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ANALOGIES BETWEEN LOGIC PROGRAMMING AND LINGUISTICS FOR DEVELOPING STUDENTS' UNDERSTANDING OF ARGUMENTATION TEXTS

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ABSTRACT

Aim/Purpose Research shows that students encounter difficulties in identifying the structure of argumentation texts and in understanding the main message of the argument. The research examined the effect that learning Logic Programming (LP), while applying logic inference, has on students' understanding of argumentation texts.

Background Understanding an argumentation text means exposure to its structure, which requires the ability to identify the argument presented and to distinguish between the argument and its justifications. Argumentation is an important cognitive capacity for handling conflicting information, viewpoints, and opinions. Students' lack of ability to identify the structure of argumentation texts, and to understand its' main message, affects the understanding of texts in general, the writing of texts, and the presentation of oral arguments. Since Logic Programming is based on inference that is similar to the way in which people commonly believe that human inferential thinking is performed, our research approach was to investigate how learning LP in Computer Science affects the understanding of argumentation texts in Linguistics.

Methodology The research population included 319 11th-grade students from five high schools, divided into a study group and a control group. Students' understanding was tested using knowledge questionnaires after completing their language studies, before (pre-study) and after (post-study) a year of learning LP. The knowledge questionnaires included argumentation paragraphs where students were asked to give each paragraph a title and to analyze the argument structure. In addition, an attitudes questionnaire was administered at the end of the school year in order to examine the students' attitudes towards the connection between the two disciplines. The research applied a mixed method approach, combining both qualitative and quantitative methods.

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Contribution	The research and its' findings contribute to the previous body of knowledge with relation to students difficulties in understanding argumentation texts in Linguistics studies. Moreover, it suggests a new approach of using argumentation in the framework of inference as apply in LP to scaffold students' conceptions. The use of an interactive computerized system (like the logic programming language Prolog) can scaffold students in constructing their knowledge, develop their computational thinking skills, and also enables to vary the teaching methods.
Findings	Findings show that the students' understanding of argumentation texts improved after learning LP. The study group students' achievements were explicitly better compared with the control group students, who did not learn LP, though this was not always reflected with significant statistics. Students' attitudes questionnaire revealed that students did not identify on their own the connections between the two disciplines and so could not explicitly use it to promote their understanding.
Recommendations for Practitioners	Creative educators, who value challenges, can greatly benefit their students if they collaborate in aim for applying interdisciplinary learning while combining those two disciplines. The research conclusions shows that it is possible to improve students' understanding if teachers explicitly mediate and guide students in drawing analogies.
Recommendations for Researchers	The analysis tool we developed and apply can be used by educators and researchers to evaluate the understanding of argumentative texts by learners. It can be used in language classes at all levels as well as by educators in other disciplines in which the understanding of the argumentative structure is fundamental.
Impact on Society	Developing argumentation skills and computational thinking skills.
Future Research	Vary future possible research can follow the presented approach: examining how LP teachers expose the logical structure of an argumentation paragraph when they write logic programs that describe the inference represented in texts; examining how language teachers coupe with learning and using LP; examines the knowledge and skills of students that experienced a mediate learning process in the two disciplines in parallel.
Keywords	argumentation, logic programming education, language education, computational thinking, interdisciplinary analogies

INTRODUCTION

Argumentation texts are the subject of study at all educational levels, from kindergarten, through elementary school and high school, to academic studies. Understanding an argumentation text requires exposure to its structure and relies on the ability to identify the presented argument and to distinguish between the arguments to its justifications. Argumentation texts can also take on different structures that may make them more difficult to understand. In some structures, the inference is concealed in the text, and thus is more complicated for readers to recognize and understand. Research shows that students encounter difficulties capturing the essence of argumentation texts. For example, they have trouble distinguishing between the claim and the justifications (Berkowitz, Oser, & Althoff, 1987) or presenting suitable justifications and arguing with counterclaims (Kuhn, 1991). The ability to support a claim is accepted today as a required basic skill, but while argumentation is usually learned in language studies, it serves all disciplines. This is reflected, for example, with the emphasis given in recent US science education reform efforts (National Research Council [NRC], 2012; NGSS Lead States, 2013;. Respectively, in the field of science teaching education emphasis is given to the need to promote students' ability to present arguments; for example, the development of computer games (Wallon, Jasti, Lauren, & Hug, 2017) and web-based argumentation systems (Tsai, Jack, Huang, & Yang, 2012) to support students in acquiring this skill. Moreover, it is accepted as a required skill in all disciplines, for example in Medicine, when doctors are required to argue orally and in writing, to justify their conclusions (e.g. Shilo & Shilo, 2018). In accordance, teacher training frameworks are being developed to provide teachers with tools to scaffold their students in developing their own capacities (Cavlazoglu & Stuessy, 2018).

In two previous papers (Ragonis & Shilo, 2014; Shilo & Ragonis, 2014) we presented a theoretical investigational study of the potential advantages that secondary school learners may gain from learning argumentation in two different subjects, namely logic programming within computer science studies and argumentation texts within language studies. In both domains, students are required to apply similar abstraction skills manifested in the analysis of texts and in capturing their logic structure and inference. Logic programming (LP), a field in computer science, is based on inference similar to how people believe that human inferential thinking is performed. Logic rules are formalized in a programming language (Prolog) that is very similar to a natural language. The nature of inference in LP can be observed both in the inference engine of the language and in the way programs are written as knowledge bases, described by facts and logic rules. Logic programming is based on elementary structures that capture the formation of argumentation texts, enabling students who master it to check and "run" their arguments on a computer. We believe that using LP might facilitate students' understanding of augmentation texts and develop their computational thinking skills as well. Given that, the intention of our study was to investigate whether or not learning LP will indeed realize this potential.

Accordingly, two questions were defined: (1) does learning LP affect the students' ability to understand the logical meaning of an argumentation text previously learned as part of their language studies?, and (2) what are the students' attitudes regarding the effect that learning the two disciplines, LP and argumentation paragraphs in language, has on their understanding?

The paper describes research conducted among high school students to examine the claim that learning LP will scaffold and enhance students' understanding of argumentation texts. In the Literature Review, we highlight different connections between the two disciplines and present the origins of argumentation texts found in both disciplines. In what follows, we describe the study rationale, targets, population, tools, and the analysis methods we used. In the Findings section, we present in detail and discuss the analyzed findings. In the Summary we present the lessons that may be learned from the research and offer recommendations for teaching. Specifically, we emphasize the need for mediated teaching to maximize the potential of drawing analogies between different domains to enhance understanding and develop higher-order thinking skills, based on different representations, as well as develop students' computational thinking skills.

LITERATURE REVIEW

ARGUMENTATION IN NATURAL LANGUAGE

Argumentation is recognized as an important cognitive capacity in the purpose of handling conflicting information, viewpoints, and opinions (Besnard et al., 2014). Researchers indicate that integrating argumentation activities into learning results in the enhancement of students' thought processes (Simon, Erduran, & Osborne, 2004). Support for this claim is seen, for example, in the context of a scientific claim, which requires supporting evidence (Horton, Golden, & Parmly, 2013). Students' participation in argumentation activities helps them acquire a deeper understanding of the scientific content and demonstrates the steps of the argument construction process that is a requirement for presenting proof.

An argument is a statement the justification, correctness or validity of which is debatable. It can be a determination, a position, an opinion, a decision, a hypothesis, an assumption, a conclusion, a command, a theory, or a specific solution to a problem. An argumentation text is one in which the addresser presents an argument, expresses his or her opinion, makes an assumption, or thinks a thought, and then must prove that he or she is right. Thus, the addresser tries to convince the addressee of the rightness of what he or she claims. In other words, the addresser expresses support for a certain opinion using means of persuasion such as reasoning and proofs, comparative statements, restrictions and exceptions. An argumentation text must lead to a conclusion, making assumptions that lead to that conclusion (Antaki 1994). Theoretical argumentation texts, which attempt to prove their claims logically and theoretically primarily address the addresser's thoughts rather than his or her emotions (e.g., Besnard et al., 2014). Argumentation texts are distinguished from theoretical texts that present facts and ideas, interpret historic events and social phenomena, and clarify opinions without taking a stand (Goelman, 1982).

The analysis and presentation of a claim may be approached in several ways. One approach, the logico-philosophical approach presented by Toulmin (1958), addresses the logical connection between the claim and the conclusion. Toulmin describes stages in the construction of a claim, whereby emphasis is on the text ra-

ther than on the addressee; in other words, the development of the claim is not related to a process. Another approach, the new rhetorical approach, was presented by Perelman and Olbrechts-Tyteca (1969). This approach addresses the addressee's position and perception and examines whether or not he or she opposes the claim. A third approach, the pragma-dialectical approach, was presented by van Eemeren and Grottendorst (1992) and refers to all the parties involved in the claim, including opponents with different opinions, who reinforce the dialogicity involved when dealing with argumentation. Researchers also address the connection between understanding the text and writing it, as well as the effect of the addressees on the understanding of the text. For instance, according to Carciu (2009), it is important to know who the readers are when examining the interpretation of the text.

In this work we used the model proposed by Toulmin (1958), which presents six stages in the presentation of an argument, the first four of which are mandatory: 1 - claim; 2 - grounds (or data); 3 - warrant; 4 - backing (or support); 5 - qualifier (or modal qualifier); and 6 - rebuttal.

We also considered Mann and Thompson's (1988) and Mann, Matthiessen, and Thompson's (1992) reference to the organizing parts of the argument. The theory of rhetoric structure they presented introduced the core of the text and its accompanying parts. Azar (1999), who analyzed this theory, showed that the anti-thesis can indeed lie within the proof of the claim, in other words, after presentation of the claim, but that it can also come before the proof

We chose these models as the basis for the current study, since they are used in presenting argumentation in school curricula as part of language and language studies. The focus is on models that address the understanding of the text rather than its writing, since the students who participated in the study are asked to analyze a given paragraph and to identify the structure of the inference concealed in it, and are not required to construct an argument themselves. The analysis of the argument focuses on its structure rather than on the readers who are involved and who take a stand with respect to the argument.

These approaches were applied in the teaching process as follows. The argument structure usually taught is as follows: the text begins with some kind of introduction, (although some texts may have no introduction); then, the addresser usually presents the claim, supporting it with one or more kinds of justification (data, examples, proof, detailing, reasoning, and more). Finally, the addresser concludes with one of several types of endings, or with a combination of ending types; nevertheless, some texts have no ending. Argumentation also makes it possible to introduce a position that is in opposition to the opinion of the addresser (Azar, 1999; Toulmin, 1958), either at the beginning of the text or later on. Another structure presents both the subject and the controversy that surrounds the subject in the introduction, then objectively presents two opposing opinions, and finally concludes by taking a stand. Teachers reinforce these two main argumentation models in class and develop the justification options.

Argumentation in Logic Programming

Logic programming is based on inference that is similar to the way in which people commonly believe that human inferential thinking is performed. Such inference expresses basic rules of mathematical logics. For example, if condition cond1 is met (its logical value is true) and if condition cond2 is not met (its logical value is false), then the following composite conditions can be inferred: (cond1 and cond2) is false, (cond1 or cond2) is true, (not cond2) is true. This kind of inference is observed in LP, both in the inference engines of the LP languages and in how programs are written as knowledge bases, described by facts and logic rules that can be derived from such facts. Table 1 presents an example of a logic program in which Paragraph A of the research questionnaire is displayed as a Prolog program.

Argumentation and LP have reciprocal influence in current research issues and underlie research in sub-areas of computer science such multi-agent systems, knowledge representation and reasoning, and artificial intelligence. The origins of this connection can be partially attributed to Chomsky (1957), who introduced the theory of formal languages and expanded it in his later works (Chomsky, 1965, 1975). Chomsky's theory enabled the definition of a set of rules that facilitate the construction of all valid sentences in a language. This theory, which arose from linguistic research on natural languages, became a central tool in mathematical theory and computer science theory with respect to programming languages. One of the intersection points between linguistics and computer science is the theoretical assertions about the similarities between computer computational methods and how humans learn and use natural language, specifically in reference to argumentation

(Rahwan and Simari 2009). The field of artificial intelligence, which developed in the 1950s and 1960s parallel to the development of the formal language theories (McCarthy 1958; Bratko, 1990; Sterling and Shapiro 1994), influenced the field of computational linguistics. The connection between the fields is mutually beneficial: argumentation formalism is used to define semantics for LP, while LP serves as an underlying representational language for argumentation formalism (Alsinet et al. 2008; Garcia, Dix, and Simari 2009; Caminada, Sa, and Alcantara 2015). Interest in this relationship between the fields is evident also in the establishment of the first international Workshop on Argumentation and Logic Programming (ArgLP 2015).

Previous research addressed knowledge representation and logic representation in logic programming. For example, Lopez (2001) presented a methodology for teaching logic programming using analogies based on similar relations within different contexts. Moreover, researchers highlighted the key role of logic in computer science education, specifically in the context of knowledge representation, and recommended integrating these two seemingly different disciplines—language and computer science (Habiballa, and Kmet 2008). The interest in the field is expressed in a survey of the current state of the software systems for solving tasks in abstract argumentation frameworks, structured argumentation frameworks, and approaches for visualizing and analyzing argumentation (Cerutti, Gaggl, Thimm, et al. 2017). An up-to-date work is done in relation to representing argumentation frameworks (AF) in Answer Set Programming (ASP) where four different transformations from AFs to logic programs are used and exploit new connections between argumentation theory and logic programming, and enable to perform various argumentation tasks using existing answer set solvers (Sakama, and Rienstra 2017).

Difficulties Understanding Argumentation

Understanding an argumentation text means exposure to its structure, which requires the ability to identify the argument presented and to distinguish between the argument and its justifications. Some of the argument constructions are more complicated for readers to recognize and understand, for example, when the inference is concealed in the text.

Since argumentation texts are studied at all educational levels, from kindergarten, through grade school and high school, to academic studies, it is a key subject for research. Studies show that understanding argumentation texts and constructing such texts may be problematic and that students often have difficulties formulating good arguments (Orsolini 1993). Such difficulties are often related to different populations. Pre-school children encounter difficulties using arguments when trying to justify their claims (Stein and Miller 1993); young students aged 9-11 typically encounter problems finding justifications for their claims (e.g. Berkowitz, Oser, & Althoff 1987); and older students and adults reveal difficulties presenting eligible justifications and arguing with counterclaims, and they tend to base their claims on explanations rather than on evidence (Kuhn, 1991).

Regarding LP, research works also indicates difficulties novice students encounter while writing a logic program. The process is based on abstraction that leads to knowledge representation, and students' main obstacle is to define which rule results in another rule, or what can be inferred from what (Habiballa & Kmet', 2008). Research on students' misconceptions has been done in the past (Bottino, Forcheri, & Molfino, 1988; Brna, 1994; Campos, 2010), and now the focus is more on how to build an appropriate curriculum (Di Bitonto, Roselli, & Rossano, 2009; Linck & Schubert 2011; Stamatis & Kefalas, 2007), and how to attract students to this important field which develops reasoning, logic and thinking skills (Vosinakis, Anastassakis, & Koutsabasis, 2016).

Analogies Between Argumentation Structure in Natural Language and Prolog Programming Language

Our investigation builds on our previous study, in which we drew analogies between argumentation texts and Prolog programming as studied in high schools (Ragonis & Shilo, 2014; Shilo & Ragonis, 2014). Table 1 presents an example of this analogy, taking Paragraph A of the research questionnaire as an example. Column 1 presents the four basic structural parts of an argumentation text, Column 2 displays the text presented in Paragraph A of the research questionnaire, and Column 3 presents a simple formalization of the paragraph in propositional Prolog.

Table 1. Analysis of argumentation paragraph structure and its representation in logic programming

Argumentation structure	Paragraph text	LP statements (Propositional Prolog)
Introduction	Many educators have recently addressed the issue of introducing computers into the education system in a serious manner.	The "subject" of the program does not appear in the program
Claim	We believe that computers are important in all realms of life, and we must therefore increase their use.	?-we_must_support_the_introduction_of_computers_into _areas_in_which_they_are_not_yet_predominant.
Justification	The importance of computers is evident in the area of banking: thanks to computers, we receive large amounts of information about the economic situation of various companies, within very short periods of time, both from Israel and from abroad, and we are thus able to do business anywhere in the world in real time. Another example is the world of medical research: human lives may be saved using computers that can perform rapid diagnostic tests or receive information, for instance, on the worldwide availability of blood units of a rare blood type.	Logic rules formulated in programming language: use_of_computers_should_be_increased :- (means <if>) computers_are_important_in_all_realms_of_life. computers_are_important_in_all_realms_of_life :- computers_are_important_in_banking. computers_are_important_in_banking :- we_receive_large_amounts_of_information_about _the_economic_status_of_various_companites_within_ very_short_periods_of_time_both_from_Israel_and_ from_abroad ; (means <or>) it_is_possible_to_conduct_realtime_surveys_anywhere _in_the_world. computers_are_important_in_all_realms_of_life :- computers_are_important_in_medicine. computers_are_important_in_medicine :- human_lives_may_be_saved_using_computers_that _perform_rapid_diagnostic_tests; information_may_be_received_on_the_worldwide _availability_of_blood_units_of_rare_blood_types. Sample fact from the description in the text: it_is_possible_to_conduct_realtime_surveys_anywhere_in_ the_world.
End	We must, therefore, support the introduction of computers into fields in which they are not yet predominant.	When presenting the query that appears as a claim, the prolog inference engine will give the answer: yes.

The syntax of writing rules (relationships) in Prolog:

The programming language requires the text to be written continuously, with no spaces, and so the character _ is added to separate and link the words (so that the text is more readable).

The character :- means if, the character ,means and; the character ;means or; and the character .denotes the end of the logic rule. The part that comes before the character :- is called the "rule head", and the part that comes after it is called the "rule body". The rule head is fulfilled (or is true) if the rule body is fulfilled (or is true), and the rule body is fulfilled (or is true) if it can be proved using another rule head or a proven fact.

An examination of the sentences in the Introduction reveals that the language is in fact based, to a large extent, on natural language, and that its syntax is basic.

The structure of the text that must be uncovered by learners in both disciplines is similar. Students must use abilities of abstraction when reading the text in order to cope with its meaning, i.e. the argument. They must discover what the claim is, what justifications are presented, and what can be concluded (inferred) as a result. The process is essentially the same in both representations, although the method of formalizing the text is different. Thus, by alternating between the two forms of representation and by highlighting the analogies, the two different representations of the text may mutually develop students' skills and so enhance their understanding of the text.

THE STUDY

STUDY RATIONALE AND OBJECTIVES

We claim that the abstraction abilities required to understand argumentation texts are similar to those required for the formalization of problems in LP languages (Ragonis & Shilo, 2014; Shilo & Ragonis, 2014). Accordingly, the objective of the study was to determine whether or not we can enhance the understanding of argumentation texts by learning from different representations of the texts and by giving students the opportunity to use computerized systems that enable interaction with texts.

Accordingly, two questions were defined:

1. Does learning LP affect the students' ability to understand the logical meaning of an argumentation text previously learned as part of their language studies?
2. What are the students' attitudes regarding the effect that learning the two disciplines, LP and argumentation paragraphs in language, has on their understanding?

STUDY POPULATION

The Logic Programming academic unit is an elective in the Israeli computer science curriculum taught in about ten high schools throughout the country. The research included 11th grade students (aged ~17) from four high schools in different cities (denoted I-IV). The students came from similar socio-economic backgrounds, had completed the language matriculation exam the year before the study year, and had studied the Logic Programming unit as part of their computer science studies during the study year. The students did not study language during the study year at all.

A total of 319 students participated in the research, of whom 313 completed the pre-study questionnaire, 141 completed the post-study questionnaire, and 91 completed the attitudes questionnaire. Of these 319 participants, 135 completed both the pre- and post-study questionnaires.

The study also included a control group comprising 55 students from three of the four high schools. These students were at the same stage in their high school studies as the students in the main study group, but did not study LP. The control group subjects completed the post-study questionnaire only. It was assumed that the knowledge level of students in both the control group and the study group was similar at the beginning of the school year (school, year of studies, completed linguistic studies the year before, chose computer science as their specialty study track).

Table 2 presents a breakdown of the students according to school and the questionnaires they completed. It is evident from this table that significantly fewer students completed the post-study questionnaires at the end of the school year; fewer students cooperated with the researchers at this stage.

Table 2. Number of respondents to questionnaires by school

Number / School	Pre-study	Post-study	Attitudes	Pre-study & post-study	Control group
I	26	23	24	21	-
II	84	11	-	11	19
III	37	32	31	30	18
IV	166	75	45	73	18
Total	313	141	91	135	55

Study Tools

The research applied a mixed method approach combining qualitative and quantitative methods (Cohen, Manion, & Morrison, 2017; Creswell, 2018). Two knowledge questionnaires were used in the research: one was administered at the beginning of the school year (pre-study) and the other at the end of the school year (post-study). The knowledge questionnaires included argumentation paragraphs; the students were asked to give each paragraph a title and to analyze the argument structure in each. The two questionnaires contained three identical paragraphs, and the post-study questionnaire administered at the end of the school year included a fourth paragraph. The rationale for adding this fourth paragraph will be presented later on. The data was first analyzed qualitatively, and then the qualitative findings were quantified and analyzed using methods of descriptive statistics. In order to validate the paragraphs that was chosen to be included in the questionnaires, and to validate the qualitative analysis, we consulted ten linguistic experts, each with a Ph.D., currently teaching academic writing courses and with extensive experience in high school teaching. The experts first received the text and determined if the paragraphs meet the required structure. There was full agreement regard that. Later on in the stage of analyzing students answers a sample of analyzed paragraphs were addressed to the experts. In most cases they approved the classifications. In cases where there was disagreement, a conversation was held for clarification and adjusting the classifications rules, and accordingly the entire sample was examined. All the expert approved the weighted score for students' success in each of the paragraphs analyses. A third attitudes questionnaire was also administered at the end of the school year in order to examine the students' attitudes towards the connection between the two disciplines. The students' attitudes were analyzed quantitatively, and the open question, was analyzed qualitatively.

The study was approved by Israel's Chief Scientist and did not require parental approval since the questionnaires were knowledge and attitudes questionnaires. All the questionnaires were administered by the students' computer science teachers in their classrooms. Responding to the questionnaires was voluntary. The students were informed that their answers were to be used anonymously for research purposes only, and that they would not be used for evaluation purposes. Questionnaires administered at the beginning of the year (pre-study) were matched with those administered at the end of the year (post-study) using the students' serial numbers on their class student lists.

Pre-study Questionnaire

The pre-study questionnaire investigated the understanding of the argumentation paragraph before the students started learning LP. The questionnaire included three argumentation texts, each with a different structure. To help the students complete the questionnaire, they were given a table that contained the characteristic components of an argument: Introduction, Claim, Justifications, and End. The instructions specifically noted that not all argumentation paragraphs contain all four components. The students were asked to give the paragraph a title and to copy parts of the paragraph into the different sections of the table, as they deemed appropriate. Students were asked to give the paragraph a title since this task requires the students to think about the essence of the text and to formulate it as a phrase that is not a true sentence. Giving titles to paragraphs is taught as part of the linguistic studies and it is also part of the matriculation exam. The emphasis in teaching is to indicate the connection between the claim, which is the essence of the text, and the title, which should also present the essence. In other words, if the claim was understood, then the presentation of the text subject, in the form of the title, should also be clear.

Paragraph A

Paragraph A has regular, basic argument structure: Introduction, the writer's claim, justification of the writer's claim, and an ending in which the claim is revisited or repeated. The paragraph contains connecting conjunctions and other words that direct the addressee to the next section and hint at its essence (for instance, "we believe that" - an opinion; "this is evident" - justification). This structure constitutes the basis for the other structures described below and is taught as the basis for the argumentation paragraph.

The following presents the breakdown of Paragraph A according to the paragraph's structural components, as it was expected to appear in the students' analyses (from Shilo, 2003, p. 11).

Paragraph A Title: The Importance of Computers in Different Areas of Life

Introduction	Many educators have recently addressed the issue of introducing computers into the education system in a serious manner.
Claim	We believe that computers are important in all realms of life, and we must therefore increase their use.
Justification	The importance of computers is evident in the area of banking: Thanks to computers, we receive large amounts of information about the economic situation of various companies, within very short periods of time, both from Israel and from abroad, and we are thus able to do business anywhere in the world in real time. Another example is the world of medical research: human lives may be saved using computers that can perform rapid diagnostic tests or receive information, for instance, on the worldwide availability of blood units of a rare blood type.
End	Therefore, we must support the introduction of computers into fields in which they are not yet predominant.

Paragraph B

Paragraph B differs from Paragraph A in that in addition to the introduction, it presents an opposing opinion, followed by the writer's position and its justification. The justification concludes the text, and there is no ending. To understand the claim, the reader must first distinguish between the counterclaim and the writer's claim, and understand that they are opposing opinions and, therefore, cannot be a single component. The appropriate place to present the counterclaim is in the introduction, which includes a presentation of the subject and can include also an opposing position. Thus it follows that the counterclaim cannot be part of the claim. The counterclaim cannot be part of the justification either, since it is not supported by reasoning and it does not confront the claim in terms of logic. In principle, the counterclaim should stand on its own, but it was not included in the table as a separate analysis component since we did not want it to give away the solution; we expect it, therefore, to be classified as part of the introduction.

The following presents the breakdown of Paragraph B according to the paragraph's structural components, as it was expected to appear in the students' analyses (from Shilo, 2003, p. 23).

Paragraph B Title: The Importance of Tales

Introduction	A tale is a kind of folk story. Some people claim that tales are old stories and even childish stories, and they wonder why we should dust them off and tell them.
Claim	We believe that tales comprise a huge treasure that warrants attention both on the part of readers who are interested in the stories and on the part of researchers investigating the development of tales.

Justification	A seemingly innocent tale can contain infinite treasures of wisdom, original presentations of human problems, stories about tensions that may exist between us and the people closest to us, all told through simple stories, which many consider to be the epitome of stories of all times. Many artists—painters, authors, musicians—have been inspired by the treasures of tales. Tale characteristics may be seen in the literary works of Hans Christian Andersen, S.Y. Agnon, Oscar Wilde, and others; in movies such as The Princess Bride and Pretty Woman; and in various science fiction works that include movies in which people return to the present from the future and robots and elaborate machines play active roles.
End	None

Paragraph C

This paragraph, too, is based on the aforementioned basic structure, but in this case the claim is missing and the text has the following structure: First there is an introduction, followed by the justification, which leads into the claim, which doubles as the ending. This is a structure in which the claim stems from the justification and is presented at the end as the conclusion of the paragraph.

The following presents the breakdown of Paragraph C according to the paragraph's structural components, as it was expected to appear in the students' analyses (rewritten from Ortner 2000, p. 99).

Paragraph C Title: The Importance of School Design

Introduction	Over the past decade, far-**reaching** changes in the perception of the planning and design of schools and education buildings in general may be discerned.
Claim	None
Justification	As an architectural creation, the school is the site of the child's first encounter with cultural and artistic values. It is the place where the child acquires knowledge of various kinds in various ways, and is a place that is a crucial environment for hands-on experimentation and experiences. The school and its environment have a substantial and continuous influence over the child and his or her spiritual and cultural development.
End	Therefore, more attention should be paid to the planning and design of the school as a well-kept and aesthetic physical environment.

Post-study Questionnaire

This questionnaire was administered at the end of the school year, after the students learned LP. The questionnaire included the same three texts that appeared in the pre-study questionnaire, as well as a fourth text that had the same complete, basic structure as Paragraph A. Although the students presumably did not remember the texts from the beginning of the year, especially since the solutions were not discussed in class, we decided to add another paragraph. The intention of Paragraph D was to validate and test implementation on an additional text that the students had not seen before. The assumption was that the students' understanding of Paragraph D would be similar to their understanding of Paragraph A.

Paragraph D

The structure of this paragraph is basic, like Paragraph A, but it lacks connecting words and conjunctions that allude to the paragraph components, apart from the ending, which begins with the conjunction "therefore".

The following presents the breakdown of Paragraph D according to the paragraph's structural components, as it was expected to appear in the students' analyses (rewritten from Glick and Beyman 2010, p. 36).

Paragraph D Title: The Importance of Humor at All Ages

Introduction	Humor has existed from before Saturday Night Live. It is a human phenomenon that is manifested in two main ways: smiling and laughter.
Claim	In these two manifestations, humor not only makes our life more enjoyable, but also plays a very important psychological social role at all ages.
Justification	Babies from all cultures begin to laugh at around four months old and research tells us that smiling and laughter on the part of parents are essential to the survival of babies, since they impart a sense of security and protection. Humor is also important during childhood and adolescence. Children with a poor sense of humor are chosen less often to participate in social activities and adolescents that are considered humorists enjoy a higher social status and greater popularity. Shared humor reinforces bonds among social group members and heightens their sense of belonging. Older people also appreciate humor and it is one of the personal traits people value most in a partner.
End	Therefore, we should encourage humor in the home, from the moment children are born, and later on in the education system, when they grow and develop.

Attitudes Questionnaire

An attitudes questionnaire was administered at the end of the school year, immediately following the post-study questionnaire. The objective of this questionnaire was to examine the students' attitudes towards the effect of learning LP on their understanding of argumentation paragraphs and on its connection with their linguistic studies the previous year. The questionnaire contained closed questions, which the students were requested to respond to using a 4-point Likert scale (strongly agree, somewhat agree, somewhat disagree, strongly disagree), as well as one open-ended question, in which students were requested to verbally address their attitudes and opinions regarding the parallelism inherent in learning the two disciplines.

The attitudes questionnaire is hereby presented in full:

No.	Statement
1	I see the connection between argumentation paragraphs in language and writing Prolog programs.
2	Learning LP will help me understand argumentation paragraphs in language.
3	It is beneficial to study argumentation paragraphs in language before learning LP.
4	I don't think there is a connection between Prolog programs and argumentation paragraphs that I studied in language.
5	Studying argumentation paragraphs in language will help me understand LP.
6	It is beneficial to learn LP before studying argumentation paragraphs in language.
7	The connection between argumentation in language and argumentation in LP is clear.
8	It is beneficial to deepen the understanding of an argumentation paragraph by writing a Prolog program.
9	We welcome any additional comments or clarifications you might have: _

Coding and Scoring of Student Answers

After reviewing a sample of completed questionnaires, a method for coding student responses was formed. We decided that each paragraph would be given a number made up of a score for the paragraph title and scores for each of the paragraph components. Each of the paragraph components, as well as the paragraph

title, was given a score in the range of 0-100, and a weighted final score was calculated for the entire paragraph.

Coding and scoring of paragraph subjects

The objective of asking the students to give the paragraphs titles was to see whether or not the students understood the essence of the text. The emphasis, when analyzing the students' responses, was on the fact that the paragraphs were argumentation paragraphs and so we expected that the students' titles would, in each case, address the addresser's claim. For Paragraph A, for instance, we expected to see the title "The Importance of Computers in Different Areas of Life", rather than "The Importance of Computers in the Education System", since the latter refers only to the education system (which is the general background for the issue addressed in the paragraph), rather than to all areas of life (as mentioned in the paragraph). To define the correct answer scale for each paragraph, we asked ten lecturers involved in reading comprehension and articulation to score the students' answers to each paragraph. We determined the maximum score each title could receive based on the specialists' answers regarding each paragraph.

A title scored 0 when it was completely inappropriate, and 50, 70, 90 or 100 in other cases according to the aforementioned title scale. Uniform criteria were applied, as far as possible, in scoring the titles given to all four paragraphs.

Coding and scoring of paragraph structure

Students' responses to each paragraph were encoded according to the following guidelines:

a) Correct division of the paragraph text into its components: claim and/or counterclaim, justification, and ending. Deduct 50 points from the score of a paragraph component if the student's answer does not include all of the content required in the analysis of that component.
b) Attention to logical connections of each component: did the student specify them or not? Deduct 20 points from the score of a paragraph component if the student's answer does not include all the content required in the analysis of that component.
c) Is the content attributed correctly to each paragraph component? For example, in Paragraph B, which includes a counterclaim, did the student include part of the justification in the claim? Did the student include the opposing position in the claim? Did the student include the claim as part of the justification? Was the end taken from the justification? If the student's answer was incorrect, deduct 10-40 points from the score of this paragraph component, according to the severity of the error.
d) The weighted score is calculated for each paragraph for use in the statistical analyses presented later on. Table 3 presents the weights used to calculate the final score for each paragraph according to its components.

Table 3. Partial weight percentages of paragraph components for final paragraph score

Paragraph / Structural component	A	B	C	D
Introduction	15%	15%	15%	15%
Counter Claim	-	25%	-	-
Claim	30%	30%	30%	30%
Justification	40%	15%	40%	40%
End	15%	15%	15%	15%
Total Score	100%	100%	100%	100%

Encoding the attitudes questionnaire

In the attitudes questionnaire, students were asked to respond to eight statements using a 4-point Likert scale ranging from "Strongly agree" (1) to "Strongly disagree" (4). The responses were categorized into two categories: agree (positive attitude) - students who responded "Strongly agree" or "Somewhat agree"; and disagree (negative attitude) - students who responded "Strongly disagree" or "Somewhat disagree". Reliability analysis revealed good Cronbach α values ($0.8 < \alpha$ value <0.9) (Klein, 2000): 0.90 for the 4-point items version and 0.86 for the 2-point items version. To examine the extent of agreement, an average score (in the range 1-4) was calculated for the students' answers to all questions excluding nos. 3 and 6, which do not refer to the connection between learning and/or understanding the disciplines but to the order in which those disciplines are taught.

Statistical Methods

The following statistical methods were used:

For each paragraph component we present the average score (0-100), standard deviation, median, and interquartile range.

The average weighted score for each entire paragraph was calculated using the weight percentages presented in above Table 3. We also calculated the standard deviation, median, and interquartile range for each entire paragraph.

We found that the distribution of scores is not normal for either the paragraphs or the paragraph components. Thus, to compare the scores of students who completed both the pre-study questionnaire and the post-study questionnaire, i.e. paired samples, we applied the Wilcoxon signed-rank test, which is an a-parametric test that grades the students' scores. Then, to compare the post-study questionnaire scores of the study group students and the control group students, i.e. different samples, we applied the a-parametric Mann-Whitney test.

Findings and Discussion

In this chapter we present and discuss the research findings as revealed in the analyses described in Chapter 3. We first present findings from the analysis of each paragraph with respect to the identification of its structural components. For each paragraph, we present statistical analysis of the pre-study, post-study, and control group questionnaires, and discuss their differences and similarities. We will also present the analysis of our findings from the attitudes questionnaire. In the current paper we will not discuss the titles the students gave the different paragraphs for several reasons. The title is the only part that does not appear in the LP program, hence there is no basis for an analogy. Moreover, we found that students' achievements with respect to addressing the title were very poor and hence could overshadow the analysis of the understanding of the paragraph structure. For instance, average study group scores for title appropriateness were: Paragraph A - 31(25), Paragraph B - 21(2), and Paragraph C - 21(2). These findings will be discussed in a separate future paper.

The research findings revealed no differences between the study groups by schools and so they are presented for the entire population.

Student Scores

Analysis of Paragraph A scores

Paragraph A (presented in section 3.3.1) has the structure of a basic, 4-component argument. Table 4 presents descriptive statistics of the students' scores for each of the four components of the paragraph and for the paragraph's final score on the pre-study, post-study and control group questionnaires.

Table 4. Average scores for Paragraph A - pre-study, post-study and control questionnaires (Npre=313, Npost=141, Ncontrol=51)

Statistics / Struct. component	Weight in total score	Mean (Std.)			Median			Interquartile Range		
		Pre-study	Post-study	Ctrl.	Pre-study	Post-study	Ctrl.	Pre-study	Post-study	Ctrl.
Introduction	15%	95 (21)	91 (27)	90 (26)	100	100	100	100-100	100-100	100-100
Claim	30%	92 (21)	88 (27)	86 (21)	100	100	100	100-100	100-100	80-100
Justification	40%	91 (22)	90 (24)	88 (20)	100	100	100	100-100	100-100	80-100
End	15%	97 (16)	96 (19)	29 (5)	100	100	100	100-100	100-100	100-100
Total Score	100%	93 (18)	91 (22)	89 (15)	100	100	100	100-100	98-100	83-100

It is evident from Table 4 that scores for Paragraph A are high. This is understandable since the paragraph reflects the simple, basic structure learned in any framework in which language is studied. In addition, it could be argued that the content of the paragraph, which deals with the integration of computers, is clear and close to the learners' daily life.

Average total scores for the paragraph are 93(18) for the pre-study questionnaire, 91(22) for the post-study questionnaire, and 89(15) for the control group. Although the students' average score is slightly lower in the post-study questionnaire compared with the pre-study questionnaire and are even lower for the control group, the scores are high and appropriate for the basic structure of the paragraph.

Figure 1 presents a comparison of the pre-study, post-study and control group questionnaire scores for all four paragraph components. Note the high scores for all four paragraph components.

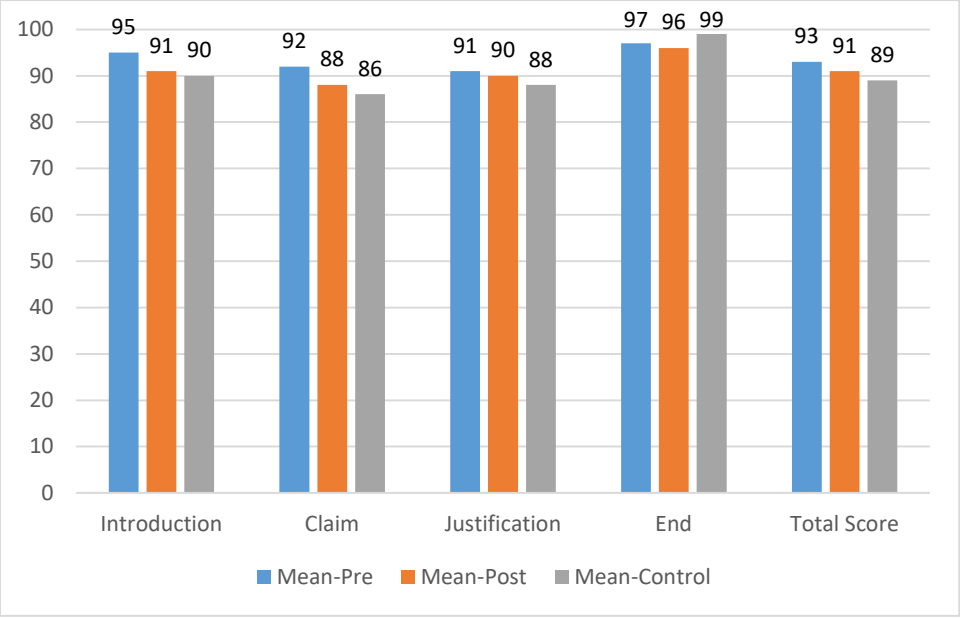


Figure 1: Paragraph A - Average scores for pre-study, post-study and control group questionnaires (Npre=313, Npost=141, Ncontrol=51)

As evident in Figure 2, scores are not distributed normally, nor are the scores for the paragraph components. This is evident also in the fact that both the mode and the median are 100, and aside from the total score, which is close to that value, the interquartile range for most paragraph components is also 100-100.

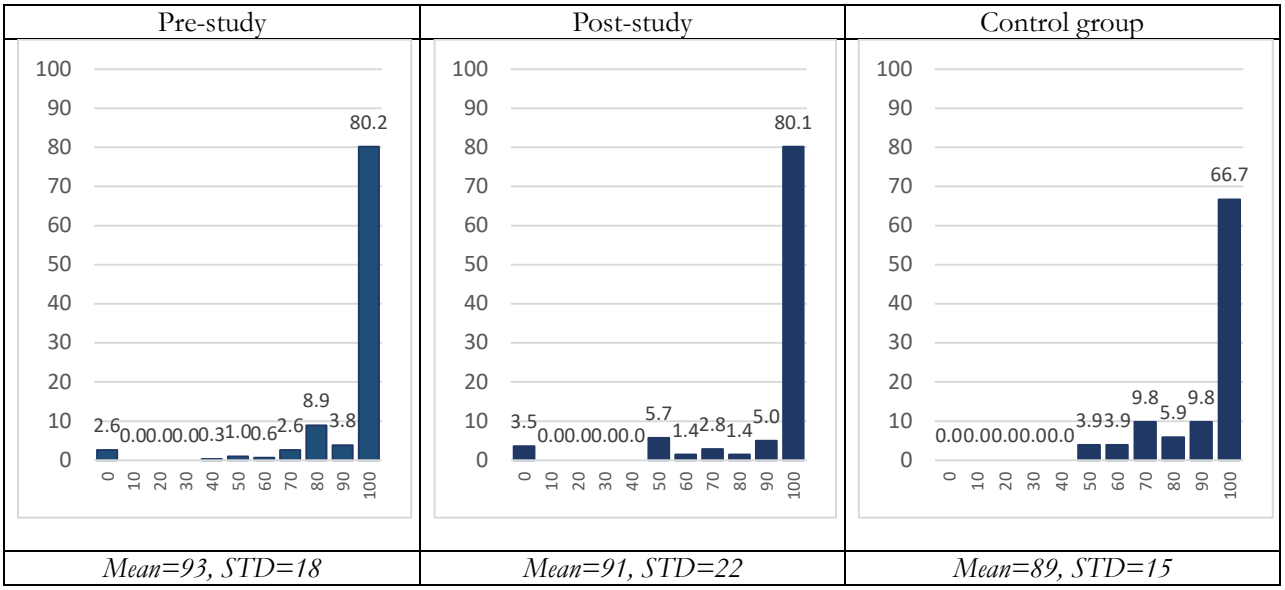


Figure 2. Paragraph A - Score distributions for pre-study, post-study and control group questionnaires (Npre=313, Npost=141, Ncontrol=51)

A comparison of the scores of students who answered both the pre-study and the post-study questionnaires revealed a non-significant difference (Z=-0.430b, P=0.667). In other words, although there was a drop in the scores, this drop was only slight. However, a comparison between the post-study questionnaire scores of the study group students and the control group students revealed a statistically significant difference (Z=-2.257, P=0.024), i.e. the control group students' scores were significantly lower than those of the study group students. Although we expected the study group students' performance to improve after learning LP, an expectation that in fact was not supported, the control group scores are significantly lower than those of the study group students: 85.1% of study group students scored between 81 and 100 on the post-study questionnaire, while only 76.5% of the control group students scored in this range. This may indicate that learning LP does indeed support the students' understanding of argumentation paragraphs, or at least preserves their understanding, whereas the control group students exhibited a significant decline. A more extensive discussion of this issue will be presented in the Conclusion.

Analysis of Paragraph B scores

Paragraph B (presented in section 3.3.1) is a 5-component argumentation paragraph with a counterclaim. Table 5 presents descriptive statistics of the students' scores for each of the five components of the paragraph and for the paragraph's final score on the pre-study, post-study and control group questionnaires.

Table 5. Average scores for Paragraph B - pre-study, post-study and control questionnaires (Npre=313, Npost=141, Ncontrol=51)

Statistics / Struct. Component	Weight in total score	Mean (Std.)			Median			Interquartile Range		
		Pre-study	Post-study	Ctrl.	Pre-study	Post-study	Ctrl.	Pre-study	Post-study	Ctrl.
Introduction	15%	89 (26)	90 (25)	96 (17)	100	100	100	100-100	100-100	100-100
Counter-claim	%25	66 (47)	73 (45)	73 (45)	100	100	100	0-100	0-100	0-100
Claim	30%	77 (39)	79 (39)	81 (37)	100	100	100	60-100	80-100	100-100
Justification	15%	73 (31)	73 (30)	76 (25)	100	100	100	50-100	50-100	50-100
End	15%	67 (47)	66 (47)	58 (49)	100	100	100	0-100	0-100	0-100
Total Score	100%	75 (26)	76 (26)	77 (25)	75	85	85	59-100	60-100	60-100

Table 5 reveals that this paragraph was more difficult for the students to understand; for instance, the average pre-study score for Paragraph A was 93, while the average pre-study score for Paragraph B was 75. Achievements are lower for this paragraph since the paragraph structure is not the basic classic structure: Paragraph B is missing an ending and contains a counterclaim.

Average total scores for Paragraph B are 75(26) for the pre-study questionnaire, 76(26) for the post-study questionnaire, 77(25) for the control group.

Figure 3 presents a comparison of the pre-study, post-study and control group questionnaire scores for all five-paragraph components. Besides the final Paragraph B score, the interquartile range shows a significant decline that is in line with the fact that compared with Paragraph A, this paragraph is more difficult to understand.

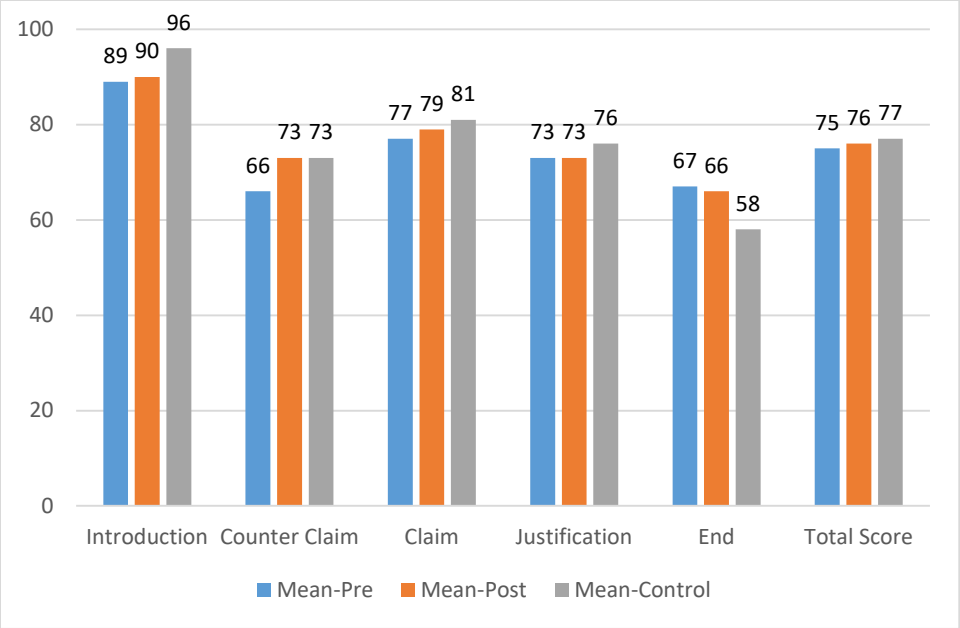


Figure 3. Paragraph B - Average scores for pre-study, post-study and control group questionnaires (Npre=313, Npost=141, Ncontrol=51)

It is evident that the students' performance improved with respect to the introduction, counterclaim and claim components. The average counterclaim score rose from 66(47) for the pre-study questionnaire to 73(44) for the post-study questionnaire. This increase stems from a decrease in the number of students who mistakenly included the counterclaim in the claim, from 17% on the pre-study questionnaire to 14% on the post-study questionnaire. The justification score for this paragraph is low, possibly because the paragraph contained no clear connections or allusions that lead to the justification. The ending score is the lowest of all five components. Students should have understood that there is no ending based on the basic structure of an argument, whereby the justification leads into a general ending, in which the claim is revisited in different manners. The students felt the need to write an ending, but took it from the justification. Nevertheless, improvement was seen for this component: 29% of students erred on the pre-study questionnaire and attributed part of the justification to the ending compared with only 22% who did so on the post-study questionnaire.

In the case of Paragraph B, the control group scores are lower than those of the study group only for the end component.

Here too, score distribution, as reflected in Figure 4, is not a normal distribution, nor are the scores for the paragraph components. This is evident also in the fact that both the mode and the median are 100, although a decline is seen in the interquartile range compared with Paragraph A.

The median of the total score reflects a positive change in the score trend: the median for the pre-study questionnaire was 75 (IqR: 59-100) while for the post-study questionnaire it was 85 (IqR: 60-100).

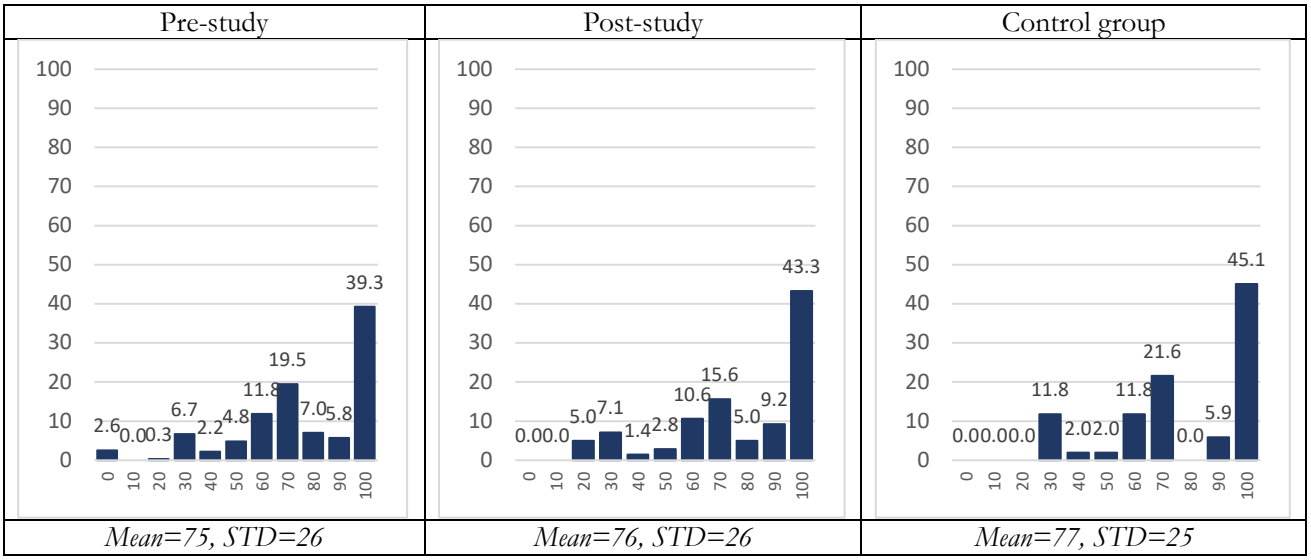


Figure 4. Paragraph B pre-, post- and control- questionnaire scores distribution (Npre=313, Npost=141, Ncontrol=51)

A comparison of the scores of students who completed both the pre-study and the post-study questionnaires revealed a non-significant difference (Z=-0.833, P=.405). In other words, the increase in scores is very slight. A comparison between the post-study questionnaire scores of the study group students and the control group students showed that the performance of the control group students was higher, but that the improvement was not statistically significant (Z=-0.234, P=0.815). Looking at the distribution of scores it is evident that 52.5% of the study group students scored in the 81-100 range on the post-study questionnaire, while 51.0% of the control group students scored in this range.

Analysis of Paragraph C scores

Paragraph C (presented in section 3.3.1) is an argumentation paragraph without a claim. Table 6 presents descriptive statistics of the students' scores for each of the four components of the paragraph and for the paragraph's final score on the pre-study, post-study and control group questionnaires.

Table 6. Average scores Paragraph C - pre-study, post-study and control group questionnaires (Npre=313, Npost=141, Ncontrol=51)

Statistics / Struct. component	Weight in total score	Mean (Std.)			Median			Interquartile Range		
		Pre-study	Post-study	Ctrl.	Pre-study	Post-study	Ctrl.	Pre-study	Post-study	Ctrl.
Introduction	15%	92 (26)	87 (32)	88 (30)	100	100	100	100-100	100-100	100-100
Claim	30%	41 (48)	52 (48)	29 (44)	0	90	0	0-100	0-100	0-90
Justification	40%	64 (27)	69 (32)	59 (28)	50	50	50	50-100	50-100	50-100
End	15%	87 (30)	84 (31)	92 (21)	100	100	100	100-100	100-100	100-100
Total Score	100%	65 (29)	69 (29)	59 (23)	50	70	50	50-97	50-100	50-72.5

The average scores presented in Table 6 reveal that this paragraph is, apparently, difficult for the students to understand, since the order of the basic structure is disrupted. The claim does not appear before the justification, and the order of paragraph components is: Introduction, Justification, and End. Average total scores for

this paragraph are 65(26) for the pre-study questionnaire, 69(29) for the post-study questionnaire, 59(22) for the control group. Unlike the two previous paragraphs, the mode score for Paragraph C on both pre-study and post-study questionnaires was 50. An examination of the median score reveals the difficulty of the paragraph, but indicates a significant improvement in scores for the study group students: median scores were 50 for the pre-study questionnaire and 70 for the post-study questionnaire, while the median score for the control group was 50.

Figure 5 presents a comparison of the pre-study, post-study and control group questionnaire scores for all four paragraph components.

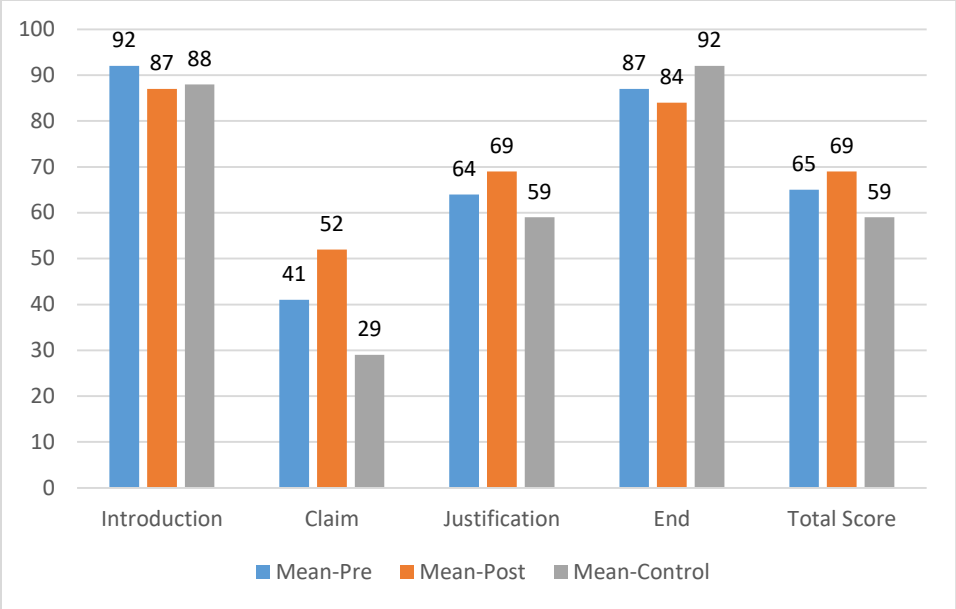


Figure 5 Paragraph C - Average scores for pre-study, post-study and control group questionnaires (Npre=313, Npost=141, Ncontrol=51)

Although the paragraph did not contain a claim, the students were graded on this component: the paragraph analysis was considered to be successful if the students did not write anything in the Claim cell. Some of the students, however, erred and attributed part of the justification to the claim. The number of students who made this mistake on the post-study questionnaire was clearly lower than the number of students who made the same mistake on the pre-study questionnaire: 50% erred on the pre-study questionnaire compared with only 37% who made the same mistake on the post-study questionnaire. Since the ending might be considered to be a claim, answers in which the end was classified as a claim, that is, led up to by the justification, were also accepted in the analysis of the students' answers.

Some students understood the connection between the claim and the ending and regarded them to be equivalent, attributing part of the ending to the claim. The percent of students who analyzed the paragraph in this way was 15% on the pre-study questionnaire and 20% on the post-study questionnaire, an increase that indicated a better understanding of the paragraph structure.

Finding the end was easy since it begins with the conjunction "therefore", which alludes to the ending. Nevertheless, the average score for the End component on the post-study questionnaire, 84(31) is lower than the average score for this component on the pre-study questionnaire. One possible explanation may be that students who classified the end as a claim were scored lower due to inappropriate structural analysis, but were nevertheless correct in their logic analysis because the content of the ending is similar to the content of the claim. Again, score distribution, as reflected in Figure 6, is not a normal distribution, nor are the scores for the paragraph components.

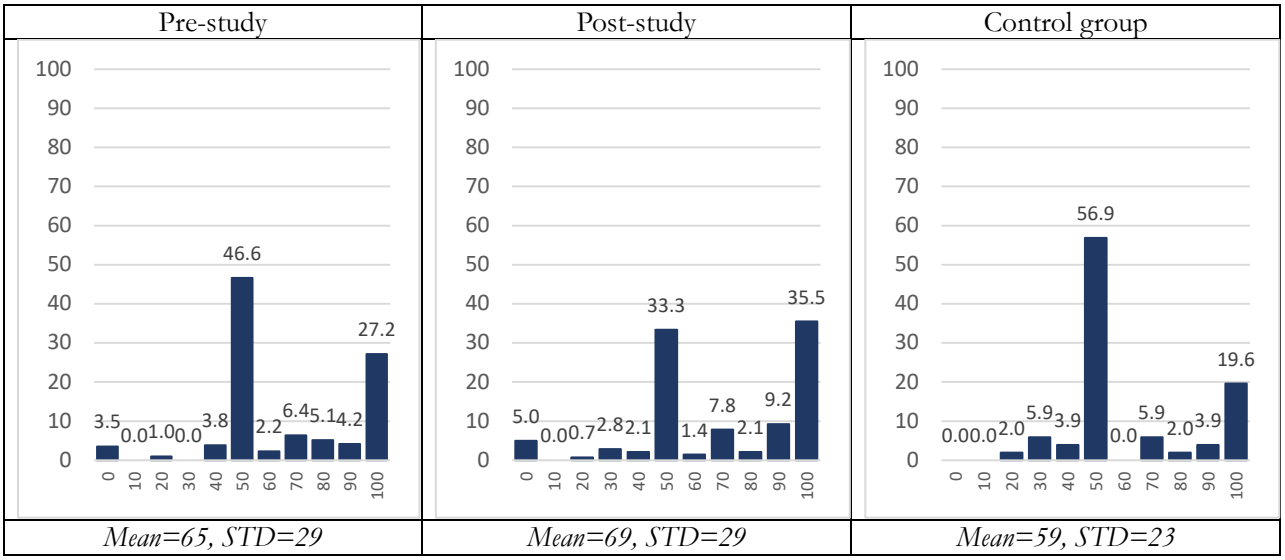


Figure 6. Paragraph C - Scores distribution for pre-study, post-study and control group questionnaires (Npre=313, Npost=141, Ncontrol=51)

A comparison of the scores of students who answered both the pre-study and the post-study questionnaires again revealed a non-significant difference (Z=-1.068, P=.286). This comparison showed that scores for some of the paragraph components decreased while others increased. The components that showed an increase were the more significant ones, namely Claim and Justification; this increase was not, however, statistically significant.

A statistically significant difference was found in the post-study questionnaire score between the study group students and the control group students (Z=-2.518, P=0.012): 44.7% of the study group students scored in the 81-100 range on the post-study questionnaire, while only 23.5% of the control group students scored in this range. In other words, the control group scores were significantly lower than those of the study group student, and this trend was especially evident in the claim scores.

Analysis of Paragraph D scores

Paragraph D has a basic, four-component structure, like Paragraph A, but it appeared only on the post-study questionnaire and the control group questionnaire. Table 7 presents descriptive statistics of the students' scores for each of the four components of the paragraph and for the paragraph's final score on the post-study questionnaire and the control group questionnaire.

Table 7. Paragraph D - post-study questionnaire scores (Npost=141, Ncontrol=51)

Statistics / Struct. component	Weight in total score	Mean (Std.)		Median		Interquartile Range	
		Post-study	Ctrl.	Post-study	Ctrl.	Post-study	Ctrl.
Introduction	15%	76 (42)	71 (44)	100	100	50-100	0-100
Claim	30%	61 (43)	53 (48)	100	50	0-100	0-100
Justification	40%	71 (42)	56 (46)	100	50	50-100	0-100
End	15%	84 (35)	85 (34)	100	100	100-100	100-100
Total Score	100%	71 (33)	62 (39)	80	65	45-100	30-100

It is evident from Table 7 that the paragraph scores are not high, despite the fact that this paragraph reflects the simple, basic structure. A possible explanation will be offered below (see Note). The average score for

Paragraph D was 76 (42) for the study group and 71 (44) for the control group. Although the mode was 100, the median for the study group was 80 and for the control group was 65. Figure 7 presents a comparison of the post-study and control group questionnaire scores for all four Paragraph D components.

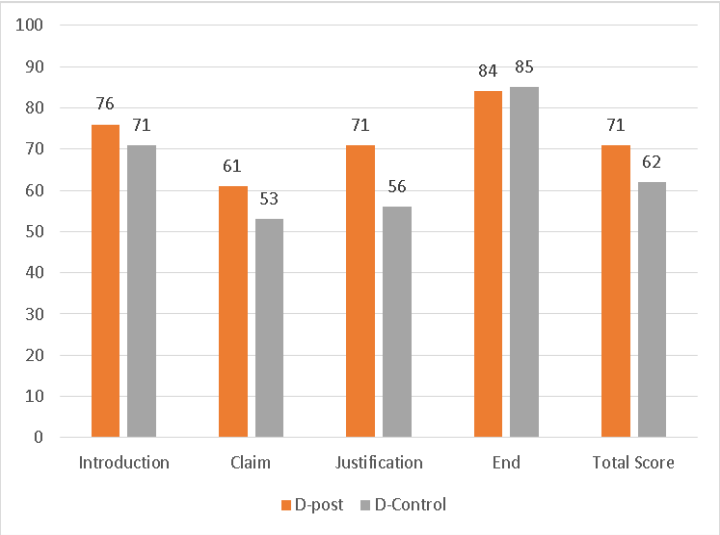


Figure 7. Paragraph D - Average scores for post-study and control group questionnaires (Npost=141, Ncontrol=51)

A comparison between the post-study questionnaire scores of the study group students and the control group students reveals a statistically non-significant difference (Z=-1.37, P=0.1695). In other words, the average control group scores are lower than the average study group scores but not significantly so.

Note: Our expectation was to obtain high scores for this paragraph, as were obtained for Paragraph A, since both paragraphs follow a basic structure. The findings, however, show otherwise. A decrease was observed in the average score for each of the four components of Paragraph D when compared with the average scores for the same components in Paragraph A. This decrease was statistically significant for both the study group (Introduction: Z=-3.774, P=0.000, Claim: Z=-5.928, P=0.000, Justification: Z=-5.306, P=0.000, End: Z=-4.206, P=0.000) and the control group (Introduction: Z=-2.544, P=0.011, Claim: Z=-4.041, P=0.000, Justification: Z=-4.056, P=0.000, End: Z=-2.726, P=0.006). One possible reason for this decline, which we did not foresee, is that Paragraph A contained words and expressions that clearly connected and distinguished between the paragraph components (for instance, "We believe" and "Therefore"), whereas Paragraph D contained no such clear linguistic aids other than the conjunction ("Therefore") that preceded the end of the paragraph; indeed, the decrease in the average score for the end component was smaller than for the other paragraph components. Other reasons that might explain the low scores obtained for Paragraph D are the content of the paragraph, which related less to the students' world (the perception of humor) than the content of Paragraph A (computers); the length of Paragraph D, which was longer than that of Paragraph A; and the physical fatigue of the students, who exhibited a lower level of concentration when analyzing the last paragraph.

Interpretation of student scores

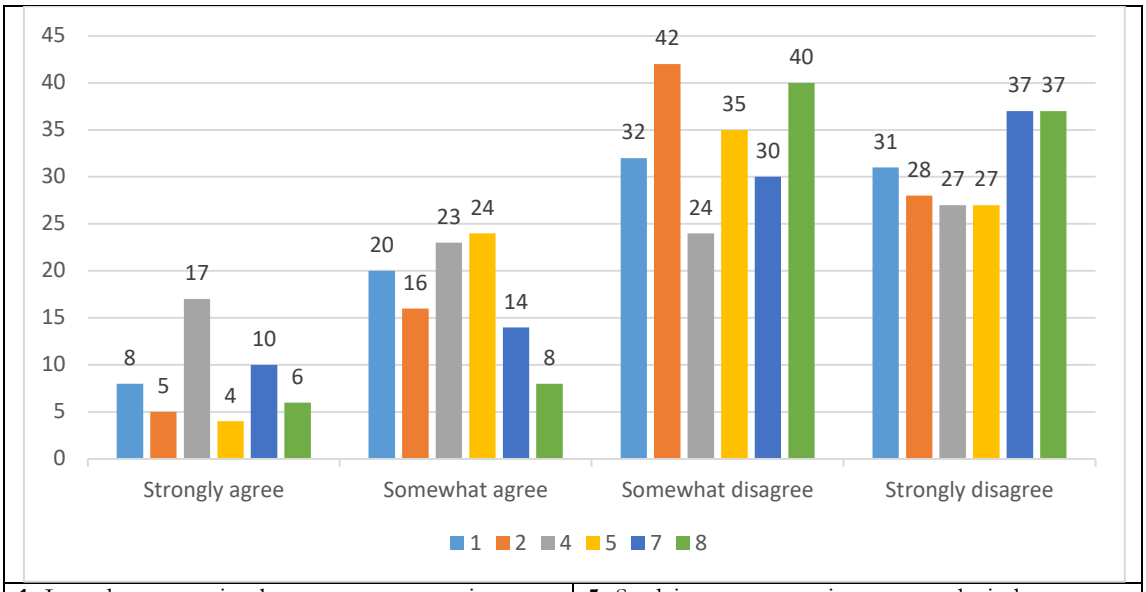
In general, we found that the average scores for Paragraphs A-C improved from the pre-study questionnaire to the post-study questionnaire, but in a non-significant manner. It is important to address the continuity of learning with respect to the research. Both the study group students and the control group students took the matriculation exams in language about 3-4 months before the study group completed the pre-study questionnaire. They had no language classes during the year in which they studied LP, and at the end of that year they completed the post-study questionnaire as did the control group students. Indeed, the study group students exhibited a small and non-significant improvement, but the control group students, who did not study LP, exhibited a substantial decrease in performance, in the form of a statistically significant decrease in scores for Paragraphs A and C. This fact may indicate that had the study group students not learned LP, their performance would have declined as well.

Another analysis was performed based on a distinction between two sub-groups of the study group students. Students whose average score exceeded 70 were defined as "good" students whereas the others, whose understanding was weaker, were defined as "poor" students. Based on this distinction, we found that the poor students actually improve more, and that the scores of the good students dropped, although only by a little. A possible explanation for this finding may be that learning LP, which presents a different perspective for analyzing the argument, enables poor students to perform a different cognitive processing that leads to an improvement in their logic analysis.

Analyzing the Attitudes Questionnaire

The objective of the positions questionnaire was to examine the students' attitudes regarding the effect learning LP has on the understanding of argumentation paragraphs. In a series of closed questions, students were asked to rank the degree to which they agreed with statements regarding the connection between learning argumentation paragraphs and learning LP.

Figure 8 presents the percent of students who selected each optional response for Questions Nos. 1, 2, 4, 5, 7, and 8.



1- I see the connection between argumentation paragraphs in language and writing Prolog programs. **2-** Learning logic programming will help me understand argumentation paragraphs in language. **4-** I do not think there is a connection between Prolog programs and argumentation paragraphs that a study in language.	**5-** Studying argumentation paragraphs in language will help me understand LP. **7-** The connection between argumentation in language and argumentation in LP is clear. **8-** It is beneficial to deepen the understanding of and argumentation paragraph by writing a Prolog program.

Figure 8. The percent of students answers to statements on positions questionnaire (Nposition=91)

It is evident that most students did not identify any connection between the two disciplines: a total of 33% of students indicated agree positions in at least one of their answers ("Somewhat agree" or "Strongly agree") as opposed to 67% of students who indicated disagree positions ("Somewhat disagree" or "Strongly disagree").

For each student, an average score of his or her attitudes was calculated and the distribution of scores was determined. Analysis revealed that while 71% of students saw no connection between the disciplines, only 29% of them realized that some connection exists.

We then examined the students' performance on the pre- and post-study questionnaires versus their attitudes. Table 8 presents the weighted scores for Paragraphs A, B and C on the pre-study and post-study question-

naire according to two categories of students based on their answers to the positions questionnaire: "Agree" or "Disagree".

Table 8. Students positions versus their pre- and post-study questionnaire scores for Paragraphs A-C (Npositon=91)

Statistics / Paragraph	Agree (N=26)			Disagree (N=65)			Significance	
	Pre-study	Post-study	Diff.	Pre-study	Post-study	Diff.	*Z*	*P*
A-Mean	91 (23)	93 (14)	2	88 (27)	93 (16)	5	0.935	0.35
A-Median	100	100	0	100	100	0		
B-Mean	76 (28)	71 (27)	-5	71 (31)	79 (23)	8	-2.413	0.016
B-Median	81	75	-6	75	85	10		
C-Mean	71 (27)	68 (23)	-3	62 (31)	72 (25)	10	-2.307	0.021
C-Median	75	59	-16	50	70	20		

The findings of this analysis are surprising. It is evident that the scores of students in the "Disagree" group improved consistently for all paragraphs and did so in a statistically significant manner for Paragraphs B and C, which are more difficult due to their non-basic structures. In other words, although they failed to see any connection between the disciplines, these students actually improved their performance more significantly than did the others, while students who were classified as the "Agree" group, exhibited lower performance, except with respect to Paragraph A, which has a basic structure. This trend is evident also in the average and median values. Thus, despite the fact that these students did not grasp the connection between the two disciplines, this connection actually benefited them, and it is fair to assume that had the teachers mediated between what the students learned in language about argumentation and what they learned in LP, their performance would have been enhanced to an even greater degree.

The attitudes questionnaire also included one open-ended question in which students could verbally address their attitudes and opinions regarding the parallelism between the two disciplines. Only a small number of students (20 out of 91) responded to this question. Most of those who did, tried to find of a connection, but had difficulties seeing it. For example, one student wrote: "I'm not clear on what the connection is, the argumentation paragraph deals with the expression of an opinion as opposed to Prolog, which requires logical thinking". In other words, the student did not consider understanding an argumentation paragraph to be the application of logical thinking, nor did he identify its logical structure - an aspect that may be supported by appropriate teaching processes.

CONCLUSIONS

The effect of learning LP on the understanding of argumentation text

Regarding the research first question we wished to investigate whether learning LP affected the students' ability to understand the logical meaning of an argumentation text. The research results support our hypothesis, although some of the analyses yielded non-significant differences. The achievements of the study group students on the post-study questionnaire increased on almost all partial scores for the structural analysis of the paragraphs as well as on the weighted paragraph scores.

With relation to paragraph A with its basic argumentation structure, the post-study scores were slightly lower than those obtained on the pre-study questionnaire. However, the scores were high, since the paragraph structure, which comprises clear components distinguished from one another by appropriate logical connec-

tions, was clear. It is possible that the paragraph content, which is closely related to the students' areas of interest (computers), made it easier for them to analyze.

Paragraphs B and C indicated improvement. The performance of the control group on the post-study questionnaire was significantly lower than that of the study group. This finding supports the claim that learning LP helps students better understand argumentation paragraphs.

It is important to clarify that the students in both groups took the language matriculation exam at the end of the year prior to the year of the study. The control group students did not deal explicitly with argumentation texts during the study year, whereas the study group students were exposed to argumentation as part of their LP studies. We can argue that the results indicate that the study-group knowledge did not deteriorate as it did for the control-group. The study-group knowledge was preserved and their performance even improved with respect to the more complex paragraph structures.

Students' success in analyzing the structure of the paragraph while using a guided table as has been used in the questionnaire is in accordance to the recommendations of Mann et al.'s (1992) and Horton, Golden, and Parmly (2013). Further, we wise to emphasize that integrated teaching of the both disciplines can use the structured analysis as we used in Table 1.

The perspective of linguistic studies

From the perspective of linguistic studies, the findings can be analyzed with regard to difficulties in understanding argumentation text. for example: students encountered difficulties with the structural division of a paragraph that lacked conjunctions; students encountered difficulties with relation to non-trivial structure, maybe as a result of lack of variety in the examples that are presented in class or perhaps as a result of rules given to the students that are misinterpreted; students were not able to indicate the paragraph's subject correctly (or accurately). They believe that the subject or essence is located at the beginning of the paragraph, i.e. in the first sentence. These insights are not within the scope of this research and so have not been presented. Those findings correspond previous studies that pointed on students obstacles in analyzing argumentation texts and in writing them (Campos, 2010; Habiballa & Kmet', 2008; Stein & Miller, 1993).

Students' attitudes regarding the connection between LP and argumentation texts

Regarding the research second question we wished to explore students' attitudes regarding the effect that learning the two disciplines, LP and understanding argumentation paragraphs in language, has on their understanding. Results shows that the students were unaware of the connection between the disciplines and that it was never discussed with them. Some of them claimed specifically that no connection exists between language and LP, for example: "Argumentation paragraph ≠ Prolog". Others, however, wrote that they understood the logic behind the connection, but did not see how it was actually manifested. Some even asked to be shown the connection, for example: "The connection between LP and argumentation paragraphs in language is not exactly clear; it should be explained to us at some level". Such quotes demonstrate that teachers did not mediate and did not explain the analogies to the students and we believe that they should.

It is interesting to note that students who did not agree with the claim that there is or should be a connection between the two disciplines and analyzed the argumentation paragraphs incorrectly in the pre-study - are those that improved more in the post-study. For some of the paragraphs this difference was statistically significant.

SUMMARY

There is a connection between the disciplines of computer science and language as implied in the Literature Review. The current research focuses on the analysis of argumentation paragraphs manifested both in linguistic studies and in LP studies. Our previous papers (Ragonis & Shilo, 2014; Shilo & Ragonis, 2014) presented a theoretic analysis that supports this connection and indicated how these connections might be used in teaching and learning to advance students' logical thinking skills.

The research was conducted among high school students after they studied logic argumentation as part of their linguistic studies for the matriculation examination (10th grade). The research was conducted the follow-

ing year (11th grade). In that year, the study-group studied logical argumentation from different perspective, as part of their LP studies in computer science, while the control group did not learn LP.

The detailed data analysis revealed that the study group achievements were better than those of the control group, particularly regarding the non-trivial paragraph structures.

The research demonstrates that students do not draw analogies by themselves. Hence, they cannot benefit from the advantage of learning similar inference structures in two different disciplines. Instructional planning should take proper advantage of the connection between the disciplines in order to enhance the students' knowledge and understanding. For instance, the role of each part of an argument and its declaration in both types of representation. If students understand the inter-disciplinary context, they will be able to use the knowledge and analogy skills when studying new material as well, and will be able to draw inferences about different areas of knowledge.

The order of teaching the content between the two disciplines is not important, i.e. argumentation may be taught as part of linguistic studies and then projected onto LP or vice versa. The main issue is to show the students how one learning process may be used in the other discipline. Collaboration among professional teachers can lead students throughout high-order thinking processes of analysis, deduction and reasoning that characterize computational thinking. Implementing the deduction of an argumentation text in LP will reinforce further aspects of this thinking.

Because the LP language Prolog is available in many natural languages, and is very easy to learn and use, we recommend that teachers benefit from the advantage of "running" argumentation texts on computers, and enhance students' understanding of the relations between argument justifications and the argument claim by presenting queries. The proposal to make analogies between the disciplines is relevant to the teaching world because there are applications of LP instruction to schools in many parts of the world (Bottino, Forcheri and Molfino 1995; Cope 1989; Di Bitonto, Roselli and Rossano 2009; Haberman and Scherz 2005; Linck and Schubert 2011; Ragonis et, al. 1998; Stamatis and Kefalas 2007).

Further possible research should examine how LP teachers expose the logical structure of an argumentation paragraph when they write logic programs that describe the inference represented in the paragraph. Accordingly, a teacher training workshop could be developed to impart tools how to deliver the emphases in their teaching.

Reinforcement of the connection presented in the article is the framework of Computational Thinking. The approach of Computational Thinking is appreciated these days as a tool for thinking and inferring in any discipline, and many countries are attempting to integrate it into the curricula of different subjects at all levels (Barr, Harrison, & Conery, 2011; Weigand 2006; Wing, 2011, 2014). We believe that the potential of drawing analogies between language and computer science, while "running" texts on computers, may be of value. It is a natural example of developing the students' computational thinking by giving them the opportunity to verify their abstract investigation.

This interdisciplinary teaching approach can strengthen students' discourse abilities in presenting a written or a spoken argument, which is relevant and needed in all disciplines, including in the cultural and public discourse. Particularly this practice can be integrated into the Engineering curricula for example: in fundamental courses lecturers can emphasize in teaching and in learning assignments, the need to drive conclusions from theory and to support their conclusions using an organized structured; or in projects presentations, to develop students' skills that allow logical and concrete presentation that emphasizes a hierarchical process in which an argument stems from the justifications that are based on the previous stages.

The current research conclusions have the potential to promote those meaningful connections in an education setting and lead to guidelines for advancing high school students" understanding of arguments and their justifications.

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