A lifespan developmental perspective on strategic processing

Strategic processing: from a conditioned state to a growth perspective

From the time humans first appeared on earth, we are facing a desire to understand our world and to learn what we need to know to survive (Weinstein et al., 2011). However, it is only from the 1970s onwards that the psychological study of strategies began in earnest. By then, educational research and practice was dominated by the behaviouristic theory on learning and instruction, which considered learning merely as a result of certain environmental contingencies (i.e., trial and error, rewards and punishments). Accordingly, the research at that time demonstrated that learners' knowledge could significantly be modified through training (Bryant, Vincent, Shaqlaih, & Moss, 2013). Behaviouristic studies, in this respect, more particularly targeted observable learning behaviour and took a main interest in instructional techniques contributing to better performance (Bryant et al., 2013). In essence, behaviourists perceived learning as a conditioned state, failing to acknowledge the potential of a growth or developmental orientation on learning.

From the late 1990s onwards, researchers gradually started to recognize learning as a lifelong process, thereby emphasising the changing nature of individuals' learning behaviour with increasing expertise (Alexander, 2003). Especially the work of Alexander and colleagues (1998, 2004) has contributed to our knowledge on the development of learning. As a result, current research on strategic processing (i.e., processing information strategically) continues to extend its focus beyond the initial phases of learning during childhood. From a developmental perspective, individuals are perceived as continuously evolving in the process of learning. Consequently, learning is no longer merely related to young learners, but is rather associated with learners of all ages, including adolescents and adults. In the current 21st century and knowledge society, where lifelong learning is pivotal for active societal participation (Cornford, 2002), this developmental focus started to thrive and found its way into the educational research community. From this perspective, the focus increasingly lies on the complex evolution in strategic processing across the lifespan. This expanded view on learning becomes evident in, for instance, the more recent and increased attention for adolescent and adult learning and education (Alexander & Fox, 2004).

The purpose of this chapter is to elaborate further on this developmental orientation by presenting a framework for strategic processing that encompasses changes in learners' strategy use across the lifespan. A first prerequisite, in this respect, concerns deconstructing how the concept 'strategy' is defined and described in the literature. Surprisingly, although it has been widely used in cognitive

research since the 1970s, attempts to unravel the concept 'strategy' mainly stem from the 1990s (e.g., Alexander, Schallert, & Hare, 1991; Dole, Duffy, Roehler, & Pearson, 1991). Even in the current empirical literature, it remains muddled and vague what a strategy precisely entails (Alexander, 2006; Harris, Alexander, & Graham, 2008). This lack of conceptual clarity can be considered as a substantial roadblock for strategy research, a concern that was already strongly expressed in the late eighties by Alexander and Judy (1988). Therefore, we begin this particular chapter by providing an operational definition of what we constitute as a strategy.

As Harris and colleagues (2008) justly state, the history of strategies in the educational research literature during the past quarter century has been a story of conceptualization and reconceptualization. Accordingly, also differences in the categorisation of strategies came to the fore (Harris et al., 2008). Building on the conceptualization of strategies presented by Weinstein and Mayer (1986), we define strategies as mental activities selected by learners to acquire, organize, and elaborate information, as well as to reflect upon and to guide their learning. Specifically, strategies should be understood as procedural, purposeful, effortful, wilful, essential, and facilitative by nature (Alexander, Graham, & Harris, 1998). This implies that strategies should be interpreted as procedures or techniques that are employed by learners to bridge the gap between their actual and their potential or desired level of learning, understanding, and performance (Alexander, Grossnickle, Dumas, & Hattan, 2018; Pressley, Graham, & Harris, 2006; Weinstein & Mayer, 1986). Consequently, and taken into account the scope of the present chapter, any consideration of instructional or pedagogical strategies is precluded in this conceptualisation (Alexander et al., 2018). Despite fully acknowledging the importance and added value of instructional strategies for facilitating students' learning process and performance (Alexander et al., 1998), our focus in the remainder of this chapter will be on learners and their applied strategies.

Next to various conceptualizations of the term 'strategies', also differences in their categorization occurred in literature. For instance, they have been distinguished according to their nature, perceptibility, level of depth, and domain of application. First, regarding their nature, strategies can be categorized as either *cognitive* (e.g., paraphrasing), *metacognitive* (e.g., planning), or *motivational-affective* (e.g., using positive self-talk) (Pintrich, 2004). Second, some strategies can be applied *overtly* and are consequently easily observable (e.g., schematizing), whereas others take the form of *covert* mental strategies (e.g., monitoring) (Wade, Trathen, & Schraw, 1990). Third, a distinction can be made between *deep-level* strategies, aimed at profound understanding and active transformation of information (e.g., elaborating), and more *surface-level* strategies, that merely aim at basic comprehension without integrating information (e.g., applying read-and-repeat techniques)

(Dinsmore & Alexander, 2012). Finally, we discern *general* or *domain-independent* strategies, that are applicable in a wide variety of learning contexts (e.g., planning) from *domain-specific* strategies, which range of applicability is restricted to a particular learning domain (e.g., using problem solving steps for mathematics) (Alexander, et al., 1998; Weinstein et al., 2011). Taking into account these different conceptualisations, the same strategy can be placed within different categorisations. For example, the 'read-and-repeat' strategy is a cognitive, overt, surface-level, as well as a domain-independent strategy.

Notwithstanding the value of each separate strategy, it is particularly the ability to flexibly and selectively use a variety of apt strategies that has been shown to be crucial for learning, understanding, and performance across the lifelong journey towards proficiency (Alexander, 2018; Pressley & Harris, 2006). Indeed, effective learning, understanding, and performance requires the orchestration of strategies from different categorisations (Alexander, 2018). Consequently, in view of handling and solving a variety of tasks and problems, having access to a *strategic repertoire* and being able to efficiently make use of it, is indispensable. Different theoretical models developed within the last decade point attention to this strategic repertoire. Especially three overarching theoretical models are relevant here, that is the 'Good Strategy User Model' (Pressley, Borkowski, & Schneider, 1987), the 'Model of Strategic Learning' (Weinstein et al., 2011), and the 'Model of Domain Learning' (Alexander, 1998).

Pressley and colleagues (1987) focus in their *Good Strategy User (GSU) Model* on five identified components. The good strategy user (1) can exert many strategies to attain goals, (2) has metacognitive knowledge about specific strategies, that is knowing how, when, and where to apply these strategies, (3) understands that good performance is tied to personal effort expended in carrying out appropriate strategies, (4) possesses a non-strategic knowledge base (e.g., the existence of categorizations), and (5) has automatized the first four components and their coordination (Pressley et al., 1987). According to the GSU model, novice learners possess very limited strategy knowledge and tendencies, while more proficient learners thoroughly understand and apply a wide range of strategies.

Weinstein and colleagues' (2011) *Model of Strategic Learning (MSL)* summarizes three interacting components of strategic learning that are connected causally with performance (i.e., skill, will and self-regulation). 'Skill' refers to the knowledge of a variety of strategies, and how, when, and where to apply them (i.e., respectively declarative, procedural, and conditional knowledge). 'Will' refers to the motivational-affective component within strategic learning, referring to learners' attitudes, beliefs,

and goals that drive their learning. Self-regulation, the third component according the MSL, enables learners to monitor and manage their learning process.

Finally, the *Model of Domain Learning (MDL)* was described by Alexander (1998) and approaches strategic processing through a developmental lens. More particularly, the MDL describes strategic processing through three different stages, that is how learners progress from acclimation through competence to proficiency-expertise. Knowledge, strategies and interest are identified as three interplaying factors, configuring differently during progression through these stages (Alexander, 1998, 2003). As learners progress from one stage to another, their strategy knowledge increases, and their strategy repertoire extends.

Despite their slightly different focus, the GSU model, MSL, and MDL show important parallels. On the one hand, all theoretical models point to the importance of having a diverse amount of strategies available. On the other hand, they also emphasize the efficient and adaptive use of this strategy repertoire. In this respect, all models entail a quantitative and qualitative dimension wherein shifts can take place. Furthermore, all models highlight the key role of motivational-affective aspects in strategic processing by considering learners' personal effort (i.e., GSU), will to learn (i.e., MSL), and interest (i.e., MDL). Next to the abovementioned parallels between the theoretical models, the MDL explicitly distinguishes itself by the predominant focus on strategic processing from a developmental perspective. Before presenting an overarching framework on strategic processing, we therefore take a closer look at this developmental view in the next section.

A developmental perspective on learning

From a developmental perspective, learning is conceptualised as a process wherein change unfolds through different stages. Change is a fundamental characteristic of learning that affects the beginning, middle, and late stages of learning (Alexander, Schallert, & Reynolds, 2009). Accordingly, learning is different at different points in and over time (Alexander et al., 2009).

Change can be understood as arising from the evolved, and innate processing capacities of the learner. As Alexander et al. (2009) state: "Being alive means being a learner" (p. 178), thereby referring to learners entering the world in a helpless state but possessing innate capacities or a strategic predisposition enabling them to learn through experience. Neurological and biological changes enable us to learn differently at different ages, and children generally use increasingly more and effective strategies with age (Bjorklund & Pellegrini, 2000). Although the course of strategy development

corresponds to age and years of schooling, it is not strictly aligned with chronological age (Alexander et al., 1998). The fact that children of the same age do not simultaneously develop and use similar strategies (Pressley, 1979, 1986; Pressley et al., 1992; Pressley & Harris, 2006) implies an explicit need to acknowledge individual differences in learners' strategic processing. Rather than with age or grade, the course of strategy development is closely related to learners' experience (Alexander et al., 2009). As children gain experience and become more competent, their initial signs of strategic behaviour are gradually and continuously transformed (Alexander et al., 1998).

In the following sections of this chapter, we elaborate on the developmental stages of strategic processing by presenting a framework that encompasses shifts in learners' strategy use across the lifespan. To develop this conceptual framework, we build on the developmental stages within MDL. The presented developmental framework illuminates essential characteristics throughout the distinct stages of strategic processing for diverse individuals' learning in markedly different contexts. It should, however, be noted that it is not our intention to capture the full nature of the developmental learning process in detail (Alexander, 2018). Our framework provides a general road map of the course of strategy development and highlights important facets in this respect, but it is by no means all encompassing. Rather, it is a way of aligning aspects of learners' strategy development within a coherent and comprehensive overview.

Strategic processing in a multi-staged framework

The developmental framework we present is multi-staged in nature and centres on the evolution in learners' strategy use across time. This implies that learning constitutes over the lifespan, involving systematic changes in a learner's strategic processing (Alexander et al., 2009). In accordance with Alexander (1998, 2003), we perceive strategic development as a lifelong journey or process that unfolds across multiple stages: the beginning, middle, and late stages of learning. This continuing development is depicted in the three fusing stages in Figure 1.

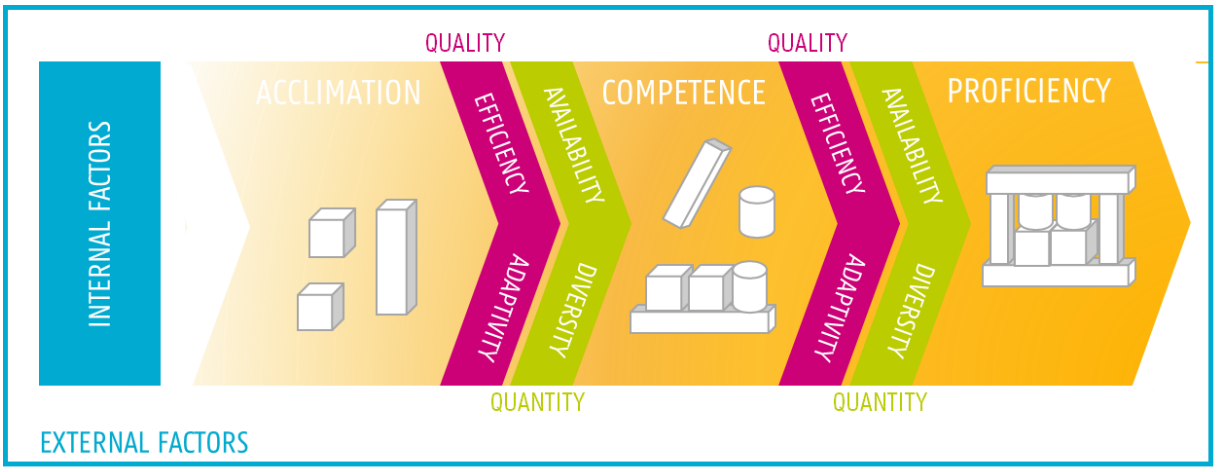

Figure 1. The multi-staged framework of the lifespan development of strategic processing, entailing strategies (cf., different building blocks) within three fusing stages of strategic processing (i.e., acclimation, competence, and proficiency) and four shifts of strategic development (i.e., availability, diversity, efficiency and adaptivity) clustered in two major dimensions (i.e., quantity and quality).

Further, four main characteristics (i.e., availability, diversity, efficiency, and adaptivity) underlying learners' global changes in strategic processing are incorporated in the framework (Figure 1). As mentioned above, these are derived from the main theoretical models on strategic processing (i.e., GSU, MSL, MDL) and can be respectively clustered into two major dimensions, wherein *quantity* refers to the availability and diversity of strategies, while *quality* refers to the efficiency and adaptivity of strategies. Over the typical course of learners' strategy development, from acclimation to proficiency, each characteristic undergoes profound changes. More particularly, as learners gain experience and become more competent and proficient in a task or domain, their strategic behaviour changes and is characterized by increased availability, diversity, efficiency, and adaptivity (Alexander, 2003; Pressley et al., 1987; Weinstein et al., 2011). In other words, over time, learners' strategy adoption will be characterized by a *quantitative shift,* referring to a more extensive and more diversified strategy repertoire (Alexander et al., 1998; Pressley et al., 1987; Weinstein et al., 2011). Accordingly, a *qualitative shift* in strategic behaviour will occur, referring to a more efficient, flexible, and apt application of available strategies (Alexander et al., 1998; Pressley et al., 1987; Weinstein et al., 2011). However, it is important to stress that, although the abovementioned characteristics are considered separately in the theoretical framework, they are interwoven and interactive in reality. Hence, the development of one characteristic might enable the development of another, implying they might evolve symbiotically. We now turn to our framework and influential internal and external factors more in-depth.

As mentioned in the beginning of the chapter, learners can apply various strategies. These strategies are represented as different building blocks in Figure 1, which can take different forms or shapes according to how they are conceptualized or categorized. As also can be seen in Figure 1, the configuration of these strategies can differ throughout different stages. In this respect, three fusing stages (i.e., acclimation, competence, and proficiency) represent the systematic transformations that unfold in learners' strategic processing (Alexander, 1998, 2003). These systematic transformations occur both within and across developmental stages. In the early stage of learning (i.e., acclimation stage), when learners are first introduced in a task or problem, strategies are primarily used as tools for acquiring task-specific knowledge and for solving problems that are perceived by the learner as challenging and unfamiliar. As learners are just beginning to develop their strategies in this initial stage, their strategic processing is often inefficient, inelegant, and ineffective, whereas their strategy repertoire itself is relatively unsophisticated, limited, fragile, and disorganized (Alexander, 1998, 2003; Berninger, Fuller, & Whitaker, 1996). In the context of text-learning, for example, studies in both elementary and secondary education show that a fairly large number of learners possess a very limited initial strategy base (Merchie, Van Keer & Vandevelde, 2014; Rogiers, Merchie, & Van Keer, in press). It was found that only 19% of late elementary graders and 32% of secondary school students respectively addressed a rich strategy repertoire. Students at this acclimation stage apply strategies thus rather superficially, showing that their strategic processing is still in their infancy. In addition, learners exhibit minimal strategy transfer, which is restricted to new situations that are similar to the contexts in which these strategies were initially applied (Alexander et al., 1995; Garner, 1990). In this stage, learners are mainly concerned with getting through the task, instead of developing competency or proficiency in the task. As such, their interest is classified as more situational (Alexander, Jetton, & Kulikowich, 1995).

With increased exposure to the domain and related tasks and problems, learners will move to a stage of competence. Unlike the acclimated phase, learners in the competence phase have developed a richer and more integrated strategic knowledge base. As this knowledge base grows, their personal investment increases noticeably, and their interest begins to take on a greater role (Alexander, 1997). As learners gain more competence, their strategic repertoire is being expanded steadily and strategic processing becomes more automatic, sophisticated, effective, and flexible. Existing strategies are modified, upgraded, and fine-tuned to serve new purposes, different strategies are combined in novel ways, and new strategies are learned and acquired. As is illustrated in Figure 1, the configuration of strategies becomes more stable and flexible during this stage. When it comes to learning from text, for example, a recent study of Rogiers and colleagues (2019) shows that, by means of a strategy-focused program, learners are able to extend their strategic repertoire considerably. Both learners' self-

reported and observed strategy-use pointed towards a strategic and integrated combination of various text-learning strategies. As problems and tasks that acquire a strategic solution become more familiar during this stage, competent learners approach these by combining a mix of diverse strategies. Finally, their ability to decide whether and when a strategic solution is needed, and which strategies are needed to accomplish this, is growing (Alexander & Judy, 1988). Learners at this stage are more likely to transfer their learned strategies from one situation to another and become less reliant on strategic solutions for solving common problems (Garner, 1990).

Finally, another shift in strategic behaviour occurs as learners acquire expertise and enter the proficiency stage. This particular stage is considered the most advanced level of learning and only a few learners actually reach this stage (Alexander et al., 1995). To reach this stage, experts possess a solid and extensive repertoire of highly structured and cohesive strategies (Alexander et al., 1995). This is also illustrated in the configuration of the diverse building blocks - representing strategies - in Figure 1. Along with the well-organized strategy base, they demonstrate a deep personal interest in the tasks and the broader field, and a high level of persistence. The shift from competence to expertise is associated with a qualitative shift in the types of strategies learners most commonly rely on. Here, deep-processing strategies become paramount in learners' refined repertoire, while surface-processing strategies become fairly automated (Alexander & Fox, 2004). Even more than in the competence phase, expert learners are able to use the most suitable strategies to tackle problems or tasks as efficiently as possible. In addition, proficient learners exhibit maximal transfer of strategies to novel situations (Garner, 1990).

To conclude, as learners acquire expertise in a task, a shift in their strategic behaviour is taking place. This shift can be both quantitative and qualitative by nature, implying changes in the amount and the diversity of strategies becoming available in learners' repertoire as well as in the way strategies are applied by them (Alexander et al., 1998). As learners move forward in their journey toward competence or perhaps even expertise, their strategy repertoire become more extensive and their strategic processing becomes more automatic (Alexander, 1998, 2003; Berninger et al., 1996). Accordingly, learners' strategies are configured differently and strengthened gradually across developmental stages. This global path in strategic development looks different, however, depending on both individual and contextual factors.

Internal and external differences in learning

Individual differences are inherently connected with human nature. Strategies are always initiated, enacted, and monitored by a learner who approaches tasks or problems in a unique way depending on individual variation in biological, psychological, as well as cognitive factors (Alexander et al., 2018; Shen & Chen, 2006; Strømsø & Bråten, 2010). Even though there is a generalizable character in the pattern of strategy development, developmental patterns are still truly individual, varying from one person to the other. Learners of the same age and at the same developmental stage within a domain may, for example, still apply different strategies to solve the same problem, even when the context is held constant (Pressley et al., 1990; Merchie, Van Keer, & Vandevelde, 2014; Rogiers et al., in press). For example, in a study of Merchie and colleagues (2014) and Rogiers and colleagues (in press), four learner profiles were identified in both late elementary and secondary school students' text-learning strategy use by means of cluster analysis. Whereas integrated strategy users (ISU) engaged in the strategic combination of different text-learning strategies, limited strategy users (LSU) generally used only a limited number of text-learning strategies. Information organizers (IO) frequently applied text-noting strategies and reported limited use of mental-learning strategies, while mental learners (ML) restricted their repertoire to mental-learning strategies without text-noting strategy use. The individual nature of learners' strategic processing is also explicitly acknowledged in Figure 1, by positioning *internal factors* in front as an important precondition. Various internal influences, such as learner characteristics (e.g., age, gender, prior knowledge, domain interest, assigned task value, general cognitive capacity, and working memory), might shape a different path *between* individuals. For example, the approaches suitable for young learners taking their first steps toward competence are, therefore, not likely to work for older or more proficient learners (Alexander, 2005). Next to these inter-individual differences between learners, learning activities are inevitably shaped by the changing conditions *within* individuals. These intra-individual differences are connected to factors external to the learner. That is, specific task features (e.g., complexity or structure of the task) and context features (e.g., supportive environment, time constraints) as well as the interplay among these features, might shape learners' individual pattern of strategic development (Alexander et al., 2009). These significant differences between and within individuals can set boundaries or create opportunities for learning (Alexander et al., 2018). It is these (inter- or intra-) individual variabilities that determine what the path of strategy development may look like. Furthermore, as learning does not take place in a vacuum but emerges over time and space in a learning context, conditions *external* to the learner play a role in strategy development as well (Alexander et al., 2009). Accordingly, diverse individuals are learning at markedly different places both within and across time. These external factors refer to the ecological context in which learning occurs, which influences learning and is influenced by the learner. In this

respect, we particularly refer to the physical and socio-cultural context as well as to the relationships among learners or between the learner and the wider environment. The latter involves the instructional support and guidance offered by educational practitioners or peers to foster learners' strategy use and development. For example, acclimated learners need more support, time, and scaffolding to achieve the advantages that come more easily to expert learners. Additionally, this wider environment can also refer to the classroom or work context in which learning occurs, as well as to the increasingly diverse, online, and rapidly changing learning context 21st century learners face. In this regard, not only the learner himself develops and changes over time, the context in which learning is embedded (e.g., classroom, school, work, society) is subject to continual change as well (Nist & Simpson, 2000). As learners and their learning environment are reciprocally influencing each other, a complex interplay between the two occurs. In fact, learning to become strategic involves becoming responsive to the shifting demands of the learning context (Pressley et al., 1989). By embracing external factors in our developmental framework, it acknowledges the learning context and the accompanying changes and challenges learners in all developmental stages face.

To conclude, we presented a framework of strategic processing that encompasses changes in learners' strategy use across the lifespan. In sum, this conceptual framework is multi-staged in nature, including the configuration of strategies throughout three stages of strategy development (Alexander, 1988, 2003) and the accompanying quantitative (i.e. from less to more available and diverse strategies) and qualitative (i.e. from less to more efficient and adaptive strategies) shifts in learners' strategy use.

Issues and limitations in the current field, and future directions

We are still facing a number of challenges with regard to the study of learners' strategic development process. Partly due to the rapidly changing society, there is to date no straightforward answer to the question how strategic processing systematically changes over the course of a learner's lifespan or academic career (Alexander, 2018). In fact, research into the development of strategic processing is currently still emerging. In line with Alexander (2018), we therefore recommend future studies to explicitly focus on this developmental trajectory. Accordingly, longitudinal studies on strategic processing, focussing on the transformations that unfold as learners move toward competence or expertise are required. These studies could unravel how learners at different developmental stages internalize the external support they receive, and at which point in time external support can be faded (Alexander, 2018). Accordingly, a well-established understanding of learners' strategic processing can help curriculum developers and educators in deciding what to emphasize in strategy development and when to teach it (Harris & Graham, 2016). Instead of merely making educated guesses, this enhanced

understanding could serve as a sufficient evidence base for effective methods to optimally teach and support learners in all stages (Alexander, 2005). This should not, however, interfere with acknowledging the differences between learners' individual developmental trajectories as indicated above. Given the individual nature of strategic processing (Alexander et al., 1998), research considering individual differences both between and within learners on this developmental path, remains needed.

In order to study the development in learners' strategy use over a longer period of time, the adoption of different measurement instruments is recommended (McCardle & Hadwin, 2015; Samuelstuen & Bråten, 2007; Schellings, 2011; Veenman, 2011). To capture this development, both off-line measures, administered prospectively or retrospectively to performance on a task (e.g., self-report data), and on-line measures, gathered concurrently during task performance (e.g., trace data) should be used at different points in time, given their complementary particularities. These multiple instruments enable us to gauge both quality and quantity differences in learners' strategic processing and give us insight in which strategies learners applied (retrospective), are applying (real time), or will apply (prospective) (McCardle & Hadwin, 2015; Schellings, 2011; Veenman, 2011). This implies that researchers need to determine the best way to capture and examine learners' strategic processing at different stages and which measures are most adequate in their specific study. Accordingly, there is an urgent need for appropriate and valid measurement instruments to capture and follow learners' strategy use and transfer throughout its developmental course, to track learners accurately in their journey toward proficiency. Currently, more technology-driven measures (e.g., physiological measures, eye tracking measures, keystroke logging tools etc.) are incorporated into research (e.g., Haataja, Malmberg, & Järvelä, 2018; Leijten & Van Waes, 2013; Malmberg, Järvelä, & Kirschner, 2013). These measures can give us insight in factors underlying learners' strategic processing, and which factors provoke or hinder the application of certain strategies. Furthermore, the technological revolution and its associated increase of information sources places new demands on today's learners. Educational researchers acknowledge that this evolving technology has transformed both learning and teaching and may hold both promises and pitfalls (Alexander & Fox, 2004). The growing presence of hypermedia centralizes the question about what it means to be a strategic learner in this digital era. Studies on strategic processing within hypermedia environments are, therefore, recommended.

Implications for practice

Derived from our developmental framework, several implications for practice can be put forward. First, it is important to inform educators and practitioners on the stages and related important shifts in the development of strategic processing. In addition, they should be aware of the obstacles that might arise during that journey. In this way, they could attune their interventions and educational support to anticipate to these (Alexander, 2005).

Second and as outlined above, strategies are acquired through experience. This implies that we must provide learners with the experiences as well as with the tools necessary to move forward in their journey toward competence, and perhaps, proficiency. The different stages of development, however, acquire a different and customized educational approach. For example, learners in the acclimation phase usually demonstrate a strong reliance on surface-level strategies and their strategic processing remains ineffective and inefficient during this phase (Alexander & Judy, 1988, Merchie, Van Keer, & Vandevelde, 2014; Rogiers et al., in press; Vandevelde, Van Keer, & Rosseel, 2013; Vandevelde, Van Keer, Schellings, & Van Hout-Wolters, 2015). Consequently, learners in this phase require more assistance and possess a stronger need for explicit instruction on how to become strategic. During explicit instruction, educators not only model the application of the strategies (i.e., explain, verbalize, and demonstrate their thoughts, actions, and reasons while strategic processing), but also provide specific strategy knowledge so that learners become aware of the how, when, and where to apply strategies (Kistner et al., 2010; Paris & Paris, 2001; Veenman et al., 2006). More concretely, by focussing on declarative knowledge (i.e., knowing about a variety of strategies), procedural knowledge (i.e., knowing how to use strategies), and conditional knowledge (i.e., knowing when and where to use particular strategies) learners' strategy growth is fostered. Important to notice is, however, that explicit attention to strategies does not solely apply for acclimated learners but for learners in all stages of strategic processing (Alexander et al., 2018). In this regard, strategy instruction requires that educators move beyond a mere "content approach", where the focus is often on facts and learning content. Instead, a "strategies approach", where learners' mental processes are directly targeted is needed (Alfassi, 2004; Hall-Kenyon & Black, 2010; McKeown, Beck, & Blake, 2009; McNamara, 2011). By means of strategy instruction, strategies are made ''transparent'' and ''transportable'' for learners, enabling them to see why a particular strategy is useful, as well as how to apply the strategies in a subject-specific manner to other content areas (Alfassi, 2004; Parris & Block, 2008; Paris, Byrnes, & Paris, 2001; Pressley, 2000). For example, research in secondary education shows that by means of explicit strategy instruction, learners can become more competent in text-learning and extend their strategy repertoire considerably (Rogiers et al., 2019). Consequently, and line with several researchers,

we recommend strategy instruction as an integral part in the regular instruction course embedded in all content areas (e.g., Alexander et al., 2018; Hamman et al., 2000; Harris et al., 2008). Instead of addressing strategy instruction as a separate course, a meta-curricular approach which systematically interweaves strategy adoption with acquiring domain-specific knowledge and skills, appears more valuable for learners' strategy transfer (e.g., Cornford, 2002; Kistner et al., 2010; Veenman, 2011).

Furthermore, strategy instruction should explicitly focus on teaching for transfer as being strategic equally implies that strategies can be employed across a variety of situations. Next to strategy instruction, educators should provide various practice opportunities for learners to strategically solve novel tasks and problems while providing process feedback and gradually fading guidance as learners' proficiency increases (Garner, 1990; Graham & Harris, 1994; Kirschner, Sweller, & Clark, 2006; Weinstein et al., 2011; Pressley et al., 1989). Here, strategies should be practiced and developed in diverse and relevant contexts and learners must be encouraged to modify and combine their strategies according to the task or problem at hand (Alexander, 2003; Alexander et al., 2018). In this respect, learning contexts must be authentic and adaptable to the tasks learners encounter and vice versa. Support for strategy development can be provided by both educators and peers within a collaborative environment that meet the needs of diverse learners (e.g., De Backer, Van Keer, & Valcke, 2015; De Backer, Van Keer, & Valcke, 2016; De Smedt, Graham, & Van Keer, 2019; De Smedt & Van Keer, 2018).

Third, and perhaps most fundamental, commitment to this lifespan perspective on strategic processing requires a change in the mindset of educators, practitioners, the public and policy makers to accept strategic processing as a complex process of growth and development. When considering strategic processing from a developmental orientation, we must see the changes and challenges in the initial stages of learning as parts within a larger whole and vice versa (Alexander, 2005). Within this growth perspective, attention is not exclusively focused on the actual state of one's strategic processing, but also on the changes that unfold in the strategic process and the way we can foster them. In essence, good information processing must be perceived as a long-term endeavour (Pressley et al., 1989). In this respect, we cannot longer consider strategic development as confined to the early years of schooling, but we are spanning learning readiness to a process of proficient strategic processing. Additionally, we must acknowledge that becoming an expert learner and building up a repertoire of strategies takes considerable time, with several years of strategies instruction likely necessary for learners to truly take ownership of the strategies, and to apply these adaptively when encountering novel situations (Pressley, 2005; Pressley & Harris, 2006). Within the 21st century where lifelong learning is central, strategic development must, therefore, be seen as an integral responsibility of all educators across all educational levels and far beyond (Pressley, et al., 1989).

Further, rather than focussing on the deficiencies, we must direct our attention to the growth opportunities for all learners. Although only a minority will reach the expert stage (Alexander, 1997), our expectations towards all learners should be high enough, even when they are only taking their first steps toward competence (Jang, Reeve, & Deci, 2010; Vansteenkiste et al., 2012). At the same time, unreasonable expectations might hamper learners' growth as well (Alexander, 2003). Expecting learners to make significant progress in their strategic processing by the time they complete formal education, appears reasonable. This implies that we must be sensitive to see the marked changes and movements in learners' strategic process (Murphy & Alexander, 2002). In addition, strategic development must be seen as an integral part of educators' professional development. Explicit attention to the instruction of strategies can increase their competence to guide learners through this developmental course and equip them with a rich strategic repertoire.

Concluding thoughts

Our overarching intention was to consider the development of strategic processing across the lifespan as well as to offer a framework in which this development is illustrated. We believe the current developmental framework enables us to better understand previously executed empirical studies and to design future studies on mapping and stimulating strategic processing. More particularly, the framework offers a rationale for the use of interventions targeting learners' strategic processing, as well as envisions the paths for strategy research that lies ahead.

As the saying goes, the present belongs to those who have learned but the future belongs to those who are learning (Weinstein et al., 2011). Our 21st century requires us to prepare learners for lifelong learning throughout the different stages of their lifespan. Having an extensive strategy repertoire that can be applied efficiently and flexibly, is a first important step toward becoming an effective learner.

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