroom goal orientations (i.e., comparison vs. individual progress) and achievement orientations are critical. Within classes, there are differences among students. Some students are clearly oriented to perform better than others, and some are oriented to learn as much as possible. Students who are achievement-oriented vis-à-vis their peers are less motivated than those who are oriented toward improving their performance and learning (Ames and Archer, 1988).

Similar perspectives were emphasized in other motivational educational theories, such as Dweck's theory (*Entity Theory of Intelligence*, 1986) and Bandura's (1982) theory of self-efficacy. According to Dweck, students who believe that their abilities are fixed (i.e., like intellectual abilities that are fixed and determined by heredity and therefore cannot be modified) are not particularly interested in striving for improvement. On the contrary, students who strongly believe in the possibility of change are more academically motivated. As for Bandura's proposal on self-efficacy, academic motivation would largely depend on our perception of how well we can perform a given task, a perception that is determined by past experiences of success or failure.

Thus, the orientation in motivation studies is cognitive. A noteworthy empirical result in the field of motivation has been that tangible rewards sometimes minimise motivation if applied to behaviours that were intrinsically motivated in the student (Lepper, Greene & Nisbett, 1973; Deci, 1971). Lepper and Deci were two authors, among a large group of scholars, who developed cognitive theories of academic motivation that were testable.

**Individual differences in cognitive processes**

In the recent literature on educational psychology, analyses on individual differences stand out, with outstanding subareas such as studies on intellectual disabilities or learning difficulties.

Learning to read was a prominent variable of individual differences. Some primary school children learn to read very easily, and others experience significant difficulties. Because of the difficulties of some children in learning to read, much empirical effort was devoted to reading research during the modern era. An illustrative book of the various positions that emerged on the onset of reading is Jeanne Chall's (1967) *The Great Debate*. She argued that reading initiation with systematic phonological training was more effective than the whole-word strategy that prevailed in schools in the 1950s and 1960s. This debate continued with the confrontation between phonological methodologies and whole language approaches, which emphasized that the ability to recognise words would be facilitated if children were exposed to multiple linguistic situations with real stories, so that explicit phonological teaching would possibly be both unnecessary and even harmful.

In general, it was concluded at this time that many struggling readers had a common problem: they had experienced difficulties in achieving phonological discrimination (i.e., Snow, Burns & Griffin, 1998). In summary, basic cognitive research contributed to explaining the learning difficulties of early readers, as reflected in a large proportion of articles published on these topics (such as *basic reading*) in the *Journal of Educational Psychology*.

It is worth mentioning an article published in the *Harvard Educational Review* in 1969 that had a notable impact and generated considerable debate. In *How Much Can We Increase IQ and Scholastic Achievement?* Arthur Jensen expressed a firmly deterministic position that individual differences in intelligence are fundamentally given by heredity and not the environment. Jensen also indicated that differences between blacks and whites in intelligence were also due to genetics. These highly controversial issues caused a stir in the turbulent 1960s, when paradoxically there was great hope that racial differences could be explained by environmental deprivation.

Despite innatist arguments, a line of research began that provided sufficient evidence in favour of the modifiability of intelligence or IQ based on environmental elements. Ceci (1991, 1996) defended the role of schooling in the improvement of intellectual abilities. He collected sufficient evidence to support the idea that IQ can vary due to different circumstances such as the number of years spent in school, the age at the beginning of schooling, and the time of the year when evaluation takes place. Thus, sufficient evidence was found in favour of the statement that more schooling produces more intelligence.

This latter perspective led educational psychology to believe in the power of schooling to shape student skills. In summary, during the modern era, educational psychologists have focused on the study of individual differences of a clearly cognitive nature, such as reading and intelligence. Moreover, explanatory theories about these individual differences were developed that facilitated interventions –

and with a clear message that schooling is fundamental for the development of basic skills such as reading and general intelligence.

**Psychological foundations of the curriculum. Application of cognitive psychology in schools**

The work of Robert Gagné (1977) and his daughter Ellen Gagné (1985) facilitated the introduction of cognitive theory among educational psychologists. Gagné's book *The Conditions of Learning* translated information processing theory into a language that facilitated the understanding of educational problems (such as concept learning, cognitive strategies, and transfer of learning). Ellen Gagné's *The Cognitive Psychology of School Learning* brilliantly synthesised the research on reading, writing, and problem solving that inspired cognitive theory in the late 1970s and early 1980s.

Efforts to understand major educational problems in the modern era shifted from the vision present in Robert Gagné's manual (more oriented by basic cognitive theory) to the predominant perspective revealed in Ellen Gagné's manual (more linked to theory and research in applied cognitive psychology). As an example of this growing concern with applied cognitive psychology, Richard Anderson and his collaborators at the University of Illinois proposed *schema theory* (Schank and Abelson, 1977) as applied to the psychology of text comprehension. The basic idea is that readers' level of prior comprehension can powerfully affect the comprehension of texts read. In fact, it was shown (Anderson and Peterson, 1984) that learners' prior schemas clearly influenced student comprehension.

The modern reading curriculum also included many recommendations for teaching students to use cognitive strategies to understand what they read. These recommendations grew out of research showing that students improve when they are taught to construct images while reading, synthesise information, or wonder about the content of texts. Cognitive theory also influenced the teaching of writing in school (Flower and Hayes, 1980, 1981). Building on the notion of cognitive plans by Miller et al. (1960), Flower and Hayes proposed that the writing task could be conceptualised as a process of *planning, drafting, and revision* – with the writer moving recursively between these activities. This conception inspired a great deal of research on students' composition processes, including the development of teaching strategies for students with writing difficulties (Harris & Graham, 1992).

Cognitive theory has also influenced the problem-solving curriculum. Problem solving has fascinated 20th century psychologists and has been a central theme in the cognitive psychology of the modern era. Undoubtedly, the greatest influence on contemporary mathematics education is the *constructivist theories of cognitive development* (i.e., Piaget). Based on Piaget's assumptions, many mathematics educators believe that problem solving is best developed when students discover solutions to various problems on their own, rather than being

explicitly taught algorithms. Finally, cognitive psychology also influenced the *teaching of ethics*. The work of Lawrence Kohlberg (Kohlberg and Mayer, 1972) had an impact on numerous educators, who would urge their students to confront moral dilemmas as problems to be solved, so that children could discuss these dilemmas with one another. When children are given the opportunity to discuss alternative ways of solving moral dilemmas, their moral reasoning skills improve, and they develop the ability to perceive the perspective and rights of others (Enright, Lapsley and Levy, 1983).

In short, cognitive theory proved effective in thinking about curricular problems that had always haunted educators. For example, how to teach children to read, compose texts, solve problems, and confront ethical dilemmas. Educational psychologists designed and tested new theories about reading, writing, problem solving, and moral education. These efforts had clear consequences on educational practice and reforms: transforming what and how children read, how they learn to write, how they are taught to solve problems, and how they learn to address ethical dilemmas through discussion. All these successes justify the great dominance of cognitive psychology at the end of the modern era.

**Teaching and instruction. Teachers' cognitions and students' cognitive characteristics influence instruction**

One of the important influences during the modern era was the realisation that teaching is influenced by teachers' beliefs about learning, instruction, and their students, as noted by Calderhead (1996). Thus, the expectations and beliefs that teachers have about their students from their experiences with them determine the behaviour of teachers. A complementary position that developed during the modern era is that students differ in their cognitive abilities sufficiently to receive instruction tailored to these characteristics.

Thus, instruction will work to the extent that there is a match between instruction and the cognitive characteristics of students, a position strongly developed by Lee J. Cronbach, Richard Snow, and their collaborators (Cronbach & Snow, 1977; Snow, Federico & Montagne, 1980a, 1980b). Despite the attractiveness of this position, it is difficult to prove (and continues to be the subject of research) how different types of instruction vary according to the cognitive characteristics of students. At present, there continues to be much interest in understanding the minds of teachers and students as determinants of instruction. Thus, research continues to establish which cognitive characteristics of teachers and students determine certain instructional effects (Gustafsson and Undheim, 1996).

**Education and technology. Cognitive analysis of educational technology**

In the early modern era, the most common educational technology was programmed learning, and this technology progressively included cognitive analysis. For example, under the direction of John Brandsford, the *Cognition and Technology Group* at *Vanderbilt University* (Van Haneghan, Barron, Young, Williams, Vye & Brandsford, 1992) developed an applied problem-solving curriculum using computer technology. The curriculum encourages students to plan as part of the problem-solving process, to generate alternative solutions, and to evaluate alternatives before deciding on one approach over others. All this results from a flexible computerised system.

Richard Mayer's group has developed another strong line of research focused on the impact of different types of visual and verbal presentations on computer-mediated learning (Mayer and Moreno, 1998; Plass, Chun, Mayer, and Leutner, 1998). Thus, Mayer and his collaborators are significantly extending the scope of basic cognitive theory (such as *dual coding theory*, Paivio, 1971) for an understanding of how learning occurs through technological means.

**Research methods. Analytical advances that have contributed to cognitive psychology**

Campbell and Stanley published their classic treatise on the design of experiments and quasi-experiments in 1966. From this monograph, the use of experimentation was consolidated among the community of educational psychologists. This was truer among cognitively-oriented educational psychologists than those who continued supporting behavioural postulates and emphasised the analysis of behaviour in individual subjects (Sidman, 1960). However, most cognitive psychologists accepted the assumptions of Campbell and Stanley (1966).

One outcome of Campbell and Stanley's revolution was the *instructional cognitive experiment* model (Belmont and Butterfield, 1977). In one condition of this type of experiment, a cognitive process is instructed (constructing mental images from the content of a text). The control condition is identical to the experimental condition, except that there is no instruction for the cognitive process. If performance (comprehension and memory) is better in the experimental condition than in the control, the inference is that the instruction induced the observed processing and outcome. Educational psychology journals include plenty of such cognitive-instructional studies.

During the modern era, cognitive psychologists developed a set of *measures of the cognitive processes* that take place in memorisation, problem solving, and reading tasks. Thus, both strictly quantitative (reaction times) and qualitative (thinking aloud) measures have been developed. What made many of these

process measures compelling was the fact that they frequently correlated with outcome measures (verbal protocols collected during reading correlate with text recall and comprehension, Pressley and Afflerbach, 1995). In summary, there has been a methodological revolution during the modern era. Advances in research design and the measurement of cognitive processes have enabled cognitive educational psychology to flourish. Thus, educational psychologists generated a significant amount of work that made more visible the practical relevance of work generated from educational psychology.

**Synthesis of contents modern era**

In the modern era, educational psychology has transformed from a behavioural to a cognitive discipline. This has occurred because of multiple converging factors, including powerful new theories of cognition and cognitive development; theoretical work that has brought together cognitive and behavioural perspectives; cross-cultural research; new perspectives on the study of motivation; interest in individual differences in cognitive domains; applicability of cognitive theory to curricular problems; and advances in educational methodology and technology. These efforts have been driven by the applied advances they have produced, leading to a reliance on interventions based on the cognitive approach.

Current debates in educational psychology and future challenges

*1.2.1. Current debates in educational psychology*

First, we should ask what constitutes the essence of educational psychology. The 11 categories of learning and instruction outlined by Pressley and Roehrig (2003) may constitute the essence of educational psychology but they are not exclusive.

It seems clear that what unites or divides us are not theories of learning such as constructivism or behaviourism. Nor does it seem to be the research methods employed. Neither theory nor method are the essence of educational psychology. Our fundamental focus is a set of related issues about human learning and teaching, with a particular interest in the empirical study of these phenomena (Berliner, 2006). If we look at the recent past, we can see how our major distinctive feature is the use of psychological concepts to *understand the four fundamental elements in education* outlined by the philosopher Joseph Schwab (1973): someone (a teacher, a parent, or a technological device) teaches something (such as how to fix a bicycle or the periodic table) to someone else (a student, a novice, or a worker) in a specific context (classroom, garden, or work).

Thus, the teaching and learning we study almost always takes place at the intersection of the following elements: *teachers x students x tasks x contexts*. The complexity is apparent, as we do not simply study teaching, but all attributes related to teachers, such as their training, intelligence, ethnicity, sociability, performance, along with attributes of non-human teachers (instruction from printed text, television, and computers). The complexity of the curriculum is shown in the diversity of content areas taught (mathematics, history, physical education, art, music, and so on). The dimension of the environment or context is no less relevant, since learning differs to the extent that it takes place in the classroom or at home, in groups, or individually. We could say that the essence of educational psychology lies in the study of these phenomena.

Because of the complexity of what we study, we do not always design research that explores the four-level interactions mentioned above, which is the essence of what is of interest in educational psychology. We do what scientists typically do: we *simplify to understand*. One way we simplify is by moving away from actual practice, as historically has been the case – especially during the discipline's period of prominence. We also simplify by studying one or two of the elements, without considering the rest. By adopting the sensible strategy of simplification in our research, we may at times appear irrelevant to educators, who are required to solve complex situations beyond the simplicity of laboratories. Irrelevance and disconnection may sadly also be part of the essence of educational psychology (Berliner, 2006).

This perceived irrelevance would be apparent in the eyes of educators. Educational psychology has made great contributions to the study of transfer, memory, learning through technology, behavioural control of special students, classroom management, bullying, group work, teacher thinking, teaching in content areas, and many other areas. But this scientific work of which we are reasonably proud seems to have difficulty being translated into practice. For many reasons, we seem to have no influence on teacher practice in the ways that the founders of the discipline had envisioned. Our work often has implications for teaching practice, but it does not seem to directly change practice. Irrelevance is something we live with, probably because scientists and educators present different perspectives on what constitutes useful research, and the complexity of classrooms makes it difficult to apply laboratory findings directly.

The essence of our discipline seems to be irrelevant to the world of practice. This constitutes a historical discussion as reviewed in two volumes of the *Journal of Educational Psychology* (Fenstermacher and Richardson, 1994) and *Educational Psychology Review* (Salomon, 1996). Although educational research conducted in real settings began to emerge after 1981, as discussed in the previous chapter, two of the leading European educational psychologists have taken a pessimistic view (Weinert and De Corte, 1996):

After 100 years of systematic research in the field of education and educational psychology, there was in the early 1990s no agreement about whether, how, and under what conditions, research could improve educational practice. Although research and educational practice have changed substantially since the beginning of the twentieth century, the question of how science can contribute to the solution of real educational problems remains controversial.

The prevailing ideas in each era change research preferences and styles much more than the objects of study. History reveals that the most obvious change in educational psychology (from behavioural to cognitive psychology) was accompanied by a more subtle change in the prevailing paradigms. This refers to a shift from studying the individual in isolation to studying the individual in context. Thus, while learning and instruction continue to be our focus of study, there is a growing support for learning and instruction in context.

Method does not constitute what we can call the essence of a discipline. One thing that distinguishes educational psychology from other educational research is the emphasis on empirical methods and the desire for studies to be evaluated according to the standards common to any science: rigor, competence, public availability of data, a strong guarantee of the statements made, etc. Thus, the preference for empirical work often goes hand in hand with a preference for quantitative studies. However, neither Piaget nor Vygotsky relied much on numbers, and they are considered in textbooks as important educational psychologists. Prestigious members of the community of educational psychologists are carrying out studies of a qualitative nature, and this does not discredit their membership of the group known as educational psychologists.

Moreover, a large body of work in the field of cognitive psychology increasingly combines quantitative and qualitative studies and this remains the leading research in educational psychology. *Mixed-methods studies* are becoming increasingly visible in the field of educational psychology (Creswell & Plano Clark, 2007; McCrudden, Magliano & Schraw, 2010), with the founding of a journal that channels mixed methods research (*Journal of Mixed Methods Research*), as well as an increasing number of papers addressing instructional issues. This reflects the interest of educational psychology researchers in approaching their objects of study from perspectives that combine the rigor of more traditional quantitative methodologies with qualitative methodologies that make it possible to capture the behaviour of a greater number of variables in more natural situations.

The issue of detachment from real practice should not lead us to disdain research practices that involve creating artificial and manipulated situations to isolate the explanatory factors of the phenomenon we are studying. Educational psychology, as an empirical discipline, has powerful methodological tools, such as experiments which allow us to isolate the elements that interest us in the complex interaction of *teachers x students x tasks x contexts***.** Using experimentation does not always imply working in artificial laboratory conditions, since it is possible to

experiment in natural situations with real tasks. At the same time, experiments can and should be combined with other more qualitative methodologies that enable us to capture the essence of what happens in real educational contexts.

The challenge of educational psychology as a scientific discipline with a strong and necessary applied tradition (strongly marked from its functionalist origins with William James) is to maintain its capacity to isolate the causal agents of the phenomena to be studied and to verify what consequences derive from the manipulated and controlled factors. This must be done while approaching the studied phenomena using tasks that are as realistic as possible. Finally, it must be possible to successfully combine more experimental methods (which facilitate the isolation of causes and consequences) with more qualitative methods (which enable studying a larger set of variables in their natural interaction).

In summary, according to Calfee (2006), educational psychology must address the following pending issues to reach maturity as a discipline. Firstly, educational psychology continues to question what the best linkage with practice might be. As we have seen, this is the main historical debate in the discipline. Although most researchers are immersed in issues clearly linked to practice (teacher training, assistance to centres, and so on), most of the theorising and empirical studies continue to be excessively distant from educational reality. Secondly, educational psychology scarcely considers the training of adults. Educational psychologists were instrumental in the development of *human engineering* during World War II. However, today, the fields of professional development and workplace training are the responsibility of sociologists and ethnographers rather than educational psychologists.

Thirdly, neither the first nor second editions of the HBEP have chapters containing exclusively the title learning. While schools offer unique environments that enable the long-term study of complex learning acquisition processes (such as reading), this has been difficult to implement for a variety of reasons in classrooms. Fourthly, one of the outstanding issues is related to methodology. The field offers a variety of methods, and the challenge lies in selecting the appropriate method for the research question at hand. The growing tendency to use mixed methodologies indicates the interest of educational psychology researchers in maintaining control of the phenomena studied while progressively entering more complex natural situations by studying individuals and materials in context (which should help overcome the gap between educational research and actual practice).

### *1.2.2. Future challenges for educational psychology*

This analysis will be organised around a set of questions (Calfee, 2006): *who are we; what are we likely to do in the future; what should we be doing; how should we train the next generation of professionals?*

***Who are we?*** A recurring struggle for educational psychologists has been to define and defend their identity (Berliner, 2006). According to APA Division 15, (APA, 2000, p.7. Membership Dues Statements): '*membership provides a collegial environment for psychologists with interests in research, teaching or practice in educational settings at all levels to present and publish papers about their work in the theory, methodology, and applications to a broad spectrum of teaching, training and learning issues*'. This description includes a set of interesting parameters: theory; methodology; practice; and application to teaching, training, and learning.

But discussions arise around what our worldview (*Weltanschaaung*) is or should be. For example, Richardson (2003) raises the recurring question about whether educational psychology should advance psychology through the study of education or advance the practice of education through the application of psychological principles.

Stokes (1997) reflected this tension in a two-dimensional scheme, suggesting that research and development activities can be analysed as contributing either to basic knowledge or for practical utility. He represents these two dimensions as a 2 x 2 matrix, with the most basic research in one quadrant, applied research in another quadrant, and a mixture of the two in a third, which he called *Pasteur's quadrant*. Stokes did not offer a name for the fourth quadrant (research of little value), because it contains little basic weight and little application. It is tempting to place educational psychology in Pasteur's quadrant, but the reality is that the discipline moves through several quadrants, depending on time, context, and individual and group interests.

The suggestion that the discipline should take on a worldview may once have been appealing, but it is arguably neither possible nor desirable to limit the activities of individuals in the field of educational psychology, even with the goal of adjusting or unifying the discipline for the next several decades (Berliner, 2006). The major peculiarity of the field is the variability among individuals who consider themselves to be educational psychologists, regardless of their background (Berliner, 2003a).

The question of who we are reflects in part the essence of the area: education, teaching, training, learning, and so on. This question also reflects the various perspectives or paradigms that coexist in the field, and their transformation processes. For example, cognition has been the dominant paradigm in recent decades (Mayer, 2001; Pressley and Roehrig, 2003). This label in turn reflects the existence of various scenarios – from explanatory mechanisms based on computer-simulated human processing to socio-constructivist models.

Voices of protest have arisen given the validity of the cognitive paradigm. In fact, Roediger (2004) has promulgated the victory of behaviourism, offering evidence that: a) all researchers in psychology rely on observed behaviours as the source of their data; b) behavioural methods have shown their success in a broad

set of educational challenges (from classroom management to the treatment of children with special educational needs).

In recent years, tension has arisen between educational methodologies. This tension includes intra- and interdisciplinary elements. Fields such as anthropology, sociology, and humanities have shown themselves to be relevant actors in educational research, and each contributes its own research methods. However, many current educational psychologists identify with research methods that would have been considered non-traditional just a few decades ago. Thus, educational psychologists may vary in their relative commitment to pure or applied research, their positioning or not within Pasteur's quadrant, and in their epistemological positions generally.

As an academic or a professional educational psychologist, context has a great influence in determining the identity of individuals. Some practitioners can easily move between the worlds of research and application; and some academics, even those who do more applied research, still manage to approach the world of practice. But this can be difficult.

Finally, we rely on organisations to identify us as a discipline and profession. In the American Psychological Association, *Division 15* provides the primary membership for educational psychologists. This division strongly supports the *Journal of Educational Psychology*, which is the major and oldest journal in the field. However, many educational psychologists prefer *Division C (learning and instruction)* in the *American Educational Research Association (AERA)*. The strongest European association for researchers in psychology and education is the *EARLI (European Association of Research on Learning and Instruction)* with a significant representation of Spanish educational psychology researchers.

Educational psychologists occupy a variety of academic settings. From teaching positions in teaching colleges, to research in psychological research institutes, to participation in faculties of education. This creates a wide variety of approaches to the view of educational psychology – without considering the world of professional educational psychology.

***What image will educational psychology project in the coming years?*** Inertia tells us that the picture will remain largely the same, unless the profession takes steps to change it (Berliner, 2006). We might think that educators in the school community should have something to say about educational psychology's contribution to research and practice. Unfortunately, educational policy decisions are often based on anecdotes rather than systematic evidence. Clearly, the profession and the discipline must continue to work to define itself. The evidence shows that we are doing important work, and the key issue is how to unify the discipline with a compelling and coherent portrait.

***What are we likely to be doing in the future?*** Journals and manuals have an important influence on the development of the discipline. The number of print

and online journals in our discipline is staggering. The most prestigious journals belong to professional organisations. However, many journals are private publications unconnected with professional organisations. The publications vary in terms of readership, character, quality, and recognition. Faced with the vast number publications and diverse access to them, the question arises as to how to introduce new doctoral students, as well as future educational psychologists and researchers to the most relevant literature in the discipline. The answers to these challenges (including the emergence of *open-access* journals) will be important for the future of the discipline.

Professional organisations support journals and regularly organise conferences (APA, AERA, and EARLI). Participation in these meetings can do much to shape professional identity and support variations in this identity. Handbooks designed for introductory courses play an important role in educational psychology. These books – like handbooks – attempt to paint a comprehensive portrait of the field with the primary purpose of demonstrating the application of psychological principles and research findings to classroom practice.

Finally, it is important to consider the variability of jobs and positions held by educational psychologists. A relatively small number hold positions in universities and research centres. Many others are dedicated exclusively to participation in teacher preparation programmes, where research is a much lower priority. Most professionals work for educational institutions. The impact of these professionals on the 'business of schools' is substantial, but almost invisible. According to Calfee (2006), we should pay more attention to those professionals who take responsibility for the day-to-day application of educational psychology to local problems in local situations.

***What should we be doing?*** The first recommendation is that as a profession we should be professing: that is, we should be advocating intensely for action from educational psychology, based on the safeguards available in the concepts and theories developed and the empirical evidence (Calfee, 2006). We must arrive at a fundamental understanding of psychological and educational problems based on experimentation, evaluation, and rigorous implementation. A second challenge is related to finding the '*really important problems*' (RIPs) facing today's schools. A first group of these problems is related, for example, to the evaluation and use of tests, and questions to what extent classical measures of intelligence serve as valid indicators of performance.

A second RIP would focus on how to best provide effective and efficient teaching for all children (e.g., Pressley, 2002). A very topical issue is the analysis of the role of technology in schools, which reflects the enormous impact of technologies on different strata of society and, at the same time, the limited transformation of teaching and learning methods in classrooms, as well as the resources available. A third RIP is related to brain studies and the possible impact on educational practices. The relative complexity in the interpretation of brain

imaging and possible ambiguity (are reading patterns at the cortical level cause or effect?) mean that the management of these data at the educational level is still limited. Finally, the last of the RIPs relates to the study of school leadership and organisation. Although this topic can be clearly attributed to the study of psychologists, no relevant studies have been published in the main journals.

To conclude, according to Calfee (2006): a) we should consider establishing an agenda of issues to be addressed in the next decade; b) we should encourage the development of professional networks working on such an agenda.

***How should we train the next generation of professionals?*** A continuing challenge is to define and defend the essence of the discipline, while recognising the sub-disciplines of specialisation. Berliner (2003b) has suggested an agenda for revitalising the discipline that includes: *a) rethinking research methods courses; b) introducing concepts from big ideas rather than from schools or theories, c) requiring professional educational psychologists to specialise from practice* (specialised masters or practicums), *d) ensuring training in educational policy*. In addition to fostering training in practice and connection to real-life problems, another area of fundamental importance when preparing the next generation of educational psychology professionals is research competence.

Finally, Calfee (2006) suggests that educational psychologists should begin work to further unite quantitative and qualitative approaches in research by encouraging the trend towards the use of mixed methods. The field of educational psychology will benefit from efforts to promote better communication among researchers, and from supporting the preparation of a new generation of graduates with more extensive training in various research tools.

### 1.3. Fostering evidence-based educational practices

Once we have contemplated the development of the discipline from a thematic and historical perspective, we can identify that one of the recurrent debates in educational psychology has been about its relative closeness to educational reality. The problem of how to translate the findings in educational psychology to real educational practices continues to be valid. However, as we pointed out at the end of the previous chapter, educational psychology seems to have entered a promising period where educational theory has begun to be built from real educational environments with real tasks and mixed methodologies. The task is to understand educational problems and instructional needs in situ and transfer these problems and needs to the field of psychological research.

Some voices (Coll, 2002) have repeatedly pointed out that another of the main tensions of educational psychology has been its dependence on general psychology or, on the contrary, its capacity to generate its own body of knowledge and constitute itself as an independent discipline between psychology and

educational practice. This debate would be parallel to that concerning the proximity or estrangement from current educational practices**.**

In this Mayer (2010) makes a clarifying analysis of *three different ways of conceiving the relationship between psychology and education*. Thus, he states that psychology would imply the study of how people develop and learn, while education would imply helping people to develop and learn. For Mayer, we have three possible relationships between psychology and education.

a) Psychologists should conduct laboratory research on learning and development and explain the resulting theories to educators; educators should apply this scientific research to instruction (*one-way street from psychology to education*).
b) Psychologists should conduct laboratory research on learning and development without concern for what educators do; educators should develop instructional processes that meet the practical needs of learners without examining the relevant psychological theories (*dead end as psychology and education do not meet*).
c) Psychologists should study how people learn and develop in real educational situations, basing their research on the problems faced by educators; educators should base their instructional decisions on psychological theories about how people develop and learn (*two-way street – from psychology to education and from education to psychology*).

These three tracks represent three phases in the history of educational psychology (Mayer, 1992a, 1996a, 2010). Around 1890, the psychologists who had just given rise to what Gardner (1985) called *'the new science of the mind' were* striving to keep their newborn science alive. Simultaneously, educators faced with the task of providing the population with compulsory and universal education were striving to professionalise teaching. The emergence of psychology and education at the end of the 19th century raised the question of what should be the relationship between the science of psychology and the practice of education.

The answer to this question went through three stages: 1) the one-way, optimistic stage at the beginning of the 20th century in which advances in psychology were directly applied to improving education; 2) a dead end-pessimistic stage in the middle of the 20th century, in which the paths of psychology and education ceased to meet; and where a sense of irrelevance among educators was the dominant sentiment, leading to evident discontent and disenchantment; 3) a two-way track and a renewed sense of optimism during the latter part of the 20th century in which educational issues shape psychological research and psychological research informs educational practice.

We must remember that in the early days of educational psychology there was great hope that the new science would be able to provide answers to the many questions that arose following the increase in the number of individuals attending school. The emergence of a rigorous and systematic science such as psychology

led educators to place their hopes on the contributions of this discipline for improving teacher and student performances. Psychology applied to the educational world from an eminently functionalist perspective – as William James had proposed – should have evident consequences on teaching practices and learning processes.

Thus, educational psychology emerged as a branch of psychology applied to the educational world. Under the influence of Thorndike, this new applied discipline (educational psychology) was refining research methods and procedures, focusing on relevant research on learning processes and measurement issues. So, while it may have lost some realism, it gained in scientism and systematicity. It seems that this growing scientism in the discipline caused some educators to begin to lose their initial enthusiasm for the contributions of educational psychology, so that the feeling of irrelevance and disillusionment pointed out by Grinder (1978) began to set in.

The review of the discipline that we have undertaken in this chapter reveals an initial illusion and confidence in a new science called psychology, with one of its preferred fields of application as the classroom. It also shows us the disappointment and crisis on the part of educators as they watched educational psychology move away from the most natural contexts and forgot about the most relevant issues in the real life of schools. Finally, educational psychology provided us with hope as we saw how authors and academics who feel part of contemporary educational psychology are calling for a repositioning of the area, generating their own knowledge that does not lose the essence of psychology as a scientific discipline and that considers educational reality in its complex interaction of *teachers x students x tasks x contexts*.

Regarding the debate on the dependence or independence of the discipline with respect to general psychology, we agree with Calfee (2006) that educational psychology is a field for the preferential application of psychology. Moreover, educational psychology, as an applied area, has also been a driving force in general psychology and contributes research and classic authors – especially in the areas of learning and measurement. Rather than focusing on a possibly unproductive debate, educational psychology should look to the future by considering the challenges we have outlined in the preceding pages. One of the central challenges is how to how to generate relevant knowledge of its own, combining experimental rigor with methodologies of a more qualitative nature – and how to help this knowledge be understood and used in the educational world to generate evidence-based practice for educational professionals, as some authors are advocating (i.e. Mayer, 2010).

According to Mayer (2010), the future of educational psychology is once again promising. Although education and psychology have had a thorny relationship in the past, current educational psychology brings great possibilities of improvement to educational practice and contributes to the development of

psychological theory. Following Mayer's proposal, we discuss how educational psychology can contribute to evidence-based practice and improve the ability of students to learn school subjects.

### *1.3.1. Practice based on empirical data*

Educational practice guided by research-based principles is referred to as *evidence-based practice* or *evidence-based practice*. In this approach, educational decisions are based on an understanding of how students learn and on relevant research findings about how to encourage learning.

A recent review commissioned by the National Research Council synthesised the rationale for evidence-based practice as follows (Shavelson and Towne, 2002):

*No one imagines traveling to the moon or eliminating a disease without resorting to research. Similarly, attempts at educational reform cannot be expected to have significant effects without being guided by research-based knowledge (p.1).*

As a classic alternative to empirically based practice, Shavelson and Towne (2002) point out that:

*...Occasionally, decisions are made about education that lack the slightest scientific basis but are derived directly from ideology or deeply held beliefs (p.17).*

Along the same lines, Mayer (2005) has stated that:

*...When educational reformers base educational practice on doctrine rather than theory based on empirical data, they constitute significant obstacles to educational reform (p. 68).*

In summary, Shavelson and Towne (2002) have shown that effective educational research (*Table 2*) should pose meaningful questions that can be investigated empirically, link the research to relevant theory, use methods that enable direct investigation of the issue, provide a coherent and explicit line of reasoning, be replicable and generalisable, and publish the research to encourage public scrutiny and critique.

| Features | Principles |
|---|---|
| *Testable predictions* | Raise significant questions that can be investigated empirically. Link research to relevant theories. |

| | |
|---|---|
| *Appropriate methods* | Employ methods that allow for direct investigation of the issue. |
| *Logical conclusions* | Provide a coherent, explicit, and consistent line of reasoning. |
| *Constant scrutiny* | Replicable and generalisable across research. Make research public to encourage professional scrutiny and critique. |

*Table 2. Four characteristics of scientific research in education (Shavelson and Towne, 2002; taken from Mayer, 2010).*

To conclude, the proposal we have presented aims to generate educational practices based on empirical evidence in the community of educators, and thus avoid making educational decisions based on intuition. Promoting an educational psychology that encourages educational practices based on empirical data should contribute to lessen the classic feeling of misunderstanding between research in educational psychology and professional education – and so help lay the foundations of the discipline in the 21st century.

### *1.3.2. The training future teachers in evidence-based practices*

If universities can transmit to future professional educational psychologists and future educators in general an organised, relevant, interconnected knowledge capable of contributing to the improvement of professional practice, future teachers will undoubtedly rely on the implementation of practical principles directly derived from the knowledge generated from research in educational psychology. However, the idea still prevails among students that what they learn in various university subjects is completely distant from the future needs that professional life will impose on them. This also seems to be the case among future primary school teachers acquiring knowledge in developmental and educational psychology.

The theoretical and historical problem that underlies educational psychology as a scientific discipline that must inspire relevant professional practices is that of organising accumulated knowledge and communicating it effectively to future educators so that it can inspire systematic and relevant professional practices. This must be done in a way that simultaneously encourages future educators to get involved and participate in research tasks. These educators are privileged participants of what happens in the world of education and necessary allies for generating a theory and research in educational psychology anchored in the real situations of teaching and learning. This is either because this research is carried out in the natural situations of teaching and learning, or because it inspires the use of realistic tasks and materials in various investigations that can

be carried out in a more ‘laboratory-like’ way, without either situation preventing educational psychology from losing its eminently scientific essence.

Therefore, it follows from our discourse that we have enough confidence in the potential of university teacher training (as well as professional educational psychologist training) in educational psychology to gradually build confidence in the scientific knowledge generated and its potential to generate coherent, effective, and relevant educational practices.

Mayer (2010) has strongly defended the potential of the knowledge generated in educational psychology research to generate educational practices consistent with general learning principles. He is a pioneer in the development of manuals for use in university teaching from the perspective of integrating the most basic psychological knowledge and professional practice (Mayer, 2010, 2011).

Mayer defines educational psychology as the branch of psychology that seeks to understand how the instructional environment and learner characteristics can interact to produce cognitive growth in learners (Mayer, 2010). Educational psychology focuses on the scientific study of the precise techniques that encourage changes in the learner's knowledge, and so it is a perspective with a clear vocation to modify learning processes.

Three important components stand out in Mayer's definition:

1. Educational psychology is a science – one of the branches of psychology.
2. Educational psychology investigates the changes that the instructor introduces in the environment (instruction).
3. Educational psychology investigates the resulting changes in the learner's knowledge (learning).

In short, educational psychology studies how instruction affects learning. According to Mayer, educational psychology is situated between instruction and learning (between the instructional changes made by the teacher and the changes in knowledge created in the learner). Instruction refers to the preparation for the learner by the teacher of environments intended to foster changes in the learner's knowledge. Thus, the definition of instruction has two components:

1. Instruction is something the teacher does.
2. The goal of instruction is to promote student learning.
   Learning depends on the learner's experience. A change that is transient or due to a physiological state does not constitute learning.

While the two components of the definition of learning (learning is lifelong and based on experience) have been maintained for a century, the question of what changes has proved more controversial (Mayer, 1992a, 2001a). Does learning involve cognitive change or behavioural change? This question reflects the classic tension between cognitive and behavioural approaches to learning. In his classic

textbook, *Principles of Teaching,* E.L. Thorndike (1906) posited that the central issue in education is externally promoted change in the learner:

*The word education is used with many meanings, but in all its meanings it refers to change. No one is educated to remain as they are. We will not be educating anyone if we do nothing that promotes change or difference in anyone [...] In studying education, therefore, what is studied is always the existence, nature, cause, or value of change of some kind (p.1)*.

In his book *Experience & Education*, John Dewey (1951) described the relationship between teaching, providing students with useful experiences, and learning, or the acquisition of knowledge. Dewey asserted that *'all true education originates in experience'* (p. 25). However, he made an important caveat that *'not all experiences are true and equally educational'* (p.25).

In short, instructional strategies promote changes in the learner's knowledge. Since all learning involves connecting new information with prior knowledge, it is crucial to help learners develop knowledge structures that can drive the acquisition of useful new information. According to Mayer (2010), it is essential to ask and convey to our students the following questions, so that they can begin to reflect on the practical relevance of knowledge in educational psychology: how can we know if instruction acts on learning, that is, how can we know if one way of teaching is better than another to help students learn?

According to Mayer (2010) there are reasons again for optimism in the recovery of a concept of educational practice founded on a scientific theory and a psychological theory based on real human learning. Thus, the path between psychology and education has become a two-way street. The *path from education to psychology*: education drives psychology to develop theories about real people in real situations, rather than developing theories that describe how people learn through unreal tasks in artificial laboratory situations. The *path from psychology to education*: psychology develops useful theories about learning, cognition, and human development, thus providing the foundation for making rational decisions about educational practice. This is precisely where the training of future teachers is an essential channel of transmission.

In short, educational psychology, rather than being only the place of application of psychological theories that have been developed in another field, has become a stimulating initiative to shape and test the dominant psychological theories (Mayer, 1993, p. 553). According to Mayer (2010) the future of educational psychology is once again promising. Although education and psychology have gone through thorny relationships in the past, current educational psychology offers great possibilities for improvement in educational practice and contributes to the development of psychological theory.

We next discuss how educational psychology can contribute to evidence-based practice and improve the ability of students to learn school subjects. Two of the most promising contributions of educational psychology are (Mayer, 2010):

1. *Knowledge area psychologies:* development, learning, teaching, and thinking within specific knowledge areas.
2. *Instruction in cognitive processes:* focus on improving the cognitive processes that lead to meaningful learning.

The first promising contribution of educational psychology is attention to the psychologies of knowledge areas. Current educational psychology seeks to develop domain-specific theories for each knowledge area, as opposed to experimental psychology, which was interested in general theories of how people learn, develop, and think. Thus, cognition is examined in the context of actual academic tasks. This makes it possible to develop more realistic theories about how people learn, develop, and think, which make it easier for future teachers to adopt the principles derived from these theories and apply them to daily educational practice. In the last 25 years there has been an innovative consensus for focusing on specific areas of knowledge (Mayer, 2004; Shulman and Quinlan, 1996). According to Mayer (2010) four of the most promising lines of research in learning in knowledge areas are: *reading, writing, mathematics, science*.

The second promising contribution of educational psychology is its attention to *instruction in meaningful learning*. Researchers and teachers have discovered several avenues that can facilitate the transfer of learning, each of which should be tailored to the needs of the learner, the requirements of the learning task, and the skills of the teacher. Mayer (2010) highlights the following eight promising avenues for promoting meaningful learning:

1. *Teaching through productive feedback*. Teachers comment on student performance with varying consequences on performance.
2. *Teaching by providing concreteness, activity, and familiarity*. Teachers establish teaching through guided exploration.
3. *Teaching by providing examples*. Teachers show students how to learn from examples of how to perform an academic task.
4. *Teaching by guiding cognitive processing during learning*. Teachers encourage students to perform appropriate cognitive processing during learning.
5. *Teaching through the development of learning strategies*. Teachers help students learn how to learn.
6. *Teaching by developing problem-solving strategies*: teachers help students learn how to think.
7. *Teaching through creative learning models in the classroom*. Teachers establish collaborative learning among students for the completion of academic tasks.

8. *Teaching by developing motivation to learn*: teachers motivate students to work harder.

Thus, according to Mayer (2010), educational psychology can provide education with a theoretical explanation of how the human mind works in academic settings – and including how students learn; how they remember; and how they use academic knowledge. By developing cognitive theories of academic learning, educational psychologists facilitate the development of more effective instructional methods. Thus, educational psychology can provide psychology with an ecologically valid context for generating and testing cognitive theories. By challenging psychologists to develop theories to explain academic learning, educational psychologists reinforce the authenticity of cognitive theories. In summary, educational psychology as envisioned by Mayer offers an alternative to the unproductive psychological tradition of developing exact theories from artificial learning tasks (Mayer, 2010). It also facilitates the transmission of the body of knowledge generated to educational practitioners in the form of principles and prescriptions focused on learning in subject areas, as well as principles for promoting cognitive processes relevant to meaningful learning.

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In this section we review a set of thematic axes and contents that cover the subject matter of educational psychology (teacher training degrees, early childhood and primary). We will first compile the main perspectives from the hand of recognised authors in the area on the role of educational psychology as a scientific discipline and the challenges for the future (*see Thematic Block I, Introduction to Educational Psychology, Chapter 6*). We will then present an approach to the study of learning and cognitive processes, pointing out their coordinated nature, and highlighting the role of education as a facilitator of such coordination (content linked to *Thematic Block II: Main Approaches to Learning and its Educational Implications, Chapter 6***).** We will then address the *Intrapersonal Dimensions in the Teaching and Learning Process* (Thematic Block III, Chapter 6), with an emphasis on the study of human cognitive abilities and motivational processes. To address the *Interpersonal Dimensions in the Teaching and Learning Process* (Thematic Block IV, Chapter 6), we present a section entitled ***'****Being a Teacher: Efficacy, Emotions and Interpersonal Relationships in the Classroom'*. Theoretical perspectives and tools derived from the study of *'learning as collaboration'* are also presented. To conclude this chapter, we present a section with recent research on *assessment processes, feedback,* and *consequences on student learning* (Thematic Block V, Chapter 6.).

## 2.1. Perspectives on the past, present, and future of educational psychology

There are differences among the major authors in the field of educational psychology regarding the current portrait of educational psychology as a scientific discipline (Corno & Anderman, 2015). However, most agree on the following three perspectives: *(a) the main contributions within educational psychology have evolved with the move from behaviourist approaches to cognitive psychology; (b) educational psychology is a multidisciplinary field that spans several subjects and other fields; and (c) educational psychology remains relevant to education*. Despite these advances, some authors felt, for a variety of reasons, that the field may be losing relevance. Decades ago, educational psychology thrived as it developed a strong scientific basis for its research; however, other related disciplines have become increasingly grounded in scientific principles, and more importance has been given to emerging qualitative and mixed methods approaches that need full incorporation into educational psychology. Finally, two authors discussed common core standards and neuroscience as important topics for educational psychology today.

To summarise, renowned essayists (Corno & Anderman, 2015), delineations of issues related to the discipline's past include: *the nature of science in our field; the multidisciplinarity of educational psychology; the transition from behaviourist to cognitive theories; the importance of learning transfer; and the role of effective*

*instructional and learning strategies*. Their description of issues related to the present included: *the efficacy of transfer of learning; connecting research to practice; the status of educational psychology as a multidisciplinary field; and addressing the common core standards*. Issues they raised as future concerns included: *the field remaining multidisciplinary; continuing to connect research to practice; and addressing relevant developments in neuroscience***.**

**Educational psychology as a progenitor discipline (Patricia A. Alexander)**

We cannot appreciate who we are as educational psychologists if we do not understand the influence that our disciplinary progenitor, philosophy, has exerted and continues to exert. Our philosophical DNA is inescapable, even if the passage of time has obscured this reality. However, as Alexander, Murphy, and Greene (2012) argued, the creation of each discipline comes with certain costs and benefits that must be understood. Using the metaphor of childbirth, these researchers (who represent three generations of educational psychologists) argue that 'disciplinary childbirth' is 'neither painless nor without postpartum complications' (p. 7). To date, educational psychology, while serving as the disciplinary progenitor for several recognised domains and disciplines, has managed to maintain its genetic integrity. That is, educational psychology has retained enough of its basic disciplinary substance to remain viable and relevant even within an increasingly multidisciplinary and interdisciplinary academic world.

But *what will become of educational psychology in the coming decades?* Internal and external forces give us reason to pause (Alexander et al., 2012). Our credibility in discussing educational policy and practice has long been a point of contention and remains so in a *climate in which empirical evidence does not always seem to inform educational policy or instructional practice*. As David Berliner (2006) has so eloquently argued, part of the blame lies with us and our inability to communicate well with the educational and policy communities. Whatever the causes, it remains imperative that educational psychology does not lose the ties that bind it to educational policy and practice and provide it with essential sustenance.

However, part of the concern for the future lies in the *world beyond the classroom, where evidence and justification for actions are often elusive or too often based on speculation, mythology, or unfounded beliefs* (Alexander and the Disciplined Reading and Learning Research Laboratory [DRLRL], 2012; Murphy, Alexander & Muis, 2012). Certainly, a dearth of critical and analytical thinking would be a problem at any time or place. But especially given the digital lives of today's learners and the information deluge they face, the ability to reflect, weigh, and justify epistemic competence (Alexander and DRLRL, 2012), seems even more imperative (Murphy and Alexander, 2013). The role that educational psychology will play in understanding learning and development in this new century has yet to be defined, although promising trends are emerging.

**Reflections on the Psychology of Education (David C. Berliner)**

*'I believe that educational psychology is now almost irrelevant as a field of study for a very unusual reason, namely, because it was so spectacularly successful. It was so remarkably influential, especially in faculties of education, that it has now almost self-destructed'* (Corno & Anderman, 2015).

In summary, three influences on educational psychology have had negative effects on the way our field is perceived. One is our spectacular success in training other educational scholars to conduct high quality research, thus reducing our influence on schools of education and their research programmes. The second negative influence on us was the rise of other social sciences as credible ways to study educational phenomena. Finally, the rise of alternative methods for the study of education eroded some of the methodological monopoly that educational psychologists had in many American schools of education.

According to Berliner (2006) educational psychologists must remember that schools are places, and that education is an enterprise in which individuals and societies choose to engage. Understanding the complex places in which the multiple forms of the educational enterprise take place may require multidisciplinary research approaches and mixed methodologies. Thus, *psychologists well trained in the learning sciences and psychometrics will always be needed to better understand how schools function and how the educational enterprise can be improved*. Educational psychology will not go away. We have ideas, research findings, and methods that can contribute to the study and improvement of education. But in the future, educational psychologists will have to share research tasks with other social sciences and humanistic fields of study. Although the changes discussed above may have diminished the discipline of educational psychology, it is likely that the object of our studies, the educational enterprise, will be better illuminated.

**Two Faces of Educational Psychology: The Advancement of Knowledge Disconnected from Educational Practice (Erik De Corte)**

*'Due perhaps to my basic training as an primary school teacher, the choice of my research topics has always been guided by two goals: to contribute to the advancement of our scientific knowledge about the processes and outcomes of learning and teaching in schools and, at the same time, to contribute to research-based improvement of educational practices. The tension between the two goals has always been a challenge for me personally, but the history of educational psychology shows that the field as a whole has been struggling with the problem of reconciling the two goals since its origin in the early years of the 20th century. And today, reducing and overcoming what David Berliner (2008) has called "the*

*great disconnect" between research and classroom practice continues to constitute one of educational psychology's primary missions' (De Corte, 2015).*

In her 1994 presidential address at the annual meeting of the American Educational Research Association, the late Ann Brown confirmed this disconnect: 'This century has seen enormous advances in our understanding of learning and development. School practices in general have not changed to reflect these advances' (1994, p. 4; see also Weinert and De Corte, 1996). But in this statement, she also argued that educational psychology has made substantial progress in the 20th century in the understanding of learning. This progress is well documented in a series of important books published in recent decades, beginning in 1996 with the first volume of the *Handbook of Educational Psychology* (Berliner & Calfee, 1996), the *International Encyclopedia of Developmental and Instructional Psychology (*De Corte & Weinert, 1996), the second edition of the Handbook of Educational Psychology (Alexander & Winne, 2006), The Cambridge Handbook of the Learning Sciences (Sawyer, 2006); and, in 2011, by the Handbook of Research on Learning and Instruction (Mayer & Alexander, 2011).

The progressive broadening and deepening of our understanding of the processes and outcomes of learning and teaching, as well as the multiple variables that influence them, has been aided by *major paradigm shifts during the 20th century in* general views of cognition and learning. We have moved from behaviourism to the cognitive view of information processing, to constructivism, and socio-constructivism (De Corte, 2010; see also Greeno, Collins & Resnick, 1996). As a result of these developments, there is now a fairly broad consensus on the following principles of learning in schools presented and discussed, for example, in a booklet in the International Academy of Education's *'Educational Practices Series'* entitled How Children Learn (Vosniadou, 2001; also available in Spanish, Chinese, Greek, Korean, Polish, and Portuguese, on the website of the International Bureau of Education): *(a) active involvement; (b) social participation; (c) meaningful activities; (d) relating new information to prior knowledge; (e) being strategic; (f) self-regulating and reflective; (g) restructuring prior knowledge; (h) aiming for understanding rather than memorisation; (i) helping students learn to transfer; (j) spending time on practice; (k) taking into account individual and developmental differences; and (l) creating motivated learners*. The American Psychological Association has published a similar list of principles (Learner-Centered Principles Work Group of the APA Board of Educational Affairs, 1997).

Apart from this general shift in the conception of learning, the last 25 years have seen substantial advances in our knowledge and understanding of important phenomena related to learning. The main examples are *conceptual change, self-regulated learning, and transfer*. Research on conceptual change initially focused on science, investigating how scientific concepts are acquired and explaining student difficulties in learning advanced and counterintuitive concepts.

An important development in the last ten years has been the expansion of this area through the application of the **conceptual change** approach to other subject areas, first to mathematics, and more recently to the social and behavioural sciences. **Self-regulation refers** to the active involvement of learners in their own learning by setting goals, organising, and monitoring their cognitive activities and motivation – as well as reflecting on their learning processes (as discussed in several chapters in this volume). Although research on self-regulation began only about 25 years ago, a substantial amount of research-based knowledge has been acquired, demonstrating the importance of self-regulation skills for productive learning, and very importantly, that self-regulation can be enhanced in learners through appropriate guidance and instruction (e.g., Zimmerman and Schunk, 2011).

In contrast to conceptual change and self-regulation, transfer, as Calfee has pointed out above, is a familiar concept in educational psychology. It was studied in the early 20th century, for example, by Thorndike. This is not surprising. In fact, throughout history, educators have always tried to equip their students with knowledge and skills that they can apply beyond the initial learning situation. However, the study of transfer has been revitalised in the last 15 years by the emergence of new perspectives more in line with today's prevailing view of learning. For example, one of these alternative perspectives emphasizes preparation for future learning as the main aspect of transfer (Bransford and Schwartz, 1999).

Another productive achievement of educational psychology in the last two decades is the significant and growing research on **learning and teaching of subjects, especially mathematics, science, and reading and writing** (Mayer & Alexander, 2011). This development was facilitated by the advent of the information processing approach. Indeed, psychologists became interested in the study of the knowledge structures and processes underlying tasks and problems like those involved in school curricula. And the rise of the socio-constructivist perspective that stresses the importance of context, and especially of social interaction, stimulated interest in studying learning in the complex reality of classrooms (Greeno et al., 1996). But as Berliner stated in 2008: *'towards the end of the twentieth century, learning in real-world contexts began to be studied more seriously, but, unfortunately, it seems that such research continues to have little impact on practice' (p. 306).* In other words, despite enormous progress in relation to the first goal of educational psychology, namely, advancing our knowledge of learning and instructional processes, the field has so far largely failed to pursue and achieve the second goal, namely, innovation and improvement of educational practices. Therefore, as previously stated, bridging the gap between theory/research and classroom practices constitutes one of the major challenges ahead of us.

Finally, another provocative field of research exists at the interface of **cognitive neuroscience and education**. There is no doubt that, by providing

detailed data on brain activity, neuroscience can contribute to a more accurate description and better understanding of the cognitive processes that take place during thinking and learning. A major challenge for the near future is to initiate interdisciplinary and neuroeducational research (Howard-Jones, 2010) aimed at portraying the effects of instruction on brain activity. But the road from research to neuroscience applications and then on to educational practice appears to be long and methodologically rocky. The expulsion of resistant neuromyths is immediately important.

**The Most Important Course (Anita Woolfolk Today)**

*'In reflecting on the past of educational psychology, I only talk about the areas of educational psychology that are most directly related to* ***teaching and teachers****, the field that has been my world for the past 45 years. In looking to the future, I am quite speculative and selective. But in my perspective on the past and future of educational psychology, I maintain, as I have since the early 1970s, that this is the most important course you will take if you wish to teach' (Corno & Anderman, 2015).*

One need only glance at the contents of the journal Educational Psychologist to trace the movement toward relevance in the foci of our field from 1980 to the present. Examples include *teaching, assessment and grading of all school subjects, including the use of various technologies; classroom organisation and homework; adapting instruction to students with widely differing needs and talents; motivation and self-regulation in teaching and learning; fostering student resilience, well-being, and physical health; relationships among students, teachers and families; classroom culture and language; and school reform*. Educational psychologists clearly addressed critical and perennial issues for practitioners during these decades.

**Where are we headed and what challenges do we face?** First, as educational psychologists, we must be clear about who we are and why we matter. Our task in teacher education is daunting. It is difficult for 19-year-olds, adolescents who are still developing, with little experience of children or teaching, to acquire a sophisticated understanding of child development and learning in various cultural contexts. However, this is our challenge as teachers of educational psychology. Educational psychologists have responded with arguments for the value of our field (Anderson et al., 1995; Berliner, 1992; Patrick, Anderman, Bruening & Duffin, 2011; Woolfolk Hoy, 2000). The American Psychological Association is currently circulating another task force report on the value of educational psychology in teacher education (Worrell, 2013).

In teacher education, we perennially walk a line between being appreciated as a necessary and valuable part of teacher preparation and being incorporated into existing method and foundation courses, and then dropped because the

other courses 'cover that' (Woolfolk Today, 2000). While it is true that everyone in education has an interest and something to say about teaching and learning, *educational psychology has been systematically studying these processes for at least two centuries*. It is important that prospective and practicing teachers have access to the knowledge gained in our long and successful enterprise. Beyond the design of teacher education programmes, we are rarely consulted when our own universities make most of their decisions about teaching and learning programmes and procedures. We must resist the charge that we are irrelevant in all these areas.

As we move forward in our research, **what challenges will we face?** Collaboration and multidisciplinary work are useful and encouraged by both educational institutions and funding agencies. But when we collaborate with people from other fields, we must not lose our identity or forget our shared knowledge. Eric Anderman (2011) updated this call for educational psychologists 'to engage in specific types of outreach activities so that our research can have a real impact on policy and practice' (p. 185). As always, we must make a compelling case for the value of sound but evolving theories as the basis for thinking about and intervening in schooling, while always keeping culture and context in mind.

*Another challenge will be integrating social, motivational, relational, and contextual perspectives with classical concerns about cognition, learning, and development*. Given the multitude of claims and 'guidelines' for teachers about constructivist and brain-friendly teaching, educational psychology needs to adequately incorporate sociocultural and neuroscientific research; as well as relevant knowledge from the learning sciences. We must continue to examine how biological, psychological, and social/cultural/historical contexts act together on individuals and in classrooms.

## Past, Present and Future of Educational Psychology (Richard E. Mayer)

Educational psychology is the scientific study of how instruction affects learning (Mayer, 2008). Thus, educational psychology seeks to understand how the instructional manipulations of the instructor affect changes in knowledge in the learner. For more than 100 years, starting with the work of E. L. Thorndike, educational psychologists have been grappling with how to improve education based on scientific evidence rather than opinions, fads, and ideologies (Mayer, 2003).

The **science of learning** is the scientific study of how people learn (Mayer, 2011). Initially, psychologists conceptualised the goal of learning science as the establishment of general laws of learning, based largely on rigorous experiments on how rats and pigeons learn in artificial environments or how humans memorise lists of words. In contrast, one of the enduring contributions of educational

psychology to the science of learning is the *development of subject psychologies* (Mayer, 2004), that is, a focus on how people learn and think about subjects. Instead of asking how people learn in general, educational psychologists asked how people learn in specific school subjects such as reading, writing, mathematics, science, and history. This more contextualised (or subject-specific) approach has been enormously successful compared to the now discredited approach of looking for general laws of learning – and represents one of the major contributions of educational psychology to both psychology and education.

**Instructional science** is the scientific study of how to help people learn (Mayer, 2011). Initially, educators took a practical approach by studying what instructional methods worked, without paying much attention to the theoretical underpinnings (Mayer, 1992). The result was a fragmented collection of teaching do's and don'ts that lacked coherence or rationale. In contrast, educational psychologists have identified effective teaching methods and learning strategies that greatly enhance learning. Some consistently effective instructional methods include the appropriate use of feedback, visualisations, and examples, while some consistently effective learning strategies include summarising, self-explanation, and self-assessment (Dunlosky, Rawson, Marsh, Nathan & Willingham, 2013; Hattie, 2009; Mayer & Alexander, 2011).

The **science of assessment** is the scientific study of how to determine what people know (Mayer, 2011; Pellegrino, Chudowsky & Glaser, 2001). Early attempts by learning psychologists to measure learning focused on measuring the rate or speed of response in laboratory animals, based on the idea that learning involved the strengthening and weakening of associations (Mayer, 1992). Later attempts by learning psychologists focused on counting the number of items recalled from a memory list, based on the idea that learning involved adding items to memory that varied in trace strength (Mayer, 1992). Once educational psychologists focused on meaningful learning of authentic academic content, assessments of learning outcomes shifted from focusing solely on retention to include measures of transfer (Anderson et al., 2001; Mayer and Wittrock, 2006). *The development of useful measures of understanding (based on transfer rather than solely on retention) represents an important contribution of educational psychology to the science of assessment*.

The current situation of educational psychology. By taking a rigorous scientific approach to the challenges posed by educators, educational psychologists are making monumental advances in understanding how learning, instruction, and assessment work. One example of this progress is the increasingly practical value of basic research on effective instructional techniques, including research-based guidelines for multimedia and online instruction (Clark & Mayer, 2011; O'Neil, 2005); a report by the Association for Psychological Science task force on 25 research-based instructional design principles (Halpern, Graesser & Hakel, 2007); an Institute of Education Sciences practical guide on effective study techniques (Pashler et al., 2007); and a recent

review of research-based learning techniques in Psychological Science in the Public Interest (Dunlosky et al., 2013).

Being an educational psychologist in the future will involve navigating disciplinary boundaries in which our field is perceived as too theoretical by some educators and too practical by other psychologists. As Stokes (1997) has well explained, we work in a field that has practical and theoretical goals that are mutually reinforcing. Losing either goal would result in a future in which we would focus on theory at the expense of practice or practice at the expense of theory. The future of educational psychology is bright to the extent that it can continue to focus on basic research on practical educational problems.

## 2.2. Learning as coordination

Education has produced its share of dichotomies: abstract vs. concrete; memorisation vs. comprehension; teacher-centred vs. learner-centred; authentic tasks vs. broken-down practice; efficiency vs. innovation; among others. The categories of such dichotomies often become mutually exclusive alternatives, and people advocate one over the other. Since B. F. Skinner's behaviourism (1986), scholars have debated whether discovery or induction is better for learning (e.g., Kirschner, Sweller & Clark, 2006; Tobias & Duffy, 2009). People often accept the definition of one category as the negation of another, as in the case of active versus passive learning. On closer analysis, the familiar categories of learning, which are often seen as mutually exclusive, have underlying mechanisms that can make them complementary. So instead of choosing one or the other, the best strategy is to choose both.

*One of the main tasks of teaching and instruction is to help learners coordinate categories of cognitive processes, abilities, and representations*. While nature confers basic capacities, education synthesises them to adapt them to the demands of contemporary culture. Thus, rather than treating the categories of learning and instruction as an either/or problem, the problem is how to coordinate learning processes so that they can do more together than separately. This thesis, which proposes a systems-level analysis, is not the norm when thinking about teaching and learning.

An important goal of education is to facilitate student understanding of cultural and scientific categorisation schemes (such as republics or taxonomies). Even imperfect categories can advance science as they provide initial hypotheses that drive research and may even replace the original categories. On the negative side, once a categorisation scheme is established, it can be difficult to displace it. Bloom's taxonomy of educational outcomes provides an example of the strengths and weaknesses of categorisation schemes (Bloom, Engelhart, Furst, Hill & Krathwohl, 1956). On the positive side, the taxonomy was a brilliant effort to create an assessment framework. It helped educators focus on a more differentiated set

of outcomes than the crude observation that a student ‘learned’. The taxonomy describes a pyramid going from bottom to top: *memory* (then called ‘knowledge’), *comprehension, application, analysis, synthesis, and evaluation*. More recently, some scholars have added a new top layer called *creativity*. The pyramid was instrumental in showing that there are learning outcomes that go beyond the mere repetition of behaviours (which was the predominant behaviourist perspective at the time).

On the negative side, *many people interpret the categories as forming a prerequisite structure*. Learners must first learn the lower-order skills at the bottom of the pyramid (memory), before engaging in the skills at the top of the pyramid (assessment). This interpretation feeds a back-to-basics mentality, so that learners must memorise before attempting to apply their learning in a useful way. However, the science of learning does not support this interpretation. For example, comprehension ranks above memory in taxonomy, but people can remember ideas better when they understand them (Bransford and Johnson, 1972). Making memory a prerequisite for comprehension does not work very well. Similarly, having students learn a new topic in an application context is a useful way to help them simultaneously learn facts and evaluate their applications (Barron et al., 1998).

*Bloom's taxonomy aptly captures the strengths and weaknesses of categorisations in education*. It is a compelling and intuitive categorisation scheme and, as such, has had enormous influence on practitioners and scientists alike. At the same time, it has been difficult to change, despite 70 years of subsequent research questioning the pyramidal structure. Moreover, people use the categories in ways that violate their intent. Bloom's taxonomy is a framework for evaluating teaching outcomes. It is not a framework for learning or instructional design, but people still use it that way.

**The distributed nature of cognition**

One of the important qualities of cognition is that different categories of thought comprise distributed and overlapping subprocesses at lower level of description (Rumelhart, McClelland & the PDP Research Group, 1986). For example, subtraction and multiplication are separate categories of mathematical operations, and each requires its own set of mental steps to compute an answer. It seems safe to say that when people are doing subtraction, they have ‘switched off’ multiplication. However, at a lower level of analysis, they are performing many of the same underlying processes for both types of computation. What looks different at one level of analysis is not so different at another.

In short, cognitive processes are always ‘on’ to some degree. It is a mistake to consider them dichotomous, where one process excludes another. It is tempting to do so because dichotomous categories simplify the world. However, exclusionary categories often obscure a deeper truth about cognition.

**Nature bestows cognitive processes; education coordinates them**

One of the main goals of education is to coordinate evolutionarily conferred abilities into sets that can achieve culturally relevant goals. While almost everyone learns to speak and interpret language, education coordinates the linguistic capacity that has been evolutionarily conferred on us with the visual system so that people can also read language. Evolution has gifted humans with the ability to coordinate and re-coordinate cognitive and neural processes.

*The reader may have thought that learning is like strengthening a muscle. A better analogy would be learning to dance.* Dancing requires the coordination of many muscles, as well as the strengthening of muscles in response to each other. Strengthening without coordination is ineffective. Woltz, Gardner, and Bell (2000), for example, found that, if people already know how to do a set of computational steps very well, they may show more errors when performing a new related computation compared to a person with less initial experience. Although the experienced subjects had strengthened some relevant 'cognitive muscles' of computation, the coordination was found to be erroneous.

Dichotomous thinking involves focusing on a single cognitive process, often to the exclusion of others. This can lead to tenacious misconceptions. *One of the main misconceptions can be the belief in learning styles.* The belief is that each person has a different cognitive ability and that, therefore, teaching should be tailored to that ability. It is true that there are individual differences in some fundamental abilities. For example, some people are better than others at mentally manipulating spatial information (Hegarty & Waller, 2005). However, this does not support the claim that therefore people with high spatial ability should receive spatial instruction, which is the immediate implication of some of the research on learning styles.

Despite the widespread belief in learning styles, their effects must be small, because there is surprisingly little evidence to support the idea that people with different strengths should receive different types of instruction (Pashler, McDaniel, Rohrer & Bjork, 2009). When people claim to be visual learners, they may be claiming that they can interpret spatial information more easily or, perhaps, they are saying that they do not like to read very much, which is a motivational issue. In any case, when thinking about learning the important content taught in schools, it often depends on the coordination of linguistic, spatial, conceptual, attentional, memory, and other systems.

**Transfer and induction: where comprehension and memory go hand in hand**

*Research on transfer emphasizes the importance of coordinating memory and comprehension*. Transfer refers to the use of prior learning in a new situation. The application context usually shares the same surface and deep characteristics as the original learning conditions. Training airline pilots in a simulator does not pose major transfer problems because the simulated cockpit is very similar to the aircraft cockpit; they share the same deep and superficial features.

Discrete memories do not transfer well because they usually apply to a single situation. For example, memorising that 3 + 1 = 4 will not help solve 4 + 1. However, if people memorise that 3 + 1 = 4, 4 + 1 = 5, 5 + 1 = 6, and so on, they might induce the rule that 'any number plus 1 equals the next number in order'. Induction is an important way in which people generalise from cases they have encountered and go beyond given information (Bruner, 1957).

People are always deriving patterns from their memories and experiences. However, they may not induce what we consider most important. For example, given the series of +1 problems above, a student might correctly but inappropriately induce: 'this teacher really likes to give problems with a 1 in them'. Through education, we want people to derive patterns that generalise well, not idiosyncratic ones. Learning by analogy is a powerful way to help people induce specific understanding from a set of cases.

The value of coordinating memory and comprehension for transfer gives rise to some simple instructional prescriptions. Loewenstein, Thompson, and Gentner (2003) describe a study in which they found that asking business students to find the analogous structure between case studies led to superior learning compared to a condition in which students treated each case separately without looking for the common structure. Providing two analogous examples works well for transfer, but students need encouragement to induce the common deep structure that unifies otherwise discrete examples (Schwartz, Chase, Oppezzo & Chin, 2011).

**Concrete and abstract**

*The dichotomy between concrete and abstract mental representations is a distinction that dates back at least as far as Plato's time*. The idea is that concrete thinking is tied to the perceptual-motor particularities of a situation, while abstract operations rise above immediate experience to use logical relations and hypothetical thinking. The dichotomy is relevant to instruction because people often favour one mode of operation over the other.

*One of the main challenges of school teaching is to help students coordinate the abstract and symbolic representations of culture with the perceptual world of experience*. Glenberg, Gutierrez, Japuntich, and Kaschak (2004), for example, observed that young readers often do not construct a mental model of what they read, but merely pronounce the words aloud. To help them, the researchers had

young children manipulate figurines to match each sentence they read (e.g., 'the man went into the barn'). They then told them they had to do this mentally as they read. This subsequently improved reading comprehension, even when the children were no longer physically manipulating the figurines. A major challenge for an educationally relevant cognitive psychology is to develop new theories and evidence to help guide new instructional efforts to coordinate perception, action, and conception (Goldin-Meadow and Beilock, 2010). The simple juxtaposition of a concrete and an abstract representation may not be sufficient for people to effectively coordinate their perceptual-motor abilities with symbolic ones.

**Dichotomania (Deterministic Thinking)**

We have sampled a couple of *familiar dichotomies*. Others exist. For example, a common dichotomy is the distinction between *passive and active learning*, which appears in the literature on university teaching (e.g., Prince, 2004). Passive learning largely refers to sitting in a large lecture listening to a lecturer's presentation, while active learning refers to being involved in problem solving during class. Dichotomies with familiar resemblances include learning by doing versus being told, as well as discovery learning versus direct instruction. *The intuition that students can learn more effectively when they are engaged in the experience, or at least when they are not overwhelmed with tedious exposition, pays off*. At the same time, a tremendous amount is learned by reading and listening to explanations, for example, in the media, internet, and books. Both experience and explanation have their place. Again, the task is to coordinate these different types of learning. Experiential activities can provide direct contact with a phenomenon or problem, while lectures and readings can provide explanations of those experiences in a way that students are less likely to discover on their own. According to this model, one way to coordinate active and passive learning is to use active experience to create a time for telling (Schwartz and Bransford, 1998).

Finally, Carol Dweck (2012) has observed that people differ in their implicit views – their mindsets – about the origins of human ability. Some people with a 'fixed' theory believe that ability is largely innate. In contrast, people with a 'growth' theory believe that ability is the result of hard work. The 'fixed' mindset has a structure similar to dichotomania. A fixed mindset assumes that there are poles of 'smart' and 'not-so-smart' people, and that there is no path from one to the other. In the case of dichotomania, one can think that there are mutually exclusive cognitive processes, some better than others, and with no bridge between them.

## 2.3. Human cognitive abilities and individual differences

Some students learn quickly; others take much longer. One explanation is that students come to school with very different learning experiences and are

prepared differently. Another is that students differ in their cognitive abilities. Even if students came to school with the same set of learning experiences, they would differ in how quickly they would learn due to differences in ability. These explanations are not incompatible, and most people-experts and non-experts-believe both to be true. Their relative importance has been hotly debated for decades, if not centuries, and is unlikely to be resolved soon.

The idea that people can be characterised by ability has been with us for centuries, but the scientific identification of human cognitive ability is usually attributed to Spearman (1904). Spearman studied performance on a wide variety of school (such as spelling and arithmetic) and psychology laboratory tasks (such as susceptibility to illusions) and found that performance on one task positively predicted performance on the others, a finding known as positive multiple.

Spearman's finding of a general ability factor has remained robust. As an example, the Programme for International Student Assessment (PISA), which measures the cognitive abilities of 15-year-old students in approximately 70 countries, found high correlations between three achievement domains: r (math, reading) = 0.84, r (math, science) = 0.89, and r (reading, science) = 0.87 (OECD, 2012) and this suggests a strong common factor.

**The distinction between fluid and crystallised**

A perspective not strictly compatible with the Spearman-Thurstone hierarchical framework is the Horn-Cattell (1966) model, which distinguishes two general abilities. Fluid intelligence (Gf) is the ability used during abstract reasoning and problem solving, especially in novel situations; crystallised intelligence (Gc) reflects conceptual and verbal knowledge acquired through education and experience. Fluid ability is invested in learning to produce crystallised ability (Horn and Cattell, 1967). One source of evidence for the Gf-Gc distinction is differential growth patterns: Gf peaks in the early twenties and declines slowly thereafter; in contrast, Gc grows, or at least does not decline, until much later in life.

**The consensus model: Carroll and CHC**

Carroll (1993) summarised essentially all available research on human cognitive abilities by reanalysing approximately 450 data sets (with several thousand test scores) using an exploratory hierarchical method. The results suggested a three-stratum model. The first stratum contains a general factor (G). Eight factors are in the second stratum: fluent intelligence (Gf); crystallised intelligence (Gc); general learning and memory (Gy); broad visual perception (Gv); broad auditory perception (Ga); broad retrieval (Glr); broad cognitive speed (Gs); and reaction time/decision speed (Gt). Numerous factors are the third stratum

(within Gf there is general sequential reasoning, induction, quantitative reasoning, and Piagetian reasoning; and within Gc there is language development, verbal language comprehension, lexical knowledge and 13 other skills).

*Do cognitive test scores predict other life events?* Since its inception, the rise in popularity and scientific acceptance of modern measurement of cognitive abilities has been linked to their ability to predict important and complex real-world outcomes relatively effectively. The world's first intelligence test, the Binet-Simon scale, was supported in France for its ability to differentiate between normal schoolchildren and those with mental handicaps. Since then, hundreds of studies have been conducted on the relationship between cognitive ability test scores and various life outcomes. Thorndike (1986) showed a correlation between an overall score on the Differential Aptitude Test Battery and grades (in many schools) of r = 0.5-0.6. In higher education admission studies, cognitive ability as measured by verbal comprehension, mathematical reasoning, and logical reasoning admissions tests predict outcomes such as first-year grade point average (r = 0.35-0.60), degree completion (r = 0.10-0.40), qualification and licensure exams (r = 0.30-0.65), and research productivity and publication citations (r = 0.10-0.25) (Kuncel & Hezlett, 2007).

*Why do cognitive tests predict outcomes?*

It is quite clear that abilities measured by cognitive tests predict important real-world outcomes and that different abilities (g, Gf, Gc, Gv, Gr) predict outcomes differentially. This has had enormous practical importance for the past 100 years, which explains why schools and companies continue to use ability tests to make admission, placement, selection, and placement decisions. However, the reasons why ability tests predict outcomes are not established. The fundamental problem is that predictive studies are based on correlation. Abilities cannot be randomly assigned to individuals at different dosage levels; we can explore their effects in a randomised trial. Instead, we must rely on correlation patterns and occasional natural experiments to investigate causal relationships between capabilities and outcomes.

**Capacity building**

Cognitive abilities increase with age, at least until late adolescence and early adulthood, and even later in some cases. Thus, the concept of IQ was invented to allow comparisons between people conditioned by age. A person with a high IQ is a person who outperforms others of the same age on tests of cognitive ability. Test scores (such as the SAT) that are required to qualify for a position in the talent search (Webb et al., 2007) would be unremarkable were it not for the fact that they are achieved at an early age (at 12 rather than 17). All of this demonstrates that abilities develop with age.

The number of years a person spends studying in school correlates with levels of cognitive ability. Ceci and Williams (1997) identified seven types of evidence that suggested that the relationship was correlational and that schooling increased cognitive ability. These were: (a) a negative correlation between IQ and age for children who attended school intermittently during their school-age years; (b) lower IQ and achievement scores for children who started school late; (c) high scores for those who stayed in school longer to avoid the U.S. military draft during the Vietnam War; (d) lower scores for those who dropped out of school before graduation; (e) lower scores due to summer vacations; (f) higher IQs for those with early birthdays due to higher compulsory school attendance; and (g) children of the same age who receive different levels of schooling due to entry age requirements have scores that are more reflective of their years in school than their chronological age. Most of these sources of evidence are essentially natural experiments that allow a causal interpretation of the effects of schooling on IQ.

Finally, there is evidence that, like schooling, work experience contributes to the development of cognitive skills. The International Adult Literacy Survey (OECD and Statistics Canada, 2000) of 22 countries (16 languages) showed that levels of cognitive skills (quantitative, verbal, and documentary) were correlated with participation in the labour force, particularly with higher status jobs (those requiring higher levels of education), how skills were used at work, participation in education and training in the labour force, and the demand for cognitive skills at home.

**Experience**

Since the 1960s, studies have shown that certain cognitive abilities, such as playing chess, memorising circuit diagrams, driving a cab, interpreting radiological images or memorising, are highly susceptible to training. Moreover, *expertise is more a matter of pure practice than inheritable and immutable abilities*. For example, Ericsson, Chase, and Faloon (1980) managed to improve a student's memory capacity from a normal 7 to an incredible 79 (with digits read at a rate of one per second) following 230 hours of practice (interestingly, after that training, the student's letter memorisation ability remained at 6). This has given rise to the expertise mantra ‘10 years, 10,000 hours’ (Ericsson, Charness, Feltovich & Hoffman, 2006). The expertise movement can be understood as a *strongly environmentalist position on the nature of competency development*. The field provides many demonstrations suggesting that any cognitive skill or ability can be improved with considerable practice, especially deliberate, structured, conscious, and purposeful practice.

Ackerman (2007) has shown that trajectories of expertise growth are moderated by cognitive abilities, particularly general cognitive ability in the early stages of skill development and knowledge acquisition. MacNamara, Hambrick, and Oswald (2014) conducted a meta-analysis that showed that hours of

deliberate practice only explained 12% of the variance in overall performance (correlation of 0.35), but 26% of the variance in performance in games, 21% in music, 18% in sports, and less than 5% in education and professions, suggesting that expertise is not explained by deliberate practice alone and could be explained by other factors, such as the age at which a person starts practicing and cognitive abilities.

**Conclusions**

The measurement of cognitive abilities, dating back to Galton's observations on normally distributed individual differences, Spearman's observations on the sufficiency of a general factor of cognitive abilities, and Binet's construction of a battery of intelligence tests to identify the academic abilities of schoolchildren, represents an *applied and theoretical success story in educational psychology*. In applications, the measurement of abilities is perhaps more ubiquitous than ever, with more implications for policy, as indicated by the attention given to large-scale national and international assessments of mathematical, verbal, and problem-solving literacy. Such assessments are used to compare states and nations and draw lessons through comparative analysis to improve education systems around the world.

From a construct standpoint, we are likely to see increasing attempts to measure what have sometimes been called *noncognitive* skills (such as teamwork, work ethic, communication skills, collaborative problem solving, and tolerance for diversity) using performance measures. PISA 2015 introduced a measure of collaborative problem solving, which involved collaboration with an agent. Future cycles of international assessments are likely to introduce human-to-human collaborative problem solving. Efforts such as these will continue and expand our ideas about the organisation, development, and use of human cognitive abilities.

## 2.4. Motivational processes

Motivation refers to the processes of initiating and maintaining behaviour (Schunk, Meece & Pintrich, 2014). Furthermore, the study of motivation in educational psychology goes beyond thinking of students as motivated or unmotivated to examine how their self-related beliefs, cognitions, goals, and experiences shape engagement and learning. Importantly, these self-related motivational beliefs are believed to be 'cognitive, conscious, affective, and often under the control of the individual' (Wigfield, Eccles, Schiefele, Roeser & Davis-Kean, 2006, p. 933).

Main theoretical approaches to the study of motivation in education

## Social cognitive theory

Bandura's (1986) social cognitive theory is one of the main modern theories of motivation, both because it has provided extensive insights into social cognition and because of its theorisation of academic self-efficacy. In fact, the main motivational theories emphasize reciprocal determinism (or the interaction between person, behaviour, and environment) and this is a key concept within social cognitive theory. In addition, the concept of agency, according to which individuals are 'self-organising, proactive, self-regulating, and self-reflective' (Bandura, 2006, p. 164) underlies modern research on motivation.

Within social cognitive theory, the construct of self-efficacy is the most relevant. Self-efficacy refers to individual beliefs about their ability to perform behaviours at certain levels (Bandura, 1997). Applied to education, academic self-efficacy refers to students' beliefs about their ability to learn, develop skills, or master material. Self-efficacy is distinct from outcome expectations (the belief that a given behaviour will lead to a given outcome) and self-concept (cognitive evaluations of ability: Bong and Skaalvik, 2003; Schunk and Pajares, 2005).

Self-efficacy beliefs are related to the choice of courses and careers by students, to greater effort and persistence on task even in the face of failure, to greater use of adaptive self-regulatory strategies, more positive and fewer negative emotions, and higher academic achievement (Bandura, 1986, 1997; see also Klassen & Usher, 2010; Schunk & Pajares, 2005).

At the intersection of self-regulation and self-efficacy, researchers have also considered calibration (the congruence between efficacy judgments and actual performance), although it remains understudied. For example, Chen (2003) found that both calibration and self-efficacy had independent positive effects on adolescent mathematics performance. Klassen (2007) found that students with learning difficulties had less self-efficacy, as expected, but were also less calibrated (had more overconfidence) than students without learning difficulties, which may partly explain the differences in performance between these groups.

## Expectancy-value theory

Modern *expectancy-value* theory (Eccles et al., 1983) assumes that individual expectations of success and subjective task value are the closest predictors of academic choices, achievement-related behaviours, and ultimately, learning and achievement – and that these are predicted by a variety of

psychological, social, and cultural influences (for recent reviews, see Eccles, 2005; Wigfield, Tonks & Klauda, 2009).

Psychologists have been studying interest for more than a century (for example, Dewey 1913). Despite strong roots, it was relatively neglected but has benefited from a surge of research in recent decades. Although there are diverse views on interest, much of the current research differentiates between two forms: *individual* and *situational* (see Renninger & Hidi, 2011). *Individual interest* (also known as personal interest) is relatively stable and resides within the individual. It includes a deep personal connection to the domain and a willingness to re-engage with the domain over time (Schiefele, 2009). Individual interest is characterised by positive feelings (such as enjoyment) as well as personal value and the importance of the domain.

As with individual interest, there are several different views of *situational interest* (see Hidi and Renninger, 2006; Krapp and Prenzel, 2011; Schiefele, 2009), but most include at least two main forms. One form, *triggered situational interest*, is a heightened and relatively brief affective state that is initiated by contextual supports. The other form, *maintained situational interest*, refers to the situational support of more focused involvement, attention, and persistence in a domain (including the search for meaning and personal connections to domain content). With maintained situational interest, learners are likely to experience positive feelings (such as enjoyment), but they also develop deeper knowledge of the content. In several correlational and experimental studies conducted in classrooms and laboratories by Harackiewicz and colleagues, situational interest was positively related to task engagement (Durik & Harackiewicz, 2007) and course grades (Hulleman & Harackiewicz, 2009).

**Self-determination theory**

Self-determination theory (Ryan and Deci, 2000) is a macro theory of motivation and development that has relevance to education. Self-determination theory distinguishes between types of motivation based on reasons for action. The most basic distinction is between intrinsic motivation (doing something for the inherent satisfaction that engaging in the activity provides), and extrinsic motivation (doing something because it leads to an expected outcome – such as praise or money) (Ryan and Deci, 2000). In addition, extrinsic motivation can vary in the degree to which it is internalised and experienced in a controlled or independent manner (Ryan and Connell, 1989). In addition to fully extrinsic versus intrinsic forms, motivation for action can arise from feelings of obligation, guilt, or pride (introjected). This is because a behaviour is perceived as having utility or importance for achieving personal goals (identified), or because it is fully internalised and representative of one's core values (integrated).

Numerous investigations link students' intrinsic motivation and other independent forms of motivation to adaptive academic outcomes, such as creativity, academic engagement, deep conceptual learning strategies, and academic performance (e.g., Lepper, Corpus & Lyengar, 2005). In contrast, many studies suggest that more extrinsic forms of motivation predict negative outcomes, such as maladaptive learning strategies and attitudes, anxiety, reduced ability to cope with challenges, poor academic performance, and even dropping out (e.g., Lepper et al., 2005; Walker et al., 2006). However, some studies suggest that extrinsic motivation can sometimes be beneficial for outcomes such as self-regulation and academic adjustment (Otis et al., 2005).

Extensive research over the past decade suggests that psychological needs, and in turn engagement and performance, can be supported by the environment through teaching practices such as providing meaningful choices, emphasizing personal relevance, using noncontrolling informational language, allowing students to express negative opinions and affect, and providing feedback and structure (see Reeve, 2009; Stroet, Opdenakker & Minnaert, 2013, for reviews). In contrast, directly controlling teacher behaviours (such as intentional suppression of perspectives, commands, and monitoring) can have maladaptive consequences for motivation, engagement, and learning (e.g., Reeve & Jang, 2006).

**Theory of performance objectives**

Achievement goal theory remains one of the most prominent theories of motivation in educational psychology. Achievement goal theory proposes that there are two main reasons, or underlying purposes, related to individual participation in achievement-related activities: *mastery* (focused on the development of competence); and *performance* (focused on the demonstration of competence) (Dweck & Leggett, 1988). The trichotomous model (Elliot, 1999) further differentiates performance goals into approach goals, focused on appearing competent; and avoidance goals, focused on avoiding appearing incompetent. The 2 × 2 model (Elliot and McGregor, 2001) extends the approach-avoidance distinction to mastery, such that one can either approach the goal to develop competence (approach-mastery), or avoid declining competence, or not reach one's potential (avoidance-mastery). However, avoidance-mastery goals have not been extensively studied.

Research has established the benefits of mastery-approximation goals and the detriments of performance-avoidance goals on educational outcomes, while the results for performance-approximation goals remain mixed and controversial (see Anderman and Wolters, 2006). Although still understudied, research on mastery avoidance has increased. Mastery avoidance goals are related to negative outcomes, such as negative affect, poor study strategies, avoidance behaviours, and lower achievement levels (see Huang, 2012; Hulleman, Schrager, Bodmann & Harackiewicz, 2010 for meta-analysis).

## Attribution theory

Weiner's performance attribution theory (Weiner, 1985, 2011) assumes that people are motivated to understand the outcomes they experience, especially when the outcomes are unexpected or negative. In their quest to explain an outcome, students may arrive at many possible causal attributions (such as ability, effort, luck, or task difficulty) that are in turn influenced by a variety of factors. These attributions are organised along three underlying dimensions: *locus* or the degree to which the cause is internal to the individual (such as ability or effort) or external (such as luck or task difficulty); *stability* or the degree to which the cause will persist into the future (such as aptitude) or is transient (effort); and *controllability* or the degree of perceived influence an individual has over the cause (e.g., effort is controllable, luck is uncontrollable). These dimensions are theorised to have differential implications for expectations, values, and emotions – and subsequent achievement behaviour. Stability is theorised as relating more directly to expectations of success and failure, a locus more internal to affective reactions to success and failure (pride and self-esteem) and controllability to hope, social emotions (such as shame and guilt), and helpfulness (Weiner, 2011).

Overall, research is consistent with hypothesised patterns, such that attributions are associated with different emotions, expectations, and academic functioning (e.g., Wolters, Fan & Daugherty, 2013). Many intervention studies have shown the benefit of training students to think of academic successes as controllable and academic failures as unstable (e.g., Perry, Stupnisky, Hall, Chipperfield & Weiner, 2010). Given the links between implicit theories of intelligence and attributions, interventions that train students to adopt a mindset that emphasizes the malleable or controllable nature of intelligence appear to have similar beneficial effects (e.g., Blackwell et al., 2007).

## Integration of theoretical perspectives

One of the strengths of the theoretical research conducted in the second half of the 20th century is that it laid the foundation for many advances in our understanding of motivational functioning in the classroom. However, this emphasis on theory building was accompanied by a tendency to conduct research based on a single theoretical tradition. For more than a decade, however, this trend has been changing. Researchers are now considering, both empirically and theoretically, how multiple forms of motivation from multiple theories combine to shape engagement and learning. This shift is important and reflects the widespread idea that educational outcomes, including achievement, can be determined by multiple factors.

## 2.5. Being a teacher: effectiveness, emotions, and interpersonal relations in the classroom

As teachers teach while striving to maintain student engagement and monitoring student progress, a range of cognitive, affective, and social processes interact. How teachers carry out the day-to-day tasks of teaching is influenced by the *knowledge they possess and the beliefs they hold about the nature of what constitutes successful teaching*. Bransford, Darling-Hammond, and LePage (2005) suggest a framework of teacher knowledge that includes three intersecting areas, namely, knowledge of: (a*) learners and their development; (b) subject matter and curriculum; and (c) teaching, pedagogy, assessment, and classroom management*. The category of teacher beliefs encompasses a range of beliefs (e.g., see Woolfolk Hoy, Davis & Pape, 2006), such as beliefs about learners, including their learning and development, expectations of success, and epistemological beliefs (Buehl & Fives, 2009). Teaching efficacy, meaning judgments about individual and collective abilities to influence student outcomes (e.g., Bandura, 1997), represents teachers' beliefs about themselves or the group, rather than beliefs about students or about the nature of teaching itself. Teachers' emotions in the classroom include stress, anger, and burnout, as well as their engagement, enjoyment, and enthusiasm (Schutz & Pekrun, 2007). Finally, teachers' relationships and social interactions with students include dyadic and interpersonal relationships, instructional interactions, and the social and directive climate that the teacher helps to create in the classroom (Hamre et al., 2013).

Some of these areas of study have received much more attention than others. Research on teacher knowledge and beliefs has been conducted for more than 30 years (Munby, Russell & Martin, 2001), whereas the study of teacher emotion has emerged relatively recently (e.g., Schutz & Pekrun, 2007). The study of teacher knowledge and cognition has been a topic of particular interest in teacher education. The text *Preparing Teachers for a Changing World: What Teachers Should Learn and Be Able to Do* (Darling-Hammond & Bransford, 2005), sponsored by the National Academy of Education, echoes the emphasis on teacher knowledge and cognition, with less consideration of topics such as teacher efficacy, emotion, and relationships.

### Research on teacher effectiveness

Teacher effectiveness continues to be a fertile field of research. Teacher efficacy is associated with positive outcomes: a recent meta-analysis (Klassen and Tze, 2014) shows that teacher efficacy is robustly associated with externally measured teacher efficacy (defined as student performance or teaching ratings obtained in observations). The relationship between teaching efficacy and observed teaching performance ($d = 0.58$, $p < 0.01$) was significantly stronger than the relationship between teaching personality and observed teaching performance ($d = 0.16$, $p < 0.05$).

Efficacy beliefs are conditional, dynamic, and reflect changes and challenges in the environment (Bandura, 2012). Examination of the relationship between teaching experience and teacher self-efficacy suggests that teaching efficacy develops over time, although change may not follow a linear pattern. Several studies have shown that teaching efficacy increases during the internship (e.g., Fives, Hamman & Olivarez, 2007; Knoblauch & Woolfolk Hoy, 2008), although the pattern of increasing self-efficacy may not be linear once professional practice begins.

Theorists and policy makers increasingly conceptualise teaching as a collaborative effort (Hargreaves and Fullan, 2012), although, in practice, much of a teacher's work is done in isolation. Teachers often plan their teaching or deal with student problems individually, with little time and few opportunities to consult on immediate problems and issues. Collaboration is considered essential for success in almost all professions, and teaching is no exception; however, observations of teachers in schools show that collaboration is neither embraced by all teachers nor, by itself, a guarantee of effective practice. The benefits of collaboration among teachers can be multiplied by fostering *collective efficacy*, that is, teachers' belief in their shared abilities to achieve valued goals through collective work (Bandura, 1997). The degree to which teachers develop and foster their collective efficacy is a critical factor influencing educational outcomes.

The importance of research on teachers' emotions is underscored by the finding that the emotions experienced by teachers can be transmitted to students. Frenzel, Goetz, Lüdtke, Pekrun, and Sutton (2009) tested the transmission of the enjoyment experienced by teachers while teaching mathematics with the enjoyment experienced by students in mathematics class. Using a social cognitive framework, the authors proposed a social perception model in which teachers communicate task value and enjoyment through overt enthusiasm, but also through implicit cues about motivational orientation. In their sample of mathematics students (adolescents and their teachers), teacher enthusiasm mediated the relationship between teacher and student enjoyment, suggesting that observable teacher behaviour as related to emotions makes a difference in student emotional experiences. The finding that emotions can be contagious is important because it suggests an avenue through which teachers can influence the emotional lives of students.

Teacher enthusiasm is an emotion easily perceived by students, but it may not function as a unidimensional construct. Kunter, Frenzel, Nagy, Baumert, and Pekrun (2011) tested the dimensionality and contextual specificity of teacher enthusiasm and found two dimensions: enthusiasm for teaching and enthusiasm for the subject matter. These dimensions varied according to classroom contextual variables. The two dimensions of teaching enthusiasm may have implications for the education of new teachers, some of whom may be highly enthusiastic about a subject, but not about teaching, and with others who are enthusiastic about the act of teaching, but less enthusiastic about specific subjects. Importantly, enthusiasm

for teaching may better predict teaching success than enthusiasm for the subject (Kunter et al., 2011).

For many teachers, classroom management problems lead to high levels of negative emotions, necessitating the need to regulate these unpleasant emotions during teaching. Tsouloupas and colleagues (2010) found that although teachers' perceptions of student misbehaviour were directly associated with burnout, the emotion regulation strategies of cognitive reappraisal and suppression of expression did not mediate the relationship as expected. Self-efficacy to manage student misbehaviour decreased the impact of perceptions of student misbehaviour on feelings of burnout, and the authors proposed the need for professional development focused on developing management strategies.

**Teacher-student relations**

*Teacher relationships with their students have been the subject of considerable research over the past two decades*. At this point, it is now well established that the nature of these relationships and teacher interactions with students plays an important role in shaping a range of student outcomes, including motivation and engagement, emotional well-being, school readiness, and academic learning and achievement (e.g., Wentzel, 2010). In addition, there is emerging evidence that positive relationships and a sense of connectedness with students may also be important for teachers' level of engagement and sense of well-being (Klassen, Perry & Frenzel, 2012b).

Teacher-student relationships are multifaceted, play multiple roles, and have been studied from a variety of theoretical perspectives. As Davis (2003) points out, the definition of a 'high quality' teacher-student relationship differs depending on these theoretical frameworks and the approach being studied. In addition to interactions focused on the delivery and explanation of curricular content, teacher interactions with students can be conceptualised as serving at least three important functions: *(a) forming and maintaining an interpersonal and dyadic relationship with each student; (b) fostering and managing a positive climate in the social context of the classroom; and (c) acting as a socialising agent while communicating and reinforcing social norms, values, and expectations to students*. Each of these functions creates and sustains a different aspect of the teacher-student relationship and, although separate, these functions inevitably overlap and intersect.

Much of the research on the affective quality of teacher-student relationships is based on *attachment theory* (e.g., Ainsworth, 1989) and thus has a developmental emphasis. Based on research on young children's relationships with their parents, the attachment perspective assumes that these early attachment relationships form the basis for future relationships with other adults, including teachers. For example, Pianta et al. (1995) found that students with

warm, close, and communicative relationships with their kindergarten teachers were better adjusted in second grade than those with angry and dependent relationships. Furthermore, conflictual relationships with teachers appear to negatively influence academic achievement over time (Crosnoe et al., 2010).

Perhaps because of the emphasis on attachment models, much of the research on teacher-student relationships has focused on preschool and primary students and reflects the assumption that younger students are more strongly influenced by their relationships with teachers than older students. Roorda et al. (2011) examined this assumption in a meta-analysis of 99 studies on associations between teacher-student relationships and student engagement and achievement. Roorda et al. distinguished between positive (close, supportive, and trusting) and negative (conflictual, neglectful, and rejecting) relationships. Their results suggest that the effects of positive relationships on both engagement and performance were greater for high school students than for primary students, whereas the opposite was true for the effects of negative relationships. This finding has important implications for supporting for academic success for students.

In the case of high school students, the importance of positive relationships with teachers should be considered with other studies suggesting that such positive relationships become less common as students progress through school (e.g., Furrer and Skinner, 2003). For *primary students*, the stronger effects of negative teacher-student relationships on both engagement and academic achievement underscore the *importance of prompt intervention in conflictual or unsupportive teacher-student relationships*. Roorda et al. (2011) discuss the possibility that negative teacher-student relationships may have a cumulative effect over time, influencing and being influenced by student underachievement and externalising behaviours. Helping teachers of young children avoid the cascading effects of negative relationships, behaviour, and performance may have the potential to prevent students' subsequent disengagement from school (Finn, 1989).

**Teacher-student relations as a dimension of classroom climate**

A somewhat different approach to the study of teacher-student relationships focuses less on the dynamics of specific dyadic relationships and considers *teacher characteristics and behaviour that foster a general climate of positive regard, respect, and caring*. Overall, the findings of this body of research point to the importance of students' positive perceptions of the interpersonal climate of their classes and their teachers' classroom practices. The sense that one is accepted, respected, and cared for, and that the teacher promotes a climate of mutual respect and prosocial values, is consistently related to desirable motivational, academic, and developmental outcomes (Wentzel, 2010). However, less is known about the specific behaviours, practices, or characteristics of teachers that promote these perceptions in students (Anderman & Freeman, 2004).

The substantial body of research by Pianta and colleagues represents an important advance in the study of teacher-student interactions in the classroom (e.g., Hamre et al., 2013; Pianta & Hamre, 2009). These researchers propose a *model of effective teaching* conceptualised in terms of three main categories of interactions: *emotional support, classroom organisation, and instructional support*. All three categories are measured using an observational instrument, the Classroom Assessment Scoring System (Pianta, Hamre & Mintz, 2012). Initially developed in early childhood settings, this instrument has now been adapted for teachers of older learners (Pianta et al., 2012). Focusing on observable classroom behaviours has strengths and limitations. If the goal is to assess teacher effectiveness in promoting student achievement, the ability to 'attend to aspects of teachers' work that can be reliably observed and assessed' (Hamre et al., 2013, p. 463) is crucial. However, reliance on observable teacher behaviour, even when broadly assessed, inevitably limits the perspective on teachers' work in the classroom, omitting information about the real-time teacher decision making that drives student behaviour and perceptions that constitute the other half of classroom interactions.

One way to address this limitation is by using multiple sources of data collected from teachers and students. For example, Anderman, Andrzejewski, and Allen (2011) used student survey reports to identify high school teachers who were perceived as creating a classroom environment that supported positive beliefs related to motivation and learning, and then conducted direct observations to provide a rich description of those teachers' practice. They documented examples of teacher-student interactions that fostered positive interpersonal relationships with students while maintaining students' behavioural and cognitive engagement.

This overview of research on teachers' efficacy, emotions, and interpersonal relationships in the classroom highlights the *continuing contributions of educational psychologists to our understanding of teachers' work*. One important development is the increasing attention paid to teachers' experiences and emotions in the classroom and the changes in those experiences over the course of their careers. Similarly, the ongoing development of theorising about social relationships in the classroom and teachers' sense of personal and collective efficacy represent significant areas of progress.

## 2.6. Collaborative learning

Collaborative learning has become an increasingly important part of contemporary learning environments. Dillenbourg (1999) noted that it is surprisingly difficult for researchers to agree on a definition of collaborative learning. He concluded that collaborative learning '*describes a situation in which certain forms of interaction between people are expected to occur, which would trigger learning mechanisms, but there is no guarantee that the expected interactions will actually occur*' (p. 5). We will briefly review the theoretical

approaches to collaborative learning that are based on information processing theory, sociocultural theory, and knowledge construction theory.

**Information processing theory**

Much of the research on collaborative learning has been explicitly or implicitly guided by information processing theory. A central premise of information processing theory is that elaborative processing of information enhances understanding and recall of that information (see Webb, 2013). Examples of effective elaborative processing in collaborative groups include explaining ideas, giving reasons, articulating goals and plans, and articulating solution procedures. (e.g., Chi and Wylie, 2014). A second premise is that learning can be enhanced by receiving appropriate feedback from others. By applying elaborative processing to new information, learners incorporate this information into long-term memory structures. By appropriate design, peer groups can be encouraged to engage in verbal and overt elaborative processing when discussing ideas and solving problems with peers. Similarly, by encountering alternative perspectives presented by their peers, students receive new insights that can help them develop better ideas on their own (Chi and Wylie, 2014).

**Sociocultural theory**

Vygotsky's sociocultural theory is another predominant theory that frames work on collaborative learning (Hakkarainen, Paavola, Kangas & Seitamaa-Hakkarainen, 2013). While information processing theory is compatible with the idea that learners must learn component competencies before learning the broader competencies of which they are a part, sociocultural theorists note that, outside of school, people often learn through apprenticeships in which they participate in the whole set of activities from the beginning.

At first, trainees may perform only minor tasks, but they observe and participate in the overall process and gain a global sense of the process, and then perform more tasks over time. Accordingly, *sociocultural theorists advocate that collaborative groups engage in complex inquiry and problem solving of the kind that people perform in real-world tasks*. Rather than teaching knowledge and skills (e.g., learning anatomy) before allowing students to engage in broader processes (developing diagnoses of patients based on the symptoms they present), students are helped to engage in broader processes with scaffolding that provides help with the parts they cannot do initially (e.g., learning anatomy in the context of developing diagnoses; Rogoff, Paradise, Arauz, Correa-Chavez & Angelillo, 2003).

Sociocultural theorists also posit that learning occurs in the zone of proximal development, meaning that students learn best when they engage in tasks

in which they need help, but can perform with help. Therefore, *collaborative groups must be given authentic tasks and the necessary scaffolding (instructional supports) to help them succeed in these tasks* (Hogan and Tudge, 1999). Beginners will receive many scaffolds that can be gradually phased out, until they can succeed at the tasks on their own. In addition, the apprenticeship includes learning to use the tools that experts use (such as data visualisation software to generate graphs and charts in a science project).

**Knowledge construction or creation**

Although many collaborative learning methods have focused on individual learning as the goal, another approach to collaborative learning, called knowledge construction, addresses group knowledge creation per se as the goal (Hakkarainen et al., 2013; Scardamalia & Bereiter, 2006). The focus is less on individual knowledge acquisition than on the collective knowledge developed by the group.

In professional settings, one of the characteristics of successful collaborative interaction is that the group produces new knowledge, as when scientists produce new empirical findings or a new theory, or when a group of professionals find out the causes of absenteeism in their workplace (cf. Scardamalia & Bereiter, 2006). These researchers argue, similarly, that collaborative learning should focus on increasing the knowledge created by a classroom community. Collaborative learning is successful if the joint work done by the group or class enhances the collective knowledge of the community.

**Teaching methods**

One of the outcomes of the research on collaborative learning has been the identification of the processes that take place within collaborative learning that facilitate student learning, as well as the processes that facilitate successful group products. The *processes* that have been identified include *(a) engagement; (b) positive interdependence; (c) mutual respect; (d) use of high quality social and cognitive strategies; (e) assimilation of peer ideas; (f) communication of alternative perspectives; (g) balanced participation; and (h) co-regulation and shared regulation*. Effective methods that promote learning will succeed in fostering most or all these productive processes. Below, we discuss several instructional methods that succeed in encouraging these processes and, through them, greater learning.

<u>Rewards</u>

An important issue in collaborative learning is how to use grades and other rewards. Some researchers have argued that extrinsic rewards are essential for motivating productive group behaviour (*Slavin, 1996*). Slavin and colleagues have

presented extensive empirical evidence supporting the use of group rewards for individual learning. Under this system, all learners in a group receive the same grade or reward, but the grade or reward is based on an average of group performance. For example, a group of four students study how to spell words together and then take a test. Their grade or reward is determined by taking the average score of the group members in the spelling test. Since each group member's reward depends in part on the performance of his or her peers, a positive interdependence is established.

Complex tasks

The current trend in collaborative learning research is to develop instruction with complex tasks at higher cognitive levels. Positive interdependence without rewards is established in these tasks, as the tasks are complex enough that learners need the insight and perspective of others to be successful, and the use of high-level strategies is required to successfully negotiate the tasks. There is no emphasis on external rewards.

For example, research settings may ask students to use evidence to develop scientific models or to choose among alternative scientific models. Students may work with four or five studies related to the existence of HIV-resistant individuals; these studies vary in methodological quality and link to alternative models in complex ways (Chinn et al., 2013). Developing and evaluating models by comparing them to the data is a difficult task that can best be solved if students pool their knowledge and engage in reasoned argumentation to try to figure out which model is best supported by the evidence.

Scaffolding

One of the main objectives of collaborative learning research has been to develop and investigate scaffolds that can enhance collaborative learning processes. Scaffolds are aids that help learners perform tasks that they would not be able to perform on their own.

A prominent scaffold in recent research is the *collaborative script* (Fischer, Kollar, Stegmann & Wecker, 2013). Under the label *collaborative scripting,* we include a wide variety of methods that provide students with specific guidance on what to say during collaborative interactions; this guidance is analogous to scripts that provide guidance to actors in a play, except that, whereas a theatrical script specifies everything the actors say, an *instructional script* may direct students to state their position on a historical issue and a reason for their position, but leaves students to formulate their own position and reason. *Scripted methods* have their origins in research in which students worked in pairs to recall material in turn and check what the others remembered. Research on this method revealed great benefits for learning for primary students (e.g., Fuchs, Fuchs, Mathes & Simmons, 1997) to college students (e.g., O'Donnell, 1999).

Another type of scaffolding that has been extensively explored in recent work is the *use of roles*. Social roles focus on the social and procedural processes that groups perform. For example, one possible social role is that of discussion leader. The discussion leader is responsible for ensuring that the discussion runs smoothly and that everyone contributes. Cognitive roles focus on the use of specific cognitive strategies that the group must use to solve a problem (Herrenkohl and Guerra, 1998). For example, one possible cognitive role is the theory checker. The theory checker is responsible for ensuring that the group carefully checks their theories against the evidence and learns questions that could be asked to assist in this task. Herrenkohl and Guerra (1998) found that students who used cognitive roles during peer research presentations had more productive discussions than students who did not.

Finally, an important and powerful scaffold is teachers' *modelling of desired forms of discourse,* along with pushing students to use these forms of discourse (Jadallah et al., 2011). For example, teachers who model the practice of giving good explanations and urge students to do the same may promote better explanations. Similarly, students who model how to give good reasons may encourage better argumentative discourse (Jadallah et al., 2011).

## 2.7. Assessment of learning: the formative-summative assessment continuum

The last decade has seen a growing interest in formative assessment, the purpose of which is to gather evidence of student learning that can guide instructional decisions. Black and Wiliam (1998) and Stiggins (2005) distinguished between assessments used for summative judgments and assessments to inform instruction and learning. Formative assessment is a process rather than a test (Heritage, 2013). In the formative assessment process, student knowledge and understanding are monitored so that feedback can be given in a timely manner that is both informative and useful for facilitating student growth. Therefore, the formative assessment process, which includes instruction and the conversion of assessments into data, is intimately tied to learning. It includes goal setting and the expected progression of learning.

Pellegrino (2010) cautioned that distinctions across the formative-summative assessment continuum are not clear. In some situations, summative assessments may be used for more formative purposes and formative assessments for more summative decisions. Herman (2013) notes that key elements that interact in the formative assessment process include *learning objectives, assessment tasks, interpretations,* and *feedback*. While these components may be applicable for summative purposes, in formative situations there are various forms of assessment, closer links to the curriculum, and a learner-centred feedback and interpretation cycle.

**Key features of formative evaluations**

The formative evaluation process may focus on individuals or groups of students. The process may be oral or written, open or closed-ended. It can be teacher-initiated or student-initiated and evaluated by students, peers, or teachers. In theory, information from any assessment could be used formatively, to guide instruction; but in practice, the assessments most useful for this purpose would be closely tied to curriculum and instructional content and are often moment-to-moment and short-cycle. Shavelson (Shavelson, Yin, Furtak, Ruiz-Prino, Ayala, Young et al., 2008) identified degrees of formality in formative assessments. They can occur '*on the fly',* that is, during teaching in response to an opportunity, learner action, or requested response. A teacher may, for example, ask a follow-up question in response to a learner's comment suggesting a possible misunderstanding. '*Planned interactions*' are questions or activities that teachers design for the lesson to assess student understanding, while '*curriculum-integrated*' activities may be problems or questions included in a prepackaged curriculum that students might use to assess their own understanding. The *formative assessment process* is diagnostic to inform subsequent instruction; that is, to help identify where students are, but also to determine challenges to their success, and obstacles that might be overcome with targeted instruction. Regardless of their form or timing, formative assessments monitor student progress toward learning objectives. Underlying all formative assessment is a theory or model of how students develop the understanding or skills they are trying to learn.

**Formative assessment and classroom instruction**

The classroom environment necessary for formative assessment is collaborative and supportive; students must be comfortable with constructive feedback and questions. Students engage in assessment activities with their teachers, and in self-assessments and sometimes peer assessments. During *formative assessment,* students can evaluate their own understanding and provide feedback to their peers. They should know what they are expected to learn and be able to assess progress toward those goals. Perhaps most importantly, when students understand that assessment information *can help promote learning*, and that it is not used solely for summative purposes, they can begin to regulate their own learning (Corno, 2008).

Teachers using formative assessments must not only determine whether students have learned the target material, but also probe into students' thinking to understand why they may not have learned it (Trumbull & Lash, 2013). This feature explains why teaching with formative assessment requires an underlying model of how students learn, knowledge of actions that can be taken to move a student forward, and ways in which feedback can support learning.

## The key role of feedback in formative evaluation

Feedback is an essential element of formative assessment that distinguishes it from other forms of assessment and should result in immediate action to improve instruction. The provision of timely, specific, and actionable feedback is a component for all assessments, but particularly in the formative assessment process (Hattie & Timperley, 2007). The goal of feedback is to reduce the gap between the learner's current state and the desired goal. Decades of research on feedback (e.g., Weiner, 1986) indicate that feedback should be given in a way that does not communicate to students that underachievement or failure is due to immutable traits such as intelligence. Instead, feedback should be given on something malleable, such as effort or constructive information.

As a component of formative assessment, feedback should also be descriptive, evidence-based, non-evaluative, and aligned with instructional objectives and outcomes within a given context (Heritage, 2010). It should lead to new learning (Heritage, 2010). Feedback should help students understand what they need to improve their performance. It addresses three questions: (a) *where am I going, (b) where am I now, and (c) where to now?* Ruiz-Primo and Li (2013) emphasize that formative feedback should be a component of the instructional and assessment cycle, rather than a discrete process.

Hattie and Timperley's (2007) review of feedback provides a framework based on three questions: *where am I going, how am I doing, what is the next step?* The fundamental principle is that feedback should be timely and constructive so that it is informative for teachers and learners. The most opportune time for feedback seems to vary according to the type of task. Shute (2008) finds the results of research on feedback to be contradictory and inconsistent, with some variables and characteristics related to positive outcomes, depending on the environment, context, prior knowledge, learner characteristics, and task. Shute's review recommends that feedback should: (a*) focus on the task, not the learner; (b) be elaborated; (c) be provided in manageable units; (d) be specific and clear; (e) be simple; (f) reduce uncertainty; (g) be objective; and (h) promote a learning goal orientation* (a goal of mastering the material rather than getting a high grade).

## Technological aids for formative evaluation

While learning analytics uses technology as a powerful medium for learning analytics, other technologies offer venues for creative assessments. Applications of new computer and web-based technologies to education offer the potential to improve the primary task of assessments: gathering high-quality evidence about student knowledge and skills that is useful for its intended purpose. New technologies offer *greater flexibility in how assessment tasks are presented to*

*students and how students can respond to them*, making it possible for more students to demonstrate their knowledge and skills. Technologies allow for a *greater diversity of data and can provide faster feedback because of their greater information processing speed* and their ability to organise, manage, and retrieve assessment information. With new technologies come dynamic ways of representing information that, in combination with advances in learning theories and psychometrics, provide the means to gather useful evidence on a wider range of learner knowledge and skills. The technologies also make it possible to collect data on dynamic and complex cognitive processes and patterns of performance that would not be possible with more static means (Quellmalz & Pellegrino, 2009).

With their ability to quickly manipulate large amounts of information, *new technologies can improve the accuracy and efficiency of assessments*. There is more flexibility about when and where assessments are administered. It is no longer necessary to stop teaching and administer assessments to groups of students when computers can present assessment tasks to individuals at any time. Computerised assessments can quickly score responses to provide immediate feedback to teachers and students. When combined with psychometric methods that model student responses to items, computerised assessments can be designed to be tailored to individual students, selecting tasks that best match their level of performance. When linked closely to instruction, feedback can provide formative information to direct the next instructional steps (Pellegrino & Quellmalz, 2010).

**Future directions for evaluation**

Assessments provide an essential repository of data about students' learning, their strengths and weaknesses, and the instructional remediation necessary for them to achieve proficiency in a subject. As mentioned above, there is a wide variety of assessments, and some are aligned to inform instruction and student learning trajectories. The tighter the feedback loop between instruction, assessment, and the resulting data, the greater the potential to inform the learning and instructional process.

New evaluation models are being designed and existing models are being readapted to maximise their informative value. In the past, annual summative evaluations were widely used for accountability and more local purposes. Today, formative evaluations are taking center stage. *This momentum reflects a philosophical shift toward assessments that can inform educational practice*. These changes and trends have implications for practice. Current and future educators must be prepared to understand and use new forms of educational assessment and be able to competently interpret results in ways that transform data into actionable knowledge.

Professional development must address the realisation that while teachers are able to understand and use assessment results, they may have difficulty determining instructional action (Heritage et al., 2009). The transition to assessments that can inform learning requires a culture shift, particularly from a *culture of accountability to a culture of improvement* (Wise, 2014). The real transformation is to *provide information to students and teachers about where students are along their learning progressions so that appropriate instructional actions can be determined and implemented*.

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# FUNDAMENTALS OF TEACHING AND LEARNING

In this section, we justify the fundamentals of teaching and learning that we consider as essential knowledge for a future teacher. Thus, we will first define synthetically what we understand by learning and teaching from a psychological point of view. We present a proposal for instructional design with the goal of promoting meaningful learning in students. Finally, we present a set of *evidence-based* recommendations for the organisation of teaching and learning, based on the connection between psychological theory and professional practice.

## 3.1. Teaching and learning: transmitting and constructing mental representations

It is worthwhile understanding the psychological aspects of learning and teaching – and analysing both in terms of transmission and acquisition of mental representations (Vidal-Abarca, 2010).

In an educational situation a teacher (real or virtual) develops teaching procedures for learners to learn knowledge or skills. Only humans teach as a set of activities of the members of a community or social group to transmit cultural knowledge to other members of that culture. Although in other species we see the transmission of skills and abilities by adult members of the group to younger ones, the peculiarity of human teaching lies in its intentionality. In the case of human teaching, the teacher wants the learner to learn something and not just do something (Kruger and Tomasello, 1996).

The cognitive abilities of humans explain their ability to teach. These include the ability to store and retrieve mental representations at will and cognitive-social skills, such as the ability to observe and reproduce behaviours, the understanding of communicative cues, and the comprehension of the intention of others. In particular, the ability to share and compare mental representations explains the possibility of teaching and learning in humans. Thus, we can affirm that there is a clear relationship between human psychological capacities and teaching.

Depending on beliefs about the learning process, we can distinguish three different instructional processes (Vidal-Abarca, 2010). First, *minimal teaching*. When adults have confidence in the ability of younger members to acquire a competence or skill on their own, the degree of explicit teaching they will provide will be minimal. For example, adults rely on infants' ability to acquire speech, so they do not usually devote additional effort to teaching infants to articulate early sounds, beyond small interactions to model or correct.

Secondly, teaching can be qualified as *guided* when the level of adult intervention is directed, for example, at training children to incorporate themselves into the multiple tasks of adult life, such as learning to set the table at home or learning to make their own beds. This is very valuable learning where adults will guide the execution of a series of steps that children learn to execute on their own.

Finally, when teaching is developed explicitly and requires a systematic organisation, we call it *designed teaching*. This takes place in a specific environment with the objective of teaching complex knowledge and skills that require a long training process. This type of teaching, exclusively human, is also called formal teaching and is the type of teaching we focus on in this project.

The objective of designed instruction is to transmit mental representations. Kintsch (1998) defines mental representations as *any idea, concept, image, skill, or in generic terms, knowledge that we have in our mind which enables us to remember, understand, or act in our environment*. This concept is central to educational psychology because learning can be defined as the formation of mental representations that enable the learner to act in an environment in a new way (Kintsch, Franzke and Kintsch, 1996). Mental representations make it possible to operate virtually with objects and events, to evoke memories, to plan, to communicate, and so on.

The possibility of operating virtually with objects and events is what gives power and utility to representations. The more abstract the representations, and the more they are flexible and independent of the concrete environment, the more powerful they will be because they enable us to operate in a greater number of environments. But not all representations are abstract, and most are very close to reality. The learner captures this more specific information from direct experience with the physical world, in *direct representations* (such as interpreting the combination of eyes, nose, and mouth as a face), *episodic* (such as learning to be polite at the dinner table after repeatedly watching our parents and being rewarded for being so), or *symbolic* (such as learning that the signal of extending the thumb and little finger means 'call me'). In these cases, we are dealing with representations that have a strong analogical character with the reality they represent. This makes it difficult to generalise their usefulness to new situations. At the pole closest to abstraction, and therefore most relevant for education, we find narrative and abstract representations (Kintsch, 1998).

*Teaching and learning consist of transmitting and constructing mental representations,* respectively. In the case of learning, it is a matter of forming mental representations of the knowledge that is relevant to acquire; and in the case of teaching, the teacher must be aware of the mental representations that the learner has and those that it is necessary for the learner to reach through the designed teaching. In these situations, the teacher must: a) have a clear mental representation of the final goal or learning that the students must achieve; b) assess to what extent the students are approaching that goal; c) continuously

integrate both aspects by providing the appropriate aids and feedback to achieve the progression towards the desired goal.

Learning involves acquiring knowledge to understand the natural and social environment that surrounds us and to be able to act effectively in that environment. The knowledge we acquire and organise into mental representations is of two types: a) *declarative* (equivalent to knowledge that can be said) and b) *procedural* (knowledge that reflects know-how). It is known that this knowledge is neither learned in the same way, nor represented in the same way, and that it must be taught in a different way. Declarative knowledge has to do with forming abstract mental representations from ideas and their relationships. The formation and relation of ideas is usually done from working with texts or from listening. However, it requires an active effort on the part of the learner in processing and relating incoming information.

For the study of written material, the student will find, for example, a 1000-word text that explains a process or event. According to the mental processes that Kinstch (1998) says occur in comprehension and learning from texts, the student will read the information and capture simple ideas and their relationships, relationships that will be established both from explicit clues in the text, and from causal connections between ideas, or from the activation of previous knowledge.

The student establishes which ideas are central for synthesising the main nuclei of the text (*macroideas* in Kinstch's terms) and how the new information is grouped around these central ideas. Finally, from the reading of the document the student would have constructed a mental representation that enables evoking that information at will in the future. Undoubtedly, in this process there may be misinterpretations, the activation of irrelevant prior knowledge, and failures in the construction of a coherent mental representation from the text. This depends on the depth of the processing that the reader has activated, level of prior knowledge, and the characteristics of the text.

Procedural knowledge refers to knowledge that reflects knowing how to do something, such as cooking, dancing, reading (in its decoding aspect), or operating a computer. Procedural knowledge can be automatic or strategic. When automatic it is incorporated into the learner's repertoire from learning rules and their simple varied practice (such as writing a letter of the alphabet). Strategic procedural knowledge requires initial learning of a principle followed by analysis of varied examples, varied and guided practice to deduce principles and commonalities, and a conscious self-regulation when monitoring execution. Examples of strategic procedural learning would be the ability to apply addition-subtraction algorithms to various problem statements, or the resolution of practical cases (i.e., how to intervene in each case) using the same principle of intervention.

*Declarative and procedural knowledge are complementary and* must be integrated in the teaching process, since they constitute the components of

complex skills. They are treated differentially in the initial teaching process to ensure that each is acquired in a meaningful way.

We will discuss the concept of meaningful learning, the processes involved, and their relationship with instructional design in the following section. These reflections will help us organise the teaching of psychology of education in such a way as to promote *meaningful learning in students, the transfer of acquired knowledge and skills, and the incorporation of strategies for organising learning that they can use throughout their professional lives* – without forgetting the generation of a growing confidence in the professional practice of evidence-based teaching.

## 3.2. Instructional design for meaningful learning

As we pointed out in previous chapters, for Mayer (2010) educational psychology is situated between instruction and learning (between the instructional changes made by the teacher and the changes in knowledge created in the learner). Instruction refers to the elaboration for the learner by the teacher of environments intended to foster changes in the learner's knowledge. Thus, the definition of instruction has two components:

2 Instruction is something the teacher does
3 The goal of instruction is to promote student learning

Let us also remember that according to Mayer (2010) two of the most promising current contributions of educational psychology are the psychology of knowledge areas and instruction in cognitive processes to support meaningful learning. Appropriately stimulating the cognitive processes of our students to achieve meaningful learning from the content we present to them must also be one of the essential objectives of our teaching proposal. However, what is meaningful learning? We will try to clarify the meaning in the following subsections.

### *3.2.1. Learning metaphors*

For Mayer, educational practice can be influenced by the educator's underlying metaphor for learning. These are detailed below.

#### Learning as response intensification

This conception was developed during the first half of the 20th century and was mainly based on research with laboratory animals. Learning was seen as a mechanical process in which successful responses are automatically intensified, while unsuccessful ones are weakened. Thus, learning is like the intensification or

weakening of the association between a stimulus (E) and a response (R). According to this metaphor, the learner is a passive recipient of feedback shaped by rewards and punishments, and the teacher turns out to be a dispenser providing rewards and punishments.

Learning as response intensification approach suggests an educational practice in which the teacher generates situations that require brief responses, the learner gives a response, and the teacher provides the appropriate reward or punishment. Drills and practice constitute a popular method of instruction consistent with the learning-as-response-intensification metaphor. If educators accept this metaphor, it underscores the teaching of basic skills in reading, writing, and mathematics.

**Learning as knowledge acquisition**

Developed during the 1960s and 1970s, research has evolved from the study of animal learning in laboratory situations to the study of human learning in laboratory situations. According to this approach, learning takes place when information is transferred from a more knowledgeable person (the teacher) to a less knowledgeable person (the learner). The learner is an information processor and the teacher is an information dispenser. This approach suggests an educational practice in which the teacher presents new information to be learned by the learners. The goal of instruction is to increase the amount of knowledge in the learner's memory, and so textbooks are very popular for teaching.

**Learning as knowledge construction**

Learners actively construct their own mental representations as they seek to make sense of their experiences. This concept emerged from research on human learning in real-life situations during the 1970s and 1980s. Learning occurs when people select relevant information, organise it into a coherent structure and interpret it in terms of what they already know. Resnick (1989): *learning does not happen by recording information but by interpreting it* (p. 2). According to this view, the learner is a maker of meaning and the teacher is a guide who helps the learner when trying to understand how to perform academic tasks. Thus, the central focus is on learners and helping them to construct cognitive strategies for performing academic tasks, as well as on strategies for organising teaching and learning that we will discuss later.

Instead of highlighting the products of learning (quantity learned), this approach emphasizes the processes of learning, such as strategies on how to learn and understand. When educators adopt a learner-centred approach, they are acting under the metaphor of learning as knowledge construction. According to Mayer (2010) this latter metaphor seems the most promising direction for the future of educational psychology. This metaphor does not downplay the importance of

learning basic skills, such as the facts and procedures referred to above. According to the knowledge construction metaphor, basic skills should be learned in the context of broad academic tasks – and not in isolation.

| Learning is | Apprentice is | Teacher is | Instruction methods |
|---|---|---|---|
| **Intensification of the response** | Passive recipient of rewards and punishments. | Reward and punishment dispenser. | Exercises and practice of basic skills. |
| **Knowledge acquisition** | Information processor. | Information dispenser. | Textbooks, workbooks and lectures. |
| **Knowledge construction** | Meaning maker. | Guides the understanding of academic tasks. | Discussion that is guided discovery, and supervised participation in meaningful tasks. |

Table 3. Three metaphors of learning (Taken from Mayer, 2010)

### 3.2.2. *How people learn: a cognitive theory of meaningful learning*

The student as the constructor of their learning is at the centre of the educational process. Education consists of helping students change their knowledge, as evidenced by changes in academic, motor, social, and personal behaviours (Mayer, 2010). The action is then placed in the student's learning environment.

To answer the question about how people learn, we can rely on the three basic principles of research in cognitive science (the principle of dual channels, the principle of limited capacity, and the principle of active learning. Based on Baddeley, 1999; Mayer, 2001a, Paivio, 1986; Sweller, 1999, and Wittrock, 1989).

| Principle | Description | Implications for training |
|---|---|---|
| **Dual channels** | Students have different channels for processing verbal information and images. | Help students to coordinate verbal representations and images of the same concept. |
| **Limited capacity** | There are limits to the amount of information that learners can process on each channel at any given time. | Do not exceed the learning system by presenting too much content simultaneously. |
| **Active processing** | Paying attention to relevant information, organising it into coherent mental representations, and integrating the representations with other knowledge. | Stimulate information selection, organisation and integration processes. |

Table 4. Three principles of learning derived from cognitive science (taken from Mayer, 2010)

In meaningful learning, three memory stores are involved: sensory memory; working memory; and long-term memory (Table 5). The cognitive processes of selection, organisation, and integration are also activated (Table 6).

| Principle | Description | Implications for training |
|---|---|---|
| **Sensory memory** | Very brief storage of sensations entering from eyes and ears. | Providing students with appropriate learning experiences. |
| **Operating memory** | Temporary storage and transformation of sound and visual image inputs. | Learners construct mental representations in working memory. |

| | | |
|---|---|---|
| **Long-term memory** | Permanent storage of knowledge built by the working memory. | During learning, learners retrieve appropriate knowledge from long-term memory. |

Three memory stores used in meaningful learning (taken from Mayer, 2010).

*Selection:* or the selective encoding process (Sternberg, 1985). Sternberg defines it as 'separating relevant information from irrelevant information' (p.107). It involves focusing attention on the relevant aspects of the information presented and transferring them from the sensory memory to working memory.

*Organisation:* the process of building internal connections between the fragments of information entering the working memory to organise the selected information into a coherent whole (Mayer, 1984, p.32). According to Sternberg (1985) we would speak of a process of selective combination: 'the combination of selectively encoded information in such a way as to constitute an integrated whole [...] internally connected' (p.107).

*Integration:* This process involves the act of 'connecting organised information with other familiar knowledge structures already present in memory' (Mayer, 1984, p. 33). Sternberg (1985) refers to integration as selective comparison and describes it as 'the relationship between newly acquired or retrieved knowledge [...] with prior knowledge, to constitute an externally connected whole' (p. 107). Integration also involves building connections between two fragments of newly organised knowledge, such as verbal and iconic representation of the same concept.

Thus, the learner uses the processes of selection, organisation, and integration to construct new knowledge in the working memory. The knowledge constructed in the working memory is transferred through an encoding process to the long-term memory for permanent storage.

| Cognitive processes | Description | Resulting knowledge | Implications for training |
|---|---|---|---|
| *Selection* | Pay attention to the relevant elements of the content presented. | Sounds and visual images. | Students may need orientation. |
| *Organisation* | Building internal connections between incoming elements. | Verbal models and iconic models. | Students may need orientation on how to organise. |
| *Integration* | Build external connections between representations and prior knowledge. | Integrated model. | Students may need orientation on how to integrate. |

Table 6. Three cognitive processes used in meaningful learning (taken from Mayer, 2010)

In explaining how we construct knowledge, it is fundamental to consider the *limitations of the human cognitive system*. Cognitive load theory is based on the idea that the cognitive capacity for learning is limited and that there are three main sources of cognitive load during learning: the *intrinsic cognitive load;* the *extrinsic cognitive load;* and the *germane cognitive load* (Paas, Renkl and Sweller, 2003; Sweller, 1999).

*Intrinsic cognitive load* is the amount of cognitive processing necessary to understand the contents to be learned (depending on their conceptual complexity). Sweller (1999) defines intrinsic load in terms of item interactivity: content with high interactivity has many interacting items and requires more cognitive capacity, while content with low item interactivity consists of items that can be learned independently and requires less cognitive capacity. It is a cognitive load that cannot be eliminated, but can be managed through effective instruction, for example, by breaking a lesson into manageable elements (Mayer, 2005b).

*Extraneous cognitive load*: the amount of cognitive capacity spent on cognitive processing that is not relevant to the instructional objectives. This occurs when a lesson has been poorly designed or when instructions are difficult to understand. It can be reduced by effective instructional design (i.e., by employing aids that indicate the organisation of the content or placing images near the texts describing them, Mayer 2005c).

*Germane cognitive load:* when learners engage in deep cognitive processing of the content to be learned. Germane cognitive load can be stimulated by asking the learner for activities such as self-explanation (Mayer, 2005d).

The importance of cognitive load theory for instruction is that instruction should be designed to keep the intrinsic cognitive load under control, minimise extraneous cognitive load, and promote germane cognitive load (Mayer and Moreno, 2003; Sweller, 2005). If the learner is forced to waste cognitive resources on extraneous processing, the learner may lack the remaining capacity for intrinsic and linked processing.

| Designation | Description | Cognitive process | Implications for training |
|---|---|---|---|
| *Intrinsic* | Due to the complexity of the contents. | Initial processing to begin to understand the content (select). | Control by segmentation or pre-instruction. |
| *Extraneous* | Due to poor instructional design. | Processing not relevant to learning. | Reduce, eliminating extraneous content and including previous aids. |
| *Germane* | Due to the effort to establish meaning. | In-depth content processing (organising and integrating). | Instigate, encouraging self-explanations. |

Table 7. Three sources of cognitive load during learning (taken from Mayer, 2010).

3.2.3. *Cognitive conditions conducive to meaningful learning*

We have reviewed the components, basic processes, and conditioning factors that contribute to meaningful learning. It is evident that not all learners manage to construct organised and integrated mental representations that appropriately combine the information acquired through the various sensory channels and the information already available in their long-term memory. In view of this, it is crucial to *question which cognitive conditions would lead to meaningful learning*. This aspect is briefly discussed below.

Suppose we ask students to read a text about how tides are produced. We then give them a retention test to assess how much they remember of the information presented and a transfer test to assess the extent to which they can creatively apply what they have learned to solve new problems. Some students will not remember much of the text and will not be able to answer the transfer questions. We could say that these students have fallen out of learning. Some students will remember a lot of information but will be unable to use it creatively to solve problems or establish explanations. We could say that these students have engaged in literal learning (without comprehension). Finally, some students will remember information and use it creatively to solve new problems. These students have understood and learned meaningfully.

| Type of student | Retention | Transfer |
|---|---|---|
| *No learning* | Poor | Poor |
| *No understanding* | Good | Poor |
| *Understander* | Good | Good |

Table 8. Differences in performance (three types of students). Adapted from Mayer (1984, 2010).

Which learning conditions generate these three types of outcomes?

Gagné (1974) distinguished two conditions of learning: the *internal conditions* (referring to the cognitive processes that are activated when learning); and the *external conditions* (referring to the instructional events that take place outside the learner).

Mayer (1996b, 2001b) pointed out that three internal conditions must be met to instigate meaningful learning: (1) the instruction must help the learner select relevant information; (2) organise it; and (3) integrate it. From there, three different scenarios can be generated:

a) *No learning:* if the first condition is unmet, there is no learning. In reading, for example, one does not learn if one does not read the text carefully. This is reflected in poor performance in both retention and transfer.
b) *Literal learning:* if the first condition is met, but neither the second nor the third, then the student will learn in a non-significant way. When a student reading a text about tides fails to establish causal relationships in the information provided by the text, and if the student does not activate relevant prior knowledge, the textual contents are not well integrated. This result is indicated by a good performance in retention and a poor performance in transfer.
c) *Meaningful learning:* if all three conditions are met the learner will learn in a meaningful way. This outcome is evidenced by good retention and transfer performance.

Meaningful learning depends on active cognitive processing during learning. Furthermore, according to Mayer (2010), three external conditions are necessary for instruction to foster meaningful learning: that the content be potentially meaningful; the learner is guided and supported in the cognitive processes that lead to meaningful learning; and that assessment tests measure meaningful learning (retention and transfer levels).

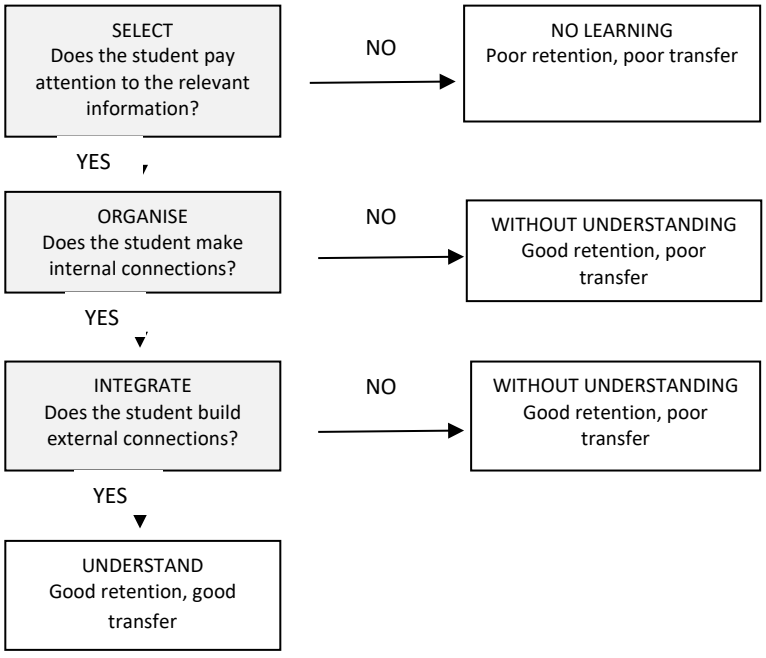


Figure 1. Three fundamental conditions of meaningful learning (taken from Mayer, 2010).

3.2.4. *Cognitive model of meaningful instruction*

From the preceding elements, Mayer proposes a cognitive model of meaningful instruction (Mayer, 1984, 2010) that incorporates the six factors that may participate in the teaching-learning process.

1. *Instructional changes*: sequence of environmental events, including the organisation and content of instructional materials and teacher behaviours. Instructional changes include what is taught and how it is taught – and depend on the characteristics of the teacher and curriculum.
2. *Learner characteristics:* learner prior knowledge, including facts, procedures, and strategies that may be needed in the learning situation. The nature of the learner's memory system, including its capacity, and the mode of representation in memory.
3. *Learning context:* social and cultural context of learning, including the social structure of the classroom and school.
4. *Learning processes:* learner internal cognitive processes during learning: how he or she selects, organises, and integrates new information with previous knowledge.
5. *Learning outcomes*: cognitive changes in the learner knowledge or memory system, including newly acquired facts, procedures, and strategies.
6. *Performance*: student performances on tests or learning tasks, as well as transfer to new tasks.

The design of effective instruction would consist in providing learning experiences (instructional changes) that are appropriate for the learner (learner characteristics) and the learning situation (learning context) that drive appropriate cognitive processing in the learner (learning processes), and lead to the construction of knowledge (learning outcomes) reflected in a change in the learner's behaviour (performance).

In short, the main goal of education should be to promote meaningful learning in which the *learner is actively involved in the cognitive processing that leads to transfer*. To this end, instruction needs to guide the basic cognitive processes that lead to meaningful learning. Significant efforts are being made to compile the main results that research has accumulated in this regard and generate practices that can be easily incorporated by educators. This is intended to foster the long-awaited connection between research and professional practice, stimulating the *evidence-based practices* referred to in this document. Below we review the most consistent recommendations that have been generated in recent years to effectively organise instruction and improve student learning.

### 3.3. Organisation of instruction to guide students' cognitive processes toward meaningful learning

*3.3.1. Organisation of instruction and study to improve student learning: general issues*

As we have seen above, teaching is about getting students to acquire new knowledge and skills, organised through mental representations, and helping students not to forget what they have learned. Leading experts in educational psychology have recently produced a report or practical guide (Pashler, Bain, Bottge, Graesser et al., 2007) to help educational professionals implement some basic recommendations derived from the main research findings. The recommendations presented in this report are intended to provide teachers with strategies to organise both teaching and the study of materials to facilitate learning and recall of information. Above all, the aim is to enable students to use what they have learned in new situations, which is especially relevant in university teaching.

One of the characteristics of the recommendations provided is the high degree of concreteness and specificity, as well as the corresponding indication of the level of scientific evidence that supports each recommendation. Specific prescriptions on how to promote learning were the focus of research in educational psychology during the first half of the 20th century but received much less attention in the second half. In recent years, according to this report, there has been a growing interest in recovering these research topics, so that the empirical basis for providing recommendations about teaching and learning has grown rapidly.

*Seven recommendations* are provided *that have been specifically selected by the experts who developed the guide as representative of the more specific applicable principles derived from research in learning and memory* (see Table 9). The first recommendation refers to the spacing of the content to be learned. This is a well-established principle to which teachers should pay attention when designing their instructional sequences. This recommendation provides tips intended to help students remember information for longer. The second, third, and fourth recommendations refer to how different forms of instruction should be combined: alternating already solved problems with cases to be solved by students independently (recommendation 2); combining verbal and graphic descriptions (recommendation 3), as well as alternating abstract and concrete representations of concepts (recommendation 4).

Recommendation five reflects the constant preoccupation with content recall. Frequently, content is forgotten at the end of the assessment. Along with the recommendation to employ a spaced presentation of materials to prevent forgetting. A substantial body of research recommends that teachers use questions or tests, both formally and informally, as tools to help students remember. While forgetting seems inevitable, its effects can be mitigated to some extent through appropriate use of the principles of spaced teaching and learning, and through the strategic use of questions and quizzes. Recommendation 6 refers to students' ability to judge how well they have learned new knowledge or skills (metacognition). One of the most important skills for students to acquire,

especially in university learning, is the ability to regulate their own learning based on what they know and what they do not know. Psychological research has shown that we are not always able to accurately assess our own level of learning. Stimulating this ability must be part of the teaching programmes at all levels, including university, and especially in the first courses, as is the case of our teaching proposal.

Finally, the seventh recommendation covers ways in which we can shape instruction once students have acquired basic skills and knowledge about a specific topic. It is recommended that teachers selectively ask students in-depth questions that cover causal and explanatory principles of the phenomena taught. A significant body of research shows that this activity (i.e., answering deep or high-level questions) can contribute to mastery of a specific topic.

The recommendations described reflect research that has been developed in the fields of cognitive science, experimental and educational psychology, and educational technology. The experts who prepared the report are sufficiently competent in these areas. Their main goal was to identify specific actions related to the use of instruction and study management that can be applied to areas of knowledge that demand the learning of a large amount of complex knowledge, as is the case in the teaching of subjects at university level.

As noted above, the novelty of this report is that it provides an explicit assessment of the level of empirical support associated with each recommendation (Table 10). Thus, when it is stated that a recommendation is supported by strong evidence, this means that it has received considerable support from experimental studies with randomisation, both in controlled laboratory situations and in schools. Moderate and low levels of evidence imply a more limited and weaker evidence base. When recommendations have been assigned to these levels it has often been because, although the evidence was experimental, it was limited to laboratory studies, and so that the applicability or generalisability of the results to other situations (classroom teaching) was uncertain.

In summary, the experts who prepared the report (Pashler, Bain, Bottge, Graesser et al., 2007) recommend a set of actions that reflect the teaching and learning process and recognise ways in which instruction should respond to the state of the learner. It also reflects the organising principle, outlined by the experts who prepared the report, that learning depends on memory, and that the memory of skills and knowledge can be reinforced from a relative and specific number of strategies.

| Recommendations | Level of evidence |
|---|---|
| 1. *Distribute learning over time*. Review key elements of the course content with a delay of several weeks or months after the initial presentation of the content. | Moderate |
| 2. *Alternately present already solved tasks with tasks to be solved by the students*. Students must be alternatively given problems or tasks already solved, which are discussed with the teacher, and tasks to be solved by the students. | Moderate |
| 3. *Combine descriptions of a graphical and verbal nature*. Try to present verbal descriptions together with graphic presentations (graphs and figures) that illustrate key processes and procedures. | Moderate |
| 4. *Connect and integrate abstract and concrete representations of concepts*. Connect and integrate abstract representations of a concept together with concrete representations of the same concept. | Moderate |
| 5. *Use quizzing to promote learning*. Use quizzes with questions that stimulate active retrieval of information at all stages of the learning process. This approach facilitates long-term memory. | |
| 5.a *Use questions to introduce new topics* (pre-questions). | Good |
| 5.b *Employ assessment tests* to show students key content again. | Very good |
| 6. Help students to *allocate study time effectively*. Help students identify the material they know well, and that which requires further study. Teach students to be competent in judging what they have learned. | |
| 6.a Teach students to employ *delayed learning judgments* to identify content to be studied. | Good |
| 6.b *Employ tests to identify the content to be learned*. | Good |
| 7. *Pose in-depth questions*. Have students answer in-depth questions about course materials. These questions should be posed in such a way that students are asked to respond through explanations that reflect a deep understanding of the material being taught. | Very good |

Table 9. Instructional recommendations and corresponding level of evidence. Adapted from Pashler, Bain, Bottge, Graesser et al., 2007.

| Levels of evidence | Justification |
|---|---|
| Good | Based on studies with high internal validity (designs guaranteeing causal conclusions) and external validity (representativeness of tasks and contexts). |
| Moderate | Studies with high internal validity, but moderate external validity. Thus, this level is granted to studies that guarantee the establishment of causal conclusions but are difficult to generalise – or studies that enable generalisability, but with uncertain causality. |
| Very good | The recommendation is made on expert opinion, consistent findings or theories, but without reaching the standards for moderate or high levels. |

Table 10. Levels of evidence. Adapted from Pashler, Bain, Bottge, Graesser et al., 2007.

### 3.3.2. *Rationale for recommendations and suggestions for implementation*

Below, we develop each of the recommendations presented in the previous section, first briefly justifying the main scientific evidence that supports them and providing suggestions on how to transfer them to the classroom at various educational levels (including university level).

#### 1. Distribute learning over time

To help students remember key concepts and knowledge, it is recommended that instructors organise courses so that students study the materials at least twice, separated by a period of several weeks or months. Research has shown that delayed re-exposure to study material significantly increases what students are able to recall about course content. This delayed exposure to content can be promoted through homework assignments, in-class reviews, quizzes, or other types of instructional exercises.

Hundreds of laboratory experiments have been conducted (i.e., Rea and Modigliani, 1985; Bloom and Shuell, 1981; Rohrer and Taylor, 2006; Carpenter, Pashler, Cepeda et al., 2007) in which learners have been presented with learning materials during two separate occasions. After a delay, learners have been

assessed on measures of recall. While some inconsistencies have been found in these studies, the most common finding is that when the time between study sessions is very short, relative to the time of the final assessment, learners are not very successful on this final assessment.

Students remember much more information when they have studied the information on at least two occasions, instead of one, and when the interval between these two occasions is not less than 5% of the interval during which the information is to be retained. In studies that have tested the principle of delayed review, researchers have kept the amount of time spent studying information constant; thus, the observed improvement in learning is not a consequence of students having more time to learn. Delayed review thus increases learning efficiency.

It is recommended that teachers review essential study material a few weeks or months after its initial presentation. The benefit of delayed review seems much greater than the same amount of time spent reviewing materials immediately after their first presentation.

Specific recommendations:

a. Identify key concepts and competencies to be taught and learned by students.
b. Ensure that students study the content to be learned on at least two occasions, separated by a period of at least a few weeks, and preferably several months.
c. Organise homework assignments, quizzes, and exams in a way that encourages delayed review of relevant course content.

**2. Alternately, present already solved tasks with tasks to be solved by the students**

Especially in teaching mathematics or scientific problem solving, it is recommended that teachers alternate the presentation of already solved problems or tasks with tasks to be solved independently by the students. Research has clearly shown that alternating these two types of tasks enhances learning.

Numerous laboratory experiments have provided evidence for this principle (i.e., Kalyuga, Chandler & Sweller, 2001; Renkl, 1997, 2002; Renkl, Atkinson & Grosse, 2004; Schworm & Renkl, 2002; Schwonke, Wittmer, Aleven et al., 2007). Some classroom experiments provide additional evidence that this recommendation can be implemented in both high school and college classrooms (i.e., McLaren, Lim, Gagnon, et al., 2006; Zhu and Simon, 1987). These experiments have tested this technique in a variety of content areas, but particularly in mathematics, science, and technology learning.

The amount of guidance and explanations that should be included in solved tasks or problems varies depending on the content to be learned and the learners. Some studies found that solved examples not containing instructional explanations of the steps to be followed were most effective (Hausmann and VanLehn, 2007; Schworm and Renkl, 2002). As students increase their proficiency level, it is recommended that the use of solved examples is reduced and the number of tasks for independent resolution is increased (Kalyuga, Chandler & Sweller, 2001; Kalyuga, Chandler, Touvinen, et al., 2001).

In classroom situations, one can begin by discussing in large or small groups an already resolved task provided by the teacher and continue by solving a similar task independently. Some classmates can then explain to others the steps taken to solve the new task, the teacher can comment on and supervise the exercise, and then students can undertake to resolve a new exercise independently, which in turn will be commented on and supervised by a different group of students. The teacher can intersperse new already-solved exercises with exercises to be independently resolved by students.

Specific recommendations:

a. Have students alternate between working on already-resolved tasks (discussion from solved tasks) and solving tasks on their own.
b. As students gain proficiency, reduce the number of solved tasks provided to students and increase the number of tasks that students solve independently.

**3. Combine descriptions of a graphic and verbal nature**

To facilitate learning, it is recommended that teachers combine presentations of a graphic nature (such as graphs and figures) that illustrate key processes and concepts with verbal descriptions of those same processes and concepts.

Many studies have shown that adding relevant graphical representations to textual descriptions can lead to better learning than textual presentation alone (see Mayer, 2001 and Sweller, 1999, for reviews). Most of these studies have focused on learning about scientific processes (i.e., volcanic eruptions). These studies emphasize that to further facilitate learning it is important that textual descriptions appear close to the relevant graphical elements (i.e., Moreno and Mayer, 1999a). In addition, students learn better if the verbal description is presented aurally rather than in written text (i.e., Clark and Mayer, 2003), probably because students find it very difficult to read text and interpret a graph simultaneously.

When teaching content and processes that can be well represented through images, graphs, figures, video clips, or other graphic formats, teachers should try to combine verbal descriptions with graphic representations.

When visual representations are used in study materials, they should include a brief textual explanation that labels unfamiliar elements of the representation and briefly explains the content and processes being represented. These explanations should be placed as close as possible to the graphic representations to help students visualise the most relevant parts of the representation. When graphical representations are used during classes, it is recommended to explain orally which elements of the graphic the students should focus on.

Teachers must carefully select which representations are most appropriate to illustrate specific concepts or processes. In some instances, an inappropriate representation may be distracting rather than conducive to learning. Representations should be relevant to the processes or concepts being taught.

Visual representations do not necessarily have to be completely realistic to be useful. In many instances, a more schematic or abstract representation will better illustrate an idea, while a more realistic representation may distract the learner from the essential elements to be learned. Animations can be of great value, but a well-chosen sequence of static images is often just as useful in promoting learning.

Finally, graphical representations can help students understand abstract ideas. For example, using multiple representations (i.e., symbols, graphs, pictures, or real objects) of the same abstract concept enables students to understand that the same concept can be represented in different ways. Real situations can be represented through stories, scenarios that reflect real problems, video clips, or movies. When teachers employ multiple visual representations of the same concept, they should focus student attention on the components of the representations that are relevant to understanding the abstract concept. In this way, students will understand that the same idea can be expressed in a variety of forms.

Specific recommendations:

a. Employ graphic representations (such as graphs and figures) that illustrate key processes and procedures. This integration leads to better learning than presenting text alone.
b. When possible, present verbal descriptions as audio recordings rather than written words. In this way, students can use the brain's visual and auditory processing capabilities separately, rather than potentially overloading the visual processing capability by processing visualisation and written text together.

**4. Connect and integrate abstract and concrete representations of concepts**

It is recommended that teachers connect and integrate abstract and concrete representations of the same concept. Connecting different forms of representations helps students better learn the concepts taught and increases the likelihood that they will employ them across different contexts in the future.

A significant number of laboratory studies and a growing number of quasi-experimental studies conducted in classrooms have found that teaching students about principles or concepts using only abstract representations or concrete representations leads to inferior and more inflexible learning than teaching students to recognise those same principles and concepts across a varied repertoire of situations. Experimental research conducted with college and high school students has found that while students initially find it easier to learn concepts and processes presented in a concrete way, these same students later have difficulty using that knowledge in a different context (i.e., Kaminski, Sloutsky & Heckler, 2006a). When students begin to learn a concept through a more abstract representation, they initially find it more difficult to learn the concept, but later have more success in applying those concepts in different situations.

An emerging line of research is examining the best approaches for teachers to incorporate abstract and concrete representations during instruction. A technique called *concreteness fading* has been proposed (i.e., Goldstone & Son, 2005). This technique incorporates the benefits of the initial presentation of concrete representations and the undoubted long-term benefits of employing abstract representations. Concreteness fading consists of beginning instruction through concrete representations, and progressively replacing these representations with abstract ones.

A second line of research stresses the desirability for learning of explicitly marking the relationships between different types of representations (for example, Ainsworth, Bibby & Wood, 2002). When teachers explicitly identify the essential components of a representation and direct student attention to these components, their performance improves (Richland, Zur & Holyoak, 2007). Finally, there is evidence that lower-performing students improve their learning when they are asked to solve authentic problems and cases that require the use of underlying concepts and principles (Bottge, Rueda, LaRoque, et al., 2007).

In general, these results support the recommendation that teachers use both abstract and concrete representations during instruction and point out the essential components of the processes and concepts to be learned. This has been found to enhance learning, as well as transfer to other tasks that require students to use the same principle or concept.

When teaching students an abstract principle or skill, teachers should connect those abstract ideas to equivalent concrete representations and situations, ensuring that the relevant features of the principles or skills being taught are pointed out. Employing a variety of representations and discussing the explicit relationships between them can prevent students from developing

misconceptions. In addition, it is advisable to ask students to apply the knowledge taught to a variety of situations and examples that vary in their degree of concreteness or level of abstraction. This approach ensures that students acquire a flexible understanding of the key concepts learned.

A related and relevant technique is to connect or embed new ideas in stories or scenarios that are familiar to students. Students will be more motivated to learn, while having a strong base on which to build new ideas and refer to when they need the knowledge. By successively employing a variety of increasingly abstract representations, learners can develop concepts that go beyond superficial features to the deep features that are the essence of the content.

Specific recommendations:

a. Connect and integrate abstract and concrete representations of concepts, ensuring that the most relevant features are highlighted regardless of the type of representation.
b. Begin instruction through concrete representations, and progressively replace these representations with abstract ones (fading of concreteness).
c. Solve problems and authentic cases.

**5. Use tests and questionnaires to promote learning**

Conducting quizzes with questions or tests contributes to learning in the classroom and reduces the rate at which information is forgotten. There are two ways in which this recommendation can be employed: a) using pre-quizzes to activate prior knowledge and focus students on the content to be learned; b) using questions and quizzes to again show students the essential content of the course.

*a) Use of pre-questionnaires to activate prior knowledge and introduce new topics*.

It is recommended that teachers use pre-questionnaires as a way of introducing new topics. Pre-quizzes help students identify material they do not yet know and therefore need to study. In addition, answering pre-questions automatically activates any relevant prior knowledge. These processes contribute to better learning of the content.

Experimental studies on reading (i.e., Wisher and Graesser, 2007) have established that when students are given pre-questions to answer before reading both expository and narrative text, they learn more from the texts than when they do not answer these pre-questions. Some of these studies have employed real classroom materials. However, there is little published experimental evidence regarding whether pre-questionnaires would also enhance learning from material presented orally in the classroom.

Teachers should use pre-questionnaires when introducing new topics. Pre-questionnaires should cover some of the most important concepts that will be covered in the new materials. Teachers should avoid using pre-questionnaires that highlight circumstantial or incidental information, since the purpose of pre-questionnaires is to direct student attention to key facts and concepts.

*b) Employ assessment tests to re-expose students to key content*

It is recommended that instructors employ quizzes without available materials or tests as a method of re-exposing students to key course content. As noted in Recommendation 1, a delayed re-exposure to course materials helps students remember the information longer. In addition, quizzes or tests that require students to actively recall specific information (such as open-ended questions, rather than multiple choice questions) encourage learning and help students remember information longer. Using quizzes or tests with the goal of facilitating learning requires that feedback be provided on the correct answer.

Laboratory studies have repeatedly shown that taking a test on already-studied material aids the recall of that information on a final test, a phenomenon called the testing effect. Experimental memory research has shown that the test effect is very robust (i.e., Butler and Roediger, 2007; McDaniel, Roediger, and McDermott, 2007).

Research has shown that having students take a test is almost always more effective than having students spend additional time studying the material (Roediger and Karpicke, 2006b). This is especially the case when the test requires active recall of information (such as open-ended questions). The act of retrieving information from memory helps to consolidate learned information and thus reduces forgetting. By answering open-ended questions, students are practicing the retrieval of concrete information from memory. In addition, several recent studies have shown that taking tests not only facilitates learning, but also reduces the rate at which information is forgotten (i.e., Roediger and Karpicke, 2006b; Carpenter, Pashler, Wixted, et al., 2008).

In conclusion, teachers should administer questionnaires and tests without the available study materials between the first exposure to the content and the final assessment. These can be both formal and informal interim assessments. Requiring students to recall information from memory provides them with opportunities to practice recalling and retrieving information, and this practice helps to consolidate this knowledge in the students' memory. The basic recommendation is to take every opportunity to prompt students to recall the information learned, and provide corrective feedback if a significant number of errors occur. In the absence of corrective feedback, any errors that appear on a test will remain, and will reappear on successive retrievals of the information (i.e. Butterfield and Metcalfe, 2001).

Specific recommendations:

a. Prepare pre-questions and have students answer them before introducing a new topic.
b. Use quizzes to practice retrieval and spaced exposure to concepts, thus reducing forgetfulness.
c. Use play questionnaires to provide additional exposure to the materials.

**6. Help students to allocate study time effectively**

To encourage more efficient and effective study habits, it is recommended that teachers help students assess more accurately what they know and do not know – and use this information to organise study time more efficiently. Teachers can help students in two ways: by teaching students to use delayed learning judgments to identify concepts that require additional study (6a); and by using tests and quizzes to identify content that needs to be learned (6b).

*a) Teach students to employ delayed learning judgments to identify content to be studied*

Research has been conducted on the ability to judge how well new knowledge or skills have been learned, known as metacognition (Metcalfe and Dunlosky, 2008). This research has shown that in the absence of training most learners are unable to adequately judge what they know and what they do not know, and typically overestimate what they have learned when they finish studying the content (the *illusion of knowing* effect). Fortunately, a growing body of research has identified some ways to improve the ability of learners to judge what they know and what they do not know after a study session. This information can then effectively orient their learning towards the content they have not yet mastered.

One technique for breaking the well-known illusion of learning is the use of delayed learning judgments. Studies with students of different ages have found that when students are asked to make judgments after a period of delay since the material was studied, and without the correct answers available, they are fairly accurate in their ability to judge whether they know the answer (Metcalfe and Finn, 2008). This involves having students try to recall what they have learned or read after a delay and then generate key words or phrases that synthesise the main points of the learned material. Performing this task has been shown to improve students' learning judgments (Dunlosky, Rawson & Middleton, 2005).

*b) Use tests to identify the content to be learned*

It is recommended that teachers use tests and quizzes after the presentation of new material to identify content that requires additional study. It is recommended that tests and quizzes be used in conjunction with feedback that

identifies incorrect answers and provides the correct answers as a tool for students to identify material that they have not yet mastered.

In laboratory studies, researchers have found that learners tend to devote their study time to items they believe they have not learned well and abandon learning content that they have already mastered. When their learning judgments are inaccurate, trainees cannot make sensible decisions about how to organise their study time. Quizzes and tests can help learners identify content that has not been mastered, and thus facilitate the effective organisation of study time. Quizzes have improved foreign vocabulary learning better than extra study time (Karpicke, 2007).

Teachers provide students with questionnaires without the materials to give students an opportunity to check their level of learning. These questionnaires may be oral or written; moreover, they may be formal or informal assessments. Secondly, teachers can conduct occasional reviews in which they begin a class with a short quiz on the content studied in the previous session (like the recommendation related to pre-questionnaires). Immediately after the quiz or review, the teacher will reveal the correct answer and explicitly tell the students that if they did not know the answer, they should review the material (specific pages or content to be reviewed). In summary, the basic principle of using quizzes is to help students better identify the material and concepts they need to study further.

Specific recommendations:

a. Conduct regular study sessions where students are taught to judge if they have learned key concepts.
b. Teach students that the best time to test whether they have learned something is not immediately, but after a delay. Only then will they be able to determine whether key concepts have been well learned or require additional study.
c. Use quizzes to alert students to what is not yet mastered.
d. When students are not able to generate correct answers to tasks or questions, provide corrective feedback, or show them where they can find the answer to these questions.

**7. Ask in-depth questions**

When students have acquired a basic set of knowledge about a given topic and are ready to build a more complex level of understanding, it is recommended that teachers find opportunities to pose questions and shape answers around key concepts. By ‘deep explanations’, we mean explanations that allude to causal mechanisms, planning, well-reasoned arguments, and logic. Examples of deep explanations are those that ask about the causes and consequences of historical events, the motivations of the people involved in historical events, scientific evidence for theories, and logical justifications for the steps of a mathematical demonstration. Examples of the types of questions that promote deep

explanations are: why, why not, what if, how does x compare to y, what is the evidence for x? These questions and their corresponding explanations take place during classroom instruction, class discussions or debates, and during independent study.

Many experiments have been conducted in which students are randomly assigned to conditions that promote deep explanations, or to equivalent conditions that expose students to the same material, but without the process of constructing explanations. The consistent finding is that comprehension and learning improve in interventions that specifically train students to ask deep questions while they are reading text, listening to a lecture, or studying materials (Rosenshine, Meister & Chapman, 1996). Research has involved group discussions, classroom exercises where explanations of question types are provided and examples are provided, and computer-based pedagogical agents that shape the process of asking and answering questions. These manipulations have been found to increase the frequency of student questions, the depth of questions, and the comprehension of study materials (Wisher and Graesser, 2007).

Thus, teachers should identify those in-depth questions that they can employ to prompt students to reason about the explanatory principles underlying the content of the course materials. The usefulness of these questions in instruction is greatest when students have acquired the basic knowledge of the course. It should be noted that students will need more time to answer these types of questions, as opposed to others of a more superficial nature. Additionally, teachers will often have to model the process of attempting to answer these types of questions.

Research has found several ways to use deep questioning effectively. Firstly, by periodically encouraging students to think aloud, verbalising explanations that come to mind. After presenting their own explanations, it is beneficial for them to receive appropriate feedback by observing good explanations from peers, tutors, teachers, or computerised environments (Chi, deLew, Chiu et al., 1994; McNamara, 2004; Pressley and Afflerbach, 1995; Trabasso and Magliano, 1996) as well as being encouraged to employ these techniques when studying material independently.

Secondly, the teacher can pose questions in class that elicit explanations, considering the following formulations: why, what caused x, how did x occur, what if, what if not, how does x compare with y, what is the evidence for x, why is x important? Thirdly, the teacher may also pose questions that challenge students' prior conceptions or beliefs, thus promoting more intense and deeper reasoning in students (Graesser and Olde, 2003; Otero and Graesser, 2001).

Specific recommendations:

a. Encourage students to think aloud or write their explanations as they study. Getting feedback in this process is beneficial.

b. Raise deep questions while teaching topics, and provide opportunities for students to answer questions such as: what caused Y, how did X happen, what if, how does X compare to Y, and how does X compare to Y?
c. Challenge students in a way that stimulates their thought processes, seeks explanations, and supports the process of asking and answering deep questions.

## 3.4. Conclusions

In this section we have set out the fundamentals of teaching and learning that we consider essential knowledge for future teachers, namely, teaching and learning as transmission and construction of mental representations to achieve meaningful learning and the use of a set of *evidence-based* practical recommendations that help in the meaningful acquisition of knowledge and its transfer by students.

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**CONTENTS FOR EDUCATIONAL PSYCHOLOGY PROGRAMME**

**(TEACHER TRAINING)**

We intend to detail the various contents that will be addressed throughout the course organised in thematic blocks composed of units or topics. We want to link this chapter directly to the breakdown of contents and relevant evidence presented above, which constitutes the theoretical and empirical basis for organising the teaching of the course (Educational Psychology, for teachers). In a first subsection, we will explain the contents for each of the blocks and units that compose them, including the basic documentary sources that support them (*see the contents presented extensively in Chapter 2*). The theoretical unit is constituted by a short explanation of the contents presented, as well as a brief outline of the contents that will be worked on in each topic. Finally, this information is complemented with the bibliographic resources supporting each unit.

## 6.1. Contents and documentary sources

We present each of the thematic blocks that make up the subject, break down the contents to be addressed in each of the corresponding units, and identify which basic references or documentary sources support both the study (basic bibliography) and the preparation and deeper study (complementary bibliography) of each of the blocks and topics.

### *6.1.1. Thematic Block I: Introduction to educational psychology*

This block introduces the student to the basic concepts of educational psychology and is indispensable for understanding the contents developed in the rest of the thematic blocks. Special reference is made to the relationships established between educational psychology and educational practices.

**Topic 1: *Current conceptions of educational psychology***

The relationship between psychological knowledge and educational theory and practice. Educational psychology and school educational practices.

1.1. Historical background
1.2. Object of study
1.3. Debates and proposals for the future
1.4. Evidence-based teaching practice

1.5. Educational psychology and training of future teachers

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*6.1.2 Thematic Block II: Main approaches to learning and its educational implications*

The module presents and analyses the main educational and instructional implications of the most relevant theoretical explanations on the learning of responses, skills, and complex learning in school learning. Priority is given to those implications and prescriptions with evident instructional consequences, and the classical protagonism given to theories and models is reduced.

**Topic 2: *Principles to explain response and skill learning***

Law of effect and reinforcement theory: educational implications. Relationship of the law of effect to classroom control and classroom activities. Role of feedback in learning responses and skills. Deliberate practice and learning of complex skills.

2.1. Law of effect and reinforcement theory: educational implications
2.2. Influence of classroom control techniques on classroom behaviour
2.3. Influence of awards on classroom activities
2.4. The role of feedback in learning responses and skills
2.5. Deliberate practice and learning of complex skills

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## Topic 3: *Psychological processes involved in complex learning*

Learning and teaching: building and transmitting mental representations. Learning declarative and procedural contents. Theory of conceptual change. Orientation of cognitive processes during learning. Self-regulation of learning.

3.1. Learning and teaching: building and transmitting mental representations. Learning as coordination
3.2 Learning of declarative and procedural contents
3.3. Theory of conceptual change
3.4. Orientation of cognitive processes during learning
3.5. Self-regulation of learning

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*6.1.3. Thematic Block III: Intrapersonal dimensions in the teaching and learning process*

The contents of the module focus on the analysis of the individual characteristics of students – cognitive abilities and processes, personality, and motivation – and their relationship with school learning.

**Theme 4: *Individual differences in cognitive domains***

Differential-psychometric perspective and human information processing perspective, with an emphasis on the processes of memory, metacognition, and problem solving. Individual differences in learners: study of experts and novices.

4.1. Differential-psychometric perspective: measurement of intelligence
4.2. Perspective of human information processing
4.3. Memory and metacognition
4.4. Troubleshooting processes
4.5. Individual differences in trainees: experts and novices

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## Topic 5: *Individual differences in personality and motivation*

Motivation, teaching, and learning. Learner goals and motivational styles. Motivation based on interest and self-efficacy. Motivation based on attributions. Strategies to promote motivation.

5.1. Motivation, teaching and learning
5.2. Trainee goals and motivational styles
5.3. Motivation based on interest and self-efficacy
5.4. Motivation based on attributions
5.5. Motivational teaching

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### *6.1.4. Thematic Block IV: interpersonal dimensions in the teaching and learning process*

The contents present an overview of the interpersonal factors involved in the educational situation and their impact on school learning.

**Topic 6: *Teacher-student interaction in the teaching and learning process***

Effective teaching practices and organisation of instruction to promote learning. Teacher-student interactions: role of feedback. Study influences teacher's expectations. Classroom management and organisation.

6.1. Effective teaching practices
6.2. Organisation of instruction to promote learning
6.3. Teacher-student interactions: teacher feedback
6.4. Teacher's expectations: the Pygmalion study
6.5. Classroom management and organisation

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## Topic 7: *Interaction between students and school learning*

The educational value of interaction among students. School climate, variables involved and their evaluation. Interaction among students and knowledge construction. Collaborative learning methods.

7.1. Educational value of interaction among students
7.2. School climate: variables and evaluation
7.3. Interaction among students: *cooperation vs. competition*
7.4. Collaborative learning methods: *cooperative learning and reciprocal teaching*

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### *6.1.5. Thematic Block V:* Thematic Unit V. Evaluation of the teaching and learning process

It provides models and tools for teachers to analyse how the I/O process has worked and propose improvements for future instructional processes.

**Theme 8*: Formative or instructional evaluation of teachers***

8.1. Evaluation: the formative-summative continuum
8.2. Formative assessment and classroom instruction
8.3. Formative feedback and evaluation
8.4. Formative classroom assessment and technology

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### ***6.2.*** Conclusions and future challenges for educational psychology

One of the main purposes of this document has been to defend the value of educational psychology in the training of prospective teachers. Most educational psychologists probably believe that an important role of educational psychology is to contribute to the training of prospective teachers. Moreover, educational psychologists have considerable expertise in learning, development, motivation, classroom management, and assessment – content that is integral to effective teaching and vital for prospective teachers to learn. But does *our involvement in teacher education make a difference to how graduating teachers teach? Are teachers more effective after taking our courses?* Presumably we think so, but how do we know? And how do we convince others who may be sceptical about the role of educational psychology in teacher education?

In the early 1990s, the Division of Educational Psychology (Division 15) of the American Psychological Association (APA), under the leadership of David Berliner, created a committee charged with examining the role of educational psychology in teacher education. In recent years educational psychologists have generally heeded the call to make their content more relevant and meaningful to pre-service teachers and emphasize connections between theory and classroom application.

*Challenges currently facing educational psychologists within teacher education*

In reviewing the recommendations of the Division 15 committee (Anderson et al., 1995), we contend that only a few have been addressed, most notably changing the way educational psychologists teach content to trainee teachers. Other important recommendations that have not been sufficiently addressed include: *(a) communicating the relevance of educational psychology research to the broader educational community; (b) developing collaborative relationships with colleagues in teacher education programmes that support a common discourse and a shared vision of effective teacher preparation; and (c) documenting the ways in which educational psychology courses make a difference in the practice of* graduating *teachers* and in the educational experiences of their K-12 students.

Patrick et al. (2011) highlight three issues that pose immediate challenges for educational psychologists and require their urgent attention. We present these issues briefly below.

*Challenge 1: Highlight the relevance of educational psychology research for educators*

One reason for the continued marginalisation of educational psychologists in many teacher education programmes may be that they do not take seriously enough the importance of practice in their own research. This concern is not new. For example, Berliner (1992) argued that educational psychologists must understand educational contexts and situate their work clearly within them, rather

than viewing schools or classrooms only as places where psychological principles are developed (see also Salomon, 1995). However, despite recurrent calls for explicit links to practice, it still appears that most empirical research in educational psychology is written primarily for an academic audience, and predominantly for other educational psychologists (Chase, 1998). In addition, it appears that many researchers do not take issues of ecological validity seriously.

*Challenge 2: Develop collaborative relationships and shared visions with teacher education faculties*

In addition to communicating and emphasizing the importance of educational psychology research to educational practice, educational psychologists must be proactive in establishing relationships with colleagues in other areas of teacher education programmes. The Division 15 committee addressed the issue of relationships between educational psychology faculty and the rest of the teacher education programme. Their recommendations encouraged faculty collaboration across traditional divisions within teacher education and noted that 'this requires faculty with different expertise in teacher education to develop a common discourse for thinking about teaching' (Anderson et al., 1995, p. 153).

*Challenge 3: Produce evidence of the benefits of the involvement of educational psychologists in teacher education*

The third challenge facing educational psychologists is to clearly establish that their courses make a difference to teachers' knowledge, self-efficacy, and practice, i.e., to demonstrate that teachers benefit from learning educational psychology from educational psychologists. This is an assumption that we believe is probably held by most educational psychologists, but at present remains an unanswered empirical question. This research needs to be conducted.
What is needed are studies 'that examine the links between teacher preparation contexts for learning, what teacher candidates actually learn, how their learning is put into practice in schools, and how this influences student learning' (Cochran-Smith & Zeichner, 2005, p. 2).

In short, educational psychologists should be able to convincingly demonstrate that their courses make a difference: that graduates will be better teachers if they have taken educational psychology courses than if they have not. Furthermore, there must be evidence that trainee teachers learn and understand educational psychology content better when educational psychologists teach these courses, rather than the content being lumped together or integrated into other subjects.

An example of researchers who have used more proximal indicators of teaching quality comes from a study of first-year teaching practices by Good, McCaslin et al. (2006). As part of examining teaching quality in relation to the type of teacher education programme attended, these researchers conducted classroom observations of the beginning of classes.

In conclusion, educational psychology as a field has an important contribution to make to the preparation of future teachers and a responsibility to continue to push for greater participation in teacher education programmes. However, arguing for such continued participation may depend on the field's ability to provide empirical evidence of its relevance and effectiveness (Patrick et al., 2011).

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