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ORIGINAL RESEARCH

Learning paths in synthesis writing: Which learning path contributes most to which learning outcome?

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Abstract
This paper presents a secondary analysis of data collected during an intervention study in which students learnt to synthesise pairs of texts presenting opposite views on controversial issues. The original intervention study included two treatments and examined the effects of two instruction conditions when instructional materials and tasks were held constant. The participants were 114 undergraduate psychology students. The object of the instruction was a guide on strategies for writing an argumentative synthesis text. However, the instruction varied between explicit strategy instruction, consisting of explaining each of the process's four phases (exploring and identifying arguments and counterarguments, contrasting positions, drawing an integrative conclusion, and organising and revising the final draft), modelled via videos, versus self-study of the written strategy guide. After the initial instruction session, the students in both groups practiced collaboratively writing synthesis texts over two sessions with access to the strategy guide. The primary study compared the individually written pre- and posttest syntheses and found statistically significant differences favouring explicit instruction in both dependent variables: the argumentation coverage and the level of integration. The secondary analysis reported in the current paper involved scoring additional written syntheses produced during two practice sessions and then analysing the data for all time points (pretest, posttest, and the two practice sessions) using structural equation modelling (SEM) to test whether explicit instruction directly or indirectly affected the two indicators of good argumentative synthesis texts—argument coverage and integration—via the following collaborative practice. The results suggested two different learning paths for both dependent variables: explicit instruction is effective for both variables, while collaborative practice only has an additional indirect effect on argument coverage.

Keywords Collaboration · Argumentation · Explicit strategy instruction · Synthesis writing · Integration · Multiple sources

This paper investigates the learning paths used to synthesise conflicting information in argumentative writing from multiple sources which present opposite viewpoints about an

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issue. When arguing in order to learn, students are not primarily attempting to convince each other; instead, they are exploring solutions to actual issues as well as the underlying fundamental concepts (Andriessen and Baker 2014). Writing an argumentative synthesis from multiple sources presenting different positions on an issue requires students to recognise conflicts between information in sources and to compare and contrast different points of view. Students must then integrate these different points of view and design a viewpoint that overarches them.

In this context, we ran various studies with multicomponent instruction sequences to support college students in exploring, contrasting, integrating, and synthesising alternative points of view about controversial topics in a disciplinary context through writing argumentative syntheses. The present study reanalyses data from one of these studies (Mateos et al. 2018) to gain more insight into how each instructional component contributed to the learning outcomes.

We will analyse the learning paths of two interventions. Both interventions were aimed at improving the degree of coverage and integration of the arguments displayed in an argumentative synthesis based on reading two texts presenting conflicting perspectives on educational controversies. Both interventions contained two instructional components: a preceding instruction session followed by collaborative practice. The collaborative practice component was exactly the same in both interventions: the students worked in pairs, supported by a written strategy-oriented guide which they could consult. To prepare students for this collaborative practice, they received instruction, which differed between the interventions. In one intervention, the students received the strategy guide and studied it thoroughly before using it in the upcoming collaborative synthesis tasks: the self-study approach. In the other, the participants received the same guide but received explicit instruction, which involved explaining and modelling the four stages of the process to cover and integrate conflicting information from two sources. These stages are: (a) exploring and identifying the arguments from both positions, (b) contrasting positions, (c) drawing an integrative conclusion, and (d) organising and revising the final draft. During each of the two practice sessions which followed the instruction, students collaboratively produced a synthesis text in pairs, based on two conflicting sources, with the guide available for them to use. Before and after the intervention, the students individually produced such an argumentative synthesis text, without access to the guide.

The results showed that the intervention including explicit instruction resulted in better texts with regard to both dependent variables, specifically the coverage of arguments identified from the sources and the integration level of conflicting information. From an instructional design perspective, the questions raised were whether and to which extent the initial instruction directly and indirectly contributed to both dependent variables via the following two collaborative practice sessions.

In the following sections, we present the rationale for the intervention study and the question it left unanswered.

Writing to learn in higher education by writing argumentative syntheses

Our research focusses on writing to learn in higher education. At the college level, most writing—whatever the discipline—is based on reading and integrating external documents (Klein et al. 2016; Klein and Yu 2013; Perin 2013). Synthesis writing is seen as the most

demanding and elaborate approach to writing based on sources (Mateos et al. 2007, 2014; Shanahan 2013). It requires reading to understand the sources, selecting information from various sources, and comparing and contrasting elements of information to connect them, whilst integrating them to produce a new text that differs from all of the sources (Segev-Miller 2004; Spivey 1997). To the extent that a synthesis goes beyond the information provided by the sources, it involves a learning process which requires *knowledge-transforming* (Mateos et al. 2014; Klein and Boscolo 2016).

A critical element in synthesis writing to learn is the challenge of integrating conflicting information (Wiley et al. 2014). This is particularly relevant for controversial topics characterised by the existence of alternative points of view for which there is not one clear-cut, simple conclusion, and which need to be integrated via an overarching synthesis (Kobayashi 2009). Not only must students recognise the conflicts between sources, they also have to transcend those conflicts.

Here, research on synthesis writing overlaps with research on argumentation. Argumentative writing encourages students to recognise the existence of a controversial topic's different sides and to select the main arguments for and against each of them in order to compare, evaluate, and integrate them to reach a reasoned conclusion (Kuhn 1999, 2005; Leitao 2003; Nussbaum 2008a; Voss 2001), while overcoming the "my side bias" or the tendency to ignore arguments opposing those of the writer (e.g., Nussbaum and Kardash 2005).

One issue that has arisen in argumentation research concerns the distinction between different goals and, consequently, the different approaches to argumentation (Nussbaum 2011; Nussbaum and Kardash 2005; Walton 1998). Nussbaum (2008a) proposed a distinction between persuasive writing, where the goal is to convince another and to "win" an argument (which would be the object in a debate), and reflective writing, in which writers focus on exploring and integrating an issue's various sides to reach a reasoned conclusion. Rather than having students try to support their own opinion, refute the alternative opinion, and persuade the reader, the reflective or deliberative approach to argumentation leads students to weigh the arguments for and against the various alternatives. It may even require them to synthesise the opposing positions into a new view that preserves the benefits of one of the positions while reducing the negative consequences cited in the counterargument (Felton et al. 2009; Nussbaum and Schraw 2007). As Nussbaum and Schraw (2007) argued, although a rebuttal implicitly acknowledges and responds to the counterarguments, refutation tends to be associated with defending a single position. However, according to these authors, weighing arguments and counterarguments and synthesising them are strategies clearly involved in two-sided reasoning (Nussbaum and Schraw 2007).

In a previous study (Mateos et al. 2018), we focused on *argumentative synthesis*. As previously described, this involves reading different sources that offer conflicting viewpoints about a controversial issue to explore, select, contrast, and integrate (in writing) the arguments that support the different points of view in a balanced way. The question we raised was how this task could be learnt and facilitated through instruction.

What are the best practices in teaching argumentative synthesis writing?

Research on teaching and learning argumentative writing follows either the sociocultural or the cognitive approach (Ferreti and Lewis 2013; Newell et al. 2011).

A sociocultural perspective assumes that the argument is based on people's social practices and that students acquire argumentative literacy practices through active participation in dialogic interactions. By engaging in dialogic argumentation, students have access to their peers' alternative perspectives and thinking and reasoning patterns. This access may lead to students reviewing and revising their own perspectives. Kuhn and Crowell (2011) found that students who were involved in a *dialogic intervention* wrote individual essays that contained significantly more arguments that addressed both sides of the controversy. In this dialogic intervention, students used chat software to conduct dialogues with one another, first with same-side pairs and then with opposing-side pairs on series of social issues, while the comparison group followed a more traditional whole-class discussion format. However, different goals can be reached through dialogic argumentation. We share Nussbaum's proposal (2008b), which differentiates between collaborative argumentation, in which individuals work together to construct and critique arguments, and adversarial argumentation, in which each participant takes a side and attempts to persuade others. Some evidence suggests that collaborative argumentation can enhance dialogue between the different sides of an issue, can promote more extensive and greater exploration and elaboration of arguments, and may lead to a deeper understanding of controversial topics (Andriessen and Baker 2014; Beach et al. 2016; García-Mila et al. 2013; Kanselaar et al. 2002).

Various representational tools and diagrams have been used to guide and support collaborative argumentation-based learning (Janssen et al. 2010; Kiili 2012; Van Amelsvoort et al. 2007). These tools act as mediators of collaboration (Suthers 2003), providing students with the means to externalise and explain their claims and arguments, such as to present arguments for and against a specific topic as well as graphically depict the relationships between these arguments. They also encourage students to be involved in the process of interactive argumentation. Scheur et al. (2014) showed that the quality of students' discussions about a controversial topic can be improved by combining graphic argument diagramming with peer-scripted argumentative discourse through sentence openers or guiding questions designed to stimulate critical and elaborate peer discussions (e.g., in order to promote rebuttal, one guiding question could be "What are the conflicting issues?").

Without denying the importance of social interaction, the cognitive approach focuses on individual learning. In this perspective, argumentative writing is viewed as a problem-solving process and assumes that students learn to write an argument by acquiring general self-regulatory processes and/or task-specific strategies through explicit strategy instruction (Ferreti and Fan 2016; Ferreti and Lewis 2013). The most frequently studied multicomponent instructional model in this perspective has been the self-regulated strategy development model (SRSD) by Harris and Graham (2006, 2009). In SRSD-based instruction, the teacher provides explicit support for students to acquire self-regulatory processes which can be applied across genres (e.g., in planning and revising processes) as well as strategies designed for specific types of writing (e.g., including a position, reasons, and a conclusion in argumentative writing). This support includes activating the students' background knowledge of strategies and their importance, discussing and modelling the use of the strategies, providing guided practice through teacher–student or peer interaction, and having the students use the strategies independently when the students are ready to employ them on their own. As an example of this instruction, in the field of argumentative writing in a college, Song and Ferreti (2013) applied SRSD in a study designed to teach students to revise their argumentative essays by asking and answering critical questions on various argumentation strategies. Students who received the explicit strategy instruction wrote

better essays with more counterarguments, alternative positions, and refutations than the students in the other groups.

Although most of the research on explicit strategy instruction has been conducted in the context of individual writing activities, some studies have also revealed the explicit instruction positive effect on collaborative writing. Such is the case of the studies by Van Steendam et al. (2010, 2014), in which student dyads were instructed on a six-step strategy to revise the content and structure of a text by means of two different instructional strategies: practising and observing. The results showed that the collaborative revision strategy instruction via modelling was more effective for improving undergraduates' revision skills than practising the instructed strategy following guiding questions presented in a handout. Hence, it is necessary to study the impacts of different instructional aids when collaboratively writing argumentative syntheses.

The primary intervention study

In their analysis of best practices in teaching argumentative writing, Ferreti and Lewis (2013) concluded that dialogic interactions, with the support of some representational tools and explicit strategy instruction, are complementary approaches in teaching effective argumentative thinking and writing. By combining these approaches, students can be empowered. This was the rationale for our primary study (Mateos et al. 2018). We set out to test which instruction strategy was more effective in a collaborative setting for improving the writing of argumentative syntheses. Moreover, as Ferreti and Fan (2016) noted, most of the intervention studies carried out so far were intended to support the writing of argumentative essays by young and relatively naïve authors, usually about everyday controversies, and with the goal to persuade. This research has rarely targeted the needs of older and more expert writers, and the interventions are not intended to support the argumentative writing process in disciplinary contexts, from a reflective and deliberative approach.

In that primary study (Mateos et al. 2018), we therefore compared two interventions which should improve college students' argumentative syntheses using information from various sources offering conflicting positions on academic controversies. Furthermore, the interventions were intended to guide the students towards writing an argumentative synthesis, not as a rhetorical act with the goal of persuading others of a specific position but to demonstrate a deeper understanding of particular academic controversies. Students were taught to explore an issue's opposing sides and to construct a synthesising conclusion which took both positions into account. They also learnt to suggest a possible alternative which went beyond both of the contrasting viewpoints. Both interventions focused on acquiring a four-step strategy (exploring and identifying arguments and counterarguments, contrasting positions, drawing an integrative conclusion, and organising and revising the final draft), delivered in a "strategy guide" consisting of worksheets containing graphical devices and questions designed to prompt each of the steps. To instruct this strategy, each intervention consisted of two instructional components: (a) an instructional component to introduce a strategy guide and (b) a collaborative practice component in which the participants had access to the strategy guide, which regulated four steps of the process involved in a synthesis-writing task. Only the initial instruction differed between the two interventions. In one intervention, the guide was made available for further self-study; in the other, the participants were explicitly taught the four major phases in the guide by having each step explained, illustrated by a video clip in which the strategy was modelled.

We assumed, following Ferreti and Lewis (2013), that for improving argumentative synthesis writing, collaborative practice is more effective when preceded by explicit instruction about the strategy involved. The results of our prior study indeed confirmed that explicit strategy instruction with collaborative practice was more effective than the self-study instruction with subsequent collaborative practice. Explicit instruction was more effective for both dependent variables, namely the coverage of arguments from sources and the quality of integration of information.

The present study: A secondary data analysis

Considering our background studies, we expected the best results to come from the explicit instruction condition because it contributed positively to both collaborative practice sessions, as with the individual learning outcomes. Hence, according to the prior research, we can conclude that interventions based on explicit instruction are effective. However, our previous study still did not answer the following questions. When we found that the explicit instruction intervention had a positive effect on both dependent variables, was it due to an indirect effect via collaborative practice on the individual posttest scores, a direct effect, or a combination of direct and indirect effects? Thus, the reason for the present study is to analyse the contribution of the instruction component on the effects of the collaborative practice component in terms of both dependent variables.

Furthermore, given that writing an argumentative synthesis involves different stages (identifying the arguments from the opposite positions and contrasting and integrating them), as observed in different dependent variables (argumentation coverage and integration), the relevant question is whether the learning paths for both variables occur through collaborative practice or directly from instruction. Which learning path contributes most to which learning outcome? Kimmerle et al. (2017) analysed the specific process of collaborative writing when a pair of students have to reach a common conclusion from different perspectives about an issue. The results showed different stages of collaborative writing (sharing knowledge, contrasting and restructuring arguments/counterarguments, and reaching a shared conclusion) and suggested that the different stages of collaboration might require specific instructional support. This evidence supports the interest of exploring whether different stages of argumentative synthesis writing might demand different instructional aids.

A reanalysis of the data will allow us to test whether and to what extent explicit instruction directly and/or indirectly affects both outcome variables via the collaborative practice component. For this reanalysis, we included new data from the collaborative practice activities. We have added the quality of the texts the students wrote in pairs in these collaborative sessions to the individually written pre- and posttest texts.

Method

The primary study was a pretest/posttest randomised control study. The study took place in a large state-run university in Spain. The participants were 114 third- and fourth-year students in the Psychology of Education course. The experiment was offered as a voluntary seminar, and the participants received course credit. The average age was 21.3 years, and 77.2% of the participants were female.

Table 1 Sample of questions for each stage presented in the guide

Stage	Samples
Exploration and selection of the arguments	What are the different points of view on this topic? What arguments arise each position?
Contrasting positions	Do the arguments for one position counter-argue those held by another position? How can those defending position 1 refute those defending position 2? How can those defending position 2 refute those defending position 1? Please use arrows to indicate on the table above the relationships between the arguments and counter-arguments.
Elaborating an integrative conclusion	Does any single position carry greater weight? Why? Is there any means of reconciling two positions? Is there any new alternative position that will integrate the different positions? Is there a position which only holds if a certain conditions occur?
Organizing and Revising the final draft	In what order will you set out your argumentation? In the previous order, first the arguments and then the counter-arguments, jumping from one to the other, or inserting them alternately? Is it better to begin with the strongest argument or to leave it to the end? Is your position clearly stated? Have you included all the arguments you have thought of to justify your conclusion?

The participants were randomly assigned to conditions. Both interventions consisted of two collaborative sessions in which pairs of students wrote a synthesis text based on two sources about a controversial issue which was unfamiliar to the participants. During the collaborative work, the participants had access to a written strategy guide. This guide was presented in a session prior to the collaborative sessions under two conditions. In one condition, the students received the guide and were given study time to familiarise themselves with the strategy (self-study). In the other intervention, the students were explicitly instructed on the strategy's four steps.

The strategy guide offered guidance for the collaborative work in four distinct phases. Taking into account the previously reviewed studies (e.g., Scheuer et al. 2014), the guide was interactive by nature, inviting participants to answer questions in blanks about the nature of the decisions the participants needed to make, complete graphical devices such as a table to list the arguments and counterarguments in columns, and add arrows to establish the relationships between the arguments and counterarguments. The guide included four worksheets, each of which focused on a different stage of the process: (a) exploring and identifying the arguments from both positions, (b) contrasting positions, (c) drawing an integrative conclusion, and (d) organising and revising the final draft. Samples of the questions for each stage are included in Table 1, and Fig. 1 shows the table included in the first worksheet.

In the explicit instruction condition, the participants received explicit instruction on using the strategy guide. Each of the strategy's four stages was explained by an instructor and modelled through a video clip. Each video prepared the participants for the collaborative sessions, by showing a pair of students performing one of the four stages of collaboratively writing an argumentative synthesis while consulting the guide. The

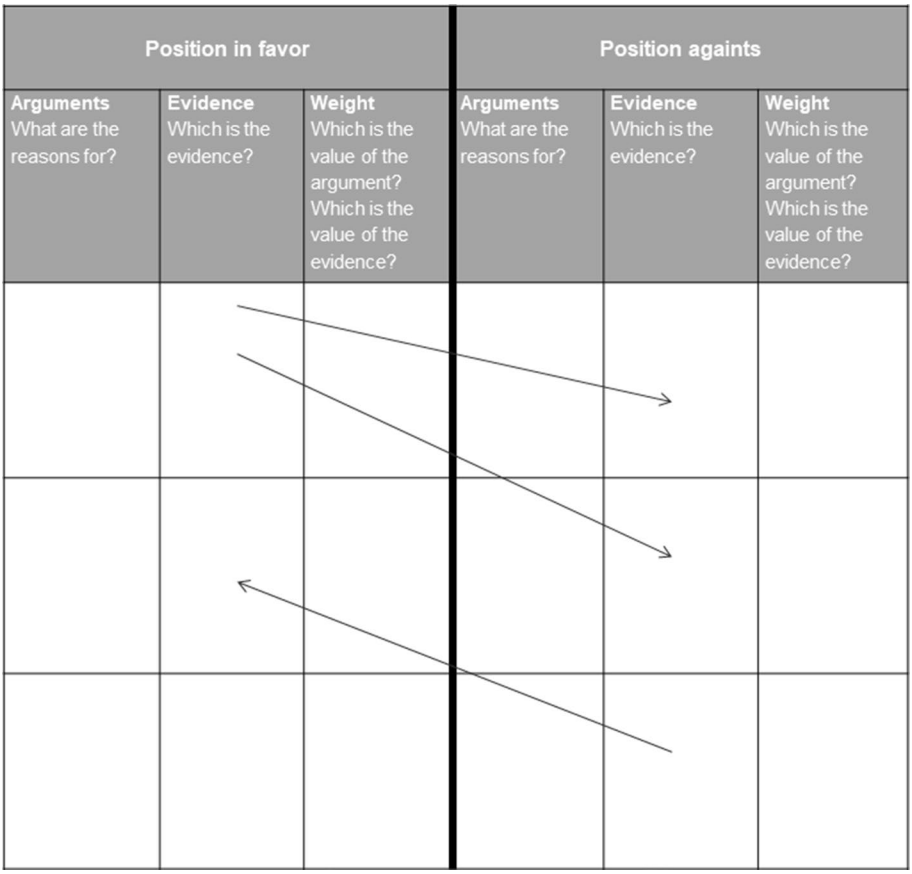

Fig. 1 Graphical format of the table used in the phases to explore and identify arguments and counterarguments, and to contrast positions

videos represented an expert-like process, showing the debates, decisions, and interactions in which the participants should engage when collaborating. The models selected for this demonstration were two researchers, whose ages were similar to those of the student participants, to help the students to identify with the models. The instruction took 40 min.

All of the participants wrote four synthesis texts total: two individually as tests (pre- and posttest) and two as practice activities, in pairs. Each synthesis text was based on two source texts offering contradictory positions on a different controversial issue in education (e.g., external assessment of academic achievement). The topics covered were so unfamiliar for the students that they could not have clear individual stances on the issues at stake. The sources were similar in terms of their length, which was between 585 and 816 words, and in the number of arguments either for or against a position, between six and nine per source. The time taken in the practice sessions varied by pair and ranged from 90 to 120 min, although the specific time each pair spent was not recorded.

Table 2 Intervention programs sessions

Session	Self-study program	Explicit instruction program
Session 1 Pre-test	Writing an argumentative synthesis (individually), without any support.	
Session 2 Instruction	Self-study of the guide	Explicit instruction: explanation-modelling.
Sessions 3 and 4 Practice	Writing two argumentative synthesis in collaboration with a pair with the support of the guide.	
Session 5 Post-test	Writing an argumentative synthesis (individually), without any support.	

The pre- and posttest texts were written without access to the strategy guide. Each test session lasted 60 min. Table 2 shows the different sessions in each intervention program.

The synthesis texts from the pre- and posttest sessions (individually) and the practice sessions (collaboratively) were scored for two variables: the level of integration and the argumentation coverage. The level of integration was scored on a scale of 0 to 6, according to the criteria presented in Table 3 (see Mateos et al. 2018, for a more detailed description of the criteria). Scores from 0 to 2 indicated that no integration had been reached because the text did not relate the two positions put forward by both of the source texts. Scores above 2 indicated different levels of integration. A score of 3

Table 3 Level of integration according to type and frequency of specific argumentative strategies and type of conclusion (Adapted from Nussbaum 2008a)

Level of integration	Type and frequency of specific argumentative strategies and type of conclusion
0. Personal opinion not based on source texts	Gives personal opinion on the topic without including arguments from the texts.
1. Neutral	Does not take a clear position. Describes or lists arguments for both positions.
2. Argues in support	Takes one of the two positions and argues in favour of that position without considering the opposing position.
3. Integration via refutation	Takes a position in support of one of the two perspectives and argues in its favour while refuting the opposing perspective.
4. Minimum integration via weighing or synthesising	Takes a position in support of one or both perspectives and argues by weighing or synthesizing arguments from both positions (two integrations) throughout the text. Does not contain an integrative conclusion.
5. Average integration via weighing or synthesising	Takes a position in support of one or both perspectives and argues by weighing or synthesizing arguments from both positions (integrating at least two) throughout the text. Contains a conclusion that is partially integrated.
6. Maximum integration via weighing or synthesising	Integrates throughout the text (at least twice). Contains a global integrative conclusion.

Table 4 Means (Standard Deviations) for two intervention modalities on four measurement occasions for argumentation coverage and level of integration

	Explicit instruction program (n = 56)				Self-study program (n = 50)			
	T1	T2	T3	T4	T1	T2	T3	T4
Argumentation coverage	.31 (.14)	.59 (.16)	.59 (.16)	.51 (.19)	.32 (.18)	.52 (.19)	.55 (.18)	.40 (.17)
Level of integration	2.5 (1.3)	3.2 (1.6)	4.1 (1.9)	3.9 (1.8)	2.7 (1.7)	2.6 (1.4)	3.2 (1.7)	2.9 (1.6)

referred to integration between the arguments and counterarguments via refutation and was associated with defending a single position. Scores of 4–6 represented increased levels of integration via weighing and synthesis, which were the most frequently used strategies in deliberative and reflective argumentative writing.

In addition to the degree of integration, we counted the number of arguments from the source texts presented in each synthesis text. The argumentation coverage was indicated by the proportion of arguments represented in the text (by the ratio of number of arguments represented in the target text to the total number of arguments in the source texts). Three independent coders were trained to fine-tune the coding and score criteria during the four training sessions. Once the criteria were refined, the coders coded a random set of 50% of the syntheses, while unaware of the intervention conditions. The interrater reliability was good. The intraclass correlation coefficient (ICC) for the degree of integration was 0.88 for the individual syntheses, 0.81 for the collaborative syntheses, 0.91 for argumentation coverage in the individual syntheses, and 0.84 for the collaborative syntheses. Thereafter, disagreements were resolved through discussion. One of the three raters was involved in rating the remaining 50% of the essays.

Results

Table 4 contains the descriptive statistics for the four measurement occasions: the individual pretest (T1), the two pair practice occasions (T2 and T3), and the individual posttest (T4). The data at T1 and T4—the individual pre- and posttests—have been reported in Mateos et al. (2018).

No differences between the intervention conditions were observed at the pretest (T1), V[1] (2, 103) = 0.119, $p = 0.888$, while the condition effect was statistically significant in the posttest, V (2, 103) = 6.178, $p = 0.003$, $\eta^2 = 0.120$, for both dependent variables, argumentation coverage, F (1, 103) = 10.052, $p = 0.002$, $\eta^2 = 0.088$; integration level, F (1, 103) = 7.510, $p = 0.007$, $\eta^2 = 0.067$. None of the T1 pretest variables explained the variance in the posttest variables as covariates, argumentation coverage, F (2,101) = 0.835, $p = 0.437$; integration level, F (2, 103) = 1.638, $p = 0.199$.

The main question in the present paper was whether the learning paths followed the same route for both dependent variables. The design included three components that could contribute to the final scores: (a) the pretest, (b) the instruction with two modalities (explicit instruction vs. self-study), and (c) the collaborative practice, comprising two sessions (T2, T3). We departed from the theoretical model described above and shown in

[1] V is the symbol of Pillai's trace.

Fig. 2, with identical paths for both dependent variables; instead, we tested the components' contributions to explain the posttest scores.

We applied structural equation modelling (SEM) with observed scores, using LISREL 9.3. We dealt with two intrinsic issues in this study. First, a problematic part of the analysis was that the results from both partners in a pair during the two collaborative practice sessions (Fig. 2: T2, T3) are clearly not independent observations. Therefore, we randomly allocated each member of a pair to one of two samples and analysed these two samples in a multigroup analysis. In this analysis, all of the parameters were designed to be equal across both groups. In a final model, we then tested whether allowing differences between both groups increased the model's fit.

Secondly, SEM is often criticised because models can be adapted endlessly. However, guided by our theoretical model, we specified the models to be tested in advance. We first considered a model which only allowed correlations between measurements on the same occasion (M0). In the successive models, we distinguished between the three

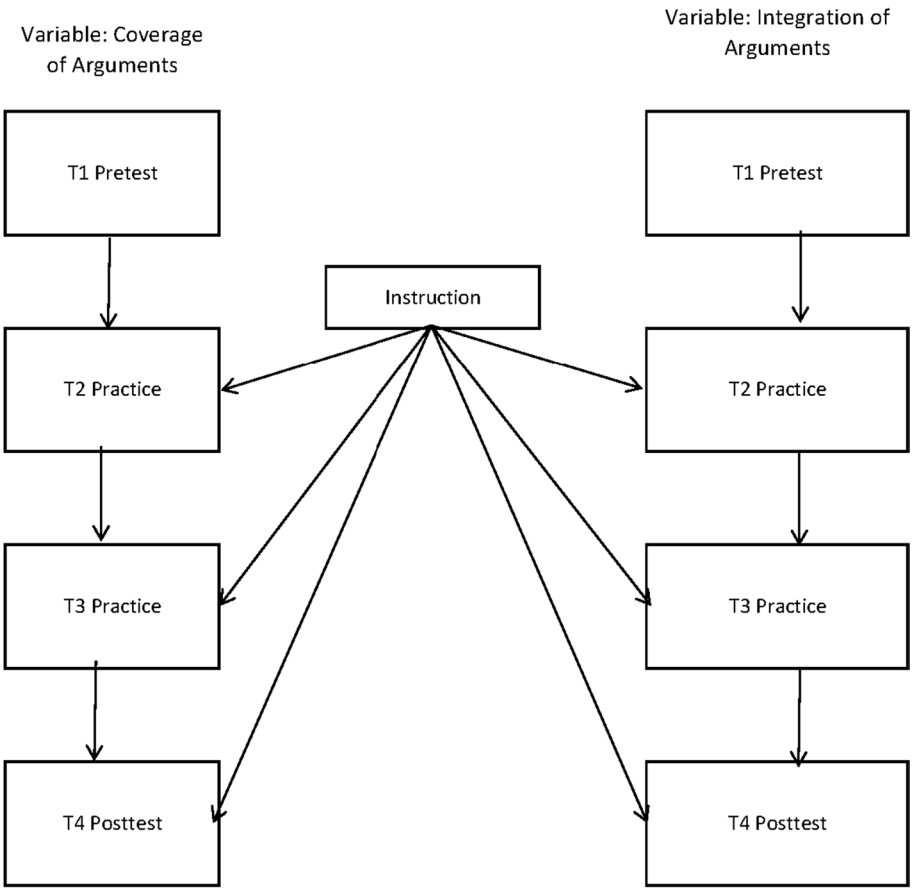

Fig. 2 Theoretical model for effects of instruction and subsequent collaborative practice sessions (T2 and T3) on two qualities of argumentative synthesis texts: coverage and integration of arguments (T4), Provided Pretest Scores (T1)

components of the model, organised according to the time line: (a) pretest, (b) instruction, and (c) practice.

1. We tested for the effects of collaborative practice on argumentation coverage (M1a) and integration (M5i).
2. Then, we added the effects of the pretest (T1) to the model for argumentation coverage (M2a) and integration (M6i), as pretest scores could contribute to the effects of the practice component.
3. In subsequent models, we estimated the effects of the instruction component. While instruction preceded the practice sessions, two models were estimated. First, the effects of the instruction component were estimated on the fourth measurement occasion (T4) for argumentation coverage (M3a) and integration (M7i). Next, the effects of the instruction component on collaborative practice sessions T2 and T3 were estimated for argumentation coverage (M4a) and integration (M8i).

We added two final models to control for whether the randomisation of students influenced the results (M9) and whether the randomisation of pair members to each of the samples influenced the results (M10).

Table 5 presents the fit of the models and compares the models, separately for both dependent variables.

In the first model, only correlations between argumentation coverage and integration within the measurement occasions were allowed. The results showed that this model poorly fit the data, $\chi^2\,(84) = 112.70$, $p = 0.020$. Adding an effect of collaborative practice on T2 and T3 increased the fit for argumentation coverage, $\Delta\chi^2\,(4) = 99.88$, $p \leq 0.001$, but not for integration, $\Delta\chi^2\,(4) = 7.89$, $p = 0.100$. The pretest scores did not seem to influence the argumentation coverage scores, $\Delta\chi^2\,(2) = 0.70$, $p = 0.705$, or the integration scores, $\Delta\chi^2\,(2) = 0.04$, $p = 0.980$ (models: M2a, M6i).

The instruction component influenced argumentation coverage at T4, $\Delta\chi^2 = 5.07$, $df = 1$, $p = 0.024$, as well as integration, $\Delta\chi^2 = 5.35$, $df = 1$, $p = 0.020$. The instruction did not appear to influence the scores on the two practice sessions for argumentation coverage, $\Delta\chi^2\,(2) = 3.89$, $p = 0.143$, but significantly did for integration, $\Delta\chi^2\,(2) = 7.75$, $p = 0.021$.

We analysed the success of the student randomisation into intervention conditions and the randomisation of pair members into groups with the two control models. Neither model significantly increased the model's fit, $\Delta\chi^2\,(4) = 0.64$, $p = 0.959$ and $\Delta\chi^2\,(26) = 15.3$, $p = 0.952$, respectively. Therefore, we can conclude that the randomisation was successful and that no differences existed between the conditions and/or groups of pair members due to flaws in the randomisation procedures.

Table 6 presents the parameter estimates for the effects of collaborative practice in both instruction groups, according to the final model (M8i).

The parameter estimates show that the collaborative practice component contributed to argumentation coverage at T4 via T2—scores at T2 influenced scores at T3 ($p = 0.006$)—and via T3—scores at T3 influenced scores at T4 ($p < 0.001$). This effect was absent for integration level, as the models' overall fit already suggested.

Figure 3 shows the estimated model for both dependent variables.

Table 7 shows a positive effect of explicit instruction on collaborative practices for argumentation coverage at T2 ($p = 0.036$) and T4 ($p = 0.001$) but not at T3 ($p = 0.226$).

Table 5 The fit of ten different models (RMSEA: root mean squared error of approximation; GFI: goodness of fit index; RMR: root mean square residual) and their comparison

Model	Model fit indices						Model comparison			
	χ^2	df	p	RMSEA	GFI	RMR	Models	$\Delta\chi^2$	Δdf	p
M0: Only correlations between argumentation coverage and integration per measurement occasion	112.70	84	.020	.081	.81	.15				
Effects on argumentation coverage										
M1a: M0 + effect practice (T2 on T3, T3 on T4)	82.82	80	.390	.026	.87	.13	M1a vs M0	29.88	4	< .001
M2a: M1a + effect pretest (T1 on T2)	82.12	78	.352	.032	.86	.13	M2a vs M1a	0.70	2	.705
M3a: M2a + effect instruction on T4	77.05	77	.477	.004	.86	.12	M3a vs M2a	5.07	1	.024
M4a: M3a + effect instruction on T2 and T3	73.16	75	.539	.000	.86	.12	M4a vs M3a	3.89	2	.143
Effects on level of integration										
M5i: M4a + effect practice (T2 on T3, T3 on T4)	65.27	71	.669	.000	.88	.11	M5i vs M4a	7.89	4	.100
M6i: M5i + effect pretest (T1 on T2)	65.23	69	.604	.000	.88	.11	M6i vs M5i	0.04	2	.980
M7i: M6i + effect instruction on T4	59.88	68	.748	.000	.89	.10	M7u vs M8i	5.35	1	.020
M8i: M7i + effect instruction on T2 and T3	52.13	66	.893	.000	.90	.09	M9i vs M8i	7.75	2	.021
Effects randomization										
M9: M8i + effect instruction on T1 (Arg + Int)	51.49	62	.816	.000	.92	.09	M9 vs M8i	0.64	4	.959
M10: M9 + effect randomization pairs	36.19	36	.460	.010	.93	.08	M10 vs M9	15.3	26	.952

Table 6 Estimates for effects of practice in both conditions according best model (Integration Level; Model M8i; Argument Coverage: Model M 3a)

	Argumentation coverage		Integration	
	Estimate	(se)	Estimate	(se)
T2 → T3	*.26*	(.10)	.10	(.10)
T3 → T4	*.35*	(.09)	.09	(.09)

The estimate is statistically significant if larger than 1, 96*se (italized)

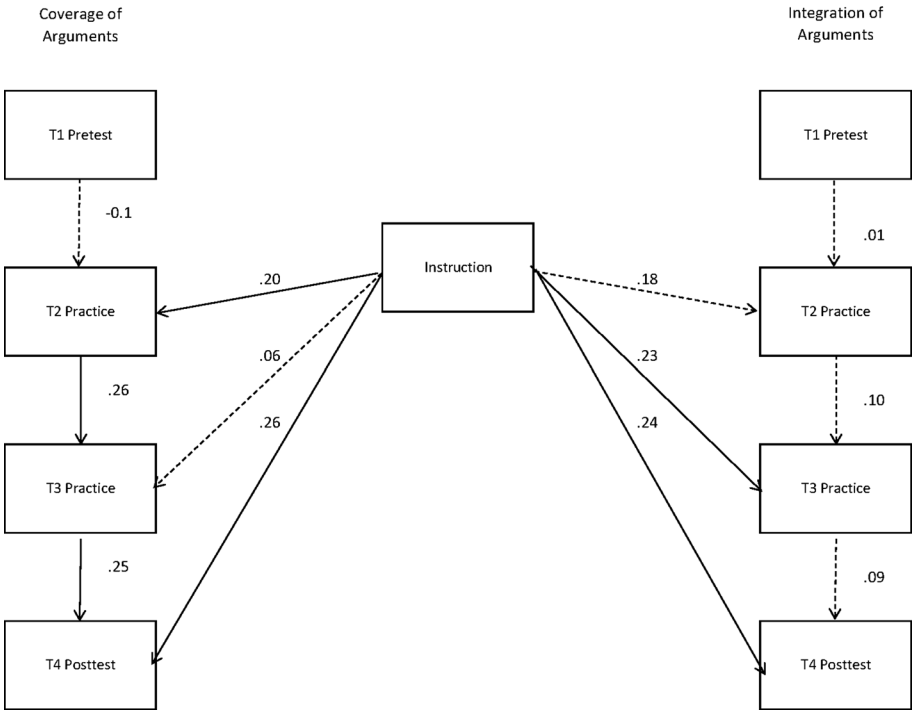

Fig. 3 Best-Fitting Model for the Effects of Instruction and Collaborative Practice Sessions (T2 and T3) on Two Qualities of the Synthesis Texts: Coverage and Integration of Arguments. $\chi^2 = 52.13$, $df = 66$, $p = .089$, RMSEA < .001 (dotted lines indicate non-significant relations)

Table 7 Estimates of instruction condition on the successive measurements for Argumentation Coverage and Integration

Effect instruction condition on	Argumentation coverage		Integration	
	Estimate	(se)	Estimate	(se)
T2	*.20*	(.10)	.18	(.10)
T3	.06	(.10)	*.23*	(.10)
T4	*.30*	(.09)	*.24*	(.10)

The estimate is statistically significant if larger than 1, 96*se (italized)

For integration, the effect of this instruction was not significant at T2 ($p = 0.066$) but appeared to be significant at T3 ($p = 0.009$) and T4 ($p = 0.006$).

The instruction component explained 5% of the variance at T2 in the differences in argumentation coverage. Collaborative practice and instruction together explained 8% of the variance in argumentation coverage at T3 and 21% of the variance at T4.

The instruction component and practice together explained 7% of the variance in T3 integration scores and 8% of the variance at T4 in integration scores. Note that at T2, the effect of instruction did not reach significance; therefore, the proportion of explained variance was meaningless.

The difference between the explained variance for T2 and T4 points to the effects of collaborative practice, which were 16% for argumentation coverage and 1% for integration.

The relationship between argumentation coverage and integration varied across the measurements, ranging from (r, with *se* in parentheses) 0.41 (0.08) at T1 to 0.21 (0.09) at T4, with nonsignificant values during the two collaborative practice sessions T2 and T3, $r = 0.09$ (0.09) and $r = -0.07$ (0.09), respectively.

Discussion

The main aim of this paper was to test assumed causal relations between explicit instruction on the two indicators of good argumentative synthesis texts—argument coverage and integration—directly and/or via the subsequent collaborative practice. We modelled the effects of practice, consisting of two collaborative practice sessions, supported by a written strategy guide, under two preceding instruction conditions. This instruction was aimed at preparing the participants for the practice sessions for using the strategy guide, which consisted of four phases for writing a synthesis text in pairs. The participants either followed explicit instruction via explaining and modelling or self-study without explicit instruction. The theoretical model assumed that the explicit instruction directly and indirectly affected both dependent variables via the practice component. The results of the present secondary analysis showed a different pattern. The theoretical model was confirmed for one of the two variables, argument coverage. Only a direct effect of instruction was observed for the other variable, integration, without any contribution to or from the practice component. In short, for integration level, the practice component—two 90-min sessions—did not seem to contribute.

The present study was inspired by our previous study, in which we found that the explicit instruction condition affected both the coverage of arguments and the integration (Mateos et al. 2018). This concurs with the findings of Harris and Graham (2006, 2009) and a review of other studies by these authors about explicit instruction in writing strategies (Graham et al. 2013). The results are also consistent with those of previous research that shows the effect of explicit instruction via modeling in collaborative writing settings on students' writing skills (Van Steendam et al. 2010, 2014).

This raised questions about whether the instruction affected the outcome directly or via the collaborative practice component and whether the learning paths were different for the two distinguished indicators of synthesis quality.

First, the instruction component was positively related to both indicators of synthesis quality. Explaining and modelling how to apply the four stages outlined by the strategy guide directly and positively affected both learning outcomes, when compared to the self-study variant. Consistent with the results of our previous analysis (Mateos et al. 2018) and

with other research (Song and Ferreti 2013), explicit instruction, compared with self-study, resulted in more arguments being covered from the source texts and higher scores on integration of information.

Secondly, the collaborative practice sessions affected the learning outcomes among both groups for both outcome variables differently, most probably as a result of the preceding instruction variable. Regarding the coverage of arguments, the practice sessions provided an additional learning path, which positively affected outcomes by the preceding explicit instruction (on T2 and then via T3 at T4). However, for the other learning outcome—integrating arguments from various sources into a unified text—collaborative practice *did not* contribute to the final posttest scores (no effect of the preceding instruction on T2, on the effect from T2 to T3, or at T4). The students' progression during the practice sessions for argumentation coverage was brought into the individual posttest session. However, this was not the case for integration. Integration of information may have received less attention in the collaborative sessions and/or might have been less transferable from pair work to individual practice. The improvement of integration did not seem to be due to collaborative practice.

A possible interpretation of these results is that identifying arguments is easier than integrating, and that moving from identifying to integration requires a shift in task representation. Such a shift is crucial for reaching higher levels of integration, as we distinguished in our assessment of integration. This shift is indicated between Levels 3 and 4 of the assessment (see Table 3). It is possible to effectively identify arguments and defend just one of the positions (our Level 2 of integration) or to use it to refute just one of the positions (our Level 3). However, integrating the controversial information in the texts requires an additional in-depth understanding of the arguments from weighing the advantages and disadvantages of each. It also involves exploring a new stance based on this in-depth understanding in order to reduce or cancel out the differences between both sides of the argument (our Levels 4 to 6 of integration). Integration requires reflective argumentative writing, as proposed by Nussbaum (2008a) and Nussbaum and Kardash (2005). Moving from identifying to integration implies a change in the task's representation—that is, its representation from a relatively simple persuasive objective to the construction of a conclusion that none of the sources provides. Such a representation requires the content to be transformed and entails greater complexity and cognitive effort (Bereiter and Scardamalia 1987). In the strategy guide which all of the students studied under different instruction conditions, this transition from identifying and selecting the arguments to their integration was indicated by a segment in the text, moving from (a) exploring and identifying the arguments from both positions and (b) contrasting the positions to (c) integrative construction of a conclusion. Based upon the results in the secondary analysis, we tend to assume that such an important metacognitive shift is better instructed by explicit instruction through explaining and modelling.

Another finding was the changing relationship between the two outcome variables over time. At the pretest, both outcome variables were correlated in both intervention conditions ($r = 0.41$). However, the correlation became weaker during the posttest ($r = 0.21$), and no correlations were observed in the two texts produced during the collaborative practice—the coverage of arguments and the level of integration were not related. For the collaborative practice papers, this might imply that some pairs were invested more in one variable, while other pairs did the opposite. In further studies, analyses of pair work interactions could reveal differences in task representations among pairs. From our data, additional evidence about changes to task representation is found in the estimates of the instruction condition on the successive measurements

of argumentation coverage and integration. These data could indicate that instruction first affected argumentation coverage (in T2) and then integration (in T3). During the first practice session (T2), students who received explicit instruction were more focused on identifying the arguments of both positions, but in the second practice session (T3), the students were more able to focus on contrasting the positions and constructing an integrated conclusion. Identifying the arguments in the second practice session (T3) might have required less cognitive resources, which could be dedicated to integration. The students could have changed their task representation and set other goals, while prioritizing integration and being more selective in identifying the arguments. This might indicate a crossover effect which could be tested in future studies.

In conclusion, we tend to view the task representation as decisive. To write an argumentative synthesis, one must understand that covering the arguments from the sources is a necessary preliminary step. However, the quality of integration depends on the next phase of synthesis writing: the integration of both sides, which goes beyond the source text information.

This secondary analysis suggests the importance of explicit instruction that focusses, in this case, on explaining and modelling the writing strategy to improve the quality of argumentative syntheses, both for analysing the opposing positions and for synthesising them in an integrated conclusion. Collaborative practice with the support of a strategy guide would improve the quality of the analysis of opposing positions. This result is consistent with Kuhn and Crowell (2011), who observed that teenage students involved in dialogic argumentation wrote essays containing significantly more arguments which addressed both sides of the controversy than a comparison group that followed a more traditional discussion format. However, collaborative practice did not seem to be a helpful activity for synthesising the identified arguments and counterarguments in an integrated conclusion. A tentative explanation for this result is that collaborative practice only facilitates some phases of the process. The presence of a partner, who can provide a viewpoint to help broaden the other's perspective by explaining the reasons behind his or her opinion, could be useful in the first two phases of the task: (a) exploring and identifying the arguments from both positions and (b) contrasting positions. However, pair work could lead to difficulties in (c) constructing an integrative conclusion and (d) the textualisation. From an instructional design perspective, it is worth reconsidering the design of the collaborative sessions, in terms of the task provided. An alternative would be to first individually draw an integrative conclusion. Then, the student pairs could compare and discuss their individual conclusions to create a higher level of integration, before individually organising and revising the final draft again. This could also then be followed by the students sharing their individual texts.

Another tentative explanation is that integration needs more practice than argumentation coverage does. In a study by Kuhn et al. (2016), at the end of the first year of the intervention, although the students in the dialogic argumentation group improved their essay writing in terms of addressing both sides of an issue, they needed more practice for further development towards an integrative stance (which includes the negatives of their preferred position or positives of the opposing position). Therefore, if the students in our study had undergone more practical sessions, perhaps we would have observed this indirect effect of the explicit instruction through collaborative practice with the help of the guide, when it came to integration. This tentative interpretation is compatible with the possibility that collaborative practice for improving integration needs to be supported by more guidance. The graphical format of the table in the guide, with the double column and the sections with different arguments in each, probably allowed the participants to identify the reasons

put forward in each text. Conversely, the critical questions in the guide aimed at promoting integration processes might not have been very helpful for triggering these processes. In addition, good integration might also require some support, in terms of language skills and vocabulary, because two-sided argumentation and writing an integrative conclusion are quite difficult for students.

Although we may have shed some light on the black box of learning to write synthesis texts, the collaboration process is still a black box in the current study because we did not collect data on how student pairs collaborated and used the strategy guide. Although each member of a pair had a copy of the guide, nobody was required to complete the worksheets during the collaborative process. We observed that some of the pairs completed both of their copies, whilst others only completed one, and some did not complete either. We cannot rule out the possibility that some pairs used the questions posed in the guide but did not show their answers by writing in the guide. Nor can we determine whether the work with the guide—either when the pairs completed both copies or when only one was completed—was done in collaboration or individually. Therefore, there is an evident need to open up this secondary black box by analysing the writing and collaboration processes in greater depth. Moving forward, we need to record the students' actions and verbalisations during the intermediate intervention sessions, obtain time (duration) stamps for the various activities during the practice as well as overall writing times, and understand the steps of each phase of the process. This analysis could help to shed light on the conditions that shape effective learning.

Despite these limitations, our study's main contribution is its analysis of the different paths which the learning processes for the two elements of argumentative synthesis writing seemed to follow, specifically the identification and coverage of the arguments from both sources and the integration of the opposing positions they record. We generally found that the sociocultural perspective on argumentative synthesis text writing would support the generative aspect of the process, while the cognitive perspective would support its integrative aspect. This theoretical perspective must be tested via experimental designs to draw causal conclusions.

As a result, the contributions of this study include its educational implications. It is important to make teachers and course designers aware that collaborative practice, even with the help of a strategy guide, might not be sufficient to support students in acquiring the skills involved in writing argumentative syntheses. Explicit instruction might be necessary, by modelling the different writing phases and unravelling the processes involved by explaining and fostering strategic learning, which is not merely technical, in the practice sessions. Without explicit instruction, it is difficult for students to perform the more complex task of writing argumentative syntheses—that is, to integrate the opposing positions. Teaching students to go beyond standing for one of the positions and limiting themselves to refuting the opposite, requires explaining and modelling of the strategies involved in the overall process.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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