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**Dr.  
BahaaEddin El-Sayed El-Naggar**  
English Language Instructor  
Faculty of Education,  
Benha University

**Michael Abd Elmesih Awad**  
Associate Professor of  
Curriculum and Instruction  
(TEFL)  
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**Eman Morris Towfeelis Farag**  
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### **Abstract**

The aim of this study was to introduce scientific discourse analysis (SDA) as a new research technique for enhancing scientific argumentative writing skills of engineering students through a suggested program based on this research technique. The participants were 30 sophomore students from civil engineering department at the Higher Institute of Engineering, El Shorouk Academy. The training was conducted during the academic year 2016-2017. To collect data, the researcher prepared an argumentative writing skills questionnaire, an argumentative writing test (pre-post) and an argumentative writing assessment rubric. The program consisted of two parts; the instructor's guide and the course material in which the participants practiced three levels of (SDA); textual analysis, contextual analysis and genre analysis as well as some argumentative writing activities. Data was processed by using the statistical Package for the Social Science (SPSS). The findings revealed the suggested program based on SDA can be effective in developing engineering students' argumentative writing skills.

### **Keywords:**

Scientific discourse, discourse analysis, scientific discourse analysis, scientific argumentative writing.

## **Introduction**

Writing ability plays an important role in students' learning. The act of writing creates an environment for the development of cognitive and organizational strategies whereby students link new concepts with familiar ones, synthesize knowledge, explore relations and implications, outline information, and strengthen conceptual frameworks (Bangert-Drowns et al., 2004; Scardamalia & Bereiter, 1986). Furthermore, it involves self-monitoring, planning, concept-building, and reviewing of information processes, which promote the building of domain knowledge (Bangert-Drowns et al., 2004).

Hence academic writing requires conscious effort and much practice in composing, developing, and analyzing ideas. Students writing in a second language are also faced with social and cognitive challenges related to second language acquisition. The ability to write well is not a naturally acquired skill; it is usually learned or culturally transmitted as a set of practices in formal instructional settings or other environments. Writing skills must be practiced and learned through experience. Writing also involves composing, which implies the ability either to tell or retell pieces of information in the form of narratives or description, or to transform information into new texts, as in expository or argumentative writing (Myles, 2002).

In recent years, the learning and teaching of argumentation i.e., the coordination of evidence and theory to support or refute an explanatory conclusion, model or prediction (Suppe, 1998) has emerged as a significant educational goal. Of growing importance in science education is the need to educate students about how we know and why we believe

in certain claims (Jimenez-Aleixandre and Erduran, 2008). The shift from what-we-know to how-we-know requires a renewed focus on how science education can promote students' skills in justifying claims with evidence. Argumentation is a critically important discourse process in science (Toulmin, 1958) and it should be taught and learned in the science classroom.

The ability to explain scientific results or defend engineering designs effectively is also an institutional requirement for advancement in both academic and professional science and engineering communities of practice (Lemke, 1990).

The global purpose of scientific communication is to convey new ideas and results of scientific research, as well as to explain and rationalize them. Therefore, scientific discourse involves reasoning that is organized as a sequence of mental operations of informing and arguing. Among typical operations we should point out assuming hypotheses defining new terms, determining causal relations, exemplification, resuming and so on. We will call such intellectual operations scientific discourse operations. (Bolshakova, 2007).

Discourse analysis is considered the examination of language used by members of a speech community. It involves looking at both language form and language functions, and includes the study of both spoken interaction and written texts. It identifies linguistic features that characterize different genres as well as social and cultural factors that aid in our interpretation and understanding of different texts and types of talk. A discourse analysis of written texts may include a study of topic development and cohesion across the sentences, while an analysis of

spoken language may focus on these aspects plus turn-taking practices, opening and closing sequences of social encounters, or narrative structure Demo (2001).

Scientific Discourse analysis as a new research technique is suggested to help engineering students identify linguistic features that characterize scientific discourse as well as social and cultural factors that aid in their interpretation and understanding of different texts and achieve scientific communication goals based on scientific negotiation and reasoning.

### **Context of the Problem**

In order to investigate that there is a problem in the Egyptian context, the researcher assigned a group of sophomore students (n=30) to write an argumentative piece of writing about "Recycling". The results revealed whole weakness related to technical content and organization skills and some weakness points related to technical writing conventions skills.

### **Statement of the Problem**

The problem of the present study could be stated as thus: engineering sophomores lack the mastery of scientific argumentative writing skills and interpretation of the scientific discourse. In order to help students overcome such problems, a program based on scientific discourse analysis is suggested to enhance engineering students' scientific argumentation skills and consequently their writing performance would be positively developed. This will be expressed in the following main question:

*What is the effect of a proposed program-based on scientific discourse analysis in developing engineering students' scientific argumentative writing skills?*

This main question could be subdivided into the following:

- 1- What are the argumentative writing skills required for engineering students?
- 2- To what extent do those students master these skills?
- 3- How can a program based on scientific discourse analysis be designed to enhance engineering students' scientific argumentative writing skills?
- 4- To what extent is the proposed program-based on scientific discourse analysis effective in developing engineering students' scientific argumentative writing skills?

### **Significance of the Study**

This study is hopefully expected to be useful to the following:

#### **Engineering students:**

- 1- It would help them get the skills of scientific discourse analysis which hopefully would affect their success in scientific argumentative writing.

#### **Instructors of English:**

- 1- It might provide them with new research technique and procedures that would help improve their students' scientific argumentation, negotiation and reasoning skills.

### **Hypotheses of the study**

- 1- There would be a statistically significant difference between the mean scores of the students in their performance of the pre and post administrations of the scientific argumentative writing test favoring the post administration.

The first hypothesis is divided into the following hypotheses:

- 1- There would be a statistically significant difference between the mean scores of the students on the pre and post test favoring the post test in content and organization.
- 2- There would be a statistically significant difference between the mean scores of the students on the pre and post test favoring the post test in writing conventions.
- 2- The suggested program-based on scientific discourse analysis has an effect on developing the scientific argumentative writing skills of engineering students.

### **Delimitations of the Study**

This study was limited to:

- 1- A sample of 30 sophomores drawn randomly from the Civil Engineering Department (CED) at the Higher Institute of Engineering, El Shorouk Academy.
- 2- Some of scientific argumentative writing skills that were approved by the jury.

### **Procedures of the study**

- 1- Reviewing literature in the fields of:
  - a) Discourse analysis in scientific and technical fields to conclude the levels of analysis to be applied.

- b) Argumentative writing to conclude the most appropriate and needed skills for scientific and technical fields.
- 3- Designing a Scientific argumentative writing skills questionnaire and submitting it to the jury.
  - 4- Designing a scientific argumentative writing test (pre-post) and submitting it to the jury.
  - 5- Designing a scientific argumentative writing assessment rubric and submitting it to the jury.
  - 6- Drawing a sample from civil engineering sophomores (n=30).
  - 7- Pre administering of the argumentative writing test.
  - 8- Subjecting the group to the program-based on scientific discourse analysis.
  - 9- Post administering of the argumentative writing test.
  - 10- Comparing the pre and post test results of the study group to conclude the study results.
  - 11- Using suitable statistical methods to measure the effect of the suggested program in developing scientific argumentative writing performance.
  - 12- Presenting results, conclusion, recommendations and suggestions for further studies.

### **Definition of terms**

#### **Argumentative writing**

According to (Bond& Hughes, 2013), argumentative writing is the process in which the writer uses reasoning, logic and evidence to try to persuade the reader with his point of view.



## **Scientific argumentative writing**

Operationally, Scientific argumentative writing is a type of writing in which the writer attempts to validate or refute a claim on the basis of reasons in a manner that reflects the values of the scientific community.

## **Discourse analysis**

Demo (2001) defined discourse analysis as the examination of language use by members of a speech community. It involves looking at both language form and language function. It identifies linguistic features that characterize different genres as well as social and cultural factors that aid in our interpretation and understanding of different texts and types of talk. A discourse analysis of written texts might include a study of topic development and cohesion across the sentences, while an analysis of spoken language might focus on these aspects plus turn-taking practices, opening and closing sequences of social encounters, or narrative structure

## **Scientific Discourse analysis**

Operationally, Scientific Discourse analysis is a method of analyzing the surf structure level that deals with coherence and cohesion of the text and what and how social actors, entities, events, problems, facts and opinions are presented and the deep-structure level that deals with why these elements of the scientific text are presented in order to empower the students to talk and write the language of science, and practice the scientific culture for the development of epistemic criteria for knowledge evaluation.

**Review of literature**

Engineering students are expected to be able to communicate effectively in various linguistic, cultural, professional, and disciplinary contexts, and to realize what communication strategies are congruent with their target audiences (Caspersen, 2002; Jansen, 2002; Riemer, 2002; Cheah, Chen, and Ting, 2005). Although engineering students naively believe that writing is supplemental and subordinate part of their professional work, research reveals the consequential role that writing plays within engineering field .

According to NRC (2012) the study of science and engineering should produce a sense of the process of argument necessary for advancing and defending a new idea or an explanation of a phenomenon and the norms for conducting such arguments. In that spirit, students should argue for the explanations they construct, defend their interpretations of the associated data, and advocate for the designs they propose. Argumentation is a process for reaching agreements about explanations and design solutions. In science, reasoning and argument based on evidence are essential in identifying the best explanation for a natural phenomenon. In engineering, reasoning and argument are needed to identify the best solution to a design problem. Student engagement in scientific argumentation is critical if students are to understand the culture in which scientists live, and how to apply science and engineering for the benefit of society. As such, argument is a process based on evidence and reasoning that leads to explanations acceptable by the scientific community and design solutions acceptable by the engineering community. Argument in science goes beyond reaching agreements in explanations and design solutions. Whether investigating a phenomenon, testing a design, or constructing a model to provide a mechanism for an explanation, students are expected to use argumentation to listen to, compare, and evaluate competing ideas and methods based on their merits. Scientists and engineers engage in

argumentation when investigating a phenomenon, testing a design solution, resolving questions about measurements, building data models, and using evidence to evaluate claims.

Jin and Geslin (2009) argued that arguments are the basis of persuasive communication. Designers use arguments during negotiation with the intent of changing the minds of other designers. There are two basic requirements for argument modeling. First, the model should be 'logical' so that the reasons behind an argument are traceable. On the other hand, the model should also allow incomplete knowledge and qualitative information. To develop such a model, they turned to Toulmin's well-accepted argument structure (Toulmin, 1969) in which three important elements of an argument are identified, namely, *claim*, *data*, and *warrant*. In this structure, argumentation starts with one party expressing an opinion, called 'claim'. If the claim is challenged, it can be defended by 'data', if the 'data' alone is still not persuasive enough, then 'warrant' can be provided to support the claim and claim-data relationship

The global purpose of scientific communication is to convey new ideas and results of scientific research, as well as to explain and rationalize them. Therefore, scientific discourse involves reasoning that is organized as a sequence of mental operations of informing and arguing (Bolshakova, 2007)

As for discourse analysis, Van Dijk (1985) argued that discourse analysis transforms from structural analysis which holds for grammar, metrics, narrative theory, and conversational analysis to the functional analysis of discourse in which the production and comprehension of discourse by speakers and hearers (writers and readers) is done. They are interested in the cognitive representations of discourse in memory as well as in other information, such as knowledge and beliefs, necessary during discourse understanding. And finally, the complex interactions between textual representations of this type with other forms of personal and social knowledge, or beliefs and attitudes, in memory need to be

spelled out. This complex framework, then, counts as an empirical description of the interpretation of a discourse by language users

According to Celce-Murcia and Olshtain (2000) discourse analysis is minimally the study of language in use that extends beyond sentence boundaries. It started to attract attention from a variety of disciplines in the late 1960s and through the 1970s. At least two terms came to be used in parallel fashion: text linguistics, which focused on written texts from a variety of fields and genres, and discourse analysis, which entailed a more cognitive and social perspective on language use and communication, from the sociological or anthropological point of view, for instance, is language analysis of communicative behavior and of its role within given social contexts. Within linguistics discourse analysis has taken at least two different paths: one is the extension of grammatical analysis to include functional objectives and the other is the study of institutionalized language use within specific cultural settings (Bhatia, 1993:3-4). The former, which is theoretical in nature, can often be related to a particular school of linguistic analysis such as formal linguistics (e.g, van Dijk's text linguistics) or systemic linguistics (e.g, Bhatia's genre analysis); while the latter is more concerned with describing actual communication within institutionalized contexts (e.g doctor patient interaction, legal contrast). More general discourse analysis investigates everyday conversation, written discourse of all types, narrative, and other kinds of written or spoken texts.

Discourse analysis can be characterized as a way of approaching and thinking about a problem. It is making the world meaningful. Interpretation arises from an act of reading or analyzing which makes meaning of a text. Locke (2004) argued that discourse is a coherent way of making sense of the world as reflected in human sign systems including verbal language. He further describes discourse as a concept that is in an active relation to reality. Language signifies reality in the

sense that discourse is in a passive relation to reality, with language merely referring to objects which are taken to be given in reality.

According Rogers et al., (2005) the first goal of the analyst is to describe the relationships among certain texts, interactions and social practices; the second goal is to interpret the configuration of discourse practices; and the third goal is to use the description and interpretation to offer an explanation of why and how social practices are constituted, changed, and transformed in the ways that they are. The aims, choices and criteria of critical discourse analysis are to monitor theory formation, analytical method and procedures of empirical research (Van Dijk, 2006).

Fulcher (2010) ascertained that discussions and conversations with the people involved with teaching and learning policies can bring about the reality of the situation on the ground. Since language is a social and cultural instrument, our sense of reality is socially and culturally constructed.

Discourse analysis can be applied to any text. That is, to any problem or situation. It has no definite guidelines to follow because it is basically an interpretative and deconstructing reading (Palmquist, 2004)

## **Method**

In order to practically carry out discourse analysis in the scientific area as a new technique entitled "*scientific discourse analysis*", the researcher developed a program that included two parts; *the course material* and *the instructor guide* that consists of several techniques, activities and background information which are designed and suggested to help students identify scientific argumentative writing as characterized by being: clear, precise in word choice, well organized, concise, coherent, cohesive, fact-based and logical.

Some of the activities are designed as analysis measures at linguistic, context and genre levels that help students understand the discourse available and the dynamics of scientific argumentation than making before starting the writing process.

The analytical measures suggested for the program are divided into three levels as follows:

- 1- *Textual analysis level* (surf structure level) that deals with the coherence and cohesion of the text; what and how social actors, entities, events, problems, facts and opinions are presented.
- 2- *Contextual analysis level* (deep structure level) that deals with why these social actors, entities, events, problems, facts and opinions are presented, and why in that way.
- 3- *Genre analysis level* that deals with techniques, objectives, similarities, differences, macro structure and language choice of argumentative writing mode.

Some other activities are designed to be conducted during the writing process while others as evaluative ones to be conducted after the writing performance.

## **Results and Discussion**

Data obtained from pretesting and post testing was treated statistically in the light of the study questions and hypotheses using SPSS.

Results related to hypothesis one which stated that "There would be a statistically significant difference between the mean scores of the students in their performance of the pre and post administrations of the scientific argumentative writing test favoring the post administration", t-

test was used to find out whether or not there is any significant difference.

Table 1. Paired Samples t-test for the difference in the mean scores of pre and post administrations of the scientific argumentative writing test as a whole.

<b>Adm.</b>	<b>N</b>	<b>Mean</b>	<b>SD</b>	<b>t-value</b>	<b>Sig.</b>
Pre	30	10.00	0.00		
post	30	28.36	1.15	86.78	.000

Results related to hypothesis one showed that there is a statistically significant difference at 0.00 between the mean scores of the students in their performance of the pre and post scientific argumentative writing test favoring the post administration. The results of the present study showed improvement in students' argumentative writing performance. Hence, the significant difference may be due to the new technique of SDA that used throughout the suggested program.

Results related to the sub hypothesis one which stated that "There would be a statistically significant difference between the mean scores of the students on the pre and post administrations of the scientific argumentative writing test in content and organization favoring the post administration".

Table 2. Paired Samples t-test for the difference in the mean scores of pre and post administrations of the test for content and organization.

<b>Adm.</b>	<b>N</b>	<b>Mean</b>	<b>SD</b>	<b>t-value</b>	<b>Sig.</b>
Pre	30	13.30	.53		
post	30	36.70	1.46	76.59	.000

Results related to the sub hypothesis one showed that there is a statistically significant difference at 0.00 between the mean scores of the students in their performance of the pre-post scientific argumentative writing test in content and organization favoring the post administration. The results of the present study showed improvement in students' argumentative writing performance in content and organization. Hence, the significance difference may be due to the new technique of SDA. It is concluded that the suggested program based on SDA proved to be effective in developing content and organization skills of scientific argumentative writing.

Results related to the sub hypothesis two of which stated that "There would be a statistically significant difference between the mean scores of the students on the pre and post administrations of the scientific argumentative writing test in writing conventions favoring the post administration".

Table 3. Paired Samples t-test for the Difference in the Mean Scores of pre and post administrations of the test for writing conventions.

<b>Adm.</b>	<b>N</b>	<b>Mean</b>	<b>SD</b>	<b>t-value</b>	<b>Sig.</b>
Pre	30	3.30	.53	29.71	.000
post	30	8.33	.66		

Results related to the sub hypothesis two showed that there is a statistically significant difference at 0.00 between the mean scores of the students in their performance of the pre-post scientific argumentative writing test in writing conventions favoring the post administration. The



results of the present study showed improvement in students' argumentative writing performance in writing conventions. Hence, the significance difference may be due to the new technique of SDA. It is concluded that the suggested program based on SDA proved to be effective in developing writing conventions skills of scientific argumentative writing.

To test the second hypothesis of the study, the Cohen's formula was used to calculate the effect of the suggested program-based on scientific discourse analysis on developing the scientific argumentative writing skills of engineering students.

$$\eta^2 = \frac{t^2}{t^2 + DF} \qquad ES = d = 2\sqrt{\frac{\eta^2}{1 - \eta^2}}$$

$\eta^2$  (eta-squared), **DF** (degree of freedom), **t** (t-test value),  
**ES** (Effect Size)

Table 4. Mean scores of the scientific argumentative writing test before and after the experiment

<b>SAWT</b>	<b>t-value</b>	<b><math>\eta^2</math> Value</b>	<b>ES</b>
Total	86.78	0.856	19.89 Large

As shown in the table, using the scientific discourse analysis program is effective in developing scientific argumentative writing skills as the total d. value ratio is 19.89. Thus this ratio is higher than the standard of effectiveness determined by cohen (0.08).

The discussion of the study results is related to the objectives as well as the hypotheses of the study. The results of the present study

showed that the study sample indicated a significant improvement on the post administration of the scientific argumentative writing test as a whole and in each sub-skill. This improvement can be attributed to a number of factors:

**First:** The change of the instructor's role through SDAP from a disseminator of information, directive, rooted in authority to facilitator, interactive, rooted in negotiation and guide help students construct their own knowledge.

**Second:** The activities of analysis allowed students to participate as active learners working in groups, pairs and as individuals in order to get the intended skills and assess each other's progress than being recipients of knowledge. This helps them build successful relationship among them.

**Third:** The role of the students as analysts during practice makes them in responsibility and concentration all the time and ready for any discussion or inquiry.

**Fourth:** The change of the learning process climate from the one based on repetition to an interactive one builds on what the students already know. Supporting the class with examples, models as well as involved them in scientific discussions related to the most relevant issues and problems in their specialization and asking them to express their opinions and defend them attract students' attention and make them interested in practicing the activities.

**Fifth:** The change of the material from the textbooks to variety of activities presented in sheets of paper.

*Sixth:* The change of the tradition way of assessment through testing and correct answers only to the assessment includes student works, peer evaluation, checklists, observation and points of view as well as tests. Process is as important as product.

The SDA technique was used as a bridge to build upon what students already know to arrive at something they do not know. It supports comprehensible input, increased verbal interaction, contextualize language, reduce anxiety, get intended skills, and active involvement of the learner.

### **Conclusion**

In this study, the researcher has explored how scientific discourse analysis is conducted and how it is primarily positioned in the environment of language as the success of discourse analysis can be measured with a measuring rod of the study of languages. Since written messages convey meanings, the analysis of the written text on the surf structure and deep structure levels as well as the genre level of analysis can assist in interpreting issues, conditions and events in which the engineers find scientific support to their opinions, arguments, predictions and solutions and expressing them in a scientific coherent and cohesion style.

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## ملخص

تهدف الدراسة الحاليه لتقديم اسلوب التحليل العلمى للنص كأسلوب بحثى جديد لتنمية مهارات الكتابه الجدليه لطلاب الهندسه من خلال برنامج مقترح قائم على هذا الاسلوب البحثى . تشكلت عينه الدراسه من ٣٠ طالب من الفرقة الثانيه بقسم الهندسه المدنيه - المعهد العالى للهندسه - اكاديميه الشروق, وتم تطبيق الدراسه فى الفصل الدراسى الثانى للعام الدراسى (٢٠١٦-٢٠١٧). وقد قامت الباحثة بتصميم استبيان لمهارات الكتابه الجدليه واختبار (قبلى- بعدى) لمهارات الكتابه الجدليه ومقياس لتقييم الاختبار للحصول على بيانات الدراسه. تكون البرنامج المقترح من جزئين ١- كتاب المعلم ٢- كتاب الطالب حيث يمارس الطلاب ثلاث انواع من التحليل العلمى للنص: التحليل الحرفى والتحليل السياقى وتحليل الإسلوب ويمارسون بعض انشطه الكتابه الجدليه. وتم معالجه البيانات باستخدام الحزمه الإحصائية للعلوم الاجتماعيه . أظهرت نتائج الدراسه أن التحليل العلمى للنص والبرنامج المقترح القائم عليه فعال لتنمية مهارات الكتابه الجدليه لطلاب الهندسه.

### الكلمات المفتاحيه:

الخطاب العلمى - تحليل الخطاب - التحليل العلمى للنص - الكتابه الجدليه العلميه.