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Neo-Piagetian Theory and Research: enhancing pedagogical practice for educators of adults

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ABSTRACT   Educators are continuously challenged to increase their pedagogical effectiveness when teaching adult learners. Neo-Piagetian theory and research, based on Piaget's classic work, provides promising concepts and tools to help educators enhance their pedagogical knowledge and competence when teaching adults. Consequently, through research findings and examples we explore the pedagogical utility of neo-Piagetian theory. Specifically, we examine: (1) the influence of cognitive development into adulthood on teaching, (2) the roles of functional and optimal levels of learner cognition, and (3) the pedagogical implications of employing neo-Piagetian concepts and research to support the teaching and learning endeavours of adult learners.

Introduction

Education as a profession has become increasingly challenging. For example, educators of adults are no longer primarily disseminators of knowledge to their students. Rather, teachers must also support and structure their students' learning in ways that enhance student achievement, build effective problem-solving skills and teach higher order learning. Further, educators are typically held accountable for achieving nationally or community specified standards of student learning and achievement. Such standards, and those that specify amplified professional knowledge (e.g., National Board for Professional Teaching Standards in the USA), are driving efforts to increase the effectiveness of classroom teachers. These growing expectations for ever greater pedagogical knowledge and skills can be daunting not only to practising teachers but also to those who may consider entering the teaching profession.

Fortunately, over the past few decades much research has contributed to our pedagogical knowledge, spanning a myriad of topics—the development of cognition in learners, information processing approaches, social cognitive approaches to motivation, effective teaching and learning, and teacher beliefs and expectations, to name but a few. Though we now have a helpful research-based knowledge base, the sheer enormity of the task of mastering new knowledge can be intimidating and even off-putting for the busy, resource-limited practitioner. Consequently, a critical question is, 'How might an educator develop

more effective pedagogical skills and knowledge to meet the increasing demands of successfully teaching adult students at all levels?' In this paper, we will present a research-based approach that we have found to have widespread utility to address this important and complex challenge.

A Starting Point: Piaget

One point of entry for busy educators to enhance their pedagogical skills is through a well-researched approach already familiar to many teachers. For example, the work of the noted developmental psychologist, Jean Piaget (see Ginsberg & Opper, 1969), is typically incorporated within the curriculum for pre-service and practicing teachers alike, and consequently well known to practitioners. Because a student's learning and development are couched in and influenced by his or her level of cognition at the time of teaching, a teacher's effective knowledge of the nature and characteristics of student thinking and cognitive processes is vital to effective educational practice. Piaget's work provided a useful framework for understanding how children and adolescents grow and change in how they think about their world and solve problems. Accordingly, Piaget's work has been applied extensively for nearly 25 years after his death to a wide spectrum of areas of educational endeavours including educational psychology, science education, and early childhood education (Flavell, 1996).

More recent empirical research has demonstrated that Piaget's ideas can be enhanced by modification and extension. As his work became widely known during the 1960s (see Flavell, 1963; Ginsburg & Opper, 1969), many researchers designed empirical studies to test Piagetian concepts. While the empirical data were frequently supportive, particular findings challenged aspects of Piaget's theory. Some researchers, when presented with data that challenged Piagetian ideas, rejected his theory. Others elected to modify and expand Piaget's approach to accommodate these new empirical findings. These latter researchers are generally referred to as 'neo-Piagetians.' It is their work that is the basis for our examination of the relevance and utility of neo-Piagetian theory to enhance the pedagogical knowledge and skills of educational practitioners.

While substantive neo-Piagetian work has enhanced developmental theory for over two decades, implications of this work for educators have seldom been seriously considered. This neglect is not surprising as much of neo-Piagetian theory and research has been essentially inaccessible to the very individuals who could have the greatest benefit from it, educators. The reasons are several: neo-Piagetian research is scattered over a wide variety of journals and edited volumes, few studies and examples have focused directly on educational practices and processes, and neo-Piagetian writers appear to write primarily for one another rather than for a broader audience such as teacher educators and practitioners.

This inaccessibility is regrettable because neo-Piagetian theory has potentially powerful practical implications for competence enhancement for educators of adults. Our purpose here is to consider this potential. We will explore through research findings and examples the usefulness of neo-Piagetian theory for teaching adults more effectively. Specifically, we will examine: (1) the influence of cognitive development into adulthood on teaching, (2) the roles of functional and optimal levels of learner cognition, and (3) the pedagogical implications of employing neo-Piagetian concepts and research to more effectively support the teaching and learning endeavours of adult learners.

Neo-Piagetian Concepts and Research: an introduction

For more than 25 years, neo-Piagetians have worked to (1) *preserve* the essential aspects of classical Piagetian theory, (2) *develop* aspects which needed further exploration, and (3) *alter*

aspects of Piaget's theory to be consistent with recent empirical research (see Case, 1992a; Fischer & Rose, 2001). While neo-Piagetians disagree with one other in a number of respects, in part because each has a somewhat different perspective, they do share certain conclusions, which we will detail and explore.

Principles Preserved by Neo-Piagetians

Neo-Piagetians agree that at least five principles from classic Piagetian theory should be preserved (Case, 1992a). First, consistent with Piaget, neo-Piagetians are cognitive structuralists who focus on the organisational properties of different structural parts of cognition, for example, Piaget's 'schemes' and 'stages'. Second, neo-Piagetians believe that cognitive structures are actively created by learners who construct and build knowledge rather than merely store verbatim information as if one were an audio or video recorder. Hence, a learner's development of cognitive structures is posited to involve the active construction and reconstruction of experiences. Third, neo-Piagetians explain that these cognitive structures become increasingly complex through the intricate interaction of maturation and experience in a cyclical knowledge-building process. They (see Case, 1992b; Demetriou *et al.*, 1993; Feldman, 1994; Fischer, 1980) classify this increasing degree of complexity in terms of qualitatively different cognitive levels or stages, though they may disagree on the number and characteristics of these levels. Fourth, neo-Piagetians assert that the increasingly abstract, more cognitively complex levels build on and transform the lower, less complex levels of knowledge and understanding (Case, 1992a; Fischer, 1980). This is partially analogous to successive versions of complex software, e.g., Windows builds on MS-DOS (Feldman, 1980). Finally, consistent with Piaget, neo-Piagetians contend that these transformations or levels in the quality of a learner's cognition often appear in universal sequences that are related to but not determined by age.

Principles Developed by Neo-Piagetians

Neo-Piagetian theory extends Piagetian theory in several ways (Case, 1992a, b). First, neo-Piagetian researchers have focused on the relationship between learning and development in more detail than Piaget. In classic Piagetian theory, development is considered a transformation, or 'accommodation', of an individual's existing cognitive structures, whereas learning is considered 'assimilation' of new content into existing structures. Recent research has demonstrated that such a simple distinction between learning and development is no longer viable, since learning involves changes in cognitive organization and structure, as does development (Kuhn, 1995). A major focus of many neo-Piagetians has been to specify the dynamics that underlie *both* learning and development and the conditions that support these processes.

Second, neo-Piagetians posit that people's cognitive structures tend to be local and domain-specific in nature rather than 'system-wide'. In Piaget's best-known work (Bidell & Fischer, 1992a), stages were assumed to be structures of the whole ('structures d'ensemble', or system-wide), whereas, in his later years (Piaget, 1985), Piaget suggested that processes operate on one subgroup of structures at a time (i.e., locally) rather than upon the whole. Most contemporary neo-Piagetians (Case, 1992b; Demetriou *et al.*, 1993; Feldman, 1994; Fischer, 1980; Pascual-Leone, 1987; Fischer *et al.*, 1990), using Piaget's later work as a foundation, have provided specifics about how these cognitive developmental processes take place as the individual encounters experiences and reflects upon and reacts to them. The local nature of dynamic structural change means that unevenness in development across different domains and contexts in any person is the

norm and to be expected, rather than the exception (Fischer & Farrar, 1987). Because structural change occurs 'locally', it becomes clear how a learner can be at quite different levels in different content domains, often as a function of varying levels of learner practice and instructional support. This cognitive developmental unevenness, originally called 'horizontal décalage' by Piaget, challenged his original assumptions, vexing him throughout most of his career. In contrast, neo-Piagetians have embraced unevenness as an essential characteristic of dynamic development and have made it the focus of much of their work.

Third, in addition to the concept of horizontal décalage (i.e., unevenness in development) Piaget also proposed the concept of 'vertical décalage'. According to Piaget, vertical décalage involves the notion that children repeat qualities of thinking at subsequent higher levels; i.e., what children learn during concrete operations, they must revisit and reorganize at a more complex level during adolescence in formal operations (Ginsberg & Opper, 1969). Vertical décalage refers to the gap (in years) between these reorganizations. Neo-Piagetians have elaborated and strengthened this concept, calling it 'cyclic recapitulation' (Case, 1992b), or 'cycling through levels' (Fischer, 1980). This reconceptualization has two components: (1) there is a progression in the development of thinking through the same number of small structural steps at each major stage or level, and (2) these small steps emerge in the same sequence within each major stage or level. This means, for example, an elementary age learner typically can concretely understand addition or subtraction concepts individually, before she is cognitively able to coordinate these ideas simultaneously to construct an understanding of how addition and subtraction relate to one another as reciprocal mathematical operations. Consequently, learners are able to think about and understand individual concepts (a more basic level) before they can effectively construct and understand relationships between concepts (a more complex level). Similarly, a young adolescent may initially understand the abstract concepts of mass and of weight individually, but struggle to understand how mass and weight relate concurrently in an integrated manner in physical objects. With development and experience, the adolescent will eventually be able to achieve the more cognitively complex abstract task (Fischer & Bidell, 1998). This 'individual-to-multiple-concepts' developmental progression is dynamic and ongoing and has been found in all four stages of cognitive development as described by Piaget (see Case, 1996a; Fischer, 1980).

Principles Altered by Neo-Piagetians

Neo-Piagetian theorists have extended Piagetian theory with at least three enhancing concepts: (1) the continuation of cognitive development into adulthood, often termed post-formal operational thinking, (2) the fundamental roles of contextual support and domain, and (3) the nature of individual differences in cognition. First, in classic Piagetian theory, the final stage of cognitive development, 'formal operations', emerges at about 11–12 years and continues to develop until at least 14–15 years of age (Inhelder & Piaget, 1958). Multiple neo-Piagetian investigators have studied adolescents and adults, finding additional levels of abstract thought emerging well beyond Piaget's 'final' formal operational level of early adolescence. These researchers (Case, 1992b; Commons *et al.*, 1989; Kitchener *et al.*, 1993; Labouvie-Vief, 1992) have documented several levels of increasingly complex abstract thought that characteristically emerge in young adulthood, usually by the thirtieth birthday. Further, adult thinking has been found to be increasingly flexible, dynamic, contextually based and efficient when compared to that of younger learners (Fischer *et al.*, 2002). This enhanced view of adult thinking is especially germane to those educators who work with adult students.

While the work of these neo-Piagetians varies in approach, two themes appear consistent when considering adult cognition. Firstly, whereas Piagetian formal operational thinking implies the ability to think systematically within a set of logical parameters, a more advanced level involves an individual's ability not only to think logically but also to reflect on this logical thinking. This type of thinking is sometimes described as 'metasystematic' thinking by post-formal-operational theorists (Commons *et al.*, 1989). Secondly, Piaget believed that a significant aspect in the development of thinking during childhood and early adolescence is learning to 'decenter', or separate one's thinking from one's self. Post-formal-operational theorists agree. However, they also argue that this separation from self is not the end-stage of complex, abstract thinking. For example, Labouvie-Vief (1992) asserted that at the most mature levels of thinking, adults recognize that complex problem solving requires not only the monitoring of the systematic logical thinking characteristic of formal operations but also the selection and interpretation of their own premises underlying this logical thinking. Thus, advanced adult thinkers are believed not only to understand and reflect on complex systems of abstract ideas, but also to consider their role as individuals in interpreting and interacting with these systems of abstract ideas.

A second Piagetian principle altered by neo-Piagetian researchers involves the importance of contextual factors in cognitive functioning. Historically, 'Piaget's position on the role of the environment is subtle, and consequently, often misinterpreted' (Ginsburg & Opper, 1969, p. 69). Piaget asserted that an individual does not merely react to environmental events but actively interprets them. Piaget viewed this interpretation as a core component of his notion of constructivism. However, though the role of environment is central to Piaget, his best-known work assumed that individuals in a wide range of environments progressed through the same sequence of stages (Case, 1996a). Thus, Piaget assumed spontaneous universal cognitive development regardless of the specific environmental circumstances and that the specific characteristics of a given environment were almost irrelevant.

Later in life Piaget modified this position (Piaget, 1972) and, following his lead, neo-Piagetians quickly adopted the position that learning and development is less coherent across domains and more dependent on context (Labouvie-Vief, 1992) than previously believed. While different theorists have taken different positions on the role of context, many attribute much of their conceptualisation to the expansive influence of Vygotsky's (1978) ideas, especially his concept of the zone of proximal development, as well as the enhancement of scaffolding as described by Wood, Bruner and Ross (1976). Most neo-Piagetians embrace scaffolding as a co-constructive process in which a more knowledgeable person provides hints, reminders, and cognitive supports at a level just above a learner's current cognitive level for a task. Hence, when learners build new knowledge together, they are often able to interactively support each other's understanding, effectively providing a 'scaffold' to bridge what the learners could each do alone to a more complex level learners can achieve with a bit of co-constructive support (Fischer & Granott, 1995).

Moreover, neo-Piagetians typically consider co-constructive processes involving the collaborative efforts of two or more learners to be vital to complex, integrated learning and development, and as central to the development of new learning in adults as it is in children. Moreover, these learning processes are contextually sensitive in that new learning is most robust in the context in which it was constructed. Conversely, as learning context and processes vary from the original one, new learning becomes increasingly fragile and potentially difficult to access at all at times.

These assumptions of (1) variation in cognitive level as related to learning context and (2) the powerful effects of cognitive construction through collaboration with other learners can be comprehensively captured in the concepts of optimal and functional levels

of learner performance (Fischer & Pipp, 1984). Learners, and especially adult learners, vary dynamically in learning and performance as a function of contextual support (Fischer *et al.*, 2002). If learners are provided a great deal of contextual support (i.e., familiar materials, opportunities for practice, analysis and interaction with others along with skilful scaffolding) they are likely to show complex learning and high level performance in their learning endeavours, and function cognitively at or near their optimal levels. The 'optimal level' is the most complex level at which a learner can perform. However, in the absence of supportive teaching and learning conditions, learners typically perform only at their functional, 'everyday' level. For example, If adult learners are merely asked to individually memorize terms and produce them on cue during an examination, the adults are likely to produce responses at their functional levels; their performance is typically low in cognitive level and tied to the context in which the terms were memorized (often expressed by learners as 'what we need to know to pass the exam'). The definitions would be learned almost verbatim, without elaboration or conceptual complexity and depth.

In contrast, if adult learners work together with supportive materials, opportunities for practice, collaboration and effective scaffolding, their ensuing complexity of learning and flexibility of concept use will likely approach their optimal levels. That is, the participants' new learning will likely be conceptually more integrated, in-depth, and more effectively transferable to other contexts or environments. In short, an adult's new learning is likely to be retained and accessible to the learner for future use. Consequently, adult learners (as well as adolescents) will typically perform at different levels of competence from time to time in any particular domain or context. Nevertheless, with optimal teaching and learning conditions, students' optimal levels of cognition and new knowledge will be more consistently accessed and applied. Conversely, when contextual support through co-construction, practice and scaffolding are not accessible, learners show much more variation in their everyday cognitive functioning (Bidell & Fischer, 1992b).

These ideas have great utility for those educators among us who endeavour to increase and elaborate knowledge and competence in adult learners. Specifically, adult educators who clearly appreciate that their learners' optimal and functional levels of cognition will constantly vary as a function of task, collaboration, practice, conceptual support and related conditions possess valuable pedagogical tools to help guide their teaching activities. Equipped with these understandings, educators can plan for and support the cognitive efforts of their charges toward the goal of consistent high-level optimal learning.

Similarly, if we assume that the content and organization of cognitive structures vary among individuals, then we can conceptually predict the existence of individual differences in developmental pathways (or sequences of skill acquisition) towards specific competencies (e.g., reading or mathematics). These theoretical predictions have been empirically verified. For example, Knight and Fischer (1992) reported that, when children learn to read, less competent beginning readers, compared to their more competent peers, followed different (and seemingly less efficient) developmental pathways rather than merely following the more typical, effective pathway more slowly. Not surprisingly, this variation of possible pathways is even more expansive in adult learners who have a greater range of cognitive tools and strategies (from concrete to highly abstract) available to them, as well as greater flexibility to use their extensive and more elaborate learning repertoire. The culmination of these dynamic cognitive processes is an exquisite recursive convergence; we can apply neo-Piagetian concepts and ideas when teaching educators about these concepts and ideas, who then in turn can use them to teach their own students effectively and supportively.

Summary: neo-Piagetian theory and research for adult learners

Over the past 25 years neo-Piagetians have developed a body of theory and research that has preserved essential aspects of Piagetian theory, developed aspects of the theory which needed further exploration, and altered aspects to be consistent with empirical research. Because individual theorists incorporated different theoretical perspectives into their neo-Piagetian work (e.g., Case built upon information processing theories while Fischer has incorporated aspects of Vygotsky's theory), their models vary in their conceptualisations and empirical methods. There are, however, similarities across theorists, which we have summarized above.

The components of neo-Piagetian theory that most clearly distinguishes it from other approaches to intellectual development (e.g., social-cultural, learning, information process-ing) are the assertions that cognitive development consists of central cognitive structures that advance in complexity in an age-related manner, and which are affected by contextually influenced, domain-specific processes (Case, 1996b). These dynamic, age-related central and contextually influenced cognitive developmental processes raise important issues related to the teaching and learning of all learners throughout the lifespan. The lesson to educators is straightforward. When we expect differences in students' cognitive levels and processes as they construct new knowledge, we can recognize, plan for and support appropriate variations in student learning rather than be perplexed by them (Fischer & Rose, 2001).

Using Neo-Piagetian Theory and Research in Educational Practice: an illustration

Piaget's work has had enormous impact on education because of his emphasis on modes of acquisition of knowledge. The oft-cited educational implications of traditional Piagetian theory serve as a foundation for our understanding of the educational applications of neo-Piagetian theory. Like Piaget, neo-Piagetians have rarely focused directly on education; however, we believe that their work has important implications for educational practice. These questions were initially raised by our reading of the work of Fischer and colleagues, who have extended some of Fischer's (1980) theory directly to educational contexts (Bidell & Fischer, 1992b; Fischer & Immordino-Yang, 2002; Fischer & Rose, 2001; Knight & Fischer, 1992; Parziale & Fischer, 1998).

One generally accepted implication of Piagetian theory is that educators must be able to identify and understand the developmental levels of their students. If we accept the findings of neo-Piagetian theory and research, these findings apply directly to college instructors and others who teach adults, in that cognitive development continues beyond adolescence and formal operations (e.g., Blanchard-Fields, 1986; Commons et al., 1984; Fischer *et al.*, 1984; Fischer *et al.*, 2002; Kitchener & Fischer, 1990; Kitchener *et al.*, 1993; Labouvie-Vief, 1992). Fischer and colleagues (see Fischer *et al.*, 1984) assert that all cognitive developmental levels, including concrete, formal and post formal operations, emerge at characteristic ages that are maturationally constrained. Other neo-Piagetian researchers (e.g., Case, 1985; King & Kitchener, 1990; Rose, 1991) hold this same assumption and have investigated the progression and emergence of new cognitive 'muscles' in great detail and in multiple learning domains.

One study that seems to demonstrate the relevance of neo-Piagetian concepts to adult learning investigated the development of mathematical concepts and relations from late childhood through adulthood. Fischer and Kenny (1986) studied the development of mathematical knowledge in typical middle class American students aged 9 to 25 years in Denver, Colorado, USA. The purpose of the study was to document the development of learners' understanding of relations among everyday math operations—e.g., addition and

subtraction—a topic that clearly bears on mathematical educational processes and pedagogy. Math educators typically want to know if their students truly understand the concepts underlying basic computational processes, or if they are learning little more than rote procedures that yield numerical answers. Educators are faced with such practical challenges on a regular basis, but traditional Piagetian theory can offer little guidance or aid; whether or not a student has attained conservation of number affords little insight to educators grappling with student comprehension of specific mathematical concepts. Consequently, in this study Fischer and Kenny employed skill theory (a form of neo-Piagetian theory) to analyse the manner in which learners gradually come to understand fundamental mathematical concepts. Their research revealed a robust cognitive developmental sequence used by their study participants for understanding relations among four basic mathematical operations (addition, subtraction, multiplication and division).

In this study all students, from elementary through university, were first asked to successfully complete a set of basic computational problems in addition, subtraction, multiplication and division. The researchers reasoned that learners first had to show competence in computation of problems involving the math relations before they could be expected to describe how the operations related to one another. Each learner was then asked to define and explain each of the four operations and how they might be related to one another. The learners' responses to the questions were transcribed and examined for characteristics of content, complexity and consistency. A clear and reliable sequence emerged from this analysis.

Table 1 summarizes the progression of cognitive development levels, as well as characteristics of the responses the learners demonstrated at each level revealed. The first level of the Fischer and Kenny sequence begins with representational systems—a level equivalent to Piaget's concrete operations, in which learners are able to think about and logically manipulate a set of concrete concepts or variables. This initial level in the sequence is necessary to carry out the manual numerical calculations of addition, subtraction, multiplication and division and would be consistent with Piaget's concept of concrete operational thought. At this level, when asked to define addition, a typical participant response was 'when you add nine and seven'. Hence, the concept of addition is reduced to a concrete number-based example and nothing more. All the students were able to successfully demonstrate this initial level and to carry out the basic calculations.

The next level illustrated in Table 1 is called Single Abstractions and is analogous to initial emergence of Piaget's formal operations. At this level, abstract thinking may first become observable at ages 10–12 (consistent with Inhelder & Piaget, 1958). Further, the neo-Piagetian definition of single abstractions provides additional information regarding the nature and structure of emerging abstract thought. Single abstractions involve the coordination of concrete representational systems into a single, intangible concept or category. Consequently, the learner at the level of single abstractions is able to describe addition in this conceptual way (see Table 1) and provide a specific example.

The next level identified by Fischer and Kenny (1986), called Abstract Mappings, first emerges at about 14–16 years of age. As this level emerges, adolescents are gradually able to relate two intangible or abstract concepts in a simple way. The example of an Abstract Mapping response in Table 1 illustrates this level of thinking. The learner understands that addition and multiplication are similar operations, but use either single numbers or groups of numbers.

At around 20 years of age, a new level, Abstract Systems, begins to emerge. At this level, young adults gradually become able to relate abstract, intangible concepts in more integrated and complex ways. The example in Table 1 indicates that the learner capable of Abstract Systems understands that the operations of addition and division are related through how numbers are grouped and how they are combined. Ultimately, this study

Table 1 **Examples of mathematical skills for five cognitive developmental levels**

Level	Age of emergence	Examples of skills
Representational Systems (also called Concrete Operations)	6–7 years	Concrete explanations of specific calculations in arithmetic operations: ● Addition as a specific number problem. ● Subtraction as a specific number problem. ● Multiplication as a specific number problem (Division is usually taught after the first abstractions develop).
Single Abstractions (also called Formal Operations)	10–12 years	General definitions of mathematical operations and application to problem: 'Addition is when you put together two numbers, and you end up with a bigger number called the sum. Like you put together the numbers 5 and 7, and you get the bigger number 12.'
Abstract Mappings	14–16 years	General relations of two closely related mathematical operations and applications to problems: 'Addition and multiplication are similar operations. Both put numbers together to get a larger number, but the numbers are put together in different ways—by single numbers in addition and groups of numbers in multiplication. Multiplication is really addition repeated a specific number of times. In 5 times 7, the first number, 5, tells you how many times to do the second number, 7, so you have a group of nine sevens. In addition, you take the single number 7 and put it together with another 7, and another, and another, and another.'
Abstract Systems	18–20 years	General Relations of two distantly related operations: 'Addition and division are opposite operations in two ways. Addition increases by single numbers, while division decreases by groups of numbers. The fact that one increases and the other decreases is one way they are different, and the way they increase or decrease by single numbers or groups is the other way. Repeated addition can be used to express a division problem like $35 \div 5 = 7$. Five added seven times yields 35, so we know there are seven fives in 35.'
Principles	25 years?	Principle unifying the four mathematical operations: 'Addition, subtraction, multiplication and division are all operations, which means that they all transform numbers by either combining or separating them and doing so in either groups or one number at a time. There are relations between all possible pairs of operations. Some pairs are closely related, and others are more distantly related. . . (Elaboration explaining the pairs, as diagrammed in the table below, and applying them to concrete mathematical problems, such as $5 \div 7 = 12$, $12 - 7 = 5$, $5 \times 7 = 35$, and $35 \div 5 = 7$.)'

	Single Number	Group of Numbers
Increase	Addition	Multiplication
Decrease	Subtraction	Division

Note: Adapted from Bidell & Fischer (1992), Fischer & Kenny (1986) and Fischer & Knight (1990).

found a final abstract cognitive developmental level that initially emerged at age 25 years or later. This most advanced level, called Principles (Fischer & Yan, 2002), involves the integration of two or more abstract systems in terms of some theory or framework. In the example illustrating Principles in Table 1, the adult learner actually unified all four math operations into a multifaceted abstract system of related concepts.

This cognitive developmental progression describes a learner's growing understanding of mathematical concepts underlying math computations from late childhood through adolescence and into adulthood. In other empirical neo-Piagetian studies (e.g. Fischer et al., 1990, Kitchener & Fischer, 1990), similar progressions have been documented in many other domains and content areas. This growing body of research has demonstrated the value and efficacy of neo-Piagetian theory and concepts for educational application. This research may give us the foundation to develop an array of helpful tools for adult educators to construct effective pedagogical structures and experiences for their students.

Piaget's work is particularly helpful to educators at primary and secondary levels; neo-Piagetian concepts can usefully enhance them. However, the concepts offered by neo-Piagetian theory and research are especially valuable to adult educators who previously have had little theory and guidance regarding learners' increasingly complex levels of developing thought. For example, the three abstract levels that emerge beyond Piaget's formal operations (at age 11 or 12) were not described by Piaget at all. The idea that increasingly complex and sophisticated cognitive developmental levels emerge into adulthood is a welcome revelation and clearly has important pedagogical implications for advanced teaching and learning. Consequently, an understanding of neo-Piagetian concepts can provide powerful new tools for teaching and learning for educators and especially to educators of adults.

Even so, prudence is advised in working with new concepts and structures. For example, though the ages documented represent the earliest times these thinking qualities can generally appear, many students may not reach these levels until much later. The emergence of these new 'mental muscles' seems to be related to the amount of support and practise learners may have in employing emerging cognitive skills—and much practise is necessary for the emergence of any new level (Fischer et al., 1990). The charge to the educator of adults is to thoughtfully and consistently provide both challenging and supportive learning experiences to effectively foster optimal learning in his or her students. We have found concepts and structures from neo-Piagetian research to render this daunting charge more manageable.

Implications of Neo-Piagetian Theory for Teaching Practice

The implications of neo-Piagetian theory for the teaching and learning of adults are conceptually simple and straightforward; however, their application is both subtle and complex. For example, since adult students typically come to the learning task operating at varying cognitive levels, it follows that they will have different understandings and interpretations of all aspects of any course, including the role of instructor, the nature of knowledge, the purpose of lectures and discussions, the comprehension of class requirements, and the relationship between learning and evaluation.

An illustration may be useful here. For example, in our own courses in teacher education we use case studies with the goal of helping our adult learners to analyse authentic education problems from multiple perspectives, including competing theories (e.g., cognitive vs. behavioural approaches to learning), different domains of teaching (e.g., social-emotional classroom environment vs. thinking/problem solving classroom environ-

ment) and various roles (e.g., student, parent, teacher). In addition, learners typically operate cognitively at different levels even during the span of a class period. Given these circumstances, work by Kitchener *et al.* (1993) documents that at the first level of formal operations, Single Abstractions, learners are cognitively able to think of but *one* abstract issue at a time. Consequently, a student at this level could analyse a case study from either a behavioural *or* a cognitive perspective but will be unable to systematically compare and relate these approaches simultaneously.

In marked contrast, at the highest levels of post-formal operations, often called Principles (Fischer, 1980), an older, non-traditional student should be able to compare and contrast several perspectives simultaneously, and also to understand both the context in which these perspectives were developed and the nature of evidence used to support the theory and research underlying them. Since university classrooms typically serve adults of all ages, a wide variation in student cognitive levels and skills is inevitable.

Further, in any adult classroom, not only do younger and older students bring different functional and optimal levels of thinking skills in analysis of abstract ideas, but also their ability to access their optimal levels typically differs. That is, traditional aged students will routinely operate at their functional or every-day level and struggle to reach their optimal level, even with a great deal of support. Older students not only have a higher optimal level of function than traditional students, they more readily access their higher optimal level, due in part to longer practise of higher-level thinking and in part to 'metasystematic' thinking as described by Commons *et al.* (1989); in short, they better know how to access and manage their optimal levels. Consequently, in the college classroom, the cognitive gap is even wider than a simple comparison of optimal levels would suggest. Therefore, we add even more complex challenges to the educator of adults.

Fortunately, neo-Piagetian researchers have not only defined an important constellation of challenges for adult teaching and learning, but they have also provided the educator of adults with a toolbox of concepts, strategies and tactics to help educators be more effective practitioners than they would be without these tools. Neo-Piagetian theory allows us to begin to systematically understand how adult cognition develops as well as giving some guidance in how to effectively structure and support adults in their learning.

Conclusion

The challenges of teaching adult learners will in all likelihood continue to expand in depth and complexity. Neo-Piagetian theory and research offer a systematic, flexible and integrated understanding of adult cognition and learning. With useful new tools developed using these understandings, educators will continue to help adults to achieve even greater levels of knowledge and success in their learning endeavours.

We believe that neo-Piagetian theory and research can serve as a powerful system to help educators frame and support development of their own pedagogical practice and consequently to more effectively manage and master the challenges of teaching in these increasingly demanding times. We trust that we have demonstrated a valuable and effective approach to enhance the effectiveness of educators of adult learners, and hope that this paper stimulates a dialogue among educators about further practical educational applications of neo-Piagetian theory and research.

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