



The coverage of distributed practice and retrieval practice in Flemish and Dutch teacher education textbooks[☆]

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HIGHLIGHTS

- Distributed practice and retrieval practice represent two of the most effective learning strategies.
- 61 textbooks and syllabi used in Flemish and Dutch teacher were analysed.
- Essential learning strategies were not fully covered.
- Textbooks and syllabi rarely refer to research in the field of cognitive science.
- Authors are advised to represent learning strategies more accurately.

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ABSTRACT

To determine if and how teachers are being educated about effective learning strategies we analysed the topical coverage of two highly effective strategies, distributed practice and retrieval practice, in introductory teacher education textbooks and syllabi. We examined 61 textbooks used in Flemish and Dutch teacher education programmes (TEPs) by inventorying descriptive and prescriptive information on these strategies therein. Also, we analysed whether the coverage referred to actual research. The results indicated that mostly textbooks fail to fully represent the strategies. Accurate textbooks are used in a minority of TEPs. Implications and challenges for authors, TEPs and policy-makers are discussed.

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1. Introduction

‘Should teacher candidates master the science of learning?’ is, hopefully, a rhetorical question. If a teacher’s job is to promote student learning, then their planning, execution, and evaluation of instructional moments will be more effective if they understand when, why, and how their students learn. Over the last century cognitive and educational psychologists have identified a number of research-informed cognitive strategies that have positive effects on (i.e., that enhance) learning and retention, from here on referred to as learning strategies. A solid scientific consensus appears to

have been achieved about which strategies work (Deans for Impact, 2015; Dunlosky & Rawson, 2015; Dunlosky, Rawson, Marsh, Nathan, & Willingham, 2013; Pashler et al., 2007; Putnam, Sungkhasettee, & Roediger, 2016; Roediger & Pyc, 2012; Rohrer & Pashler, 2007) and which do not (Dunlosky et al., 2013; Kirschner & Van Merriënboer, 2013). Within these strategies, distributed practice (DP)¹, encompassing the spacing effect, and retrieval practice (RP)², encompassing the testing effect have shown to be consistent and promising in both laboratory and classroom research. DP and RP are acknowledged by most cognitive psychologists as being the strongest approaches to study in terms of their potential significant influence on education (e.g., Carpenter, 2017; Carpenter, Cepeda, Rohrer, Kang, & Pashler, 2012; Cepeda, Pashler, Vul, Wixted, & Rohrer, 2006; Rohrer, 2015 for DP, and Adesope, Trevisan, & Sundararajan, 2017; Karpicke, 2017;

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¹ DP: distributed practice.

² RP: retrieval practice.

McDaniel, Roediger, & McDermott, 2007; Roediger & Karpicke, 2006b for RP). DP and RP have been shown to be useful in a range of learning conditions, for students of different ages and capabilities and for many subject areas and levels of prior knowledge (Dunlosky et al., 2013).

Since Ebbinghaus (1885, 1913) demonstrated the advantage of DP over massed practice more than a century ago, hundreds of experiments have corroborated his findings. DP enhances students' retention by having learners return to what they have learned across time (Dunlosky & Rawson, 2015). RP also has a long research history with first mentions of the testing effect in studies from Abbott (1909, p. 177) and Gates (1917, p. 101). The act of recalling information, often referred to as retrieval practice, improves both performance and retention (Roediger & Karpicke, 2006b; Roediger, Putnam, & Smith, 2011). These two learning, instructional, and study strategies represent evidence-informed, easy-to-implement principles that every teacher, and teacher candidate, could use to improve long-term retention of study materials.

However, students tend to prefer other, more ineffective learning strategies such as re-reading or copying their notes (see e.g., Hartwig & Dunlosky, 2012; Kornell & Bjork, 2007). It is, however, reassuring that educational interventions may help to increase the adoption of the most effective learning strategies, as students who receive explicit instruction on effective learning strategies are more likely to endorse these strategies (Ariel & Karpicke, 2017; Soderstrom, Yue, & Bjork, 2016). For teacher candidates, introductory educational psychology or instructional methods courses in teacher education programmes (TEPs)³ provide an opportunity for exposure to research-informed strategies. In these courses, lecturers often make use of textbooks and/or syllabi that play a major role in defining the learning objectives and content of the course for the candidates. If the textbooks used, along with actual teaching in the classroom, accurately cover such evidence-informed principles, teacher candidates have the opportunity to gain the necessary knowledge and insights needed to understand their students' learning and stimulate it. If the textbooks do not cover these principles, the teacher candidates might lack this knowledge and insight and it is likely that their students will revert to less effective study strategies. Pomerance, Greenberg, and Walsh (2016) partially addressed this issue by examining textbooks used in TEPs in the United States for coverage of DP and RP, amongst other strategies. They found sparse coverage and discussion of evidence-informed strategies in those textbooks. These findings create concern about a possible similar lack of coverage in contemporary educational psychology textbooks used elsewhere.

This study examines the coverage of DP and RP in the written course materials used in Flemish (the Dutch speaking part of Belgium) and Dutch TEPs and attempts to determine to what extent DP and RP are accurately represented in current textbooks on educational psychology or instructional methods used in Flemish and Dutch TEPs.

2. Distributed practice and retrieval practice

Distributed and Retrieval Practice in learning facts and acquiring skills are two of the most effective, reliable and widely studied strategies in educational psychology to enhance learning (e.g., Carpenter, 2017; Dunlosky & Rawson, 2015; Dunlosky et al., 2013; Karpicke, 2017; Putnam, Nestojko, & Roediger, 2017), without requiring the input of extra technology, money, or lesson time (Roediger & Pyc, 2012; Rohrer & Pashler, 2007). DP (also known as spaced repetition or spaced practice) is a learning and teaching

strategy where repeated sessions of study and practice are spaced over a longer period of time. A distributed practice intervention typically contains a first occasion to study some information and students have at least one more opportunity to relearn the information. Two or more exposures to the information occurring at non-zero gaps are regarded “spaced”, whereas if repetitions occurred immediately, the zero spacing gap constitutes “massed practice”. For example, in a study by Goossens, Camp, Verkoeijen, Tabbers and Zwaan (2012) children were taught the meaning of 15 words in a massed procedure: they learned five words in three study sessions. In the spaced condition the same 15 words were practiced once in each of three learning sessions. At retention tests after one and five weeks, they observed that students who had the opportunity to space their practice outperformed the students who massed their practice. Indeed, students who space their practice, learn more slowly but retain facts and acquire skills that are much more durable across time. Even when the overall time on task is equal, the timing of study sessions has a powerful effect. Also, longer retention intervals require longer spacing gaps (Carpenter, 2017; Carpenter et al., 2012). In summary, long-term retention benefits when practice or revision is spaced in time rather than massed together in a single period.

Research on RP has shown that taking a practice test improves learning dramatically compared to other learning strategies as re-reading or re-studying (See e.g., Gates, 1917; Glover, 1989; McDaniel & Fisher, 1991; McDaniel et al., b, 2007a.; Roediger & Karpicke, 2006a). For example, Roediger and Karpicke (2006a) presented undergraduates short prose passages for initial study, followed either by a second study trial or by practicing a free-recall test. After an interval of 5 min, two days and one week, the students completed a final free-recall test. The results showed that on the more delayed tests, prior testing produced considerably greater retention than restudying. More recently, researchers have found that not only self-tests and free recall exercises improve learning, but the same goes for low-stakes quizzes, using flash cards, end-of-chapter questions, and more (Golding, Wasarhaley, & Fletcher, 2012; Roediger & Butler, 2011; Tulving, 1967). Whenever knowledge is retrieved from long-term memory, the memory of that knowledge is strengthened because the act of retrieving it improves one's ability to retrieve it again in the future (Karpicke, 2012).

3. Distributed practice and retrieval practice in classrooms

DP and RP can be implemented in a multitude of ways, both in the classroom as effective instructional techniques for teachers and in students' self-study. Dunlosky et al. (2013), Putnam et al. (2016), and Rohrer (2015) present several activities and conditions to implement DP. Teachers, for example, could start each lesson with a short review session where key concepts from previous lessons are revisited. Homework assignments that target both old and newer material to be learned are effective to obtain a spacing effect. Essential concepts should be exposed more than twice and review opportunities should be planned weeks and months after concepts were first introduced. Teachers should also keep retention intervals in mind. In educational settings, optimal gaps vary from one week to one month. Students should clearly avoid massed repetitions and plan ahead of time. Teachers should encourage the students to plan topics so that the most important concepts can be revised repeatedly.

For the application of RP in educational practice, several guidelines for teachers have been formulated by Roediger and Karpicke (2006b), Roediger and Butler (2011), Adesope and Trevisan, 2017, and Roediger, Putnam and Smith (2011). First, teachers can use all kinds of quizzes, low-stakes tests, free or cued recall as effective ways to recall information (McDaniel, Agarwal,

³ TEPs: teacher education programmes.

Huelser, McDermott, & Roediger, 2011; McDaniel, Anderson, Derbish, & Morrisette, 2007; Roediger & Butler, 2011). Outside of the classroom during self-study, students can use flash cards, end-of-chapter exercises or self-tests as forms of RP for independent learning (Roediger & Butler, 2011). Students can also create *Cornell notes* of their to-be-learned information by making a column on one edge of the page where they write key terms or questions next to the corresponding content. Students can test themselves later by covering the notes. Bjork (1975) found that practising retrieval is more beneficial when it involves production (e.g., short-answer questions or free recall) rather than identification or recognition (e.g., fill-in-the-blank questions) because recall tests require a greater retrieval effort or depth of processing than recognition tests. RP promotes superior long-term retention, even in absence of feedback but providing the correct answer after a retrieval attempt increases the benefits of testing (Roediger & Butler, 2011; Vojdanoska, Cranney, & Newell, 2010).

The combination of the two strategies (often referred to as 'spaced retrieval practice') amplifies their benefits: spacing retrieval attempts over time compared to massing repeated retrieval attempts together leads to better retention (Carpenter, 2017; Kang, 2016; Karpicke, 2017). Bjork and Bjork (2011) argued that repeated testing constitutes a desirable difficulty because the technique tends to slow initial learning compared to repeated studying, but promotes far greater long-term retention.

4. A need for better understanding of the learning strategies

Despite the utility of RP and DP, several surveys of students' intended or actual study behaviours suggest that they underuse these effective strategies and over-use ineffective strategies such as rereading and highlighting (See e.g., Blasiman, Dunlosky, & Rawson, 2017; Hartwig & Dunlosky, 2012; Kornell & Bjork, 2007; Morehead, Rhodes, & DeLozier, 2016). Between 10 and 13% of students plan a study schedule ahead of time (e.g., Hartwig & Dunlosky, 2012; Kornell & Bjork, 2007). Students frequently mass, or 'cram' their study before an exam which indicates that there is no intentional implementation of DP. Also, while students tend to use self-tests, they primarily use them as an evaluation tool and not as a learning strategy (Kornell & Finn, 2016). This explains why students, for example, tend to drop certain items from their 'items to study list' when they answered an item correctly one time instead of continuing to test themselves on the whole. Studies by both Hartwig & Dunlosky, 2012 and Kornell and Bjork (2007) indicated that one of the reasons why students fail to use RP and DP might be because they were unaware of the strategies. One potential source of such information is the teacher, though they themselves might also hold particular beliefs conflicting with research on effective learning (Dignath-van Ewijk & van der Werf, 2012; Morehead, Rhodes, & DeLozier, 2016). Still, Kornell and Finn (2016) argue that it is mainly the teachers who should be aware of the benefits of the strategies. This vision is supported by a study of Ariel and Karpicke (2017) where they found that explicit instruction by teachers on RP resulted in more effective study behaviour of the students. There is indeed reason for optimism that a mental model of how people learn focussing on knowledge of cognitive psychology would benefit teachers and subsequently their students learning (Soderstrom et al., 2016; Willingham, 2017). Indeed, in order to give adequate instruction about these phenomena in educational settings, teachers must first know and understand the learning strategies themselves. Fiorella and Mayer (2015) strengthen this argument by stating that there should be a reciprocal relationship between the learning theory (which delivers conceptual information on e.g. RP and DP) and educational practice (prescriptive information on how to implement RP and DP), where cognitive

sciences explains how learning works, and where instructional sciences creates the optimal conditions for each classroom technique based on an understanding of how people learn.

5. Learning strategies based on research in teacher education

There is a general consensus that teachers and future teachers should understand how their students learn (See e.g., Kuijpers, Houtveen, & Wubbels, 2010; Patrick, Anderman, Bruening, & Duffin, 2011) and that teacher candidates should encounter a minimal number of psychological theories and their practical applications for the classroom (Willingham, 2017). Indeed, on a more regional scale the Flemish publication on secondary teacher core competencies states that 'the teacher is a guide for their students' learning processes' (Flemish Government, 2008); it also establishes that TEPs 'should provide a reference framework for learning' (p. 17) and that teacher candidates should 'learn their future students strategic and metacognitive skills that foster active learning' (p. 47). A comparable message can be found in the Dutch generic knowledge base for TEPs, which mentions that 'a teacher should apply a multitude of learning strategies to create an optimal climate for all students' (HBO-raad, 2011, p. 26).

There is similar unanimity on the need for teacher candidates to adopt a research-based approach. Aspiring teachers should 'learn to engage with evidence from research' (Flemish Government, 2008, p. 47) or should 'know core concepts of research and translate evidence into practice' (HBO-raad, 2011, p. 58). In other words, TEPs should encourage teacher candidates to teach in an evidence-informed way and pay attention to consuming research and delivering courses based on seminal research in the field of cognitive science.

Teacher educators have a substantial role in combining these two requirements for teacher candidates. Teacher educators should prepare teacher candidates to implement teaching practices which foster student learning and which are informed by sound research evidence. Indeed, more emphasis has been put on the fact that teacher educators are supposed to adopt an attitude in which they consume educational research (See e.g., Cochran-Smith, 2005; European Commission, 2013; Tack & Vanderlinde, 2014). The Dutch knowledge base for teacher educators (VELON, 2016) states that teacher educators should function as knowledge brokers 'which translate knowledge to the field' (p. 8). The development profile for Flemish teacher educators (VELOV, 2015) adds that teacher educators as end-users of research should systematically keep themselves informed and up to date with literature, and use this research to support their practice (p. 96). In this respect, teacher educators must simultaneously function on different levels. They are teaching future teachers about teaching, and thus must practise what they preach through modelling and congruent teaching (Loughran, 2014; Loughran & Berry, 2005; Swennen, Lunenberg, & Korthagen, 2008; VELON, 2016; VELOV, 2015). This implies that teacher educators should provide a research-informed knowledge base on how people learn. However, it is too demanding and arduous for individual educators to stay current with original, primary research in every part of the field of the cognitive sciences, even if significant time were allocated to it (Levin, 2013). Roediger (2013) claimed that there is no strong tradition of translational educational research: findings from educational research are only slowly introduced to real-world classrooms. Indeed, in a study on educational textbooks, conducted for the National Council of Teacher Quality (NCTQ), Pomerance, Greenberg, and Walsh (2016) found that only 7% of the study materials used primary sources. In another study, Sylvester Dacy, Nihalani, Cestone, and Robinson (2011) found that textbooks on learning strategies used secondary sources twice as often as primary sources.

6. Textbooks and syllabi as intermediaries

The work of intermediaries, such as teacher educators and authors of textbooks and syllabi as knowledge brokers is, thus, crucial. It can contribute either to the embracing of educational fads or making high-quality evidence widespread in education (Levin, 2013). Textbooks and syllabi are considered to be written course materials that provide the learning content (i.e., what students have to learn for a particular course) that are either obtainable as an official publication (textbook) or as a text that was written and/or compiled by the teachers themselves (syllabus). Unlike some other educational systems, Flemish and Dutch textbooks and syllabi are not written based on carefully developed guidelines provided by ministries of education (Fang & Gopinathan, 2009). As a result, teacher educators themselves must look for existing implementations of what they want to teach, or produce their own curriculum materials. From the vast amount of available material (e.g., research articles, popular scientific magazines, textbooks), teacher educators as knowledge brokers have the arduous task of selecting, organising, and converting essential knowledge into an educational artefact for their courses.

7. Assessing distributed practice and retrieval practice in textbooks and syllabi

Teacher candidates should be taught both the cognitive science that underlies the use of strategies such as DP and RP (i.e., the description and purpose of a learning strategy) and also how the strategies can be translated into practical activities and classroom use (i.e., the prescriptive information). Providing this core information is essential for future teachers, as they are novices in the field (Kirschner, Sweller, & Clark, 2006). While this does not presuppose that textbooks exclusively determine teaching and learning, Pingel (2010) states that textbooks and syllabi often guide teaching content, lesson planning, choice of learning objectives, and methods more than the ideals of teacher professionalism suggest. These written learning materials can be seen as empirical indicators (i.e., evidence) for subject matter content in TEPs. By including and excluding specific content, textbooks and syllabi can guide students' opportunity to learn.

Although topical analysis of educational materials has been conducted for introductory psychology textbooks (See e.g. Ferguson, Brown, & Torres, 2016; Lucas, Blazek, Raley, & Washington, 2005), very little research has examined the content of teacher education textbooks. Pomerance, Greenberg, and Walsh (2016) reported that textbooks used in TEPs in the United States neglected to inform about what is known about both strategies. Only 22% of the textbooks covered DP as an instructional or learning strategy, while none mentioned RP. If a mention of DP was found, in almost all cases it was too short to fully explain the concept. Pomerance, Greenberg, and Walsh (2016) claim that teachers who know the value of DP will advise their students that it is most effective to revisit or practise material spaced in time instead of massed. In their study, a textbook stated that 'periodic

review of the material should be built into every instructional plan' (Pomerance et al., 2016, p. 7). They argued that teacher candidates need more explicit guidance on how to schedule spacing gaps, as the appropriate intervals are generally much longer than anyone would guess (i.e., weeks or months, rather than days). The report also stated that teachers who acknowledge the value of RP will learn their students that it is more effective to study material by self-testing than to summarise, reread, or highlight notes or text.

It is, thus, important that teacher candidates have a complete understanding of DP and RP. Therefore, the question of whether, how, and to what extent current textbooks being used in teacher education are dealing with this essential body of educational psychology is highly significant. The goal of this study is to determine the level of allocation of evidence-informed information about DP and RP in textbooks and syllabi used in educational psychology or instructional methods courses in TEPs for secondary education in the Netherlands and Flanders, guided by two research questions. First, to what extent do textbooks and syllabi about learning and teaching in Flemish and Dutch university and colleges of higher education TEPs describe DP and RP as a learning and instructional strategy? Second, to what extent do university and colleges for higher education TEPs use textbooks and syllabi that cover DP and RP in their courses about learning and teaching?

8. Method

8.1. Textbooks and syllabi

To assess how DP and RP were covered in secondary TEPs in the Netherlands and Flanders, the researchers focused on the textbooks and syllabi (also comprising readers, brochures, and scientific articles) used in general TEPs. Institutions training teachers in specific applied subjects like music, art, and sports were excluded. Adult education programs which lead to teacher qualifications in Flanders were also excluded as they will be integrated into colleges of higher education and university TEPs in 2019 (Flemish Government, 2016). A total of 42 TEPs were contacted and asked to share their textbooks and syllabi used in educational psychology, instructional methods or other general pedagogy and didactics courses. Written learning materials of specific courses such as mathematics or history were not included as DP and RP are generally applicable across a multitude of subjects and courses, and are not restricted to subject-specific didactical approaches, such as mathematics or languages. Initially, 9 Flemish and 15 Dutch TEPs provided all their materials. The researchers were able to locate additional titles of written learning materials of 11 TEPs through European Credit Transfer System documents or information brochures (such as study guides) on their websites. In total, materials from 17 Flemish and 18 Dutch programmes were collected and analysed, which is 83% of all TEPs. Of these, 57% provided all written learning materials, including syllabi, readers and articles. Table 1 shows the descriptive data on the TEPs.

Written learning materials were screened to see if their title, learning objectives, table of contents or index mentioned topics

Table 1
Teacher education programmes of which textbooks and syllabi were collected.

| Teacher education programmes | Flanders | | | The Netherlands | | | Total | | |
|----------------------------------|----------|-------|------|-----------------|-------|------|----------|-------|------|
| | Provided | Found | Rest | Provided | Found | Rest | Provided | Found | Rest |
| University (*) | 2 | 2 | 1 | 9 | 1 | 0 | 11 | 3 | 1 |
| Colleges of higher education (*) | 7 | 6 | 2 | 6 | 2 | 4 | 13 | 8 | 6 |
| Total (*) | 9 | 8 | 3 | 15 | 3 | 4 | 24 | 11 | 7 |

Note (*) of which provided all learning materials (including syllabi).

Table 2

Textbooks and syllabi that cover the key categories of distributed and retrieval practice with different levels of coverage (n = 61).

| | 0 = No coverage (%) | 1 = Partial coverage (%) | 2 = Full coverage (%) |
|-----------------------------|---------------------|--------------------------|-----------------------|
| Distributed practice | | | |
| Conceptual information | 38 (62) | 10 (15) | 13 (21) |
| Prescriptive information | 35 (57) | 19 (31) | 7 (11) |
| Reference to research | 48 (79) | 9 (15) | 4 (7) |
| Retrieval practice | | | |
| Conceptual information | 51 (84) | 3 (5) | 7 (11) |
| Prescriptive information | 26 (43) | 29 (47) | 6 (10) |
| Reference to research | 53 (87) | 5 (8) | 3 (5) |

such as learning theory, cognitive science, memory, metacognition, advice on how to plan, deliver or evaluate instruction, or teaching strategies. Subject-specific textbooks and syllabi were excluded, as the learning strategy is universally applicable and should not be restricted to subject-specific materials. This argument also applies to other additional learning materials such as PowerPoint® presentations, tasks, and exercises. Scientific articles were also collected, merged, and regarded as one reader per TEP.

In total, 136 textbooks and syllabi used in general teaching subjects were obtained from secondary TEPs in Flanders and The Netherlands and 61 of them had chapters on human cognition and how students learn. In a second phase, textbooks and syllabi per TEP were combined to analyse to what extent DP and RP were covered. Once the analysis was completed, the results and feedback were presented to the universities, colleges of higher education and publishers that use the textbooks.

8.2. Coding

To conduct the content analysis, a 3-point scoring rubric was created (see Appendix), based on a literature study of seminal articles on DP and RP. It consisted of a:

- (1) general description of the strategy and a statement of the primary cognitive purpose for and effects of the strategy (i.e., conceptual information);
- (2) guidelines for practical implementation in classrooms (i.e., prescriptive information); and
- (3) references to research and scientific authors.

All textbooks were scored on the three categories, using three levels of coverage (0 = not covered, 1 = partially covered, 2 = fully covered). For example, a description that “students should review their lessons regularly” was considered to be partially covered as the strategy was described (i.e., review) but not its purpose (i.e., to enhance retention). Also, textbooks that addressed classroom applications which were not linked with the learning strategy were not scored at the highest level of coverage. Category 3 was fully covered (i.e., a score of 2) when a textbook or syllabi referred to primary scientific sources, including researchers in and studies on DP and RP.

To determine the construct- and content validity of the coding scheme (e.g., synonyms of the terminology and clarifications about

possible contradictory ideas in textbooks), experts on cognitive science were consulted (see Acknowledgement). The coding scheme was piloted with two textbooks and refined afterwards. Then, two coders independently examined eight randomly selected textbooks to determine if the learning strategy was covered. The coders discussed their findings, and intercoder reliability was found to be 87% for both DP and RP, which was satisfactory. When there were inconsistencies, the researchers re-reviewed the textbooks until there was complete agreement. To establish intracoder reliability, the researchers reanalysed the same textbooks and syllabi after a period of one month to obtain an 88% level of agreement for DP and 92% for RP.

9. Results

Although DP and RP are considered to be essential learning strategies that every teacher should know, the majority of texts do not fully cover DP, RP nor the two strategies combined. See Table 2 for the percentage of written learning materials that fall into each of these three outcome options (i.e., no, partial or full coverage) for each of the three issues considered.

Of the textbooks and syllabi analysed, 21% contained full coverage of the purpose and description of DP. Almost two-thirds of the textbooks did not provide any mention of the learning strategy. Some 84% of the textbooks did not refer to RP as a learning strategy.

With respect to information on the application of DP and RP in classrooms, respectively only 11% and 10% of the textbooks provided two or more prescriptive applications linked with the strategies. Aside from this, textbooks had difficulties covering areas of research carefully, often not citing primary scholarly evidence where it existed. Some 79% (for DP) and 87% (for RP) of the textbooks did not use primary research to substantiate what they wrote about the two strategies. The researchers only found two textbooks which discussed both RP and DP fully at all three levels, and two additional textbooks which offered full coverage on the conceptual and prescriptive level but lacked references to research.

In Table 3, the percentage of learning materials that provide full coverage on DP, RP, and both RP and DP are presented. Four textbooks (7%) deliver a full coverage of both DP and RP, of which two (3%) refer to relevant research in the field.

Textbooks and syllabi per TEP were combined to analyse to what extent DP and RP were fully covered. Only TEPs which provided all learning materials, including syllabi, were included. As evidenced

Table 3

Teaching materials providing accurate coverage of distributed practice, retrieval practice and both strategies (n = 61).

| Learning materials | Conceptual information (%) | Prescriptive information (%) | Reference to research (%) | Cover all categories (%) |
|------------------------------------|----------------------------|------------------------------|---------------------------|--------------------------|
| Distributed practice | 13 (21) | 7 (11) | 4 (7) | 4 (7) |
| Retrieval practice | 7 (11) | 6 (10) | 3 (5) | 3 (5) |
| Distributed and retrieval practice | 6 (10) | 4 (7) | 2 (3) | 2 (3) |

Table 4

Teacher education programmes (that provided all their materials) providing accurate coverage of distributed practice, retrieval practice and both strategies (n = 24).

| Teacher education programmes | Conceptual information (%) | Prescriptive information (%) | Reference to research (%) | Cover all categories (%) |
|------------------------------------|----------------------------|------------------------------|---------------------------|--------------------------|
| Distributed practice | 9 (36) | 10 (40) | 3 (13) | 3 (13) |
| Retrieval practice | 6 (25) | 5 (21) | 2 (8) | 2 (8) |
| Distributed and retrieval practice | 5 (21) | 3 (13) | 1 (4) | 1 (4) |

in Table 4, a total of 9 TEPs provide correct conceptual information on DP and 10 offered accurate prescriptive information. In total, 3 out of 24 TEPs (12,5%) provide full, research-based coverage of DP in their textbooks and syllabi. RP was described fully in 6 TEPs with 5 TEPs offering concrete applications of the strategy in their written learning materials. Five TEPs offered textbooks and syllabi with conceptual information on both RP and DP, and 3 TEPs provided accurate classroom-applications for DP and RP. Only one TEP offered a conceptual and prescriptive information, explicitly linked with primary research.

10. Discussion

This study examined the degree to which textbooks and syllabi, used in TEPs fully cover DP and RP as learning, studying and teaching strategies. Our results indicate that, in general, textbooks and syllabi do not sufficiently cover essential topics from cognitive psychology or, in some cases, simply do not cover it at all. The results of our study are in line with Pomerance, Greenberg, and Walsh (2016), where DP was fully covered in only 22% of the American textbooks reviewed, and where RP was not covered at all. Only three TEPs provided textbooks and syllabi with a full coverage on DP. Two TEPs covered RP accurately in their written course materials. One TEP offered material which accurately covered both strategies. Such results indicate that teacher candidates may be under-informed, or even not informed by their learning materials about DP and RP, which raises two major concerns.

A first concern is the minimal effort witnessed to apply the theory intentionally to educational contexts. Topics potentially related to DP (e.g., homework, study skills, and preparation of exams and tests) or RP (e.g., practice testing, flashcards) were often discussed in chapters on instruction and evaluation without any mention of them as a means for facilitating learning. Without this direct link to the concepts, most student teachers will fail to make these connections on their own. As an example, one textbook stated that ‘Students forget the subject matter (...) it is therefore essential to revise what they have learned in a systematic way’ in a chapter on ‘direct instruction’, while in a next chapter on ‘learning strategies’ DP was not mentioned. Also, in a different textbook, homework was described as ‘useful to automate motoric skills, such as drawing and gym-exercises’, but the textbook also explicitly stated that the advantages of practice via homework do not apply to ‘the automatisisation of cognitive skills such as mathematical exercises and calculations, grammar exercises’. Finally, the use of flashcards, which can be used by students to quiz themselves, is described in a textbook only as a means of differentiation for low-performing students. When self-testing was mentioned, it was most often in function of formative assessment (i.e., to see what students already do and do not know). However, retrieval should also be used as a learning strategy, not only as an assessment tool. While formative assessment uses evaluation results to adapt the teaching to meet student needs, retrieval practice is a component of the broader concept of assessment for learning, described by Wiliam (2011) as “any assessment for which the first priority in its design and practice is to serve the purpose of promoting students’ learning”. It is desirable that textbooks include these nuances so that future teachers

can strengthen learning processes and the future quality of teaching.

A second concern is that textbooks only sparsely refer to research in the field of cognitive science. Sylvester Dacy et al. (2011) found that theory is possibly misinterpreted because textbook authors borrow ideas from each other, in view of the large number of references to each other’s work making the information second, third and even fourth hand. As, according to the Dutch and Flemish competence profiles for teachers (Flemish Government, 2008; HBO-raad, 2011) and development profile Dutch and Flemish teacher educators (VELON, 2016; VELOV, 2015), TEPs should engage with research and as there is a large research-base on both strategies, it is noteworthy that there were very few references to the original empirical research in the study materials. The failure to explain and apply DP or RP in an evidence-informed way in textbooks and self-written syllabi is particularly disconcerting in light of connecting evidence with the field of education. A possible reason why authors have difficulties to connect with evidence is that deans or publishers tend to call for syllabi or textbooks to be updated or prescribed at short notice (Sylvester Dacy et al., 2011). This lack of research could affect the accurate presentation of conceptual and prescriptive statements, as mentioned earlier.

11. Limitations

First, a selection of two evidence-informed learning strategies is potentially arbitrary no matter how vast the evidence is that they work. Researchers could investigate how other essential bodies of evidence on theories underlying effective strategies (e.g., cognitive load theory, cognitive theory of multimedia learning, dual coding) are covered including how they can and should be applied. However, DP and RP can be considered as two representative elements in educational psychology, since they are intensively studied and well-established strategies. Second, only textbooks and syllabi in general courses were chosen as empirical indicators for coverage of the strategy. Despite the impact of a textbook or syllabus on teacher education, it is the lecturer who decides how its content is used. Even without solid coverage of DP or RP in the texts, one cannot preclude the possibility that teacher educators model good teaching and embed the core principles of the science of learning in their lessons, PowerPoint® presentations, or the tasks that they give their students. Future researchers could examine the coverage of DP or RP in subject-specific pedagogical textbooks or could go beyond textbooks and carry out research on real classroom practice in teacher education. Third, no quantification of the number of pages dedicated to the strategies was performed, as quantity does not necessarily imply quality, but future research could quantify – as did the research carried out by NCTQ (Pomerance et al., 2016) – to find the proportion of ‘what works’ versus ‘what does not work’: to what extent do educational fads, such as learning styles (Kirschner, 2016; Pashler, McDaniel, Rohrer, & Bjork, 2009), appear in textbooks in proportion to evidence-informed strategies?

12. Pedagogical implications for authors, teacher education programmes and policy-makers

In light of this study, there are three challenges that require

attention, one each for authors, teacher education programmes and policy-makers.

12.1. Implication 1: textbook authors could highlight the relevance of DP and RP in an evidence-informed way

As evidence-informed learning strategies make a significant contribution to fostering effective learning, it is desirable to emphasise them explicitly in educational psychology textbooks. Authors of textbooks and syllabi – and in fact, all intermediaries between educational research and practice – have an impact on teachers, schools and their students' learning. As [Pomerance, Greenberg, and Walsh \(2016\)](#) stated, learning materials could at least offer complete descriptive and prescriptive information on DP and RP. Teacher educators and authors are encouraged to review their coverage of the learning strategies, or add it to their syllabi (teachers educators) or the appropriate chapter about learning (authors). [Roediger and Pyc \(2012\)](#), [Dunlosky et al. \(2013\)](#) and [Pashler et al. \(2007\)](#) amongst others greatly facilitated this task for DP and RP, by providing review studies, extensive summary descriptions using material taken directly from the primary sources. If the information in the textbooks and syllabi used is not congruent with these contemporary sources, they could be revised in accordance with this scientific evidence, which also implicates that topics that have little to no scientific value should be nuanced and appropriately valued.

There is also a need for clearer guidelines on how to create instruction, based on the central principles of both strategies. The textbooks could make clear connections between various teaching activities and DP and RP (e.g., designing optimal homework tasks could be associated with multiple exposures of valuable content and at the same time linked to the active recall of previous content). Also, guidelines of appropriate spacing intervals for DP and the benefits of feedback for RP might be added. Finally, the references for instructional topics could be to scientific sources reporting well-designed studies. By referring to such sources, the relevance of cognitive science is communicated to the wider community. The meta-studies above could be used to guide authors in improving the accuracy of their texts.

12.2. Implication 2: TEPs could select study materials that provide insight into the science of learning

Teacher candidates are novices in the field of education, and it could be beneficial if they were directed by experts to avoid the building of misconceptions about learning and instruction ([Kirschner et al., 2006](#)). [Kirschner and De Bruyckere \(2017\)](#) and [Frerejean, van Strien, Kirschner, and Brand-Gruwel \(2016\)](#) advocated that one should not assume that teacher candidates automatically have the general and digital information skills required to systematically search and assess information on learning strategies. Moreover, [Mayer and Fiorella \(2015\)](#) argued that learning strategies should not be a part of a hidden curriculum that future teachers are expected to magically discover by 'every day trial and error' ([Bjork, 1975](#), p. 455). Because textbooks and syllabi are still the backbone of coursework, it is recommended that teacher educators assess their written materials in a very rigorous way and select those which fully represent the recent state of the learning and teaching science. Many popular instructional constructs related to DP or RP are complex and sometimes easily misinterpreted by teachers without deeper knowledge of cognitive science ([Patrick et al., 2011](#)). In that respect, it is advisable that teacher educators do not assign textbooks or syllabi where fundamental instructional and learning strategies are either inaccurately presented, not presented at all, or rely mostly on secondary or tertiary sources.

Possible inaccuracies in the coursework can be supplemented with the aforementioned reference articles. As stated by [Koster, Brekelmans, Korthagen, and Wubbels \(2005\)](#), a task considered to be necessary for teacher educators is indeed to regularly review one's own teaching materials (p. 166). In summary, it is recommended that TEPs choose and offer high-quality study materials that deliver research-informed knowledge on learning and instruction to the teacher candidates.

12.3. Implication 3: policy-makers and researchers could provide a clear evidence-informed framework for intermediaries

Policy-makers could provide clear guidelines for TEPs about what every future teacher should know, based on knowledge of the evidence that exists about evidence-informed practice about learning. Minimal guidance possibly might lead to non-representation or underrepresentation of essential topics. Current directives for professional competence in Flanders and The Netherlands contain guidelines for teachers (e.g., teachers should know about learning processes and be able to consume research) and teacher educators (e.g., teacher educators should keep track of literature in the field of education) but do not explain what those learning processes are or what the expectations are for role of the 'researcherly' disposition of the teacher educator. ([VELON, 2016](#); [VELOV, 2015](#)). Their prescriptions are often broad or not founded in scientific evidence (i.e., a report from the Dutch Educational Inspectorate supports learning styles) ([Dutch Educational Inspectorate, 2016](#)). [Patrick et al. \(2011\)](#) stated that some countries (e.g., Germany, Australia, United Kingdom) require teacher candidates to meet more specific standards on professional knowledge and skills to help all students learn. Thus, a framework that organises and synthesises learning theories and research, such as *The Science of Learning* ([Deans for Impact, 2015](#)), could lead to a more accurate representation of essential topics from cognitive science.

The key point for policy-makers to promote better use of research knowledge is to act on the importance of the intermediary role. [Levin \(2013\)](#) discussed that rather than individual researchers or faculties trying to serve as their own intermediaries (though some do this well), it could be more effective and sustainable to partner with various intermediary organisations (e.g., pedagogical teacher guidance organisations, professionalisation networks) or support a consultation platform between researchers and practitioners, as recently stated and supported in the publication of [Flemish Educational Council VLOR \(2017\)](#). Also, the role of teacher educators as research-consumers and translators could be made more explicit. Our findings could appeal to national and local research bodies to support teacher education as an evidence-informed profession.

13. Conclusion

The results of our content analysis revealed that there is a need for greater and more accurate coverage of DP and RP in introductory textbooks and syllabi in TEPs. Future teachers should be well-prepared to teach with good, evidence-informed knowledge of how students learn. This study demonstrates that this is not always the case, with some educational psychology textbooks omitting or neglecting this. Authors of textbooks and syllabi are invited to include essential information on learning strategies in subsequent versions of their learning materials while educational policy can promote better use of sound research knowledge in teacher education. Although this study was carried out only in Flanders and the Netherlands, the authors believe that the findings are relevant across borders as witnessed in the NCTQ report ([Pomerance et al.,](#)

2016). Delivering learning materials that report the science of learning for future teachers is an achievable objective which can be realised in the short-term.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.tate.2018.05.007>.

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