Conjunction in the educational recontextualization of Natural Science and History: Some evidence from Greek elementary school textbooks

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ΠΕΡΙΛΗΨΗ

Η μετάβαση από την καθημερινή στην εξειδικευμένη γνώση που συντελείται στο πλαίσιο του σχολείου και η αναγκαία προς αυτό το σκοπό διαφοροποίηση των γλωσσικών πόρων αποτελεί κεντρικό πυρήνα έρευνας της Συστημικής Λειτουργικής Γλωσσολογίας (ΣΛΓ). Σχετικές έρευνες, ειδικά στο γραπτό λόγο της δευτεροβάθμιας εκπαίδευσης, έχουν αναδείξει τη συστηματική λεξικογραμματική ποικιλότητα που διέπει τη δόμηση των διαφορετικών γνωστικών αντικείμενων και (ανα)συγκροτεί συστηματικά την εμπειρία των μαθητριών/μαθητών προς την κατεύθυνση της αφαιρετικής επιστημονικής γνώσης. Στο άρθρο εξετάζεται η λογική σχέση της σύνδεσης στα σχολικά εγχειρίδια φυσικών επιστημών και ιστορίας διαφορετικών τάξεων του Δημοτικού σχολείου προκειμένου να αναδειχτούν καίριες όψεις των τρόπων αναπλαισίωσης της σχολικής γνώσης στο γραπτό λόγο. Τεκνοθετώντας τα θεωρητικά και μεθοδολογικά εργαλεία της ΣΛΓ αναλύονται κεφάλαια των σχολικών εγχειριδίων και των δύο γνωστικών περιοχών (φυσικές επιστήμες και ιστορία) όλων των τάξεων ως προς τις λογικές σχέσεις (εξωτερικές, εσωτερικές, ρητές, υπόρρητες) που συνδέουν λογικά τις οντότητες και τις διαδικασίες των δύο αντικειμένων. Τα αποτελέσματα δείχνουν ότι ήδη στο Δημοτικό σχολείο χρησιμοποιούνται μηχανισμοί μεταφορικής σύνδεσης όπως η λογική μεταφορά, που προσιδιάζουν στον επιστημονικό λόγο. Επιπλέον, αναδεικνύονται διαφοροποιήσεις ανάμεσα στις φυσικές επιστήμες και την ιστορία, που εγείρουν περαιτέρω ερωτήματα για τους γλωσσικού πόρους στη διάθεση της εκπαίδευσης.

KEYWORDS: conjunction, Greek elementary education, History, logical metaphor, Natural Science, school texts, Systemic Functional Linguistics

1. Introduction[*]

Within the Systemic Functional Linguistics (SLF) framework, literature addressing the re-shaping of students' experience through textbooks has highlighted "sets of meanings" which enable young speakers/writers to re-construe experience of the social and natural world in order to meet with different scientific disciplines (Hasan 1996, Halliday 1999, 2000, Halliday & Martin 2004, Schleppegrell 2004). Based on this, school literacy reinforces the transition from everyday to educational knowledge by means of specific lexicogrammatical resources, enhancing abstract, taxonomic and universally recognized entities, qualities, facts and relations (Hasan 1996, Christie 1999, Halliday 1999, Painter 1999).

The lexicogrammatical re-shaping of experience occurs through successive "waves"; the first enables elementary school children to cope with written language and abstraction, while later ones concern secondary school students' systematic engagement in technical knowledge, that is in the discourse of specific scientific fields and the mechanism of *grammatical metaphor* (Christie 1999, Halliday 1999, 2000). Grammatical metaphors are considered incongruent non-typical realizations of meanings occurring when processes, qualities and circumstances –congruently realized by verbs, adverbs and prepositions/prepositional phrases respectively –are reconstructed as pseudo-objects, grammatically realized as nouns (Halliday 1994, 1999, Halliday & Matthiessen 1999, Simon-Vandenbergen et al. 2003, Halliday & Martin 2004, Maniou & Kondyli 2017).

While the aforementioned grammatical reconstruction of knowledge refers to the rewording of experiential categories, the aspect of *ideational metafunction* which represents logical relations between experiential processes, such as conjunction, has its

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own analytical significance. Therefore, conjunction is a lexicogrammatical resource that enables the construal of logically related clause complexes. Conjunction resources are important both as ideational and textual tools: at the level of ideational metafunction, they establish the logical scaffold where clausal elements are linked in sequences, multiplying their semantic dynamic; at the level of textual metafunction, conjunction allows the cohesive organization of experiential and interpersonal meanings in a wider semantic unit, the text (Halliday & Hasan 1976, Halliday & Matthiessen 1999, 2004, Martin & Rose 2003, Eggins 2004).

In this paper we focus on the ways in which conjunction construes specialized knowledge as early as elementary school age, as part of a broader investigation concerning both the ideational and textual written recourses of elementary school's discourse, including transitivity, grammatical metaphor, conjunction, theme/rheme, lexical density, school genre[1] (Maniou 2016, Maniou & Kondyli 2017). More specifically, here we deal with external and internal logical relations featuring Natural Science and History textbooks in Greek elementary school, in order to explore ideational and textual resources facilitating the transition to more scientific-like knowledge required in secondary education.

2. Data and analytical framework

Data for this study are taken from Greek elementary school textbooks of Environmental Study (ES) (grades 1 to 4), Physics (grades 5 and 6) and History (grades 3 to 6). In order to investigate early historical and scientific uses of language in the first two elementary school grades, where Natural Science and History are not separate disciplines, we have analyzed chapters from the Environmental Study textbook, including Animals, Plants, Energy, Time, Culture etc. On the whole, we analyzed 201 chapters with a total of 6,253 clauses, focusing on the variety of logical relations (external and internal conjunction, logical metaphor) found in the respective texts.

In order to investigate the realizations of conjunction in the discourses of History and Natural Science throughout Greek elementary school (grades 1 to 6), in the following section we make a detailed overview of external and internal conjunction resources, as well as logical metaphor, in terms of SFL (see Martin & Rose 2003). The analysis of our corpus by descriptive statistics has allowed us to draw quantitative conclusions with regard to the occurrence (relative frequency) of conjunctions per school grade and textbook, presented in section 4.

3. Conjunction: Logical relations and textual cohesion

Conjunction construes logical connections between clauses by providing resources for the logical organization of different fields of social activity, such as the required time sequence for the connection of events in the narration of a story or the unfolding of arguments in argumentative discourse. There are four types of logical relationships between clauses, namely a) addition, b) comparison, c) time sequence and d) consequence (that is, explanation of the cause/result, manner, purpose and condition). These four general types involve both *external* (experiential) and *internal* (textual) logical relations, which can be considered as rhetorical relations. External conjunction concerns the logical relations of the (extralinguistic) social context, while internal conjunction allows the textual organization and thus the construction of the internal

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[1] According to a genre analysis study based on the typology proposed by Schleppegrell (2004) and Coffin (2006), Physical Science texts found in our corpus are procedures (in grades 3 and 4), scientific accounts (grades 3 to 6) and scientific expositions (grade 6), while historical texts are historical recounts (grades 3 to 5) and historical accounts (grade 6) (Maniou 2016; see also Papagiannopoulos 2012).

logic of the text (cohesion). Lexicogrammatically, conjunction is realized through connectives, adverbs and adverbial phrases, mainly in the beginning of the clause[2] (Martin & Rose 2003; see also Georgakopoulou & Goutsos 1999, Archakis 2013).

Table 1. Roles of external and internal conjunctions (from Martin & Rose 2003: 127)

Logical relations	*External*	*Internal*
Addition	Adding activities	Adding arguments
Comparison	Comparing and contrasting events, things and qualities	Comparing and contrasting arguments and evidence
Time	Ordering events in time	Ordering arguments in the text
Consequence	Explaining why and how things happen	Drawing conclusions or counter-arguments

However, conjunctions can also be realized –less explicitly– through other grammatical elements inside the clause structure, that is processes, things, circumstances. This is the case of logical metaphor, which inevitably implies grammatical metaphor, as it reconstructs logical relations not between but inside clauses, often making them implicit (Martin & Rose 2003: 140).

As Halliday & Matthiessen (2004: 549) point out, the use (or not) of implicit conjunction is considered to be an important lexicogrammatical and textual marker that must be taken into account throughout a text's analysis. Overall, our analysis aims at tracing the kinds of logical relations constructing Natural Science and History texts throughout elementary school. In order to do this, we focus on conjunction choices (external, internal, logical metaphor) featured in the different textbooks.

In particular, external conjunction realizes logical relations of the context, that is addition, comparison, time and consequence as related to human experience. More specifically, logical relations of addition can be either additive (*and, besides, moreover* etc.) or alternative (*or, either-or, neither-nor* etc.), as well as implicitly expressed through commas. Conjunctions of *comparison* can express either similarity (*like, likewise* etc.) or difference/contrast (*but, however, while, rather, than* etc.),[3] while relations of temporal sequence can be successive (*when, before, after, until* etc.) or simultaneous (*in the mean, while, as* etc.). Moreover, conjunctions of consequence express relations of cause and result (*because, so, as a result* etc.), as well as means (*by, in this way* etc.), purpose (*in order to, so that* etc.) and condition (*if, then* etc.)(Martin & Rose 2003: 113-116). The following examples from our corpus illustrate external relations:

> (1) *And (και) when (όταν)* the night falls, women and children carry materials (ADDITION, TIME)
> (2) *and (και)* craftsmen repair the flaws that cannons opened on the walls (ADDITION)
> (3) *As soon as (μόλις)* summer began (479 b.C.), Mardonios headed to Athens (TIME), *but (αλλά)* even this time the city was empty (COMPARISON)

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[2] According to Martin & Rose (2003:127), a slightly different set of links, continuatives, placed next to verbs expressing time or mode rather than the beginning of the clause, also construe conjunction of addition, time, comparison, and can thus be analyzed in terms of conjunction.

[3] The category of comparison includes both relations of similarity and contrast/difference. More specifically, conjunctions of contrast/difference can oppose (*whereas, while, but* etc.), replace (*rather than* etc.) and except (*other than* etc.) (Martin & Rose 2003:112-113, 115, 119, 133).

(4) They are called like this, *because (γιατί)* the arrangement of carbon atoms is accidental (CAUSE)

As discussed above, a conjunction also relates to the logical steps of a text as a whole. This type of conjunction, which is applicable mostly to written discourse, allows the organization of the text's phases, such as the development of argument sequence, the setting out of examples and the drawing of conclusions (Martin & Rose 2003: 120). Thus, the addition of arguments can either be additive (*also, moreover, additionally* etc.) or alternative (*alternatively* etc.). Moreover, internal comparison, affirming or clarifying an initial supposition, can express similarity (*again, similarly* etc.), difference (*on the other hand, conversely* etc.), reworking (*for example, specifically, that is, generally* etc.) or adjustment (*indeed, in fact, actually, at least* etc.). In addition, internal time informs readers about the logical succession of textual phases (*firstly, next, finally* etc.) or simultaneously existing conditions (*at the same time* etc.). Finally, the logical progression of a text's arguments regards countering them *(in any case, nevertheless, still* etc.), as well as drawing conclusions out of them (*thus, according to the above, concluding* etc.) (op. cit.: 122-126). For example:

(5) *Indeed (Πράγματι),* the discovery of electricity changed people's lives (COMPARISON: ADJUSTMENT)
(6) *Finally (Τέλος),* gases have neither a certain volume nor a specific shape (TIME: SUCCESSION)
(7) The conductors, *therefore (λοιπόν),* make the interior of the cables (CONSEQUENCE: CONCLUSION)

Besides their congruent wording, logical relations can also be expressed metaphorically, often in technical and abstract texts, allowing the "packing" of a clausal sequence through (both experientially and logically) metaphorical grammatical schemes. As Martin & Rose (op. cit.: 140-141) comment, writers of Natural Science and Politics often choose metaphorical rather than congruent realizations of conjunction, in order to grade the expression of logical relations between facts or arguments and support their statements with flexibility.

Through logical metaphor conjunctions can be reconstructed as experiential elements inside the clausal structure (transitivity system), that is as things, processes or circumstances[4] (Halliday & Matthiessen 2004). Nevertheless, in order to "unpack" logical relations realized metaphorically, alongside with further (less explicit or rather implicit) logical constructions, a comprehensive analysis of the broader and/or the whole text is required (Halliday 1985, Martin & Rose 2003, Eggins 2004, Halliday & Matthiessen 2004, Martin 2004b, Taboada 2009, Maniou 2016).

Firstly, logical relations realized as things/names construe *logical things* (e.g. *sequence, reason, cause, result, conclusion, manner, way, condition* etc.) that can be semantically enhanced (described, numbered, classified) as typical things (Martin & Rose 2003: 143). Furthermore, a conjunction realized as the process of the clause (*add, precede, follow, lead, cause, result, presuppose* etc.) often relates two nominalized processes as if they were participants. In this way, logical and grammatical metaphor co-occur in order to "pack" logical relations of events into a more abstract representation of experience. (In a congruent/typical realization two processes are

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[4] Lexicogrammatical choices of transitivity realize the ideational metafunction in the clause, construing inner and outer world's experience (Halliday & Matthiessen 2004). Namely, the verb construes a certain *process* (classified into six different process types, namely material, mental, relative, verbal, behavioural, existential), nominal groups construe *participants* and adverbial groups define relevant *circumstances*.

related in a clausal sequence through conjunction). Finally, the expression of logical relations as circumstances[5] is also chosen in technical and abstract writing (op. cit.: 142). Examples (8) to (10) from our corpus illustrate these categories:

> (8) The *consequences (συνέπειες)* for the ecosystems may be disastrous (CONSEQUENCE AS THING)
> (9) Signing the treaty *led (οδήγησε)* to EEC's evolution into the EU (CONSEQUENCE AS PROCESS)
> (10) *For the same reason (για τον ίδιο λόγο),* a lot of house electric stoves have two burners (CONSEQUENCE AS CIRCUMSTANCE)

The analysis of our data highlighted the extended diversity of the use of external and internal conjunctions, as well as logical metaphor, in elementary school textbooks. Since a conjuction is realized both at clause and text level, in the following section we present our findings concerning clausal conjunction, something which will allow us to examine how logical relations are structured across a text (see section 5).

4. Conjunction in Environmental Study, History and Physics textbooks

Tables 2 and 3 present percentages of each category of conjunction (external, internal, logical metaphor), while tables 4 and 5 those of each category of external conjunction (addition, time, comparison, consequence) in the school texts under study. The chi-square exact tests indicate the statistical significance of the increase of internal conjunctions and logical metaphors found in the higher grades' Physics and History texts, as well as the statistically significant differentiation of external conjunctions across the analyzed textbooks.

Table 2. External, internal conjunction and logical metaphor in Physical Science texts

Grade * Estimate Cross-tabulation

			Estimate			Total
			External	*Internal*	*Logical metaphor*	
Grade	ES 1	Count	48	0	0	48
		% within Grade	100%	0%	0%	
	ES 2	Count	98	5	2	105
		% within Grade	93.3%	4.8%	1.9%	
	ES 3	Count	115	13	2	130
		% within Grade	88.5%	10%	1.5%	
	ES 4	Count	188	15	11	214
		% within Grade	87.9%	7%	5.1%	
	Physics 5	Count	211	24	16	251
		% within Grade	84.1%	9.6%	6.4%	
	Physics 6	Count	194	13	22	229
		% within Grade	84.7%	5.7%	9.6%	
Total		Count	854	70	53	977
		% within Grade	87.4%	7.2%	5.4%	

Statistical Significance (chi-square exact test, $x2=26.75$, $df=10$, $p<0.005$)

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[5] Additionally, logical relations can be realized as circumstances embedding *nominalizations* (that is grammatical metaphors of processes, qualities etc. as things). For example, in the phrase *for the reorganization of the army (για την αναδιοργάνωση του στρατού)*, the nominalization *reorganization (αναδιοργάνωση)* realizes in a circumstance of purpose the respective logical relation of the congruent (clausal) wording *in order to reorganize the army (για να αναδιοργανώσουν τον στρατό)* (Maniou 2016).

Table 3. External, internal conjunction and logical metaphor in History texts
*Grade * Estimate Cross-tabulation*

			Estimate			Total
			External	*Internal*	*Logical metaphor*	
Grade	ES 1	Count	29	1	0	30
		% within Grade	96.7%	3.3%	0%	
	ES 2	Count	21	0	1	22
		% within Grade	95.5%	0%	4,5%	
	History 3	Count	225	2	0	227
		% within Grade	99.1%	0.9%	0%	
	History 4	Count	136	17	11	164
		% within Grade	82.9%	10.4%	6,7%	
	History 5	Count	168	4	9	181
		% within Grade	92.8%	2.2%	5%	
	History 6	Count	175	3	24	202
		% within Grade	86.6%	1.5%	11,9%	
Total		Count	754	27	45	826
		% within Grade	91.3%	3.3%	5.4%	

Statistical Significance (chi-square exact test, x^2=65.912, df=10, p<0.001)

On the whole, the majority of conjunctions found in our corpus are external, linking together processes of physical and social context, with lower grades' texts being almost exclusively organized through external logical relations (e.g. ES 1 and ES 2 ranging from 93.3% to 100%, History 3 99.1%). As we move to the middle and upper grades, the occurrence of external conjunctions gradually decreases, whereas the use of internal conjunctions and logical metaphors increases.

More specifically, as can be seen in Table 2, external conjunctions in Physical Science texts steadily decrease from ES 1 (100%) to Physics 6 (84.7%), while internal conjunctions appear as conjunctive resources in ES 2 (4.8%) and following (ES 3 10%, ES 4 7%, Physics 5 9.6%, Physics 6 5.7%). Logical metaphors, on the other hand, steadily increase from ES 4 (5.1%) to Physics 6 (9.6%).

In historical texts, on the other hand, Table 3 suggests that prevailing external conjunctions (ES 1 96.7%, ES 2 95.5%, History 3 99.1%, History 5 92.8%) are reduced in History 4 (82.9%) and History 6 (86.6%), in which internal conjunctions and logical metaphors rise significantly (10.4% and 11.9% respectively).

External conjunctions found in our corpus primarily construe logical relations of addition (*and/και, or/ή, also/επίσης* etc.) and secondly relations of consequence (*because/γιατί, thus/έτσι, if/εάν* etc.) and time *(then/τότε, afterwards/μετά, before/πριν* etc.), and lastly relations of comparison (*while/ενώ, but/αλλά, however/όμως* etc.).

Table 4 suggests that in Natural Science texts, additional conjunctions prevail in ES (ES 1 47.9%, ES 2 37.8%, ES 3 56.5% and ES 4 48.9%), whereas they appear significantly less in Physics (Physics 5 27% and Physics 6 25.8%). Conjunctions of consequence proportionally follow additions (ES 1 27.1%, ES 3 32.2%, ES 4 28%) and, in some cases, appear more frequently (ES 2 43.9%, Physics 5 33.6% and Physics 6 35.6%). Subsequently, conjunctions of time are mostly found in ES 1 (20.8%), ES 4 (17.2%), Physics 5 (22.7%) and Physics 6 (23.2%), although less so in ES 2 (11.2%) and ES 3 (8.7%). Lastly, comparisons are mostly found in Physics (Physics 5 16.6%, Physics 6 15.5%).

Table 4. External conjunction in Environmental Study and Physics

Grade * Estimate Cross-tabulation

			Estimate				Total
			addition	*comparison*	*time*	*consequence*	
Grade	ES 1	Count	23	2	10	13	48
		% within Grade	47.9%	4.2%	20.8%	27.1%	
	ES 2	Count	37	7	11	43	98
		% within Grade	37.8%	7.1%	11.2%	43.9%	
	ES 3	Count	65	3	10	37	115
		% within Grade	56.5%	2.6%	8.7%	32.2%	
	ES 4	Count	91	11	32	52	186
		% within Grade	48.9%	5.9%	17.2%	28%	
	Physics 5	Count	57	35	48	71	211
		% within Grade	27%	16.6%	22.7%	33.6%	
	Physics 6	Count	50	30	45	69	194
		% within Grade	25.8%	15.5%	23.2%	35.6%	
Total		Count	323	88	156	285	852
		% within Grade	37.9%	10.3%	18.3%	33.5%	

Statistical Significance (chi-square x^2=77,05, df=15, p<0.001)

Table 5 indicates that conjunctions of addition are generally more prominent in historical texts than in Natural Science texts (49.5% over 37.9% additions in total, respectively), with the majority of them found in ES 1 (65.5%), History 3 (56%) and History 5 (61%). Most of the temporal relations are found in ES 1 (31%), ES 2 (23.8%), History 4 (23.5%) and History 6 (22.3%), although they occur significantly less in History 3 and History 5 (12.9% and 7.6% respectively). At the same time, conjunctions of consequence are mostly found in ES 2 (23.8%), History 3 (20.4%) and History 4 (21.3%), while less so in upper grades' texts (History 5 12.4% and History 6 17.7%). Lastly, conjunctions of comparison steadily increase from History 3 (10.7%) to History 6 (25.1%).

Table 5. External conjunction in Environmental Study and History

Grade * Estimate Cross-tabulation

			Estimate				Total
			addition	*comparison*	*time*	*consequence*	
Grade	ES 1	Count	19	0	9	1	29
		% within Grade	65.5%	0%	31%	3,4%	
	ES 2	Count	10	1	5	5	21
		% within Grade	47.6%	4.8%	23.8%	23.8%	
	History 3	Count	126	24	29	46	225
		% within Grade	56%	10.7%	12.9%	20.4%	
	History 4	Count	53	22	32	29	136
		% within Grade	39%	16.2%	23.5%	21.3%	
	History 5	Count	105	31	13	21	170
		% within Grade	61.8%	18.2%	7.6%	12.4%	
	History 6	Count	61	44	39	31	175
		% within Grade	34.9%	25.1%	22.3%	17.7%	
Total		Count	374	122	127	133	756
		% within Grade	49.5%	16.1%	16.8%	17.6%	

Statistical Significance (chi-square exact test, x^2=69.007, df=15, p<0.001)

Internal conjunctions are mainly found in Natural Science textbooks (with an overall proportion of 7.2%), with most found in ES 3 (13 internal conjunctions, 10%) and Physics 5 (24 internal conjunctions, 9.6%). In historical texts, internal conjunctions are significantly less (with an overall proportion of 3.3%), with an interesting exception in History 4 (17 internal conjunctions, 10.4% (see Tables 2 and 3).

Internal conjunctions mainly construe relations of comparison between clauses. In particular, internal comparison (61 conjunctions) serves mostly for reworking (53 conjunctions) and less frequently for adjustment (6 conjunctions) or difference (2 conjunctions). Moreover, internal relations construe *consequence* (8 conjunctions) and only 1 conjunction construes time. Examples (11) to (17) illustrate some realizations of internal conjunctions found in our corpus. In particular, (11) to (15) are example of comparison (reworking), (16) of comparison (adjustment) and (17) of comparison (difference)

(11) *For example (Για παράδειγμα),* in rooms with many LED lights the temperature rises (ES 4)
(12) *In other words (Με άλλα λόγια)* we must separate its useful materials (Physics 5)
(13) As the temperature rises, the ice melts, *that is (δηλαδή)* the natural state of water is changing (Physics 5)
(14) *In this case (Στην περίπτωση αυτή)* we must separate the components of the mixture (Physics 5)
(15) *Generally (Γενικά),* slaves' life in Athens, compared to others' lives, was better (History 4)
(16) *In fact (μάλιστα),* in order to see more, they chose places very close to a hill (History 4)
(17) *On the other hand (Από την άλλη πλευρά),* the decline in the dynamics of European integration and […] allowed renewed interest in the EU (History 6)

In Physical Sciences texts, logical metaphors are mostly found in ES 4 (5.1%), Physics 5 (6.4%) and Physics 6 (9.6%), whereas in historical texts logical metaphors are found in ES 2 (4.5%), History 4 (6.7%), History 5 (5%), although significantly more so in History 6 (11.9%) (see Tables 2 and 3). Logical metaphors, both in Physical Sciences and History texts, mainly construe relations of consequence and, less frequently, relations of internal comparison and time. Table 6 presents some realizations of logical metaphors found in our corpus.

Table 6. Realizations of logical metaphor in Environmental Study, Physics and History

	Transitivity	*Logical relation*
The great power of Athens became the *cause (αιτία)* of concern for Sparta and Corinth (History 4)	thing	consequence
In this discovery *we owe (οφείλουμε)* the operation of most of the electrical appliances. (Physics 6)	process	
For the same reason (λόγο), a lot of stoves have one or two burners (Physics 5)	circumstance	
Hostile Italian actions *had preceded (είχαν προηγηθεί)* (History 6)	process	time
Continuing (Στη συνέχεια) other Balkans managed to […] (History 6)	circumstance	
Examples (Παραδείγματα) of more complex separation methods [...] are centrifugation, distillation, chromatography (Physics 5)	thing	comparison (internal)

5. Logical relations across the text

Logical relations structure school knowledge according to different disciplines, from lower to upper grades, as can be seen in the text extracts from History grade 3, History grade 6, Environmental Study grade 4 and Physics grade 5 discussed below. For instance, logical relations in text 1, which narrates Achilles' life and death, mainly construe external time (2), comparison (3), cause (4) and addition (6), while the internal conjunction (5) expresses conclusion.

Text 1. (History 3)
(1) His mother, Thetis, had made him immortal
(2) *when (όταν)* he was young […]   TIME
(3) *However (Όμως),* his right heel had not got wet   COMPARISON (CONTRAST)
(4) *Because (Γιατί)* from there she hold him.   CAUSE
(5) *Well (Λοιπόν),* Paris aimed at Achilles   INTERNAL
(6) *and (και)* nailed a poisoned arrow […].   ADDITION

Text 2 discusses the aftermath of World War II and ensuing events. Conjunction construes external logical relations of purpose (1, 2) and difference (6), while logical metaphor (7) concludes the historical result of the precedent historical facts.

Text 2. (History 6)
(1) *In order to (για να)* protect its territory integrity   PURPOSE
(2) *and (και να)* approach the West,   PURPOSE (ADDITION)
(3) Greece joined the North-East Pact (NATO), an
organization set up on the initiative of the Americans
(4) as a compensation for the presence of the Soviet Union
in Europe.
(5) Since the early 1950s, country's relations with
Yugoslavia and Bulgaria progressively improved
(6) *whereas (ενώ αντίθετα)* relations with Turkey have   COMPARISON
worsened, mainly due to the Cyprus issue.   (DIFFERENCE)
(7) *The result (αποτέλεσμα)* of the frictions, were the   LOGICAL
prosecutions of the Greeks of Constantinople in   METAPHOR/RESULT
September 1955, widely known us "Septemvriana"
[September events]

In this case, the logical re-construction of consequence as a thing (*result*) allows the "packing" of also nominalized (thus, also metaphorical) foregoing and upcoming events (*frictions, prosecutions*) into a semantically dense relational process. A congruent conjunction wording could rather be *Since conflict broke out between Greece and Turkey, the Greeks of Constantinople were prosecuted in September 1955. These prosecutions are widely known as "Septemvriana".* Therefore, the metaphorical construction (both logical and grammatical metaphor) condenses events in more abstract historical terms (*Septemvriana*) (cf., Halliday & Matthiessen 1999, Simon-Vandenbergen et al. 2003, Halliday & Martin 2004, Schleppegrell 2004, Coffin 2006, Maniou et al. 2014, Maniou 2016, Maniou & Kondyli 2017).

Logical relations in the following text (3), which refers to the relations in a food pyramid, mainly construe external condition (1, 2, 4, 5), as well as result (6) and addition (7). The single internal conjunction (3) exemplifies (internal similarity-rework) the introductory sentence (1, 2), thereby organizing the description and explanation of the phenomenon.

Text 3. (ES 3)

(1) *If (Αν)* a species is missing on a food pyramid,	CONDITION
(2) *then (τότε)* the balance in nature dissolves.	CONDITION
(3) *For example (Για παράδειγμα),* snakes eat mice.	INTERNAL
(4) *If (Αν)* snakes are missing	CONDITION
(5) *then (τότε)* mice will become too many.	CONDITION
(6) *Thus (Έτσι),* there will be major disasters on IC crops	RESULT
(7) *and (και)* can bring many diseases, dangerous for humans	ADDITION

Finally, text 4, which describes the process of sorting the garbage mixture, construes external logical relations of *difference* (1, 8) and *purpose* (4), while the internal conjunction (6) rewords the described procedure (*sort out*) by means of the "synonym" process *separate.*

Extract 4. (Physics 5)

(1) *Although (Παρότι)* garbage appears to be useless at first glance,	COMPARISON (DIFFERENCE)
(2) they include many objects	
(3) which, with the appropriate treatment, can again be useful.	
(4) *In order (Για να)* to be able to use these ingredients,	CONSEQUENCE (PURPOSE)
(5) we must sort them out,	
(6) *In other words (Με άλλα λόγια),* we need to separate the useful components of the mixture.	COMPARISON (REWORKING)
(7) Separation can be done mechanically in the waste treatment centres,	
(8) *but (όμως)* can also be done in the first instance by us at home.	COMPARISON (DIFFERENCE)

The process *separate* is, in turn, nominalized (*separation*), "packing" the previous and carrying forward the new information. Internal conjunction, in this way, contributes to textual organization, clarifying its informational progression and thus conveying its technical meanings to the young readers of the text (cf. Martin & Rose 2003, Martin 2004a, Schleppegrell 2004, Maniou 2016).

6. Discussion and conclusions

The socio-semiotic approach to the discourses of different secondary school disciplines has allowed us to highlight typical lexicogrammatical and semantic aspects of Greek elementary school textbooks on the subjects of Natural Science and History, thereby expanding the analysis into the hitherto less explored educational level. We focused on the use of conjunctions in Greek school textbooks as a crucial lexicogrammatical resource with which school disciplines, even at this early educational level, are re-construed. The external and internal conjunctions, as well as the logical metaphors, examined in our corpus were taken from 201 chapters of the Environmental Study, Physics and History textbooks, used throughout the six grades of elementary school.

Our findings suggest, first of all, that, even in senior grades of elementary school, conjunctions play a significant role both in the logical reorganization of experience and the re-orientation of texts towards a more technical scientific perspective. In particular, in 4th, 5th and 6th grade textbooks, congruent logical relations between facts (external conjunction) seem to be gradually replaced by the logical organization of the text (internal conjunction), as well as by incongruent lexicogrammar (logical metaphor).

Moreover, the realization of logical relations in the system of conjunction creates a resource for a significant linguistic differentiation between Natural Science and History school texts. Thus, while external conjunction constitutes the basic relational recourse between events and facts in both school subjects, the use of internal conjunction and logical metaphor is interestingly differentiated (mainly in grades 4, 5 and 6).

In the Natural Science texts, besides the extended use of explicit causal external conjunctions, internal conjunctions often reword (*that is, for instance*) new, technical meanings, facilitating text comprehension for young readers. In History, on the other hand, external conjunction (time, comparison) is not accompanied by internal conjunction; as a result, the reconstruction of the historical field into the respective school subject is not mediated by the textual resources of rewording, adjustment etc. At the same time, external conjunctions are often transferred inside the clausal structure through logical metaphor (*lead to, as a result, cause, result, followed, preceded* etc.), while in many cases they are expressed in other implicit configurations (e.g. *for the reconstruction*).

We can, therefore, assume that the understanding of logical relations in History texts (especially in the 6th grade) requires a deeper comprehension of conjunctive resources, not only between clauses but also mainly inside them. Consequently, we can presume that the extent to which a school text identifies and foregrounds the academic nature of the field, aiming at its recontextualization according to students' linguistic abilities, establishes a critical differentiation between History and Natural Science elementary school textbooks. In particular, logical relations in Natural Science texts through the use of internal conjunction seem to favour the rhetorical resources of the text, thus making the logical relations of the scientific field more visible. History texts, on the other hand, do not generally rephrase their meanings, while temporal and causal conjunctions (through logical metaphor and other implicit configurations) embedded in the clause structure often make the logical relations of historical discourse less visible (cf. Veel 1997, Unsworth 1998, 2001, Halliday & Martin 2004, Schleppegrell 2004, Papagiannopoulos 2012, Papagiannopoulos & Kondyli 2014, Maniou 2016).

To this extent, SFL's theoretical framework applies to elementary education, confirming young readers' early engagement with specialized configurations of meanings, largely based on more metaphorical realizations of conjunction. This seems to reach the same range of complexity compared to the early secondary education, mostly concerning History in the 5th and 6th grades. In the ways discussed above, the realizations of conjunctions, alongside certain choices in the transitivity system (relational processes) and the use of grammatical metaphor (nominalization), seem to play a significant role in the grammatical "syndromes", enforcing technicality and abstraction in school discourse (cf. Halliday & Martin 2004, Maniou et al. 2014, Papagiannopoulos & Kondyli 2014).

In conclusion, this recontextualization of common sense knowledge into systematically organized educational context is expected to involve more elaborate kinds of logical organization, such as internal conjunction, logical metaphor and other implicit logical relations. In this way, both the continuity between elementary and secondary education and the specialized disciplinary knowledge look safeguarded. However, the question is whether the effects of high logical abstraction are congruent with the semantic potential of elementary school age students.

This paper certainly cannot be considered exhaustive for the analysis of logical relations in school texts. A deeper investigation of implicit conjunction would highlight logical relations that lie beyond lexicogrammar choices (cf. Halliday & Matthiessen

2004, Martin 2004b, Taboada 2009, Maniou 2016). Moreover, further research would make known the "de-packing" of metaphorical syndromes through actual classroom teaching.

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