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Introduction to the special issue on synthesis tasks: where reading and writing meet

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Synthesis writing is a type of source-based writing that requires writers to synthesize the information from different sources into a new and meaningful text. A synthesis task is a cognitively demanding, so-called hybrid task (Spivey & King, 1989) as it involves both reading and writing activities that alternate throughout the process. When carrying out such tasks, students must switch between two ‘roles’: that of a reader who wants to understand the source contents and that of a writer, who wants their text to be understood. Given that a synthesis text is based on sources, the students have to read and understand the sources. They have to identify and select the relevant information. Moreover, they have to compare and contrast information units in the sources in order to cluster information within and between sources, to generate overarching labels for such clusters, and to detect complementary and/or contradictory information within and between these clusters. Apart from these source-related comprehension-driven activities, students have to write a reliable text that can be read independently from the sources. During this process, reading activities are interspersed with writing activities, varying from making notes in the source materials, to drafting schemes and text production. At the same time, writing activities are interspersed with reading activities to generate additional meaning which must be coherently matched via abstracting activities into the text-written-so-far. Moreover, authors will regularly check the meaning of the text-so-far, against the source materials. This whole reading-writing process is guided by the goal to understand the information available coherently, and to produce a text that is understood by readers who did not have access to the sources.

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Synthesis writing is a common activity in both upper-secondary and higher education (Raedts et al., 2017; Van Ockenburg et al., 2019), as the act of synthesizing is the highest cognitive operation for comprehension, useful in academic and workplace contexts (Leijten et al., 2014). Producing synthesis texts is considered to be an important learning task in education because of its epistemic value. Synthesis tasks have a high learning potential as the reading, rereading, integration, organization and elaboration of different source texts calls for knowledge transformation (Solé et al., 2013; Spivey & King, 1989). Independently of the field of study, all students will write multiple types of synthesis texts during their academic career. Students find it challenging, which is not surprising given the cognitively demanding nature of the task (Martínez et al., 2015; Mateos et al., 2008; Solé et al., 2013).

With this special issue in *Reading and Writing*, we aimed to bring together studies on the reading-writing connection in synthesis writing. When launching the call, we expressed our interest in studies that addressed one of the following topics:

Reading and/ or writing processes of synthesis tasks Previous research with a strong focus on the synthesis writing process is rather scarce. In studies by Martínez et al. (2015) and Mateos and Solé (2009), analysis of video recordings showed that higher-grade and thus more experienced students tend to adopt a less linear approach than less-experienced students. This amounted to a more recursive process in which reading and writing activities alternate throughout the process. Leijten et al. (2019), Vandermeulen, van den Broek et al. (2020c), and Chau et al., (2022) used keystroke logging to map the use of sources during the writing process, and related the source use to the text's quality. Recent reading process studies have focused on various aspects of the reading process of source-based tasks, such as strategic processing of sources (Latini et al., 2020), sourcing and evaluating the credibility of online sources (Kiili et al., 2021; Salmerón et al., 2018), and information selection (Cameron et al., 2017).

Effects of task and learner variables in synthesis writing Current research on source-based writing involves a variety of synthesis tasks. Tasks vary, for example, in communicative goal, and source texts differ in difficulty, topic, number of sources and complementary character of the sources (Barzilai et al., 2018; Vandermeulen, De Maeyer, et al., 2020a). Additionally, several learner characteristics might play a role in the processing of source-based tasks (Anmarkrud et al., 2022; Tarchi et al., 2022). It is therefore worthwhile to explore the effect of task (e.g., task goal, perceived difficulty) and learner variables (e.g., topic interest, prior knowledge, need for cognition) on several outcome measures such as the writing or reading process, the final written product, knowledge gain, or text comprehension.

Intervention studies aiming to improve students' synthesizing performance Several studies have tested intervention programs to improve students' performance on source-based tasks (Van Ockenburg et al., 2019). Some of these studies presented extensive intervention programs within the *writing-to-learn* view, including a mix of strategy instruction, video modeling, collaborative practice and written strategy guides (Granado Peinado et al., 2019; Martínez et al., 2015). Other intervention treatments were designed from a *learning-to-write* paradigm, including analysis and discussion of good and poor synthesis texts (Boscolo et al., 2007), and feedback based on keystroke logging (Vandermeulen et al., 2022). More research

on instruction and feedback aiming to support students' synthesizing skills is very much needed, also from a learning-to-write perspective.

In response to the call, we received 22 abstracts. We invited seventeen of them for full submissions and received fourteen manuscripts to review. All papers were reviewed by three reviewers. We are particularly grateful to them for their help, and their continued dedication and engagement to provide opinions to some contributions two or three times. We are also very grateful to the authors, for moving their contributions forward based on those comments. After these rounds of review and revision, ten manuscripts were accepted for publication in this special issue on "Synthesis tasks: Where reading and writing meet".

Overview of the studies in this issue

This special issue has four parts: (1) mapping the terrain of synthesis research, (2) process studies, (3) intervention studies, and (4) automatic assessment of synthesis texts. Each part contains one or several studies. In what follows, we give an overview of all the contributions to this special issue.

Mapping the terrain of synthesis research

The special issue opens with a review by Nancy Nelson and James King (2022), *Discourse synthesis: Textual transformations in writing from sources*. They provide us with their map of the terrain of research in synthesis composition and embed their review in a historical account. The review focuses on the process of 'construction meaning from texts for texts', which requires three operations: organizing, selecting and connecting. These operations are the focus around which Nelson and King review three themes in synthesis writing. First, they analyze the role of task features, especially genres and textual functions, in these operations. They show how writers must adapt these key operations to the context of the task. Second, the authors discuss methodologies to trace these operations in processes, via text-based and process-based methods. The third perspective deals with instructional approaches, homing in on the most difficult operation – connecting or integrating – which seems to be best instructed explicitly via modeling. This holds for connecting selected content –the cognitive operation – but also for the transformative reuse of language, the way authors articulate content from other texts, using the words the sources provide them with, and adding their own content.

Process Studies

Three studies in this special issue investigate reading and writing processes of synthesis texts, sometimes in combination with different task types and learner groups. The studies deal with secondary school students (Barzilai et al., 2021) and university students (Castells et al., 2022; Valenzuela & Castillo, 2022). Barzilai et al. (2021) and Castells et al. (2022) start from a writing-to-learn perspective, that is,

they investigate how writing can support content learning (from sources) or reading comprehension of source texts. The main focus in both studies is the reading process and its relation to writing and vice versa. In Castells et al. writing is a learning activity rather than a final product as in Barzilai et al. The study of Valenzuela and Castillo then focuses on the writing process, more specifically pausing, and investigates if pausing behavior is altered as a result of source modality (i.e., digital or print) and communicative purpose (inform vs persuade).

Barzilai et al. (2021) explored the use of a document mapping tool that supports students in constructing visual representations of multiple documents while writing a synthesis text. The study focuses on argumentative synthesis writing drawing on sources presenting different positions on a controversial issue. The work is situated within the field of the Documents Model Framework and the MD-TRACE model (i.e., the multiple-document task-based relevance assessment and content extraction model, Rouet & Britt, 2011). The tool scaffolds students to critically evaluate the relevance and trustworthiness of the sources, and to form an integrated representation of the sources. In addition, the document mapping tool aids students in the visualization of claims and content from the sources and intertextual connections, in this way creating visual representations of multiple documents (so-called document models).

The authors examined both the maps students came up with (i.e., *products*) and students' mapping *processes* to get an insight into how they used the digital mapping tool to construct multiple document models. Additionally, the study aimed to understand how document mapping supports argumentative source-based writing. Finally, students' perceptions on the purpose of document mapping were explored.

To meet these research objectives, the researchers had 40 ninth-grade students from a junior high school in Israel participate in four sessions, consisting of a pre-test, two sessions in which they wrote an argumentative source-based text using the document mapping scaffold, and a post-test. A rich variety of data was collected: document maps, essays, screen recordings with cued retrospective recalls, and retrospective interviews.

The coding of the maps was based on the taxonomy proposed by Britt et al. (1999). Analysis showed that most students created models that included multiple claims, sources, and intertextual connections, and about half of the students constructed full document models (i.e., models that included both content and source integration). Based on the findings, the authors propose an expansion of the current multiple document typology, suggesting that students' multiple document representations may be more diverse than previously thought.

An exploration of the mapping processes provided the researchers with insights into the diverse processes students engage in to construct their document maps. The findings confirm the importance of *recursive processes*. Rereading and transitions between reading and mapping processes led to more elaborate and well-integrated maps. In addition, analysis of the mapping processes showed that the document mapping tool supported students in evaluating source trustworthiness and relevance.

When relating the document maps to the argumentative writing quality, the study showed that students who invested *more time in creating the map* wrote higher quality essays. Moreover, more elaborate and two-sided (i.e., representing the two

contrasting positions on the topic) maps were positively associated with essays with a higher level of integration. Students who engaged in a more *recursive process*, and who devoted more time to observing their map while writing, wrote essays that included and cited more documents.

Regarding students' perceptions, results showed that they acknowledged document mapping as a tool for selecting and connecting sources, and recognized that it supports understanding and writing.

The primary research objective of Castells et al. (2022) is to study the surplus value of writing, in the form of a synthesis task, for reading comprehension. One could also consider it a goal-setting (writing) study into the impact of a writing goal on reading comprehension. Additionally, the authors investigate students' reading processes while reading on paper and on screen (modality effect).

The authors investigated if graduate psychology students' inferential reading comprehension of multiple sources is enhanced when reading is combined with a writing activity. In line with the functional view on reading—writing (Fitzgerald & Shanahan, 2020) and prior research, (having to) select relevant information from different sources, comparing that information, integrating it in a coherent way in a synthesis text can be expected to lead to (more reflection and) a deeper understanding of the source texts (cf. Moran & Billen, 2014; Nelson & King, 2022 as cited by the authors). To empirically verify this hypothesis, Castells et al. set up an experiment in which 155 psychology graduates read three source texts after which their inferential reading comprehension was measured. Students were randomly assigned to four different conditions differing in the presence of a follow-up writing task (yes/no) and in reading medium (reading on paper vs. reading on screen).

In order to acquire an insight into the strategies students use while reading and reading-to-write, the authors had students in the reading on screen conditions read and answer questions in the Read & Answer software. The Read & Answer software presents and segments source texts and inferential comprehension questions in (two) different screens. It registers the number of switches between the screens (i.e., sources and questions) but also within the same screen (i.e. between sources), the specific segment of the text or question a reader is dealing with and the time they spend in a specific segment. Additionally, it logs the time spent on a specific action and the sequence in which actions are performed. The software allowed the researchers to study rereading strategies. Additionally, the researchers studied note-taking strategies.

Results show that, contrary to expectations, students in the reading-and-writing conditions did not outperform students in the reading-only conditions on inferential reading comprehension. Put differently, embedding a (multiple) source comprehension task in a writing task does not seem to affect source comprehension. However, texts which were rated as better in terms of textual organization, and accuracy and relevance of selected ideas were related to a higher inferential reading comprehension.

No statistically significant modality/medium effect was found neither for reading comprehension nor for text quality. Students in the (sources-on-) screen condition and students with (sources-on-) paper & pen did not perform differently on reading comprehension nor did the texts students produced in the reading-and-writing

conditions significantly differ in quality between the paper-and-pen and screen medium.

One of the few significant findings with regard to strategy use showed that compared to students in the reading-only condition, students in the reading-and-writing conditions took notes. Taking notes, however, was also related to lower-quality texts in terms of organization and copying from the source texts. Hence, note-taking, when done, served mainly to copy source information.

Valenzuela and Castillo (2022) studied pausing behavior during source-based writing processes. The study had a 2*2 factorial design. The goal was to identify the effect of reading medium (print or digital) and of the tasks' communicative purpose (to inform or to persuade) on pausing during three phases of the writing process (beginning, middle and end). To investigate whether certain effects were dependent on the writers' task performance (measured as text quality), a mixed model analysis was carried out.

Participants were 66 first-year university students. They were randomly assigned to one of the four conditions (factorial design: print vs digital sources, to inform vs to persuade). Keystroke logging was used to gather information on several pausing measures such as the frequency and average duration of pauses, and the frequency of different types of pauses (such as within- and between-word pauses, and pauses before and after sentences). Assessment of the produced texts took into account textual elements (organization of ideas and cohesive resources), language conventions (register and tone), and the degree to which the text fulfilled the communicative purpose.

No effects of reading medium nor task purpose were found on pausing frequency, duration, or pause type in none of the three writing phases. Pausing frequency varied according to the writing process phase (i.e., more pauses at the end of the process than at the beginning). Moreover, for pausing duration, an interaction effect between the task purpose and the writing phase was observed. Namely, at the end phase of the process, the pauses were significantly longer for the persuasive task compared to the informative task. Several interaction effects between pause type, writing phase, and communicative purpose were found. These interaction effects were related to writing performance.

Intervention studies

Besides the process studies and the studies on task and learner characteristics, this special issue also includes five papers that report on intervention studies to promote synthesis writing. Two intervention studies were aimed at university students. Granada Peinado et al. (2022) focused on university students who underperformed on source integration, and Luna et al. (2022) targeted university students in an online distance learning course. The studies by Casado Ledesma et al. (2021), Van Ockenburg et al. (2021), and Konstantinidou et al. (2022) studied participants from secondary education. Konstantinidou et al. 's (2022) intervention specifically focused on students in vocational secondary education. The intervention programmes presented in the various studies are diverse: explicit instruction with video modeling on

writing and collaboration in pairs (Granado Peinado et al., 2022), a product versus a process approach (Luna et al., 2022), instruction and deliberative dialogues (Casado Ledesma et al. 2021), individual learning paths within instruction (Van Ockenburg et al., 2021), and scenario-based reading and writing education (Konstantinidou et al., 2022).

Granado Peinado et al. (2022) positioned their study in academic literacy, and addressed a specific group of students, third-year university psychology students who (individually) scored relatively low on integration of information from multiple contrasting sources. These students were randomly paired during an intervention. Pairs were then randomly assigned to one of four conditions. In all conditions students worked in pairs. In the baseline group students worked in pairs without any additional scaffolding materials and/or instruction; in the other three conditions pairs worked with a strategy guide including worksheets. Two of these conditions got explicit instruction, one on synthesis writing only, and one additionally about collaboratively writing a synthesis. The strategy taught consisted of six steps: detailing/supporting, identifying and contrasting arguments from the source text(s), constructing an integrated conclusion, and planning, writing and revising the text. All texts, pretests, two intervention texts (practice sessions cf. *infra*) and posttests were written in pairs.

The authors studied the effects of the learning conditions on two variables; the identification of relevant arguments (argumentative coverage), and the (level of) integration of arguments in a new text. Results showed an effect for explicit modeling of the synthesis writing process for both dependent variables. For level of integration the condition with additional explicit modeling of collaboration outperformed the condition with modeling synthesis writing only.

Exploratively, the authors tested the contribution of each of the instruction components—type of instruction and the two practice sessions on the posttest scores—for both dependent variables separately. These explorations confirmed an earlier finding of Mateos et al. (2020), now in the context of collaborative pair activities. Explicit strategy instruction via modeling is needed to improve the integration of contrasting information in the texts in the collaborative practice sessions. For argument coverage this condition effect only affects the first practice session texts.

Luna et al. (2022) studied the effects of two learning conditions on the degree of integration of argumentative syntheses in distance learning. It is a relatively short invention targeted at part-time students. Participants were undergraduate Education and Psychology students with an average age of about 34 years. The two conditions were constructed according to Merrill's First Principles of instructional design (Merrill, 2002). One condition focused on the final product, a synthesis text, the other one on the process of reading and contrasting source materials and writing a synthesis text. These learning units were delivered via Moodle. The *process* condition outperformed the *product* condition. An exploratory analysis of responses on an intermediate task in the process conditions did not show a significant correlation between these responses and the level of integration in the pre- or posttest synthesis text.

Casado Ledesma et al. (2021) situated their study in scientific literacy, aiming at epistemological depth and science communication. Dialogic activities via both

group discussion and writing argumentative synthesis texts had to simulate the integration of existing and new knowledge and the incorporation of multiple perspectives on a scientific issue. In a 2*2 factorial quasi-experimental design, participants (aged 14–15) in intact classes were assigned to four conditions: using a strategy guide with worksheets (yes/no) and explicit instruction with modeling (yes/no). The strategy that was trained contained seven steps for identifying relevant arguments from contrastive sources, comparing these arguments, constructing an integrative conclusion, writing up and revising the text. The strategy guide supported some of these steps with graphic organizers and set tasks via questions for several of the strategy steps. Students worked in small groups for discussions, and composed a synthesis text together in two rounds, based on two contrastive sources. One condition worked without a guide and without explicit instruction, one worked with a guide, one with explicit instruction with modeling, and one with a guide and explicit instruction with modeling. The modeling component in the latter two conditions varied according to the use of the guide. When no guide was used, the synthesis process was modeled; when a guide was used, the modeling component showed the collaborative work of using the guide, which then incorporated the synthesis writing process.

To increase the generalizability of the study, the same two topics were included in both pre- and posttests, in a balanced design. Effects were measured with writing a synthesis text and a content knowledge test, which required a written response to an open question ('What do you know about ...').

None of the four conditions outperformed one another, neither for the integration score of synthesis texts nor for the content knowledge test. Students in all conditions significantly improved their performance on both synthesis text and knowledge test after the intervention. An exploratory analysis did show that the role of source integration scores on content learning varied. Compared with the baseline condition, the effect of condition on content knowledge via integration was only significant in the condition with the explicit instruction with modeling component. This finding is in line with Granado Peinado et al. (2022), and Mateos et al. (2020): learning to integrate is best achieved via modeling. New in Casado-Ledesma et al.'s (2021) study is that the level of integration related to an open content measure.

Van Ockenburg et al. (2021) reported two intervention studies on synthesis writing in the 9th Grade. For these students it was the first time that they were formally instructed about writing a synthesis text based on sources that contained additive information. The intervention was based on the results of a review study (Van Ockenburg et al., 2019), and dealt with three key subskills in synthesizing: selecting, organizing and connecting information. In both studies the researchers implemented a switching panel design, allowing them to replicate findings in the second panel (Van Steendam, 2017). In both studies, modeling the three subskills was a key element in the instruction. Two different peer models on video were available: one who invested significant effort in selecting and organizing the source information ('pre-planner'), another who read, wrote a draft, and then revised ('post-draft revisor'). Participants could choose the model they wanted to observe. In both studies the intervention was effective, compared with the control condition that followed the regular language curriculum, with reading, writing and other activities. In the first

study students who scored higher on the routine ‘pre-planning’, as measured before the intervention, profited more from the intervention. To avoid such an effect, in the second study a lesson was inserted to encourage students to reflect on their writing routine questionnaire scores and to set themselves goals for the learning unit. In the second study, the experimental effect generalized across the writing routines.

Konstantinidou et al. (2022) report a totally different study compared to the other writing intervention studies in this issue. They studied the effect of a scenario-based reading-writing intervention in vocational education. In this area of education, many students experience difficulties both reading and writing, which may affect their professional careers. To accommodate this specific group of learners, scenario-based education was introduced (in language lessons), to simulate real- or work-life situations. Reading was operationalized as functional reading which in most instances involved *reading to act*. This means that students were expected to select the information from the text that they needed to solve a problem at hand and to communicate about the problem. They thus had to transform what they read to meet a communicative goal; they wrote for a reason, selecting those sections of the source text to reach their communicative, functional goal. In a quasi-experimental design, the effects of the scenario-based reading-writing program of 12–14 sessions was compared with the regular curricular program. The experimental program consisted of three consecutive scenarios, each following the same phases, from presenting the functional context (scenario), planning actions, reading sources, to drafting, peer-feedback and revising. An effect of the experimental program was observed for writing, but not for reading. Students in the weakest strand of vocational education benefited most from the intervention.

Automatic assessment with NLP

The issue closes with a study on the automatic assessment of synthesis texts. Crossley et al. (2021) introduce the use of natural language processing techniques to assess source integration in synthesis writing. If automatic text scoring via NLP predicts human assessments of these texts, new venues for research are open. NLP is a product-focused technique that can identify the amount of information from a source text integrated into the essay, how the information is integrated, varying from quoting, paraphrasing to summarizing, and the accuracy of integration.

The NLP-measures the study discerned covered source use and inferencing, semantic overlap and semantic similarity between the essay and the sources. The authors tested this on a sample of 909 argumentative source-based essays written by participants from different populations, ranging from college undergraduates to military recruits and adults crowd-sourced from Mechanical Turk. Each participant wrote a single essay on one of four topics. The essays were holistically rated by two human raters on source use and inferencing.

Results showed that several indices of good source use and inferencing explained 47% of the variance in the human ratings. Importantly, it is not just the presence of citations that reflects good source use and inferencing: good texts have more sources later in the text, cite a greater number of sources, which should be spaced throughout

the text. Results showed that the stronger essays showed more semantic overlap. At the same time, this overlap was not induced by copying text from the sources: less copying, and less long strings of copied words were associated with better texts. The NLP-scores predicted 52% of the holistic human ratings.

Discussion

Following the overview of all the contributions to this special issue, we provide a discussion of some recurrent themes and issues in these studies that are important to current and future studies on synthesis writing tasks. We start with a discussion on the study of reading and writing processes within synthesis studies, followed by a discussion on intervention studies. Thirdly, we point to the technology-related developments within source-based writing research. We conclude by reflecting on key characteristics of synthesis tasks.

Process studies

From the studies in this issue into synthesis reading and writing processes, emerge several elements that are of importance for future studies. The process of source-based writing involves both reading and writing processes. The complexity of synthesis writing does not call for a simple “reading-then-writing” strategy. Rather, it is marked by recursivity as it involves a complex interplay of reading and writing sub-processes. Not only recursivity in itself, but also its timing is important. Studies such as the one by Breetvelt et al. (1994) showed the importance of temporal dimension during the writing process. Moreover, the patterns of interaction between reading and writing processes will be co-determined by characteristics of the task (purpose, genre), the reader/ writer (reading ability, writing ability), and interaction between the task and the reader/ writer (interest in the topic, prior knowledge, difficulty of the sources). Studies in this special issue offer some insight into this complex model.

Recursivity

Previous studies have looked into the use of sources during the writing process and its relation to text quality, and found that recursivity is crucial (Martínez et al., 2015; Mateos & Solé, 2009; Solé et al., 2013). A recursive process implies that the writer adopts a non-sequential or non-linear approach. Instead of a simple sequence of reading and then writing, the process is marked by a sequence of recurring and alternating reading and writing. Thus, in a recursive process, the reading and writing activities occur repeatedly throughout the process. Source-based writing is characterized by an interaction between reading and writing activities. Reading entails writing and vice versa. For example, while reading sources, the writer writes down notes, and while producing text, the writer goes back to the sources to look for information to include in the text. Martínez et al. (2015), Mateos and Solé (2009), and Solé et al. (2013) found a positive correlation between the quality of a synthesis

text and the amount of recursion during the process in audio–video recordings of students' synthesis processes. Also Vandermeulen, van den Broek et al. (2020c) showed the importance of alternations between on the one hand the various sources, and on the other hand, the sources and the text in production. These findings seem in accordance with the very nature of the synthesis task, which involves sub-processes such as comparing and contrasting the information from the different sources, linking the sources to one another and integrating the information in a new independent text. In order to successfully accomplish these goals, the writing process should be marked by recursion.

In this special issue, the importance of recursivity is discussed at length by Nelson and King (2022). Recursivity is also very much present in both the studies by Barzilai et al. (2021) and Castells et al. (2022). The document mapping tool presented by Barzilai et al. (2021) actually scaffolds recursive reading and writing behavior as it supports students in connecting the sources and in integrating source content into their own text. The findings of this study confirmed the importance of recursive processes. Rereading and switching between reading and writing processes resulted in more elaborate and well-integrated maps, which in turn resulted in synthesis texts with a higher level of integration. In formulating their aims and hypotheses of the study, Castells et al. acknowledged the importance of recursivity. The Read & Answer software was used to explore students' rereading activities and additionally, students' note-taking was studied. The authors expected the students in the reading-and-writing condition to engage in more recursive processes than those in the reading-only condition, which would benefit comprehension performance. These hypotheses were, however, not confirmed. Despite this, this study contributes to the understanding of activities related to recursivity such as rereading during writing and note-taking during reading. As the authors point out, it might not be the mere act of switching between reading and writing processes, but the strategic or goal-oriented use of them that determines its impact. This insight points to the importance of providing more support to students in activities such as note-taking.

Temporal dimension of activities during the process

The study of Valenzuela and Castillo (2022) confirms the findings of previous studies that it is important to take into account timing or different phases when studying the writing process. Breetvelt et al. (1994) and Rijlaarsdam and Van den Bergh (1996) showed that the moment at which certain actions occur and their variation across the writing process are essential when describing writing processes and their relation to the product (text quality). This is also the case for synthesis writing tasks. Vandermeulen, Van den Broek et al. (2020c) for example showed that spending a considerable amount of time in the sources has a positive relation to text quality in the beginning of the writing process. At the end of the writing process, however, a focus on reading the sources had a negative impact on the quality of the text. Additionally, a high amount of recursivity between reading the sources and writing the synthesis text in the first phase of the process had a positive impact on the quality of the text. Switching between the various sources in the beginning of the process

had a positive impact on the quality of informative synthesis texts. Valenzuela and Castillo confirmed the importance of the temporal distribution for pausing behavior (i.e., frequency and duration) during synthesis writing processes by showing that pausing frequency was higher at the end of the writing process than in the beginning and middle phase. This difference in pausing frequency between the process phases was associated with the writer's competence. Once the effect of the writer's competence was statistically controlled for, the observed differences among the writing stages were attenuated.

Task effects

Whether factors like task and learner affect source-based writing, is addressed in the studies by Castells et al. (2022) and Valenzuela and Castillo (2022).

Synthesis task genre Most of the studies within the field of synthesis writing study a specific type of synthesis task, for example argumentative writing based on conflicting sources. The question imposes itself how transferable these findings are to other types of synthesis tasks or genres. In order to generalize across different types of synthesis tasks, Vandermeulen, De Maeyer et al. (2020a) for example discerned several variations of 'the' synthesis task differing in communicative purpose (to argue or to inform), the number of sources and their complementarity, and the information density. Vandermeulen, van den Broek et al. (2020c) showed that source use behavior and its relation to text quality differed for two genres of synthesis writing, an argumentative genre and an informative text genre. For argumentative synthesis tasks, switching between sources and synthesis text turned out to be a significant predictor of a high-quality text process-initially whereas for an informative text switching between the sources at the beginning (linear relation) and at the end of the writing process (curvilinear) was a predictor of a good text. That genre differences can be discerned in the writing behavior is confirmed by Valenzuela and Castillo in this issue. In line with genre differences for source use behavior by Vandermeulen, van den Broek, et al. (2020c), Valenzuela and Castillo showed that pauses were significantly longer at the end of the writing process for a persuasive task than for an informative task. This implies that findings regarding synthesis writing processes if based on a specific task (i.e., genre) may possibly not be generalized to other types or genres of synthesis writing tasks.

Embedded reading and writing tasks On the basis of findings for single-source writing tasks, Castells et al. (2022) expected that having students write a synthesis text on multiple sources would enhance their reading comprehension compared to students who did not have to write. The goal-setting of reading sources and selecting information for a writing task and integrating that information into a new text was predicted to enhance students' reading and comprehension process. However, Castells et al. showed that readers who read sources with the intention of selecting and integrating the information from them for a writing task did not perform significantly better on a reading comprehension task than students in the reading-only condition. With regard to task effects, at first glance the experiment seems to contradict prior research showing the added value of writing for comprehension of multiple sources as opposed to a single source as the synthesis of multiple sources

did not lead to significantly higher inferential reading comprehension. However, the fact that the better texts were also related to more comprehension, indirectly, does confirm the instrumental writing-reading link. Students who understand the sources better, wrote the better texts or the other way around: the better writers can spend more effort in the comprehension process and vice versa.

Source medium or modality effects Castells et al. (2022) reported no statistically significant differences in inferential reading comprehension between reading source texts on paper or on screen (i.e., medium), a result which corresponds to similar findings by Valenzuela and Castillo (2022) for pausing. No statistically significant differences were found in pausing behavior (duration, frequency) across the writing process between reading printed or digital sources (medium). These highly interesting findings show that digital synthesis texts in which sources are provided on screen can be considered valid tasks. The added value is that online reading and writing processes can be adequately captured (with keystroke logging cf. infra).

The studies reviewed show the effect of different types of tasks on specific reading and writing processes such as note-taking (Castells et al.) and pausing (Valenzuela and Castillo). A logical question following from this is if genre effects can also be detected when different reading and writing activities are combined into larger integrative patterns. We know that writing activities form series or patterns of activities which follow and activate each other and are sometimes also embedded in other patterns of activities (Van den Bergh et al., 2016). In a large-scale national sample on synthesis writing, Van Steendam et al. (2022) distilled four different synthesis writing constellations which also differed between genres. These writing constellations consisted of source- and production- related activities and were extracted with profile analysis. The constellations characterized by more source use were mostly found in the informative genre. In contrast to the findings by Vandermeulen, van den Broek et al. (2020c) for source use behavior, the writing constellations including source behavior and production indicators did not translate to text quality, that is, whereas the constellations were genre-specific, their relation to text quality was not. This may be an indication that writing activities are compensatory, especially for stronger writers. Of the studies reviewed only Castells et al. study a combination of reading and writing activities, that is, note-taking and rereading. Much more research looking into clusters of writing and reading activities in different genres and modalities is needed.

Learner effects

Van Steendam et al. (2022) report that secondary school students' synthesis writing constellations are affected by their topic knowledge and topic interest. From research also emerges the central role of reading and writing skills. This is confirmed by Castells et al. (2022). Their analyses showed that almost 29% of the variance in inferential reading comprehension was explained by prior knowledge via the two key text quality attributes: textual organization and accuracy of content. Readers with more prior knowledge wrote the more organized and accurate texts content wise, leading to a higher reading comprehension and understanding of source information. Put differently: For the more knowledgeable readers embedding a writing task into a

reading activity is a meaningful activity to deepen source understanding and comprehension. Especially selecting and organizing information contribute to a learning effect. As the authors also found that students who understood the sources better, also wrote the better texts, future research could include students' writing and reading ability to explain effects of variation in tasks and of interventions.

Intervention studies

In a reflection on the intervention studies presented in this special issue, we would like to discuss some issues regarding the instructional programs that were implemented and the methodologies that were used.

Strategy instruction

All five interventions implemented a form of strategy instruction. In most cases, studies report direct instruction as effective, with a modeling component, via videos by instructors or peers. A strategy is a series of actions that reduces the complexity of the task at hand, mostly presented as 'steps'. From the descriptions of the steps in the studies, two observations emerge. First, all strategies work from reading to writing, with the integration of information as the transition point between the analytical reading phase and the comprehensive writing phase. Reading in synthesis text instruction is taught in the first place as identifying arguments in texts (Casado Ledesma et al., 2021; Granado Peinado et al., 2022; Luna et al., 2022; Van Ockenburg et al., 2021), or as selecting relevant information for a pragmatic writing task (Konstantinidou et al., 2022). It is not seen as an act of comprehension, as meaning-making, as relating new information to the existing knowledge base. In this respect, the training programs do not match current comprehension models (Van den Broek & Helder, 2017). Second, the strategy steps are presented as a linear pattern: first the reading steps, and then, via integration, the writing steps. The role of *writing during reading*, and the role of *reading during writing*, does not seem to be explicitly included in the strategy steps. The continuous switch between reading and writing throughout the integration process, the switching roles between authoring a text and understanding other texts are not addressed (see Martinez et al., 2015, for these switching roles). From process studies, however, we know that different patterns of attention for comprehending sources exist, and that various patterns can result in integrative texts. These patterns even vary within writers, due to factors such as topic interest and topic knowledge (Van Steendam et al., 2022). Such variation calls for inclusion of metacognitive awareness or conditional knowledge about factors that influence the optimal strategy for specific tasks, instead of presenting a fixed strategy for all.

Barzilai et al.'s (2021), data on the use of the scaffold mapping instrument illustrates this recursiveness: transitions between reading and mapping processes were related to better maps, and better maps led to better synthesis texts. It could be interpreted as recursive task behavior signals a more thorough process, with deeper understanding (quality of source information mapping) and better texts as a result.

This raises the question how source mapping and more investment timewise could be triggered. Such a trigger could be a 'standard of coherence' (Van den Broek & Helder, 2017), which in turn could induce motivation and effort.

Methodology

From a methodological point of view, a number of observations can be made which are informative for instructional design and learning and teaching activities.

Role of pretest activity The studies of Luna et al. (2022) and Van Ockenburg et al. (2021) built on the experience of the pretest synthesis task for (subsequent) task representation activities in the learning program. From an instructional perspective, this seems a logical decision. The instruction with new procedural knowledge about the synthesis writing process and declarative knowledge about synthesis text characteristics or criteria, can then be related to the experience of carrying out such a task during the pretest task. Such a decision matches Merrill's (2002) first Instruction principle: start the instruction sequence with the whole task. The experience can be used to deepen and reshape the initial representation of the synthesis task. Another interesting feature of the pretest task in Van Ockenburg et al.'s study is the use of a brief pre-instruction, to support the task representation of the pretest task for a sample of participants for whom the task is new, so that off-task productions are minimized.

Using intermediate activities/measures to explain the learning effects Studies by Granado Peinado et al. (2022), Luna et al. (2022) and Casado Ledesma et al. (2021) included intermediate products to explain the effects of the intervention. Granado Peinado et al. included the quality of texts written in two practice sessions between the pre- and posttest session as a factor to the analysis and confirmed for collaborative writing what Mateos et al. (2020) found for individual writing: the effect of the level of integration of texts is best explained by direct instruction with modeling, while the effect on identifying all arguments to include in the synthesis text is best explained by collaborative practice.

Casado Ledesma et al. (2021) applied another research strategy to explain the learning effects. The unique contribution in this paper is that these authors measured, next to text quality, content knowledge as an outcome. They tested for each of the four conditions – strategy guide yes/no and explicit instruction with modeling yes/no – the relations between text quality gains and content knowledge gains. Only in the condition with explicit instruction including modeling, content knowledge gain was related to the quality of integration in the synthesis text. This finding adds to the insight that explicit instruction with modeling seems to be the best choice when aiming at *integration* of source information.

Van Ockenburg et al. (2019) also used intermediate scores. They coded students' written responses in which they had to explain their choices of which model they wanted to observe (a planning or a post-draft revising model). The researchers included the variable in the analyses as a moderator variable. Luna et al. (2022) selected responses to one of the subtasks to try to explain the variance in the effect of the process condition. In both studies, these additions had an explorative, post-hoc character. One of the drawbacks of such a strategy is that as a result of the learning

task not having been strictly formulated, responses were not easy to analyze (Van Ockenburg et al., 2021), or that, because participants were free to add a response (Luna et al., 2022), the effort and the quality of the critical thinking process at hand cannot be fully or adequately demonstrated. Our recommendation is to include products of key learning activities in intervention studies in a structured way, not only to report fidelity of implementation of the conditions, but also to evaluate the mediation effects of these activities on the outcomes. Such a research strategy requires mediation hypotheses, and a well-developed rationale for including these learning activities in the learning unit.

Measurements The intervention studies in this issue aimed at improving comprehension of source materials and text quality. Most studies measured these two outcomes via the written text in terms of representations and integration of source information. Casado Ledesma et al. (2021) and Konstantinidou et al. (2022) included content knowledge. Castells et al. (2022), which was not an intervention study, also included reading scores and text quality scores in their study. Because of this inclusion, these studies could explore relations between effects of task variations or learning conditions, and different target outcomes. Such explorations enrich theory-building, but we would suggest that such explorations be more strongly prepared in the research questions and hypotheses.

Triangulation Different methods to tap into processes and triangulation of product and process measures can complement each other and as such provide researchers with more and richer data. In that respect, Barzilai et al. (2021) used a rich variety of measures combining product and process data (document maps, essays, screen recordings with cued retrospective recalls, and retrospective interviews).

Tools

In recent years, computational advances have introduced more and more tools into the field of writing research. In general, these tools found their way to three areas of writing research: writing processes, writing products, and writing interventions.

Observing writing processes via keystroke logging has become fairly popular and the possibilities to analyze the logging data have increased rapidly (Lindgren & Sullivan, 2009). Keystroke logging consists of a software that, when activated on a computer, records every keystroke and mouse click or movement. The logging data are time-coded and can be analyzed in different ways providing insights into several aspects of the writing process (Leijten & Van Waes, 2013). Previous studies on synthesis writing using keystroke logging have provided information on the use of sources during the writing process (Chau et al., 2022; Leijten et al., 2017; Vandermeulen, van den Broek, et al., 2020c; Van Steendam et al., 2022). The study by Valenzuela and Castillo (2022) in this special issue adds to existing keystroke logging studies on source-based writing by not only looking into reading times and switches between production and reading, but also by focusing on pausing behavior during production.

Natural language processing (NLP) methodologies have advanced the field of product-oriented studies in writing. NLP tools have been developed to automatically calculate information about the linguistic and semantic properties of text and

discourse. One of the most used NLP-tools in writing research are automated essay scoring systems. Various automated essay scoring tools have been developed that reach a level of accuracy in essay scoring that is as accurate as expert human raters (Allen et al., 2021). Crossley et al. (2021) contributed to this special issue with a study that used an NLP-approach to provide automatic assessment of source integration and citation reliability. The study's contribution lies in the exploration of the added value of automated text analysis or automatic NLP-features for research purposes and for learning and teaching source-based texts. From a research perspective, automated indices which have been proven to predict human ratings could serve both as a first indicator, as accompanying analytic measures, as "reliability metrics" or as "a proxies for certain aspects of source-based essays"; especially in large-scale studies where the cost of having human raters score part or all of the texts on different measures may be high. From an educational perspective, students could for example vet their texts on the textual dimensions that significantly predict and contribute to overall human (i.a. teacher, instructor) ratings, prior to submitting them to their teachers or peers provided these automated measures are (rendered) transparent and user-friendly. Ideally, as a result, texts of a potentially higher quality could be submitted which could save teachers time and resources when correcting these drafts. At the very least, the automated indices could serve as an awareness tool and trigger reflection for the students. However, more research is needed, also with regard to construct-representation, before the automated measures could serve learning or feedback purposes for students and teachers alike.

Tools have not only been used to study process and product characteristics in writing, but they are also common in current writing intervention studies. Over the last decades, technological developments have led to a fast increase in tools that aim to help writers to develop their writing process and to produce better texts (Limpo et al., 2020). As mentioned before, the study by Crossley et al. (2021) of this special issue opens up possibilities for providing students with automatic feedback on their source integration based on NLP-features. Though not yet common within synthesis writing, providing writing support by means of NLP has been proven successful in previous intervention studies (McNamara et al., 2012; Zhang et al., 2019). Also keystroke logging has been used in a couple of studies to provide students with information on their writing process as part of feedback in an intervention study (Dux Speltz & Chukharev-Hudilainen, 2021; Lindgren et al., 2009). Some of these studies also focused on improving synthesis writing (Bowen et al., 2022; Vandermeulen, Leijten, et al., 2020a, 2020b, 2020c). In the case of both NLP and keystroke logging, the tools enable automated feedback. However, as appealing as this may sound, thorough research into writing processes and products is first needed to form the basis and make it possible to generate meaningful evidence-informed feedback.

This special issue also contains a study that presents an educational tool that helps students in writing a synthesis text. Barzilai et al. (2021) presented a tool that supports students in reading and evaluating sources, and in organizing and integrating source information. With the help of the tool, students create a visual representation of multiple document models. Studies like this one, which present and test the effectiveness of tools to support students' source-based writing are of the utmost importance. Given the complexity of synthesis writing, students need support in

developing their skills. Moreover, tools like this document mapping tool, can be used by students on an individual basis, without the need for teacher intervention. This creates opportunities for, for example, large class groups (and little time for feedback or instruction), or remote learning contexts. In addition, the approach is interesting from an ecological validity and methodological perspective, as the tool provides insights into processes taking place when carrying out the activity. In this way the tool not only supports students' synthesis processes, but also provides information on *how* this support is shaped.

Coda

We aimed for a special issue on Where Reading and Writing meet. The current special issue offers a *palette* of studies in which participants perform tasks involving writing and reading. This may be the case because participants need to master a functional writing task (Konstantinidou et al., 2022), write something based on sources (Crossley et al., 2021), or, the most common task in this issue, write a synthesis text, either to demonstrate understanding of sources or to demonstrate their skill in writing (cf. other studies). Nelson and King (this issue) trace the origins of synthesis writing research to the 70 s, providing us with a rich historical account of research on synthesis writing. It is about time to reflect on the current use of the term.

The overrepresentation of synthesis texts in this special issue showcases that research in this area is flourishing. However, at the same time, the studies lay bare questions about the true nature of the task. They underline that the use of the term calls for a robust round of conceptual analysis. Texts in which participants do indeed arrive at a synthesis of information are rarely encountered: intervention research in this special issue shows that. 'Synthesis' can be achieved after intensive study, much reflection on and reprocessing of information and representations. The distinction between argumentative and informative "syntheses" should also be the object of that conceptual analysis. The question is whether a synthesis can be an argumentative or even a persuasive text. After all, the ultimate aim of a synthesis text should be to synthesize, or perhaps more accurately, 'objectively expound on' the arguments in an issue rather than take a position.

Gathering knowledge through texts of all kinds, and sharing that knowledge with others through various text forms are inextricably linked: understanding and being understood is at the heart of the human way of being. We believe that this inseparability should be the starting point for research and education, in which education is seen as the window to the world and the human being.

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