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# WRITING HYPERTEXTS: PROPOSED EFFECTS ON WRITING PROCESSES AND KNOWLEDGE ACQUISITION

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**Abstract.** In this paper we propose that hypertext writing at school could have beneficial effects on the acquisition of content knowledge and the acquisition of writing skills compared to linear writing. We view the effects of hypertext writing on writing skills from the perspective of “shared” cognitive activities in writing linear texts and hypertexts. In a pilot study we examined the effects of hypertext writing on writing processes and we related the occurrence of writing processes to the quality of the resulting writing products. We set up this study to identify students’ cognitive activities during hypertext and linear writing. We also tried to determine whether hypertext writing could facilitate linear writing. We focused on the most central, distinctive features of linear and hypertext writing. For linear writing, this is a *linearization* process: i.e., transforming elements of content into linear text. For hypertext writing, this is a *hierarchicalization* process: converting a linearly presented line of thought into a hierarchical structure. Students ( $N=123$ ) from Grades 8 and 9 performed two linearization tasks and two hierarchicalization tasks under think aloud conditions.

Results showed that Planning and Analyzing activities contributed to the final quality of hypertexts and linear texts, and that these activities were more often elicited in hypertext tasks than in linear writing. We argue that writing hypertexts stimulates the use of writing activities that are positively related to writing proficiency. Moreover, we speculate that creating hypertext writing conditions and optimizing these conditions for different writer/learner styles might be a theoretical and practical challenge for mother tongue teaching.

**Keywords:** hypertext, writing, knowledge acquisition, writing processes, argumentative texts

**Chinese**

[Translated by Shek Kam Tse]

摘要: 在學校裏, 寫作超文本比線性寫作會更有助我們獲得知識和掌握寫作技巧的運用。我們會注意到, 從「集體」認知活動方面, 寫作超文本, 對寫作技巧上所產生的影響。在試測中, 我們會發現到超文件的寫作, 會對整個寫作過程是有影響的, 我們會把這個寫作過程的發生與當中的寫作成果的素質看成是相關的。我們會做一些研究去找出不同學生在寫作超文本和進行線性寫作時的認知活動, 亦嘗試去了解超文本寫作是否能促進線性寫作, 更會針對最集中和最突出的線性和超文本的寫作。在超文本的寫作上, 這是一個線性化的過程, 即將在改變中的元素, 轉換到線性文本上; 在超文本上, 這卻是一個階梯化的過程, 即把線性的思維轉化為有階級的結構。在一個充滿思考聲音下, 第八級和第九級的 123 位學生, 也履行了兩個直線和兩個階梯化的工序。

**Dutch**

Samenvatting [Translated by Tanja Janssen]

Hypertekst schrijven op school zou een positieve invloed kunnen hebben op het verwerven van inhoudskennis en schrijfvaardigheid, in vergelijking met lineair schrijven. In deze bijdrage bezien we de effecten van hypertekst schrijven op schrijfvaardigheid vanuit het perspectief van “gedeelde” cognitieve activiteiten bij lineair en hypertekst schrijven. In een vooronderzoek onderzochten we de effecten van hypertekst schrijven op schrijfprocessen en relateerden we schrijfprocessen aan de kwaliteit van het uiteindelijke schrijfproduct. We wilden achterhalen welke cognitieve activiteiten leerlingen gebruiken tijdens hypertekst schrijven en lineair schrijven. Ook wilden we nagaan of hypertekst schrijven bevorderlijk zou kunnen zijn voor lineair schrijven. We richtten ons daarbij op de meest centrale, distinctieve kenmerken van lineair en hypertekst schrijven. Voor lineair schrijven is dit het linearisatie proces, dit is: het transformeren van inhoudselementen in een lineaire vorm. Voor hypertekst schrijven is dit het proces van hiërarchisch maken: het omzetten van een lineaire gedachtenlijn in een hiërarchische structuur. Leerlingen (N=123) uit tweede en derde klassen van het voortgezet onderwijs voerden hardop denkend twee linearisatie en twee hiërarchiseringstaken uit.

Uit de resultaten komt naar voren dat de cognitieve activiteiten Plannen en Analyseren een bijdrage leveren aan de kwaliteit van de uiteindelijke tekst, en dat deze activiteiten vaker werden opgeroepen door de hyperteksttakers dan bij het schrijven van lineaire teksten. We betogen dat hypertekst schrijven het gebruik van schrijfactiviteiten bevordert die positief samenhangen met schrijfvaardigheid. We denken dat het creëren van hypertekst schrijfcondities en het optimaliseren van deze condities voor verschillende schrijfstijlen zowel theoretisch als praktisch een interessante uitdaging zou kunnen vormen voor het moedertaalonderwijs.

**French**

Résumé [Translated by Laurence Pasa]

Dans cet article, nous postulons que l'écriture d'hypertextes à l'école, plus que l'écriture linéaire, peut avoir des effets bénéfiques sur l'acquisition de connaissances et de compétences en écriture. Nous examinons donc l'influence de l'écriture d'hypertextes sur les compétences en écriture sous l'angle des activités cognitives "partagées" lors de l'écriture d'hypertextes et de textes linéaires. Dans une étude préliminaire nous avons étudié les effets de l'écriture d'hypertextes sur les processus d'écriture et nous avons relié la fréquence des processus d'écriture à la qualité des produits en résultant. Nous avons mis au point cette étude pour identifier les activités cognitives des étudiants pendant l'écriture d'hypertextes et l'écriture linéaire. Nous avons également essayé de déterminer si l'écriture d'hypertextes pouvait faciliter l'écriture linéaire. Nous nous sommes focalisés sur les caractéristiques les plus centrales et les plus discriminantes de l'écriture linéaire et d'hypertextes. Pour l'écriture linéaire, il s'agit du processus de linéarisation qui consiste à transformer des contenus en texte linéaire. Pour l'écriture d'hypertexte, il s'agit du processus de hiérarchisation qui consiste à convertir une suite linéaire d'idées en structure hiérarchique. Des collégiens (N=123) de 4<sup>ème</sup> et 3<sup>ème</sup> ont exécuté deux tâches de linéarisation et deux tâches de hiérarchisation tout en verbalisant à haute voix.

Les résultats montrent que la planification et l'analyse de la tâche participent à la qualité des hypertextes et des textes linéaires produits, et que ces activités sont plus souvent suscitées lors de l'écriture d'hypertextes que durant l'écriture linéaire. Nous concluons que l'écriture d'hypertextes stimule l'utilisation de processus d'écriture positivement liés à la compétence scripturale. De plus, nous pensons que créer des situations d'écriture d'hypertextes et les adapter aux différents apprenants scripteurs représente un défi théorique et pratique pour l'enseignement des langues maternelles.

**German**

Zusammenfassung [Translated by Irene Pieper]

In diesem Beitrag argumentieren wir, dass das Schreiben von Hypertexten in der Schule positive Effekte auf den Wissenserwerb sowie auf den Erwerb von Schreibfähigkeiten im Vergleich zum linearen Schreiben haben kann. Wir betrachten die Effekte des Hypertext-Schreibens auf Schreibfähigkeiten aus der Perspektive der „geteilten“ kognitiven Aktivitäten im Schreiben von linearen Texten und Hypertexten. In einer Pilotstudie haben wir die Effekte des Hypertext-Schreibens auf den Schreibprozess untersucht und die beobachtbaren Schreibprozesse mit der Qualität der Schreibprodukte in Beziehung gesetzt. Ziel der Studie war es, die kognitiven Aktivitäten der Schüler und Schülerinnen beim Hypertextschreiben und beim linearen Schreiben zu beobachten. Wir versuchten auch zu klären, ob Hypertextschreiben das lineare Schreiben erleichtern könnte. Wir konzentrierten uns auf die zentralen und distinkten Charakteristika von linearem und hypertextuellem Schreiben. Für lineares Schreiben bestehen diese im Prozess der Linearisierung: d.h. es werden Elemente in einen linearen Text umgesetzt. Für hypertextuelles Schreiben bestehen diese in einem Prozess der Hierarchisierung: eine in linearer Form gefasste Linie von Gedanken wird in eine hierarchische Struktur überführt. SchülerInnen (N=123) der Jahrgänge 8 und 9 bewältigten zwei Linearisierungsaufgaben und zwei Hierarchisierungsaufgaben unter Think-Aloud-Bedingungen.

Die Ergebnisse zeigen, dass Planungs- und Analyseaktivitäten zur Endqualität sowohl der Hypertexte als auch der linearen Texte beitragen. Diese Aktivitäten waren bei den Hypertext-Aufgaben oft deutlicher konturiert. Wir argumentieren, dass das Schreiben von Hypertexten Schreibaktivitäten stimuliert, die sich positiv auf die Schreibfähigkeiten auswirken. Wir nehmen außerdem an, dass das Schaffen von Bedingungen für das Hypertext-Schreiben und ihre Optimierung für unterschiedliche Schreib-/Lernstile eine theoretische und praktische Herausforderung für den Unterricht in der Muttersprache darstellt.

**Greek**

Metafrase [Translated by Panatoya Papoulia Tzelepi]

Στο άρθρο αυτό προτείνουμε την υπόθεση ότι η γραφή υπερκειμένου στο σχολείο μπορεί να έχει θετικά αποτελέσματα στην κατάκτηση γνώσεων περιεχομένου και στην απόκτηση δεξιοτήτων παραγωγής κειμένου συγκρινόμενη με την γραμμική παραγωγή κειμένου. Εξετάζουμε τα αποτελέσματα της γραφής υπερκειμένου στις δεξιότητες παραγωγής γραπτού από την προοπτική των «μοιρασμένων/κοινών» γνωστικών δραστηριοτήτων κατά τη γραφή υπερκειμένου και γραμμικού κειμένου. Σε μια πρόδρομη έρευνα εξετάσαμε τα αποτελέσματα γραφής υπερκειμένου στις διαδικασίες παραγωγής γραπτού και παραβάλαμε την παρουσία των διαδικασιών με την ποιότητα του γραπτού προϊόντος. Οργανώσαμε αυτή την έρευνα για να διαγνώσουμε τις γνωστικές δραστηριότητες των μαθητών κατά τη διάρκεια γραφής υπερκειμένου και γραμμικού κειμένου. Επίσης προσπαθήσαμε να διακρίνουμε εάν η γραφή υπερκειμένου θα μπορούσε να διευκολύνει το γραμμικό γράψιμο. Εστίασαμε στα πιο κεντρικά, ιδιαίτερα χαρακτηριστικά της παραγωγής γραπτού υπερκειμένου ή γραμμικού. Εις ό,τι αφορά το γραμμικό γραπτό, αυτό είναι η διαδικασία «γραμμικοποίησης» δηλαδή η διαμόρφωση στοιχείων περιεχομένου σε γραμμικό κείμενο. Στο υπερκείμενο γραπτό αυτό είναι η «ιεραρχικοποίηση» δηλαδή η μετατροπή μιας σειράς σκέψεων σε μια ιεραρχική δομή. Μαθητές (N=123) από τις τάξεις 8 και 9 εκτέλεσαν δύο έργα γραμμικοποίησης, και δύο έργα ιεραρχικοποίησης υπό συνθήκες φωναχτής σκέψης.

Τα αποτελέσματα έδειξαν ότι οι δραστηριότητες σχεδιασμού και ανάλυσης συνέβαλαν στην τελική ποιότητα των υπερκειμένων και των γραμμικών κειμένων και ότι αυτές οι δραστηριότητες προκαλούνται πιο συχνά στα υπερκείμενα από ό,τι στη γραφή γραμμικών κειμένων. Υποστηρίζουμε ότι η γραφή υπερκειμένων προκαλεί τη χρήση δραστηριοτήτων γραφής που σχετίζονται θετικά με την επάρκεια στο γράψιμο. Επιπλέον αναμένεται ότι η δημιουργία συνθηκών γραφής υπερκειμένου και η ενίσχυσή τους για διαφοροποιημένα στυλ μαθητών/συγγραφέων ήταν μια θεωρητική και πρακτική πρόκληση για τη διδασκαλία της μητρικής γλώσσας.

**Polish**

Streszczenie Translated by Elżbieta Awramiuk]

W niniejszym artykule dowodzimy, że pisanie hipertekstu w szkole może mieć korzystny wpływ na przyswajanie wiedzy i umiejętność pisania w porównaniu do pisania linearnego. Wpływy pisania hipertekstu na umiejętności pisania rozpatrujemy z perspektywy wspólnych działań poznawczych w pisaniu tekstów linearnych i hipertekstów. W badaniach pilotażowych badaliśmy wpływ pisania hipertekstu na procesy pisania i powiązaliśmy występowanie procesów pisania z jakością uzyskanych produktów pisania.

Przeprowadziliśmy to badanie, aby zidentyfikować czynności poznawcze studentów w czasie pisania hipertekstu i pisania linearnego. Próbowaliśmy także ustalić, czy pisanie hipertekstu może ułatwić pisanie linearne. Skoncentrowaliśmy się na głównych, dystyngtywnych cechach pisania hipertekstu i pisania linearnego. Dla pisania linearnego jest to proces *linearyzacji*, co oznacza przetwarzanie elementów treści na linearny tekst. Dla pisania hipertekstu jest to proces *hierarchizacji*, czyli przekształcanie linearnie prezentowanej linii myśli w hierarchiczną strukturę. Studenci ( $N=123$ ) z klas 8 i 9 wykonali dwa zadania linearyzacji oraz dwa zadania hierarchizacji, dzieląc się głośno myślami.

Rezultaty wykazały, że czynności Planowania i Analizowania miały wpływ na końcową postać hipertekstów i tekstów linearnych i że działania te częściej były aktywowane w zadaniach dotyczących hipertekstu niż przy pisaniu linearnym. Twierdzimy, że pisanie hipertekstów stymuluje użycie tych czynności pisania, które są pozytywnie skorelowane z biegłością w pisaniu. Ponadto rozważamy, czy stworzenie warunków do pisania hipertekstu i ich optymalizowanie dla różnych stylów piszących / uczących się mogłoby być teoretycznym i praktycznym wyzwaniem dla nauczania języka ojczystego.

### Portuguese

Resumo [Translated by Paulo Feytor Pinto]

Neste artigo propomos que a escrita de hipertexto na escola, quando comparada com a escrita linear, pode ter efeitos benéficos sobre a aquisição de conhecimentos e sobre o desenvolvimento de competências de escrita. Os efeitos da escrita hipertextual sobre as competências de produção escrita são encarados como actividades cognitivas partilhadas de escrita de textos lineares e de hipertexto. Num estudo piloto, examinámos o efeito da escrita de hipertexto sobre os processos de escrita e relacionámos a presença desses processos com a qualidade dos produtos escritos deles resultantes. Este estudo pretendia identificar actividades cognitivas dos estudantes implicadas na escrita linear e na hipertextual. Também procurámos determinar em que medida a escrita hipertextual podia facilitar a escrita linear. Centrámos-nos, assim, nas principais características que distinguem estes dois tipos de escrita. No caso da escrita linear, o processo de linearização, ou seja, a transformação do conteúdo em texto linear. No caso da escrita hipertextual, o processo de hierarquização, isto é, a conversão de uma linha de pensamento apresentada linearmente numa estrutura hierárquica. Estudantes ( $N=123$ ) do 8º e do 9º ano realizaram duas tarefas de linearização e duas tarefas de hierarquização podendo dialogar com os colegas e/ou o professor.

Os resultados mostraram que as actividades de Planificação e Análise contribuíram para a qualidade final dos hipertextos e dos textos lineares, e que estas actividades ocorriam mais vezes nas tarefas hipertextuais que nas tarefas de escrita linear. Afigura-se-nos por isso evidente que a escrita de hipertexto estimula o uso de actividades de escrita que estão positivamente relacionadas com a competência de produção escrita. Além disso, reflectimos sobre a possibilidade de a criação de condições para a escrita de hipertexto e de a optimização dessas condições para diferentes estilos de escreventes/aprendentes poder constituir um desafio teórico e prático para o ensino da língua materna.

## 1. INTRODUCTION

Writing education in the Netherlands has changed considerably due to the introduction of a new examination program for the upper secondary grades. Both the position of writing tasks in writing education and the use of writing in the subject domains have changed. Within the school subject Dutch (“writing for communication”) writing tasks have become more frequent and varied. In other subjects writing and presenting are more often used than before (a focus on “writing as a learning tool”). Furthermore, information and communication technology (ICT) plays an important role in information retrieval and in text composition and revision. Students can choose to produce a hypertext (i.e., a nonlinear text in which information is organized as a network in which nodes are text chunks and links are relationships between the nodes (Rouet, Levonen, Dillon, and Spiro, 1996)).

Nevertheless, there is a large gap between the theoretical possibility of constructing hypertexts at school and the current practice in schools. An analysis of text books for the subject Dutch in upper secondary education showed that none of the

text books offered theory, instructions, exercises or examples for hypertext writing. Furthermore, interviews with Grade10 students about hypertext writing in the subject Dutch revealed that within the subject Dutch, students do not write hypertexts. Some students write hypertexts at school, but then, in the context of the optional course Information Technology, for instance, they write a hypertext about the presidential elections in the USA. Furthermore, from the interviews we learned that students have more experiences with writing hypertexts at home, for pleasure, than at school. Some students make web pages, for instance about their leisure interests (e.g., television series, movies, sports), usually containing pictures, columns, and biographical information. The quality and structure of the students' hypertexts differ strongly. Some students design their documents with programs like *FrontPage* and *Dreamweaver*, resulting in their own, "original" website with many navigation possibilities, but very popular with students at the moment are also "ready made" profile websites such as Cu2 (see for examples, <http://www.cu2.nl/>).

By introducing hypertext writing at school, the gap between the practice at school and the situation at home concerning hypertext writing might be bridged. We believe that introducing hypertext writing at school could have beneficial effects on learning outcomes in two respects: (a) acquisition of content knowledge, and (b) acquisition of writing skills. In this article, we will provide a theoretical basis for these expectations and report a pilot study that points to effects of hypertext writing on writing skills. Finally, we will describe implications for new research activities.

### *1.1 Effects on content knowledge*

There are high expectations about the effect of writing as a learning tool (Klein, 1999). Writing-to-learn is seen as a means of transforming the writer's knowledge. Knowledge transforming, as described by Bereiter and Scardamalia (1987), means that writing can contribute to knowledge acquisition when the text is formulated within a continuous interaction between the content-related knowledge (the topic addressed in the text) and the rhetorical knowledge (as reflected by the design of the text and, among other things, its structure). This problem-solving procedure (Hayes, 1996) requires text producers to reflect on and to extend their knowledge. However, it is difficult to engage writers in knowledge transforming activities (De Jong, Kanselaar, & Lowyck, 2003). A meta-analysis of 48-school-based writing-to-learn programs showed small average effects on content learning by conventional academic measures (Bangert-Drowns, Hurley, & Wilkinson, 2004).

Theoretically, hypertext writing might be a better candidate than linear writing to accomplish knowledge transforming activities because the text is produced in an unfamiliar (hypertext) format (Lohr, Ross, & Morrison, 1995; Yoshimura, 1998). This unusual format initiates a problem-solving process in which writers cannot simply fall back on previously acquired routines. They cannot make use of their default knowledge-telling strategy. Instead, producing hypertexts places particular constraints on the design of the documents that are due to features of the text format: the non-linear structure, the nodes, the links, ways of navigation, and so on. It is assumed that these constraints help to support a production process that can be

equated with the knowledge-transforming strategy. Stahl and Bromme (2004, 548-549) suggest that writing hypertext might support knowledge acquisition in the following way:

“(a) Writing nodes requires an author to discriminate between semantic concepts so that they can be presented as text units, each one being comprehensible by itself. As a result, writing nodes can contribute to the comprehension of concepts and conceptual differences within a subject matter. (b) Thinking about necessary links requires the processing of semantic relations between the concepts explained in different nodes. A thoughtful application of links can thereby contribute to the comprehension of semantic relations. (c) When planning the overall structure, an author has to comprehend the content structure of the subject matter. Because of their multi-linearity, hypertexts can be read in different ways. Thus, authors have to anticipate possible audience perspectives to create flexible ways of reading their hypertext. This might contribute to a deeper comprehension of semantic structures within the subject matter and to a more flexible use of this new knowledge”.

The first two assumptions of Stahl and Bromme (2004) are clearly related to the genre hypothesis of Klein (1999). This genre hypothesis supposes (among other things) that as writers generate content appropriate to each discourse element (e.g., evidence, claims and warrants in the genre of argumentation), and specify the relationships among these elements, they construct corresponding relationships among elements of their own knowledge. This might be especially the case in lengthy, hierarchically structured texts in which each section includes several subordinate propositions (Klein, 1999: 230-231). Because hypertexts are by nature hierarchically structured with different discourse elements and relationships between these elements, the construction of hypertexts could assist students in writing-to-learn.

Bromme and Stahl (2002) confirmed the expectations about the effects of hypertext writing on knowledge acquisition. In an experimental study, they asked 40 college students to create hypertexts in two sessions by linking given nodes on the topic “Internet”. Two groups were formed, an experimental group and a control group. In the first session, in the experimental group ( $n=20$ ), participants were asked to construct a hypertext for readers who were mainly interested in the historical aspects of Internet. In the second session, participants had to construct a hypertext for readers who particularly wanted information about the services of the Internet. The control group ( $n=20$ ) had to find an “optimal structure” during both sessions. In the first session they were asked to construct a hypertext so that a fictitious readership would gain general information on the topic of the Internet. In the second session, they were told that participants often like to rewrite their hypertexts, and that they now had an opportunity to improve the structure of their hypertext by linking the nodes again. By comparing these two groups, Bromme and Stahl could test how far adopting two different anticipated reader perspectives influenced the learning process. Pre-tests and post-tests on aspects of knowledge acquisition (content knowledge, relation knowledge and transfer knowledge) were administered. Furthermore, the total structures of the hypertexts, the computer operations, and the decision processes of the participants during the construction sessions were analyzed.

Constructing a hypertext from two different reader perspectives was found to involve a more intense dealing with the hypertext structure. Furthermore, and in line with the knowledge-transforming model, the participants reflected more strongly on

the semantic structures of the subject area they were dealing with. Moreover, Bromme and Stahl showed that the intervention of structuring the hypertext from two different perspectives supported knowledge gain, particularly in terms of acquiring knowledge about relations and transfer knowledge.

### *1.2 Effects on writing skills*

Besides the effects of writing hypertexts on content knowledge, we also assume there are effects on writing skills. Other researchers (Lohr et al., 1995; Snyder, 1997) have also suggested that hypertext writing enhances students' writing abilities but unfortunately little empirical research has been published (DeWitt, 1996; Snyder, 1997). More frequently published are publications about lessons in which hypertext writing plays a role (cf. DeWitt, 2001; DeWitt & Strasma, 1999) or non-empirical studies about the implications of hypertext writing (cf. Lohr et al., 1995; Russell, 1998).

We view the effects of hypertext writing on writing skills from the perspective of "shared" cognitive activities in writing linear texts and hypertexts. We expect that implementing hypertext writing in writing education will have beneficial effects on writing skills because students may learn to cope with the linearization process (Bereiter & Scardamalia, 1987; Coirier, Andriessen, & Chanquoy, 1999). In the following sections, we will elaborate on our theoretical framework and we will report on a pilot study in which we tested our expectations (see Braaksma, Rijlaarsdam, Couzijn, & Van den Bergh, 2002).

## 2. HYPERTEXT WRITING AND ITS EFFECTS ON WRITING PROCESSES: A PILOT STUDY

It usually takes considerable time and effort for students to build up some expertise in the writing of linear texts. Similarly, it takes a long while to develop from being an associative writer (as described in Bereiter and Scardamalia's knowledge-telling model, 1987) into a writer who is able to restructure, build and convey knowledge during the writing process (Bereiter and Scardamalia's knowledge-transforming model, 1987).

A major problem for adolescent writers is to write in genres other than lists and narratives, which are in the default format linear texts, consisting of sequenced elements, connected one by one. For this type of text, the knowledge-telling model of text production is sufficient and efficient. However, other text types, such as exposition and argumentation, rely on a network of multilinked ideas, which young writers do not realize, and which is often generated associatively via the knowledge telling strategy, rather than hierarchically (Coirier et al., 1999). A second problem is that this hierarchy of multilinked idea units must be presented in a linear text, with verbal markers, paragraphing, and punctuation to signal the hierarchy in the linear text. Only then, writers help their readers to understand the text, as it is the reader's task to deconstruct the linear text into an underlying hierarchical information structure (Van Dijk & Kintsch, 1983).

In addition, writing in the hypertext mode requires a well-developed sense of structure. It relies heavily on ordering, clustering and connecting ideas (whether generated from memory or from elsewhere). In the case of written sources, it also requires a deconstruction of traditional, linearly presented information. To arrive at a well-constructed hypertext, an underlying hierarchical information structure needs to be established first. If there is a sound underlying hierarchy, the composing process for hypertext is more likely to succeed. In this sense, a requirement for composing hypertext is to make an in-depth analysis of the hierarchy without thinking in linear formats, and to structure the text in a hierarchical rather than linear fashion. Learning to compose hypertext may therefore help students become aware of hierarchical text structures. Paradoxically, this may in turn contribute to students' skill in composing linear texts, for which a hierarchical information structure also serves as a good starting point.

The aim of our pilot study was to identify a set of cognitive activities performed by secondary school students while writing hypertext. There is a growing body of knowledge about the cognitive processes involved in writing (see edited volumes by Levy and Ransdell (1996); Rijlaarsdam, Van den Bergh, and Couzijn (1996)). A variety of methods have been used to model the architecture of the writing process and its sub-processes. Alamargot and Chanquoy's review of the writing models – starting from the well-known model by Hayes and Flower – provides a rich insight into the progress made (Alamargot & Chanquoy, 2001). Our pilot study is based on writing process research that we conducted previously among students in the same age group (about 14-15 years). In these studies we modeled students' writing processes empirically, using writing-aloud protocols, that we analyzed with an extensive coding scheme grounded in the Hayes and Flower model (1980). We identified the cognitive activities involved in several stages of the writing process. By relating these processes to the resulting text quality – essay scores – we identified more and less effective distributions of these cognitive activities across the process<sup>1</sup>.

Our study of hypertext writing processes was a pilot, in which we compared the processes of two types of tasks that are not “natural” writing tasks, but which are constructed to elicit basic common activities in linear and hypertext writing. The choice of these tasks was based on a global analysis of hypertext writing in comparison to linear text writing (see next section). Furthermore, our aim was to identify writing processes of so-called “good novices”, i.e., to establish which cognitive activities performed by secondary students are closely linked to higher quality linear texts and hypertexts. With this analysis we tried to detect the qualitative relationship between the two ways of writing, and the extent to which hypertext writing facilitates or hinders the development of linear writing, and vice versa.

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<sup>1</sup> See for a recent overview Rijlaarsdam and Van den Bergh (2006); for an overall study including all cognitive activities, see Breetvelt, Van den Bergh, and Rijlaarsdam (1994); for the process of structuring, see Rijlaarsdam and Van den Bergh (1996); Van den Bergh & Rijlaarsdam (1996); for re-reading, see Breetvelt et al., (1994); for several content generation processes, see Van den Bergh and Rijlaarsdam (1999); and for goal orientation, see Van den Bergh and Rijlaarsdam (2001).

2.1 Hypertext and linear text: a global analysis of cognitive activities

A significant problem in text composition is the linearization process (Coirier, 1996; Coirier et al, 1999). Students develop their ideas, chiefly following associative paths. Next, one or more structuring processes may follow (see Figure 1).

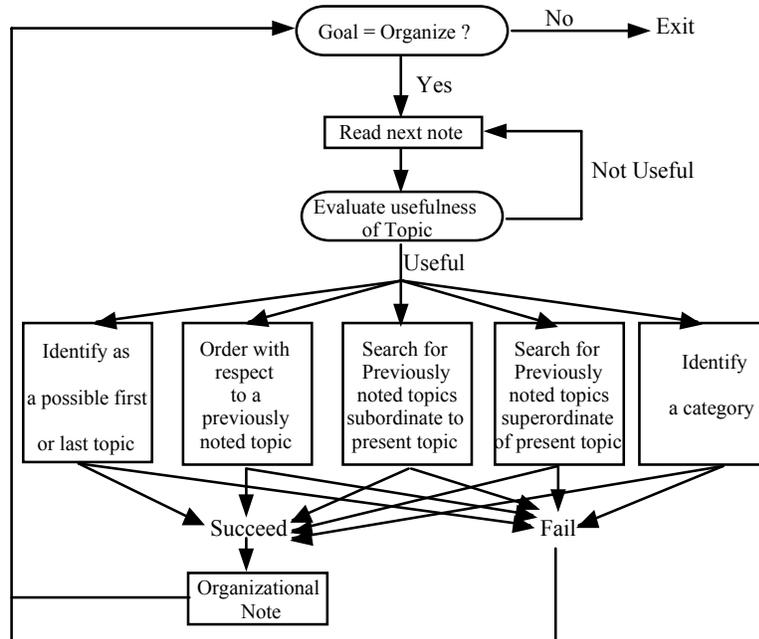


Figure 1. Framework for the sub-process “Organizing”, adapted from Hayes and Flower (1980). Copyright © 1980 by Lawrence Erlbaum Associates. Adapted with permission.

Structuring involves clustering and ordering these ideas (Hayes & Flower, 1980; for an extensive review, see Alamargot and Chanquoy (2001)). Hayes and Flower described four relationships between ideas: direct (“Order with respect to a previously noted topic”), subordinated (“Search for previously noted topics subordinate to present topic”), superordinated (“Search for previously noted topics superordinate to present topic”), or hierarchically categorized (“Identify a category”).

Structuring is an important sub-process, which as Rijlaarsdam and Van den Bergh (1996) showed, directly affects the final quality of argumentative texts. However, structuring is also difficult. Two types of structuring can be distinguished, one type following the other. First, to arrive at a writing plan, students must determine the structural relationships in a network of ideas. Next, they must transform this structure into a linear form (that is, into a logically and verbally coherent sequence), while still providing their readers with information about, and with explanations of, their hierarchical structure – for instance, by using connectors and other structure

markers. This route is presented in Figure 2, starting at the bottom from the associative network of ideas, and moving via the writing plan to the upper left hand corner, where the writing process results in a linear text. A reader of such linear text will have to deconstruct the linear form to build a hierarchy of connected ideas (resembling a hypertext: the upper right hand corner box in Figure 2). If the communication is without bias, this mental representation will successfully reflect the network of ideas with which the writer started.

In many instances, however, writers do not succeed in communicating their hierarchy of ideas to the reader without any distortion. One possible cause of this is the necessary linearity of a text. Because ideas have to be sequenced in a linear way – with a succession of words, sentences, ideas and themes – and because content is generated in an associative fashion, writers tend to produce their texts via a “shortcut” route; in other words, ideas are written in the same order in which they were generated, without being re-structured or re-ordered into a coherent writing plan.

One of the difficulties in teaching writing is to offer alternatives to this “shortcut route”, and to teach students to rework their ideas into a writing plan (whether mental or written), and then to teach the linearization process, i.e., to show students how they can sequence ideas in a linear fashion, and how they can use textual signs to guide readers in their process of reconstruction and regeneration, when the text can be converted into a hierarchical network of ideas. One may decide to teach this process once students have achieved a writing plan.

What happens when students use the same network of ideas as a basis for writing a hypertext? Again, they will transform the network of ideas into a writing plan, by articulating and structuring these ideas. But this time, the hypertext or “end product” may resemble the writing plan more closely than it would when they were writing a linear text. When guided by the goal of producing a hypertext, the process of structuring textual units is more “natural”. Obviously, ideas still need to be clustered, and some ideas, or clusters of ideas, will be subordinated, and others superordinated, and yet others co-ordinated. Thus, the process of clustering and relating ideas will remain a necessary step.

In the light of this analysis, our plea for introducing hypertext writing in schools raises some questions. From an educational perspective, one may ask whether the inclusion of such hypertext writing tasks inhibits or facilitates “normal”, i.e., linear text writing. If students write more hypertexts and fewer linear texts, the influence of the lower number of linearization exercises may become noticeable. On the other hand, when students write hypertexts they will not be able to use the “shortcut” route, but will have to transform their associative ideas into some hierarchy of ideas, and this hierarchy of ideas into an apparent textual hierarchy. In this sense, they will spend more learning time on structuring information.

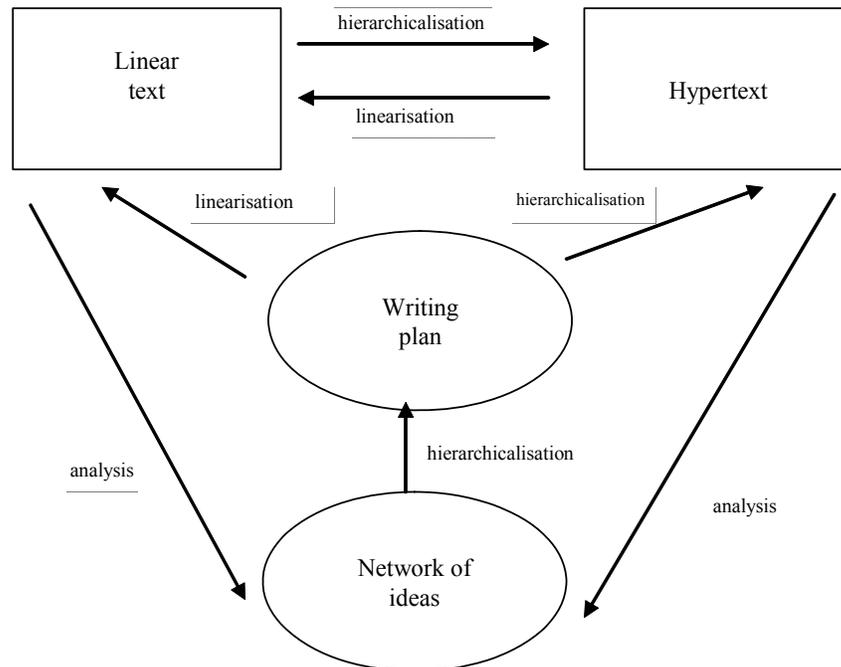


Figure 2. Different paths when writing linear or hypertexts.

Thus, learning to write hypertext has potentially beneficial and detrimental effects. So, will writing hypertext facilitate or hinder linear text writing? Most transfer theories would suggest that this will depend on the cognitive activities involved in these writing processes, and on whether students will perceive these activities to be similar. If they do consider them to be similar, transfer is more likely to occur.

In order to shed some light on the relationship between linear and hypertext writing, we set up a pilot study, addressing two questions: (a) To what extent is the writing of hypertext a new activity that needs to be learnt? (b) Does exercise in hypertext writing facilitate or interfere with writing linear texts?

In our pilot study, we focused on the most central, distinctive features of linear and hypertext writing. For linear text writing, this is the *linearization process*: i.e., transforming (subordinated, superordinated and co-ordinated) elements of the writing plan into linear text. For hypertext writing, the central feature is a *hierarchicalization process* i.e., transforming into a hierarchical structure ideas that result from a generating process and are presented in a linear fashion. The following section describes in more detail the tasks we implemented in the pilot study.

## 2.2 Method

We studied the writing processes of secondary students, each of whom wrote two short linear texts and made two short hierarchical structures. Details of the method are provided below.

### 2.2.1 Participants

In total, 123 students participated in the study. One group of participants consisted of 69 students recruited from twelve different groups in a multicultural school in Amsterdam. These participants were from eighth grade, and their average age 14. From each class, the teacher selected the six most verbally skilled students for participation in the study. Another group of participants consisted of 54 students drawn from five different schools in the Amsterdam region. They were from ninth grade, and their average age 15. All participants in this study took part on a voluntary basis; it was fully understood that the results of the study would not be part of the regular testing procedures at their schools.

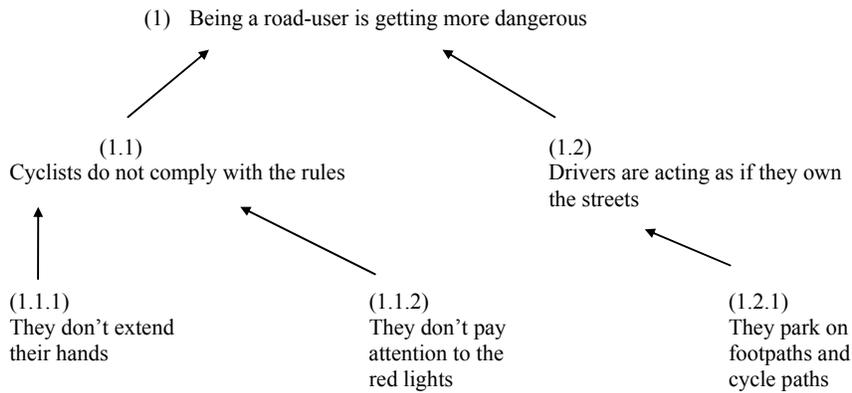
### 2.2.2 Tasks

Students were asked to think aloud while solving two linearization tasks and two hierarchicalization tasks. A linearization task consisted of transforming a given argumentation structure into a linear argumentative text. A hierarchicalization task consisted of transforming a given linear argumentative text into an argumentation structure. Both tasks were non-familiar tasks for the students; therefore differences in the verbalization process between the two tasks were not expected. In each case, students completed first a simpler task, and then a more complex task. No feedback was provided. Figure 3 shows a sample linearization task, and Figure 4 a sample hierarchicalization task. Argumentative texts were chosen because of the overt hierarchical relations between standpoint and (subordinated) arguments.

Think-aloud protocols were typed, fragmented and scored. For scoring we used categories adapted from an instrument used in previous writing process studies (Braaksma, Rijlaarsdam, Van den Bergh & Van Hout-Wolters, 2004; Breetvelt, Van den Bergh & Rijlaarsdam, 1994, 1996; Van den Bergh, Rijlaarsdam & Breetvelt, 1994; Van den Bergh & Rijlaarsdam, 1996, 1999; Rijlaarsdam & Van den Bergh, 1996; Van den Bergh & Rijlaarsdam, 2001). The categories used were Goal-orientation, Planning, Analysis, Pausing, Formulating, Writing, Evaluation, Re-reading, Revision, and Meta-analysis. Most of the categories used for the analysis of the think-aloud protocols are self-evident (see Appendix A for a complete overview with examples). Three more complex categories – Analysis, Planning and Meta-analysis – are explained below.

Task : Write a short argumentative text based on the following argumentation structure. Make sure a reader will understand the standpoint and arguments in your text.

Structure:



Write your text here:

Figure 3. Linearization task.

Task: Below you will find a short argumentative text. You are asked to draw the argumentation structure of that text. Remember to put the text and the arrows in the right place.

Text: The dollar is considerably below two guilders, thus it has a favorable exchange rate. Also at the moment, airplane tickets are very inexpensive. And the climate is also very nice, the temperature is approximately 20 degrees and there is hardly any rain. In short, it is a good moment to spend our holidays in the United States.

Figure 4. Hierarchicalization task.

*Analysis.* This category is used when the student analyses the argumentation structure of the text or the structure, labeling elements as standpoints, arguments, and so forth. For example: “Y is the standpoint.” This utterance is coded as *Analysis*, as the student labels a fragment from the text or the structure as a concept taken from argumentation theory.

*Planning.* Planning is used when an element indicates local planning. In other words, the student plans a step in the process, usually on the basis of an argumentation structure (in which, for example, argumentation will follow an initial standpoint statement). The student coaches himself through the task, usually by uttering a temporal indication: “First I will...”, “Then I must...”, and “Now I’m going to...”. For example: “First, I will start with the first argument.” This phrase indicates that the student is probably using a known task scheme to perform the task.

*Meta-analysis.* Meta-analysis is used for a broad category of fragments in which the student monitors and regulates task execution: e.g., when stopping the process for some reason; when re-generating information on how to handle this kind of task (i.e., when generating the procedures); when making a remark on the level of difficulty of the task or on his or her own ability. Problem definition, problem solution and checking the solution are also coded as Meta-analysis. Examples:

“OK, let’s see whether I’ve included all the sentences.”

(On the last part of a task): ...”So, now I’ve done all the arguments.”

“First, I will read through the whole text.”

“...This is rather a difficult one...”

We also scored the quality of the output of the writing processes: the argumentative texts and argumentation structures. The output scores were obtained by coding the resulting texts and argumentation structures on the aspects completeness, logical order, and use of connectives (or connecting arrows). We coded according to strict criteria. For instance, when writing linear texts, the students had to use explicit connectives to connect the standpoint with the subordinated arguments. If they connected a standpoint with an argument by using a comma, this was coded as incorrect. See appendix B for some illustrations of the coding of the argumentative texts and the argumentation structures.

A few weeks later, the students performed similar tasks under “normal” (i.e., non think-aloud) conditions. The quality of these tasks was also scored.

Thus, in total we acquired four think-aloud protocols from each student, plus the quality scores of the resulting products, and quality scores of products from four similar tasks administered under “normal” conditions.

### 2.2.3 Two illustrations

The first example below (see Figure 5) shows a hierarchicalization task, in which the student reads a short text fragment in which several arguments and a standpoint are given. The task involves turning the information elements into a hierarchical argumentation structure (see Figure 4). By following the thinking-aloud protocol, the particular approach taken by this student becomes clear. The second column contains the codes we used to describe the steps in the thinking process.

<i>Utterance in writing aloud process</i>	<i>Cognitive activity</i>
The dollar is considerably below the two guilders, thus it has a favorable exchange rate. Also on the moment, airplane tickets are very inexpensive. And the climate is also very nice, the temperature is approximately 20 degrees and there is hardly any rain. In short, it is a good moment to spend our holidays in the United States.	Reads text
Uhm, standpoint is	Analyses standpoint
That we should go to the United States of America	Formulates standpoint before writing
Uhm, thus a couple of pro arguments	Analyses arguments
The dollar has a favorable exchange rate	Formulates argument before writing
The climate is also very nice	Formulates argument before writing
The tickets are very inexpensive	Formulates argument before writing
And then two subordinate arguments	Plans subordinate arguments
The dollar is considerably below the two guilders	Analyses subordinate argument
The temperature is approximately 20 degrees and there is hardly rain	Analyses subordinate arguments
Thus, the standpoint	Plans standpoint
We should go to the United States of America	Formulates standpoint while writing
First argument is	Plans first argument
The dollar has a favorable exchange rate	Formulates argument while writing
That has a subordinate argument	Plans subordinate argument
The dollar is considerably below the two guilders	Formulates subordinate argument while writing
Uhm, and then there is another argument	Plans compound argumentation
The tickets are very inexpensive	Analyses argument
The tickets are very inexpensive	Formulates argument while writing
And then the third argument	Plans compound argumentation
The climate is also very nice	Analyses argument
The climate is also very nice	Formulates argument while writing
And two subordinate arguments	Plans subordinate arguments
The temperature is approximately 20 degrees	Analyses subordinate argument
And	Formulates while writing
there is hardly rain	Formulates subordinate argument while writing
So, this is it	Stops/starts new cognitive activity

*Figure 5. Example thinking-aloud protocol hierarchicalization task.*

This example shows a student who first analyses the standpoint, arguments and subordinate arguments (showing that he knows and identifies the ingredients), and then

starts drawing the argumentation structure, moving step by step, following an “internal plan”.

The second example (see Figure 6) shows the execution of a linearization task. Here, the student is presented with a hierarchical argumentation structure on paper (see Figure 3), which he has to transform into normal, linear text. The writing strategy of this student can be followed via the coded activities in the second column.

<i>Utterance in writing aloud process</i>	<i>Cognitive activity</i>
Task.	Reads task
The standpoint is.	Analyses standpoint
Being a road-user is getting more dangerous.	Reads structure
Argument 1.1 is cyclists do not comply with the rules and that is because the cyclists don't extend their hands and cyclists don't pay attention to the red lights.	Analyses arguments and subordinate arguments
And the argument 1.2 is drivers are acting if they own the streets and that is because the drivers park on footpath and cycle path.	Analyses arguments and subordinate arguments
And now I am thinking if I will first take the argument and then the standpoint.	Plans
Then, it must be thus.	Analyses connective
Cyclists do not comply with the rules.	Formulates before writing
Because they don't extend their hands.	Formulates argument before writing
Extend their hands.	Formulates subordinate argument while writing
And they don't pay attention to the red lights.	Formulates subordinate argument while writing
Further, drivers are acting if they own the streets because they park on footpath and cycle path.	Formulates argument and subordinate argument before writing
Further, drivers are acting if they own the streets because they park on footpath and cycle path.	Formulates argument and subordinate argument while writing
And then the standpoint.	Plans standpoint
Thus, being a road-user is getting more dangerous.	Analyses standpoint
Thus, being a road-user is getting more dangerous.	Formulates standpoint while writing
Ok.	Stops/starts new cognitive activity

*Figure 6. Example thinking-aloud protocol linearization task.*

The student in this example first analyses the different ingredients of the argumentation structure (standpoint, arguments, and subordinate arguments). Next, he thinks about the place he will put the standpoint. Deciding to end with it, he then writes the entire text without mentioning the ingredients until he comes to the standpoint. At that point, he plans the standpoint and writes it down.

2.3 Results

2.3.1 Processes in linear writing and hypertext writing

Results reveal that, on the whole, the hypertext writing tasks elicited more occurrences of various sub-processes verbalized by the students than linear writing tasks did, even though, in structural terms, the tasks mirrored each other in argumentative complexity. For all activities except Re-reading, hypertext tasks elicited significantly more occurrences (F values rating from 15.86 (Evaluation) to 136.44 (Analysis), all significant ( $p < .001$ ,  $df 1/122$ )). We therefore conclude that, while hypertext writing and linear text writing rely on the same set of cognitive activities, hypertext writing requires more of these activities to fulfill the task.

A second step in the search for similarities and differences between hypertext writing and linear text writing is to study the “arrangement” of the cognitive processes involved. The question is not just whether hypertext writing results in more cognitive activities, but whether the cognitive activities relate to each other in a different way than they do in linear text writing. When we compare the proportions of the cognitive activities between the two types of tasks, a clear pattern of differences emerges. Table 1 shows the differences in relative occurrences of cognitive activities between linear text writing and hypertext writing<sup>2</sup>.

Table 1. Relative occurrences of cognitive activities in hypertext writing and linear text writing (tested with logit scores)

Cognitive activities	Linear writing task	Hypertext writing task
Pausing		
Formulating		
Writing	+	
Goal-orientation		
Planning		+
Analysis		+
Evaluation		
Re-reading	+	
Meta-analysis		+

Although the hypertext and linear writing tasks were similar in structural complexity, the role played by Planning ( $F(1, 122) = 6.47$ ,  $p = .01$ ) and Analysis ( $F(1, 122) = 143.67$ ,  $p = .001$ ) was larger in the hypertext writing process than in the linear text writing process, while in linear writing relatively more Writing ( $F(1, 122) = 35.37$ ,  $p = .001$ ) and Re-reading ( $F(1, 122) = 20.33$ ,  $p = 0.01$ ) activities occurred. These differences suggest that metacognitive activities which are known to influence the quality of the writing product, like Planning, are stimulated in hypertext writing (ab-

<sup>2</sup> The activity Revision occurred so rarely that we have neglected it altogether in this study.

solite scores) and that hypertext writing is guided by more goal-oriented activities than linear writing.

The question now arises of the extent to which these cognitive activities are related to the quality of the end product, i.e., the resulting text for a linear writing task, or the resulting hierarchical structure for a hypertext writing task. In the following section we examine whether or not there is a positive link between a higher frequency of a particular cognitive activity and the quality of the writing product.

### 2.3.2 *Correlational perspective*

To investigate this question, we correlated the occurrences of cognitive activities with the quality score for the resulting products. As we explained earlier, product quality is defined as the extent to which the resulting text represented the original argumentation structure (in linear text writing), or the structure represented the original text (in hypertext writing).

When we concentrate on some general findings<sup>3</sup>, the quality of the linear texts proved to be related to the proportion of Analysis and Planning activities performed during writing; the same holds for the hypertexts: the higher the proportion of Analysis and Planning activities, the better the hypertext.

We conclude that Analysis and Planning are key activities in writing linear texts and in writing hypertext. Students who arrange their writing process by including relatively many Analysis and Planning activities have a better chance of producing not only good linear texts, but also good hierarchical texts. Combined with the finding that in hypertext writing students are more stimulated to use Analysis and Planning activities, hypertext writing could be beneficial for linear writing.

This claim could be warranted if the quality of hypertext processes is related to the quality of linear texts of the same writer. And indeed, the proportion of Planning activities during hypertext writing was not only related to the quality of the two hypertexts the student wrote, but also to the quality of the two linear texts the student wrote. The same holds for the opposite direction; the proportion of Planning and Analyzing activities in linear writing was related to the quality of the linear texts, but also to the quality of two hypertexts the same student wrote. We may conclude that processes dominated by Planning and Analysis are effective in the writing of both hypertexts and linear texts.

### 2.3.3 *Conclusions*

In sum, when we use the relative attention paid to cognitive activities in linear text writing and hypertext writing as an indication of the way students arrange their writing processes, we conclude that the extent to which students guide their production processes along Analysis and Planning, determines whether they write better texts. Given the fact that the number of these activities in linear text writing is very low in frequency, while in hypertext writing significantly more (absolute and proportional)

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<sup>3</sup> For a more detailed presentation of results we refer to Braaksma, Rijlaarsdam, Couzijn, and Van den Bergh (2002).

of these activities are undertaken, learning to write hypertexts might have a beneficial effect on linear writing.

### 3. NEXT STEPS

The pilot study we reported in this article focused on hypertext writing and cognitive activities during writing and was not aimed at exploring the effect of hypertext writing on content knowledge acquisition. In follow up experiments, we will assess the effect of hypertext writing on content knowledge acquisition, compared to linear text writing, as well. As a first step for these follow up experiments, we set up a design study in which we developed an extensive lesson series for hypertext writing (experimental group) and linear writing (control group) and several pre-tests and post-tests to study effects on writing skill and knowledge acquisition. In the next sections, we will give an overview of the lessons and test materials and share some experiences of students and teachers who worked with the lessons.

#### *3.1 Description of the lesson series on hypertext writing and linear writing*

As in the pilot study, we focused the lesson series on the text type “argumentative text” because of the “natural” urge to connect and order ideas in a hierarchical way. In an argumentative text, students have to support their standpoint with several arguments which in turn have to be supported with subordinated arguments. In this way, an overt hierarchical network is created. Furthermore, this text type is one of the major text types in writing education and is often tested on the national exam in the Netherlands. Therefore, this text type is very suitable for a lesson series in the final grades of pre-academic secondary education (Grades 10-12).

We developed the lesson series in close cooperation with a team of (upper secondary school) teachers and researchers of writing. The lesson series consisted of five lessons of 70 minutes each. Materials for the lessons included a detailed teacher’s manual and students’ workbooks containing small theoretical parts, and instructions and exercises. We developed the lesson series in two versions: (a) a hypertext version (HYP) for the experimental hypertext writing group, and (b) a linear version (LIN) for the linear writing control group. The two versions of the lesson series were similar in many respects. Both versions had the same text type (argumentative text), theme, amount of lessons, instruction time, etc. In fact, the first three lessons were exactly the same. Only the fourth and the fifth lesson differed between the groups. Then, the students in the HYP-group received a technical instruction about how to write hypertexts and wrote their argumentative text in a hypertext format. In contrast, the LIN-group wrote their argumentative text in a linear format. Before we give more detailed information about the content of each lesson, first we will describe the theme and the didactic principles of the lesson series.

The theme of the lesson series is “good charities”. We provided the students with documentation materials (e.g., newspaper articles, tables with results from research) about this topic. So, there was no need for the students to gather information about “good charities” themselves. Furthermore, students did not start with writing their

argumentative text immediately. Instead, they spent much time on practicing argumentation skills and on exploring the subject “good charities”. For this exploration, we adopted the inquiry strategy (Hillocks, 1982, 1995). Using this strategy, students investigate the subject (phenomena) by using basic strategies such as careful observation and representation in language of the phenomena observed, questioning, comparison and contrast of the phenomena with prior knowledge, and formulating and testing tentative hypotheses. The writing of extended definitions of the subject is also part of the inquiry procedure. In our lesson series, we implemented the inquiry strategy by asking students to make concept maps about “good charities”, to write down an extended definition of “good charities” and to think of a good cause in the neighborhood of the students’ school.

Another characteristic of the lesson series was the cooperation between students. In the first four lessons, most of the time the students worked together in pairs and in small groups (e.g., designing a concept map, thinking of a good cause, and formulating advice for a good introduction to a text).

Table 2 gives an overview of the aims and accompanying activities in the lesson series. As can be seen in Table 2, in lesson 4 students practiced taking care of different readers’ perspectives. We incorporated this learning activity in view of Stahl and Bromme’s (2004) finding that writing for different audiences is an effective ingredient in hypertext writing.

Table 2 also shows that in the last part of lesson 4 students in the HYP-group practiced the technical aspects of hypertext writing. They received a short instruction about making hyperlinks in Microsoft Word, making bookmarks, making new hypertext pages, and saving their hypertext pages. Afterwards, they put this knowledge into practice by writing collaboratively with a peer a short hypertext about their hometown. We provided students with technical instruction only; students were completely free in choosing and inventing the (type of) links and the structure of their hypertext. Meanwhile, students in the LIN-group wrote a piece on “how to get in a bad mood”. We inserted this activity because it was important that both groups spent equal learning time in the lesson series, without providing the LIN-group extra instructions about argumentative writing or the content “good charities”.

*Table 2. Overview of the lesson series for both groups (each lesson is 70 minutes)*

Lesson	Aims and accompanying activities	Group
1	<i>Aim:</i> acquiring content; activating prior knowledge about “good charities”. <i>Activities:</i> making concept maps about “good charities”, thinking about criteria for “good charities” and writing an extended definition of “good charities”.	HYP and LIN
2	<i>Aim:</i> acquiring content; concretizing of the criteria for “good charities”. <i>Activities:</i> thinking of, and inventing a good cause in the neighborhood of the students’ school.	HYP and LIN

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3	<p><i>Aim:</i> acquiring knowledge about argumentation; experiencing how argumentation rhetorically works.</p> <p><i>Activities:</i> playing a simulation game; fundraising of the proposal for a good cause and convincing other students of that good cause.</p> <p><i>Aim:</i> acquiring content about “good charities”.</p> <p><i>Activities:</i> processing information about “good charities” by reading documentation and taking up a standpoint in an actual issue about “good charities”.</p>	<p>HYP and LIN HYP and LIN</p>
	<p><i>Aim:</i> acquiring knowledge about argumentation; the structure of argumentation.</p> <p><i>Activities:</i> selection of arguments for the standpoint with the help of the documentation, and structuring the arguments in an argumentation structure.</p>	<p>HYP and LIN</p>
4	<p><i>Aim:</i> acquiring knowledge of presentational aspects of writing.</p> <p><i>Activities:</i> writing a first version of the introduction of the argumentative text which is rhetorically attractive.</p> <p><i>Aim:</i> acquiring knowledge of presentational aspects of writing.</p> <p><i>Activities:</i> practicing with presentational aspects of argumentative texts: getting attention from readers, taking care of different kinds of readers’ perspectives, and a clearly structured presentation of arguments.</p>	<p>HYP and LIN HYP and LIN</p>
	<p><i>Aim:</i> acquiring knowledge of technical aspects of composing hypertexts.</p> <p><i>Activities:</i> practicing with technical aspects of composing hypertexts in Microsoft Word.</p>	<p>HYP</p>
	<p><i>Aim:</i> performing a “filler activity” to compensate for the time spent on the technical aspects of hypertext in the HYP condition</p> <p><i>Activities:</i> writing a recipe for a bad mood.</p>	<p>LIN HYP</p>
5	<p><i>Aim:</i> bringing together all aspects of the lessons series; content, argumentation, and presentational aspects.</p> <p><i>Activities:</i> writing an argumentative text as a contribution to an actual issue about “good charities” in <i>hypertext</i> form.</p>	<p>LIN HYP</p>
	<p><i>Aim:</i> bringing together all aspects of the lessons series; content, argumentation, and presentational aspects.</p> <p><i>Activities:</i> writing an argumentative text as a contribution to an actual issue about “good charities” in <i>linear</i> form.</p>	<p>LIN</p>

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### 3.2 Description of the test materials

To examine the effect of hypertext writing on writing skills and content knowledge acquisition in follow up experiments, we developed several test materials.

As pre-tests, we constructed tests on computer skills (especially experiences with hypertext writing), knowledge about argumentative writing (declarative and procedural knowledge), self-efficacy for argumentative writing, knowledge about the con-

tent of writing (i.e., knowledge about “good charities”), and aptitude (verbal intelligence).

As post-tests, we measured knowledge about argumentative writing (declarative and procedural knowledge), self-efficacy for argumentative writing, knowledge about the content of writing (i.e., knowledge about “good charities”), and quality of a *linear* argumentative text about another topic (“broadcasting for youth”). Students wrote their linear texts on the computer, and their writing processes were logged with the program Inputlog (Van Waes & Leijten, 2006). Moreover, the writing style of the students was assessed by using a writing questionnaire developed by Kieft, Rijlaarsdam, and Van den Bergh (2006). This enabled us to study the possible interactions between students’ writing style and condition (see below).

During the lesson series, self-efficacy for argumentative writing was also measured after each lesson. Moreover, we looked at the quality (e.g., style, structure, readers’ perspectives) of the hypertexts and linear texts that were written in lesson 5 to get insight into the way the students composed their (hyper)text.

### 3.3 *Students’ and teachers’ experiences*

Three teachers (from three different schools in the Netherlands) implemented the lesson series in their tenth-grade classes (senior general secondary education). They also administered all pre-tests and post-tests. In total, 203 students participated (87 in the experimental HYP-group and 116 in the control group LIN). Preliminary analyses of the test materials showed that the tests we developed were of good quality. The reliability of the tests was adequate (Cronbach’s alpha .72) and the students understood the test instructions and were able to perform the tests within the time specified.

Furthermore, lesson observations and conversations with students and teachers indicated that the experiences with the lessons in both groups were quite positive. Both teachers and students liked the theme “good charities” and the issues we provided, because this theme is in the news nowadays, is broad and close to the students’ social world. The teachers appreciated the structured way in which the lessons and the students’ activities were organized, the quality of the hypertexts, linear texts, and other products of the students, and the pace of the lesson series. The teachers also gave advice for improving the lessons; for example, they suggested more explicit instruction for the composition of the structure of the hypertexts, more feed back opportunities for teachers as well as for students, and more instruction and exercises in taking up a standpoint and thinking of arguments.

The students responded positively to the cooperation with peers, the provided documentation about “good charities”, the making of the concept maps, the invention of a good cause of their own, and the practical nature of the lesson series. Furthermore, the students in the HYP-group liked the writing of the hypertexts; they found it a well-organized way of working

They also made some critical points: they would like to have more time for reading the documentation, they found some exercises difficult or vague (e.g., thinking of criteria for “good charities”), and they found that some exercises resembled each

other (first making a concept map individually and then making a concept map in small groups).

In general, the linear texts and the hypertexts the students wrote were of good quality. Due to the clear technical instruction, all students in the HYP-group were able to compose their argumentative text in hypertext form. Because we did not provide explicit instruction about the structure and (type of) links, the structure of the hypertexts differed, which is, from our point of view, a good starting point for subsequent lessons. Some students wrote quite a long “linear-like” homepage with “only” informative links in it (e.g., explanations of the work from non profit charitable organizations); other students also wrote a “linear-like” homepage but used links to the arguments for their standpoint. Other students composed a more hierarchical hypertext containing a short homepage with an introduction and the formulation of their standpoint and with links to sub pages in which they worked out their arguments and conclusion<sup>4</sup>. For a next version of the lesson series we believe these different hypertexts might be used as examples, to be discussed and evaluated by students.

### *3.4 The effects of hypertext writing and learner characteristics*

Creating hypertext writing conditions and optimizing these conditions for different writer/learner styles might be a theoretical and practical challenge for mother tongue teaching. In a recently published study, Kieft, Rijlaarsdam, and Van den Bergh (2006) reported interactions between type of writing intervention and writing style. This study shows that knowledge acquisition depends on the match between intervention and writer style. Studies by Torrance and Galbraith (see their review in Torrance and Galbraith, 2006) and Hayes (2006) indicate that the quality of the knowledge generation process depends on the match between writing conditions and writing style. Two styles can be distinguished; a style that needs writing to generate ideas (“think while writing”), and a style that leans on preplanning (“plan before writing”).

To examine the interaction between the effects of hypertext writing on writing skills and knowledge acquisition and learner characteristics, we did some preliminary analyses on the data collected in the design study. We explored the interactions between the learning conditions (HYP and LIN) and writing style profile (defined by focusing on pre-planning and level of revision) of the student on writing processes, as collected with Inputlog. Multivariate analyses showed a clear interaction between conditions and writing style on text features (e.g., number of sentences, paragraphs, variation in sentence length and paragraphs):  $F(1/32) = 4,972, p = .000$ .

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<sup>4</sup> Examples from students' hypertexts, photos from students at work, lesson materials, and more information about the project can be found on [http://www.ilo.uva.nl/homepages/martine/hypertext\\_project.htm](http://www.ilo.uva.nl/homepages/martine/hypertext_project.htm)

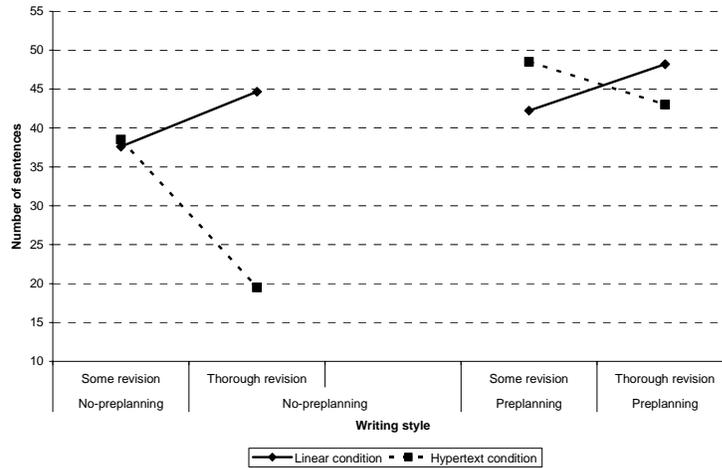


Figure 7. Interaction effects between condition and writing style on number of sentences written in the post-test (linear text).

Figure 7 shows the interaction between writing styles and learning conditions for the number of sentences produced by students during the post-test (a *linear* argumentative text about the topic “broadcasting for youth”). The solid lines show the scores for the linear text writing condition (LIN); the dotted lines show the scores for the hypertext writing condition (HYP). In the linear text condition, a clear interaction with revision style occurs: students who are used to revising their drafts thoroughly produced more sentences in this condition than students who revise little. In the hypertext condition, this interaction is just the other way around; students who usually revise little perform better (that is, produce more sentences) in the hypertext conditions than their peers who are used to revising thoroughly.

From these preliminary analyses, we became aware that learning to write text via the linear or hypertext route might have different effects for different writers. What Kieft, Rijlaarsdam, and Van den Bergh (2006) showed – students with different writing styles seem to profit from different learning arrangements – also seems to play a role in the effects of learning to write hyper- or linear texts. However, we do not know, yet, whether the variable we explored in these preliminary analyses is related to the quality of texts. It may be that we need to refine our theoretical assumptions; writing hypertexts may be effective for some writers, while learning to write linear texts might be effective for other types of writers.

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APPENDIX A

*Cognitive activities and their descriptions*

Cognitive activity	Description
Goal-orientation	Reading (parts of) the argumentation structure in the assignment and (re)definition task (for instance, “So, I have to write a text”).
Planning	Local planning. Planning of a step in the process. The participant coaches himself through the task, usually by uttering a temporal indication (for instance, “First, I will start with the first argument”).
Analysis	Analyzing the argumentation structure of the text, labeling elements as standpoints, arguments, and so forth (for instance, “Y is the standpoint”).
Evaluation	Evaluating (parts of) formulations, analyses, or already written text (for instance, “That is not a nice sentence”).
Meta-analysis	Monitoring and regulating task execution: e.g., stopping the process for some reason; re-generating information on how to handle this kind of task; making a remark on the level of difficulty of the task or on own ability (for instance, “This is rather a difficult one”).
Formulating	Formulating (parts of) texts before writing.
Transcribing	Dictating (parts of) texts while writing.
Re-reading	Re-reading (parts) of already written text.
Revision	Revising already written text by addition, deletion, or transposition.
Pausing	Silence and/or sounds indicating thoughtfulness (for instance, “Ehm, ehm”).

## APPENDIX B

*Coding of the argumentative texts*

The guiding principle for scoring the quality of the argumentative texts was "reversibility": the analysis of the written text should result in the given hierarchical argumentation structure. This principle implies that the components of the argumentation structure in the text could be identified, and that the relation between the components was clearly signaled by the way the elements were ordered and indicated by connectives. A quality score reflected the number of elements in the written text that could be correctly placed back in the original hierarchical argumentation structure.

The scoring principle takes into account that participants could choose different solutions for linearizing the hierarchical structures. For instance, they could start or end with the standpoint, as long as readers could identify the relation, indicated by the connective (e.g., "because" signaling a subordinate, "thus" signaling a superordinate relation). Writers were also allowed freedom in the way they presented coordinated arguments. For example, when a hierarchical structure contained three coordinated arguments (some with subordinate arguments), writers were not required to present these arguments in the same order as in the original structure, as long as the reconstruction in the written text resulted in a structure with three coordinated arguments (with their subordinate arguments). Three examples may illustrate the scoring procedure. All three examples are texts written by participants. The hierarchical argumentation structure that had to be transformed into linear text can be found in Figure 3.

(a) "Being a road-user is getting more dangerous because firstly cyclists don't comply with the rules, as they don't extend their hands and don't pay attention to the red lights. Secondly, drivers are acting as if they own the streets because they park on footpath and cycle path."

(Score: 100% correct, all six ingredients (standpoint, main argument 1.1, subordinate argument 1.1.1, subordinate argument 1.1.2, main argument 1.2 and subordinate argument 1.2.1) are correctly identified and connected).

(b) "Drivers are acting as if they own the streets because they park on footpath and cycle path. Moreover, cyclists don't comply with the rules because they don't extend their hands and they also don't pay attention to the red lights. Thus: being a road-user is getting more dangerous."

(Score: 100% correct, all six ingredients (main argument 1.2, subordinate argument 1.2.1, main argument 1.1, subordinate argument 1.1.1, subordinate argument 1.1.2, and standpoint) are correctly identified and connected).

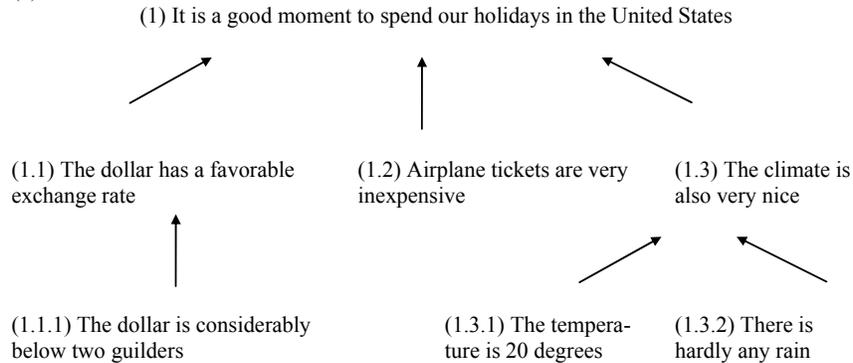
(c) "Being a road-user is getting more dangerous because cyclists don't comply with the rules, because they don't extend their hands and don't pay attention to the red lights. Secondly, drivers are acting as if they own the streets and they park on footpath and cycle path."

(Score: 83.3% correct, five ingredients (standpoint, main argument 1.1, subordinate argument 1.1.1, subordinate argument 1.1.2, and main argument 1.2) are correctly identified and connected. The subordinate argument 1.2.1 (they park on footpath and cycle path) is incorrectly identified and connected).

*Coding of the argumentation structures*

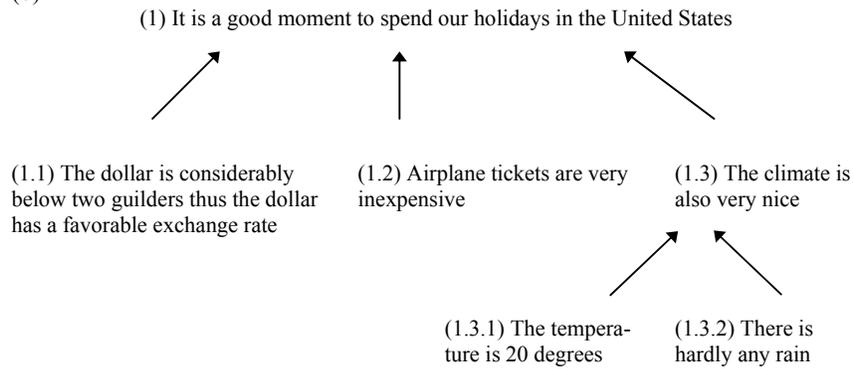
The guiding principle for scoring the quality of the argumentation structures was "reversibility" as well: the analysis of the hierarchical argumentation structure should result in the given written text. This principle implies that the components of the text could be identified, in the argumentation structure of the student. A quality score reflected the number of elements in the hierarchical argumentation structure that could be correctly placed back in the original linear text. Two examples may illustrate the scoring procedure. These examples are structures made by participants. The linear argumentative text that had to be transformed into the hierarchical argumentation structure can be found in Figure 4.

(a)



(Score: 100% correct, all seven ingredients (standpoint, main argument 1.1, subordinate argument 1.1.1, main argument 1.2, main argument 1.3, subordinate argument 1.3.1, and subordinate argument 1.3.2,) are correctly identified.

(b)



(Score: 72 % correct, five ingredients (standpoint, main argument 1.2, main argument 1.3, subordinate argument 1.3.1, and subordinate argument 1.3.2,) are correctly identified. Main argument 1.1 and subordinate argument 1.1.1 are incorrectly identified).

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