

Intra-disciplinary Variations in Academic Interaction: An EAP Study of Environmental Chemistry and Environmental Sustainability Assessed Writing

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ABSTRACT

Contemporary accounts of academic discourse increasingly stress the interactive nature of knowledge construction. The conception of science as an irrefutable, objective and reliable representation of Nature, not requiring human mediation, is now largely superseded. Consequently, for readers to bestow their ratification of propositions, writers have to show their deference to the discourse community, meticulously measuring the veracity of their claims, tapping the disciplinary heritage and displaying appropriate appraisal of their status as researchers. Equally, they must create bonds with their readers, explicitly addressing them as peers and interlocutors and appealing to disciplinary schemata. Utilizing a slightly modified version of Hyland's (2005) typology of academic interaction, this study explores patterns of stance and engagement within the discipline of Environmental Sciences. The intra-disciplinary corpus comprises 16 Ph.D. theses written by Sudanese scholars, 8 of which representing Environmental Sustainability and the other half Environmental Chemistry. Overall results indicate that pervasive interaction in Environmental Sciences is largely dictated by the discursive nature of the field as embodied in the high densities of evaluative and affective markers, though some categories such as the employment of the first pronoun were intentionally shunned. More significantly, statistically significant variations were found between the two subfields, with Environmental Sustainability deploying more intertextual ties, attitudinal markers and alignment with readers. It is argued that the disciplinary synergy characterizing Environmental Sustainability is a contributing factor. On the other hand, the empirical nature of Environmental Chemistry is more manifest in the subtle subcategories of such features as hedging, citation and directives. This is balanced by the more socially-oriented strands of the subfield that render Environmental Chemistry disciplinarily ambivalent. The implications for teaching academic discourse within the post-graduate scene in Sudan are discussed.

Keywords: Stance, Engagement, Ph.D. thesis, Intra-disciplinary variations, Environmental Sciences

INTRODUCTION

The inception and consolidation of the specialty of English for Specific/Academic Purposes (ESP/EAP) has been a salient aspect of the developments within the field of Applied Linguistics. While there were earlier attempts to study common core features of academic prose (e.g. Widdowson, 1975; Munby, 1978; Hutchinson and Waters, 1987; Spack, 1988), these efforts have been given impetus by a host of new factors. For one thing, the hegemony of English is intimately linked to the political and economic power of Anglophone countries in our post-modern world. In fact, as noted by Ricento (2015), never before in human history has a

language wielded such pervasive power, both to the benefit and detriment of the denizens of the world. Other researchers (e.g Crystal, 2003; Graddol, 2006; Canagarajah et al, 2007; Jenkins et al, 2011) have pointed out the socio-cultural implications of this ever expanding outer sphere of non-speakers. One result of the influx of the linguistically heterogeneous students seeking to undertake their post-graduate studies in Anglophone and post-colonial territories has been the emergence of English as a lingua franca of learning. Indeed, English is considered by prestigious institutions to be the global language of Science, and many academicians, researchers and publishers unconsciously regard English as the default language of knowledge dissemination (Lillis and Curry, 2010: 1). Moreover, as Hyland (2011: 173) advocates, the growth of academic discourse also relates to the changes in the nature of pedagogy itself. The increasing popularity of interdisciplinary and modular studies has necessitated initiating students into new writing practices and text types reflecting the rhetorical conventions peculiar to the worldviews of disciplinary conglomerations. A parallel development was the classification of written languages into genres (Swales, 1990) based on their structural and functional characteristics, including, for instance, research articles, textbooks and dissertations. Genres are defined as “ways of recognizing, responding to, acting meaningfully and consequentially within, and helping to reproduce recurrent situations” (Bawarshi and Reiff, 2010; 3) and, indeed, analyses of generic discursual features were aided by insights from new assumptions of the social constructedness of knowledge as well as the influence exercised by local linguistic patterns and identities on interaction within the academia.

Building on Swale’s (1990) seminal analysis of academic genres, voluminous studies have been conducted, mainly on the textual conventions of the research article, seen as the culmination of scientific logic and persuasion regarding novel knowledge claims. A good example of this tendency is Hyland’s (1996, 1999, 2000, 2001, 2002) extensive surveys of the variations within a substantial corpus of research articles representing eight disciplines have provided models for individual features of academic interaction, including hedging, citation practices and self-mention. Hyland’s (1998) work presented a model of academic interaction as comprising a textual and interpersonal components, Hyland’s (2004, 2005) investigations perceived the two levels as equally manifesting persuasive functions within academic discourse, and, hence, the two levels were purposefully termed interactional and interactive dimensions of discourse. It was only a short step for Hyland (2005, 2008) to further acknowledge the role of the reader and to propose new subcategories to what he now designated the “engagement” dimension as opposed to the “stance” subset dealing with the writer’s evaluative textual acts. This new typology has been established as a model of analysis in academic genres, including the current study.

It was the development of tools of corpus linguistics during the late 1990s that allowed researchers to study longer academic genres such as the M.Sc and Ph.D. theses. Regarding the Ph.D. genre, its neglect was documented in major monographs was noted by Swales (2004: 102). Yet it is a fact that the Ph.D. thesis is the essential requirement of initiations into the discourse community through training candidates to both assimilate and advance the heritage of the discipline. The exercising of critical faculties entailed throughout the process is deemed crucial to undertaking future research enterprises. Due to the sheer length of the texts, most studies have focused on parts of the genre within a single discipline. The bulk of the work concentrated on the schematic structure (Ridley, 2000; Paltridge, 2002; Bunton, 2002; Kwan, 2006) as compared to the research article. There was much less work on social engagement within this genre. Again, as in research articles, only some aspects of interaction were explored in the Ph.D. thesis (e.g Roberts and Cimasko, 2008; Lee and Casal, 2014; Kawase, 2015; Charles, 2006; Petric, 2007; and Soler-Monreal and Gil-Salom 2012). Analysis of whole theses was initiated by Thompson (2005, 2009) who explored both the macro-structures within two

corpora of theses from an interdisciplinary perspective. His corpus represented Agricultural Botany and Agricultural and Food Economics within a British university, as embodying experimental and discursive modes of enquiry. Thompson's attempt offers a good model despite the fact that his ethnographic and contextual factors for the production of the genre were his primary interest and that his analysis of citations was purely textual and never related to the writers' interactional purposes. Hence, the current study will combine insights from Thompson's encyclopedic and pedagogically-motivated analysis of whole theses and the need to investigate the possible differences within intra-disciplinary variations. I believe that by uncovering the major rhetorical features within a corpus of sixteen theses within two subdisciplines of the domain of Environmental Sciences. It is hoped that the findings of the study will offer better and more grounded pedagogical advice to novice Ph.D. candidates writing in English in Sudan.

INTERACTION IN ACADEMIC DISCOURSE

The concept of academic interaction is a relatively novel proposition and it is intimately linked to the changing conception of knowledge construction, particularly within the natural sciences. Ever since Enlightenment up to the middle of the 20th century, physics and chemistry, for instance, were believed to relay the Narrative of Nature (Myers, 1990) in its rationality, universality and objectivity. Consequently, the experimental procedures adopted by these fields in the form of empiricism, induction and verification were believed to yield laws that are persuasive by the virtue of their immanence and transcendence. This belief was accompanied by a view of language as superfluous and with scientific reporting as the lens merely through which the research is seen (Thompson, 2001:211). However, this version of strong empiricism was increasingly found untenable over the last three decades, and theorists such as Bazerman (1988), Berkenkotter and Huckin (1995) and Atkinson (1996) have stressed how scientific truth is much more a matter of multiple and contested interpretation, since the findings of a particular experiment ultimately depends on what set of conditions and perspectives under which it is held. Equally, the hallowed notion of impersonality scientific logic was deemed fallacious. Scientists (and, for that matter, social scientists and humanists) are no longer the selfless and humble servants of the discipline (Hyland, 2001), but rather endeavor to stamp their originality and person in hope of both visibility and advancement within the discourse community. Yet, the need for persuasion within the academia is much more dictated by the requirements of successful argumentation.

The overwhelming negation of the existence of absolute objective facts has far-reaching ramifications for the conceptualization of knowledge. Indeed, social constructionism has demonstrated that knowledge is as much rhetorically as objectively constructed. It is the social ratification of belief (Bruffee, 1986), where it is readers and the larger discourse community bestow legitimacy on the produced claims. According to Hyland (2008:195), readers always have the option of refuting the writer's interpretation, thus rendering it imperative to forestall possible criticism of their work. The notion of "face" (Yule, 2004) and face-saving acts are as much important to the academic as in other forms of social interaction. To that end, writers must display familiarity not only their heritage but also rhetorical conventions regarding its appropriate linguistic cue, setting it apart from other disciplinary tribes (Becher and Trowler, 2001). Since the ultimate goal of the writer is present novel finding and hence establish his academic credential as an insider, he has to strike the fine balance between humility and assertiveness. Cautious claims have to be accompanied by expression of conviction when the case warrants. Also, writers disclose their appraisal of the entities in the research through subjective statements of surprise, agreement, disbelief, appreciation, etc, thus uncovering part of their authorial self. Moreover, if it is disciplinary competence that ensures acceptance among readers, it is only by contribution to existing knowledge that confers credibility on the

writer as a member of the discourse community. Equally, writers must show their deference to their audience through the construction of “reader-responsible” (Hinds, 2001) prose. Texts are increasingly written to anticipate the potential difficulties of the reader, in navigating the textual and conceptual relations within the discourse. Hence, writers insert cues and transitions that aid navigation and linking not only contiguous constituents but also the interwoven physical, grammatical, semantic and pragmatic dimensions that create the meaning potential intended by the writer. Writers also have to invoke a shared ethos, termed as “constitutive intertextuality” by Fairclough (1992:217) by drawing on the generic, rhetorical and cognitive disciplinary expectations of their readers to aid processing and thus present their professional persona. Finally, the Hallidayan (1994) interpersonal function is manifest in the explicit acknowledgement of the reader, whose sympathy is enlisted and whose position as a colleague and participant is indicated by direct invocation and appeal to the consensual ethos of the discipline to frame the discourse and hence establish rapport with the audience.

The need for academic interaction as an essential means of persuasion has been largely established and investigated under various labels such as “metadiscourse” (Hyland, 2005), “metatext” (Mauranen, 1993), “evaluation” (Hunston and Thompson (2001) and “epistemic modality” by Hinkel (2005), among others. However, many recent investigations have espoused the terminology of Hyland (2005, 2008) which groups academic interaction as either writer’s stance or readers’ “engagement”, though we stress the symbiotic and dialogic relation of the two terms. Stance embodies the authorial self with regard to the information presented in writing. Through it we can sense the writer’s degree of certitude and commitment to the claims presented as well as his attitudes and judgment of the textual entities. The writer’s textual voice and his degree of assertiveness and conviction are hence conveyed. On the other hand, engagement concerns the writer’s attempt to align with the reader and to draw on shared generic and schemata. It can take the form of explicit invocation or appeal to assumed points of reference or camaraderie and politeness markers. Below I present a slightly modified version of the stance and engagement typology (Hyland, 2005:177).

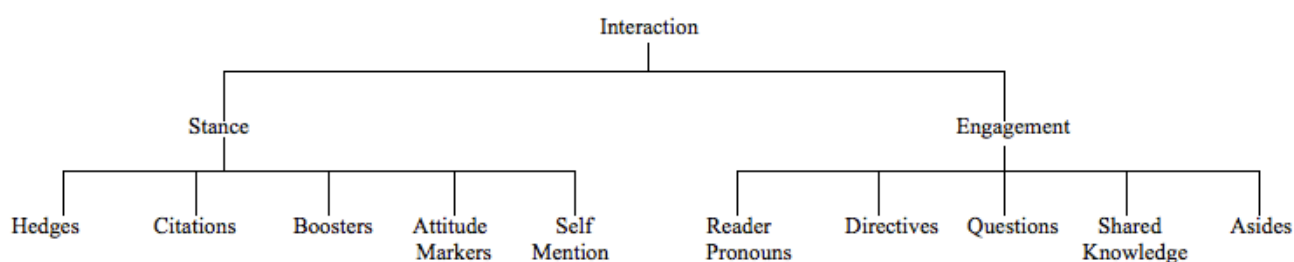


Figure 1: The taxonomy of interaction in academic discourse

It is to be noted that we have added “citation” under stance markers though it is normally categorized as textual (interactive) metadiscourse markers as established by Hyland and Tse’s (2004) study and as recently as the investigations by Lee and Casal (2014) and Kawase (2015). Probably this is rooted in formal classifications which are based on syntactic considerations to quantify the use of previous sources, and introduced into EAP literature by Swales (1990) and extended by such scholars as Thompson and Ye (1991), Hyland (2000) and Thompson (2005). However, more recent literature (notably Petric, 2007 and Howard, 2008) stress that citations should be investigated functionally as rhetorical conscious choices rather than abstract statistical figures on the page. While it has been established that a large number of citations are intended to demonstrate competence and topicality with the recent findings in heritage of the discipline, many others are evaluative in nature, reporting a critique of source and assessing the writer’s support, neutrality or disagreement. Comparison of the writer’s models with the

current ones shows the shortcomings paves the way for advancing novel ideas which seek to address a niche in the literature and, finally, citations are crucial in integrating the new conclusions within the accredited body of disciplinary knowledge. This intentionality is also true of self-citations (Hyland, 2001; Canagarajah, 2002) which are primarily employed to construct an authorial identity and to promote the writer's credentials through providing links to his previous research and, hence, gaining more visibility. While formal and functional citation taxonomies only occasionally converge (White, 2004), my argument was presented to illustrate the overwhelmingly writer-oriented nature of manifest intertextuality. But, in view of feasibility of formal typologies, they will be adopted as a measure of analysis in the two corpora. Both the five subcategories of stance as well as those of engagement will be clarified and instantiated from the two Environment Sciences subfields in The Methodology Part below.

THE CONTEXT OF THE STUDY

The context of the current study is The University of Khartoum, Sudan's oldest and most prestigious University. Due to its strong British heritage (originally named after the eminent Victorian, General Gordon), English was the medium of instruction for all the Faculties of the university. This linguistic policy was continued in the Faculties of Medicine, Science and Engineering despite mass Arabicization during the 1990s (Pitia, 2003). Indeed, in terms of research, the use English was deemed a mark of excellence even within the Faculties where undergraduate teaching was primarily carried out in Arabic. The University sought to enhance students' standards of English through adopting a two-year ESP programme covering aspects of both General English and specialized register of the discipline. It is safe to assume that these conflicting linguistic policies together with the significant increase in student enrollment have negatively affected mastery of the English among Sudanese academicians. This resulted in research problems related to conceptions, materials and syllabuses used. However, most studies such as those by Yassin (1999); Braima (2005); Hashim (2010) and Fath Alaleem (2016) are outdated and based on a vision of common core monolithic conceptions of academic writing long replaced all over the world by notions of genre, corpus pedagogy and discipline-specific epistemology.

On the other hand, studies on discipline-specific EAP in Sudan are few and far between. These investigations have generally focused on one discipline and were initiated by El Malik and Nesi (2008) who compared the ways in which Sudanese contributors to highly-referred international medical journals employed subtle but significantly different rhetorical devices from their British peers. A larger and very recent attempt by Ali (2016) found ample variations in the manner local Sudanese scholars employed metadiscourse to align with readers in six disciplines representing the continuum of academic tribes. Interdisciplinary analyses of the Ph. D. genre were pioneered by Ali (2011), who, has undertaken an earlier, but more relevant, endeavor in which he compared citation patterns in 24 Ph. D. theses produced at the University of Khartoum and equally representing Geology, Geography and Applied Linguistics. The investigation has unveiled ample variations between the objective Geology, on one hand, and the qualitative and epistemologically-divergent Applied Linguistics. This effort was complemented in a further study by Ali (2016) which compared citations practices of Sudanese and British Ph.D. candidates as represented by ten Literature Review Chapters in the realm of Applied Linguistics for each. The findings were largely to the detriment of the Sudanese candidates who generally produced Literature Review Chapters violating the strict guidelines regarding the procedure of documenting source. More significantly, most of the examples studies merely amassed sources without critical commentary or subordinating them to the textual voice of the thesis writer. To my best knowledge, the sole study by a Sudanese scholar to intra-disciplinary variations was by Al-hassan (2008) His study investigated student writing in the Accounting and Finance postgraduate scheme (ACCF) in the Essex School of Accounting,

Finance and Management (AFM). He employed discourse-based interviews ethnographic approaches as well as textual analyses of the relevant documents. Results of data analysis showed that the type of writing assigned on this discipline is the library research paper which confirmed previous studies' classification. However, the rhetorical and epistemological requirements underlying the production of this paper significantly varied across the courses and among the faculty in the discipline. ACCF students, in turn, held somewhat different beliefs and understandings to these expectations and requirements. The present study builds on both my earlier interdisciplinary explorations as well as the insights from Al-hassan's more international perspective. This investigation is equally pedagogically motivated and attempts to initiate Sudanese Ph.D. candidate suffering from a duality of medium of instruction and research into conventions of academic discourse. More specifically, it aims to enlighten students about the variations that exist regarding aspects of academic interaction not only between different academic domains but also within the same discipline, as embodied in the discursive differences between Environmental Chemistry and Environmental Sustainability Studies subsumed by the overarching discipline of Environmental Sciences.

METHODOLOGY

This Part describes the methodology employed concerning the choice of the corpus, the typology used for classifying interaction and the procedures for ensuring the reliability and elicitation of results.

Rationale for Selection of the Corpus

This research attempts to uncover the variability in the employment of rhetorical features within the discipline of Environmental Sciences. The idea originated in our frequent visits to The Sudan Library at The University of Khartoum, Sudan. A study of the repository of Ph.D. theses there had accidentally led us to the notion of conducting an interdisciplinary comparison between two different disciplines which yet share the denominator Environment. We initially had the field of Public and Environment Health as opposed to the field of Environmental Sciences in mind. The former is a decidedly scientific and hard discipline; the latter, ostensibly, much more interdisciplinary and akin to social fields. Indeed, we wished to undertake a more comprehensive appraisal of interactional elements in the two fields (on a par with our comparison of the deployment of intertextuality between Geology and Applied linguistics theses in our 2014 article). However, a more careful perusal of the theses in The Environmental Sciences initially indicated the existence of different thematic orientations and paradigms. The illuminating thought then occurred to us so as to pursue this assumption further by investigating two branches within the discipline. The conception was given impetus by the dearth of studies on intra-disciplinary variations (Godnič and Jarc, 2015). From some informal interviews with the thesis supervisors, it became apparent that two main subdisciplines existed (among others) within the field, namely Environmental Chemistry and Environmental Sustainability Studies. Further consultations with the theses supervisors assisted us in selection of what they considered the exemplary and canonical theses for the two mainstream research paradigms. Similar to Thompson's (2005) pioneering investigation, it was thought that a number of eight theses produced over the last ten years in the two specializations would afford a representative sample for examining the interactional features in research by Sudanese academicians.

Questions of The Study

1. Of the stance and engagement markers and their various subcategories, which ones are mostly utilized by Sudanese Ph.D. candidates in the discipline of Environmental Sciences?

2. Are there statistically significant variation between Environment Chemistry and Environmental Sustainability Studies Ph.D. theses in terms of the density and distribution of of interactional devices?
3. What role, if any, do the epistemological concerns of these intra-disciplinary tribes play in molding the way writers align with their readers?

A Typology of Interaction in Academic Discourse

As mentioned earlier, the effort on the writer's part to effect persuasive interaction is a pervasive aspect of all reader-responsible prose. This is primarily accomplished through either adopting a stance or conscious engagement with the reader. In this Part we will detail the five components comprising each of these major categories. The explication is accompanied by examples from the sixteen theses (numbered from 1 to 8 for both subdisciplines) in our corpus, representing Environmental Chemistry (abbreviated as EC throughout my article) and Environmental Sustainability Studies (ES for short).

Stance concerns writer-oriented features of interaction and conveys different kinds of personal feelings and assessments, including attitudes that a writer has about particular information, how certain they are about its veracity, how they obtained access to it, and what perspective they are taking to it and to the reader. It conveys three broad meanings (Hyland, 2005: 198). The first embodiment among these interactive resources is hedges, which are linguistic devices that mitigate the certitude or commitment of the writer regarding the information given. Hence, they are to be treated as evaluative and tentative rather than absolute facts, as exemplified by EC (4) and ES (4) respectively:

Inhalation of cholinesterase inhibitors may result in tremors of tongue and eyelids, miosis and blurred vision.

The agroforestry situation in the Gum Belt indicates that the depletion of the Hashab trees is strongly linked to population mobility as much as drought cycles.

Secondly, *attitude markers* indicate the writer's affective attitude to propositions, conveying surprise, agreement, importance, frustration, and so on, rather than commitment, as in this examples from EC (1) and ES (3):

Lead poisoning remains the most common and societally devastating environmental disease of young children

Some coping mechanisms introduced after the unfortunate droughts of 1984 and 1990 only tend to exacerbate the chronic water shortage problem.

Thirdly, *boosters* express another face of evidentiality with *hedges*, but unlike the latter, it is used when the writer wished to convey a high degree of conviction and confidence in his assertions. An example from EC (6):

Results showed that the adsorption of chromium from solution using SCB increased with adsorbent dose reaching a maximum (99%).

Another example is provided by ES (7):

Alleviation of poverty and realizing the goals of developments are hardly possible without attending to the question of environmental sustainability.

The fourth category is *citation* which is a research report that has a specific reference point that is clearly identifiable (Charles, 2006:74). This is clarified by an instance from EC (2) and ES (6) respectively:

The physicochemical properties of metals in exposure media, such as air, food, and water, play an important role in determining the extent of absorption into the body (Beckett et al., 2007).

Lovell (1994) has applied a Stochastic Production Frontier model to the mechanized agriculture in the clay plains of Sudan.

Finally, *self-mention* is realized through overt employment of the first person pronouns or adjectives, and allows the writer to introduce in the discourse and present a personal appraisal of it. Indeed, as Hyland (2001) reports, the use or avoidance of self-mention is usually expressive of a disciplinary-situated authorial identity. Below is an instance from ES (8):

A copy of a 220 year old Charter issued by Sultan Badei of the old Sultanate of Sennar conceding control of the entire Butana region to the Nazir of the Shukriya Awad Elkarim Abu Sin was shown during field interview to the researcher.

The second principal means by which writer-reader interaction is achieved is *engagement*. Engagement concerns the writer's conscious effort to build a shared ethos with the readers and forging bonds of solidarity and parity. Also, it allows the writer to anticipate the readers' reactions to the argument and develop disciplinary-sanctioned conventions to that effect. As with stance markers, engagement comprises five components as follows:

Firstly, there is *reader pronouns*, most commonly realized in the form of *inclusive we*. This device is a potent means to involve the reader in the discourse, creating a sense of collegiality as members of the discourse community and assuming a shared epistemological horizon. Below is an example from ES (1):

As we have seen, absence of food security in North Darfur was triggered by several interconnected factors;; environmental, political and economic .This will ultimately allow us to generalize across similar high-vulnerability regions in the country.

Secondly, *directives* are primarily expressed through imperatives and obligation modals and they engage with readers textually, physically or cognitively (Hyland, 2008: 2001). Below is an example from EC (3):

ADMS 3 is a practical dispersion model that simulates a wide range of buoyant and passive releases to the atmosphere either individually or in combination (Look at Figure 2:8 for details).

Thirdly, *questions* can be addressed to the reader at important junctures in the text. Though cast as interrogatives, they are wholly meant to act as catalysts to the argument and hence rhetorical and expounded immediately. One example from ES (4) will suffice:

But what has participatory rangelands management to do with restoring Gum Arabic yields? The answer partly lies in the conflicting interests of logging to meet energy demands and.....

Fourthly, *personal asides* are parenthetical comments by the writer that interrupt the mainstream argument. These extrapolations or personal evaluations give a glimpse into the writer's mind and hence add a layer of solidarity and engage the reader in the the narrative. ES (6) provides us with a rare example of this device:

Mechanized rain-fed farming subsector (mainly associated with the famous Gadaref fertile lands) is however as prone to effects of climate unpredictability as the traditional rain-fed practices.

Finally, *appeal to shared knowledge* involves appealing to a common schema deriving from the accredited and consensual body of disciplinary knowledge. In so doing, the readers are no longer passive receptacles but are insiders to the argument. This egalitarian strategy is likely to enlist the sympathy of the audience and to engender even higher levels of solidarity. We can exemplify this interactional strategy from EC (2):

Due to its unique circulatory characteristics, nails can provide a much more accurate history of trace poisonous elements than other biomonitors.

Procedures

The objective of this study is to quantify and compare features of academic interaction in an intra-disciplinary Ph.D. theses corpus of Environmental Chemistry and Environmental Sustainability Studies, both of which are subsumed under the field of Environmental Sciences. Direct access to the paper versions of the sixteen theses was gained at The Sudan Library, University of Khartoum. The study employs a primarily quantitative approach notwithstanding the fact that the semi-structured interviews with the thesis supervisors were crucial to the developing the conceptual framework and, indeed, inform the article as a whole. The quantitative approach was, on the other hand, hand explicit and relied on Hyland's (2005,2008) classification of stance and engagement markers. Though analysis of the ten features was conducted manually, the availability of the convertible PDF copies rendered the task of both the quantifying the features within the main body of the theses (excluding the front pages and the appendices) a feasible endeavor. The electronic copies were important in determining the relative distribution of features over the chapters as well as the facilitation of the statistical analysis.

As a subsequent step, every instance of stance and engagement markers was counted according to the functional criteria above. As a measure to increase reliability, the researcher presented at least part of each coded chapter to a native speaker who is teaching General English at Al Baha University, The Kingdom of Saudi Arabia. Then, Cohen Kappa, a measure of inter-rater reliability reflecting the degree of consistency between two researchers, was carried out on the sample data. This process yielded an inter-rater reliability of ($k = .803, p < .0$). This lent strength to the procedures despite a few controversial cases that were resolved through the native speaker's intuition. The analysis was straightforward compared, to example, to the notorious ambiguity of functions of metadiscourse (Ali, 2016). Yet, ultimately encoding of interactional elements is a highly contextual enterprise that is dictated by disciplinary conventions that are opaque to outsiders (Hyland, 2008: 198) and the best the researcher can aspire to is to elicit the overt grammatical realizations of these features.

Despite the clarity, there were recurrent cases of ambiguity. This is illustrated by modals such as *must* which can simultaneously function as an *attitude* marker indicating obligation or can alternatively act as an imperative invocation to the reader to carry out an obligation (as it is indeed uniformly applied by Hyland, 2008: 212). Hence, despite the semantic implications of *must*, it is consistently categorized as a *directive* (as, indeed, it is true of *need to be* in the last excerpt in this part). This is shown by the examples from EC (5) and EC (3) respectively:

Discernible liquid residues of cytotoxic concentrates, must be disposed of as cytotoxic pharmaceutical waste.

First, all sources of air pollution must be categorized either as gaseous or particulate emissions.

Take the example of *apparent* in the following excerpts from ES (1) and ES (3) respectively:

Millet\ demand and supply functions analysis in Northern Darfur implied that high millet price is the most apparent motive, for expansion of the cultivated area.

It is apparent that future changes in Sudan's climate variables need to be modeled, as very few related assessments have been conducted so far.

Initially, it was difficult to assign *apparent* to either the attitude or booster markers within the stance category. But on reflection, this adjective acting as pronominal modifiers was treated as

an attitude marker (in line with Hyland’s 2004 comments), as it specifies the attributes of the above motivation. In the second example, *apparent* was considered a booster, bestowing a high degree of probability on the writer’s assertion about the need to introduce climate modeling in Sudan.

RESULTS AND DISCUSSION

This Part comprises three Sections, the first of which presents the overall *stance* and *engagement* figures, while the second provides broad explanations within the framework of the sociology of knowledge. The third Section, on the other hand, contains a statistical comparison of the ten features within the two subdisciplines and exemplifies overt and subtle rhetorical differences in the interactional devices between the two subfields.

Overall Distribution of Interaction Features in the Corpus

As a study of the field of Environmental Sciences, the quantification of the two subfields has produced 726668 words which in turn yielded a total of 33910 tokens of interaction. This is equivalent to an average of 4238 tokens per thesis or 45.1 occurrences every 1000 words (corresponding to one interaction realization every 22 words). The high density of interaction devices in our corpus is a clear evidence that academicians intuitively attempt both to express their affective and authorial intentions as well as to involve readers in their argumentation. This is the more striking in the knowledge that the present Sudanese candidates would have produced their theses untutored and probably had never had an encounter with the conventions of academic discourse (Ali, 2016). The significance and ubiquity of interaction within academic discourse receives further testimony from Hyland (2008: 203) when he states that the figures are at least twice as much per 1000 words as those of common features such as passive voice constructions and past simple tense. The figures are significantly below the statistics in Hyland’s (1998, 2004) of the ratios of interactional and interactive metadiscourse which have yielded an average of 64.9 occurrences per 1000 words. Indeed, Hyland’s conclusions based on an interdisciplinary corpus of research article were found true of Sudanese academic practices in my own earlier study (Ali, 2016). Yet two considerations have to be borne in mind. Firstly, both corpora have concentrated to a large measure on textual metadiscourse (including *code glosses*, *frame markers* and *transitions*), which constituted the overwhelming majority. The *interactive* elements (corresponding to the *stance* category in the present study) were a comparable fraction and this paucity is even more true of the *engagement* group. The enlarged reader-centred categories in Hyland’s (2005, 2008) study which is generally replicated here, is a reflection of the reduction of both *stance* and *engagement* categories. His study of academic interaction has established an average of 36 tokens per 1000 words which is dwarfed by the overall ratio of 45.1 in the current study.

Table 1: Stance and engagement T.test in whole Ph.D. theses

	Categories	Mean	Std. Deviation	Independent Samples Test		
				t-test		
Environmental Sciences	Stance	2.49	1.314	T	Df	Sig. (2-tailed)
	Engagement	7.17	1.386	-24.505	198	.000

It is interesting to note that most of the discrepancy lies in the *stance* category, while Hyland’s figures on *engagement* in fact slightly exceed those of my own. Yet, again, it should be noted that Hyland’s (2005, 2008) corpus consists of 240 research articles encompassing eight scientific, social and humanities-based fields compared to the present study which is devoted to Environmental Sciences Ph.D. theses. It is tempting to postulate that the nature of this field is responsible for the high incidence of interaction features. Like all social fields, Environmental Sciences broadly involve human agency and multiple interpretations of

phenomena. This proposition receives some evidence from Hyland and Tse's (2004) and Hyland's (2010) investigations of interactional elements in an interdisciplinary and parallel corpus of Ph.D. theses where the ratios were either similar or, generally, significantly below the average for the current discipline. Even so, we should recognize the subcultures within the field, whose different epistemological affiliations is the subject of this article.

The statistics in Table 2 reveal that *stance* features form the bulk of the interaction devices in The Environmental Sciences Ph.D. theses as a whole and that the *engagement* features constitute merely a tenth of the figures. The overwhelming differences are equally reflected in the proportions of the two divisions per 1000 words (40.7 to 4.4 tokens for *stance* and *engagement* respectively). This statistical measure allows the comparability of figures despite the disparity of word counts or different rhetorical organization of the genre under study. The discrepancy is necessarily reflected in both the means and the associated calculated figures. As shown in Table 1 above, there are statistically significant differences between the distribution of these two major features over whole Ph. D. theses. In the T-test, t has a value of -24.505 and the p value is $.000$ which is less than $.05$ and is hence statistically significant and indicative of substantial variations between the two categories.

Table 2: Stance and engagement subcategories in whole Ph.D. theses

Stance	Total Items	Subcategories per 1000 Words	% of Total Interaction	Engagement	Total Items	Subcategories per 1000 Words	% of Total Interaction
Hedges	10522	.14.1	35.0	Reader pronouns	1714	2.1	48.0
Attitude markers	1297	6.6	17.0	Directives	727	1.0	20.0
Boosters	4353	5.9	14.0	Questions	207	0.2	6.0
Citations	9637	13.0	32.0	Appeal to Shared knowledge	653	0.8	19.0
Self-mention	828	1.1	2.0	Asides	260	0.3	7.0
Grand Totals	30349	40.7	100%		3561	4.4	100%

There are substantial differences in the distribution of the features within the two interaction categories. The *stance* category is overwhelmingly composed of *hedges* and *citation* features. Though it is less than Hyland and Tse's (2004) percentage of 41% in mixed Ph.D. theses, *hedges* comprise almost a third of all interaction cases in The Environment Science corpus and indicates writers' attempts to mitigate their propositions and signaling the relative accuracy of their assertions as is consistent with disciplinary-sanctioned norms. Regarding *citations*, they are exceptionally dense in the corpus and far exceed the figures in Hyland and Tse's (2004) corpus. This is partly justified by the nature of the Ph.D. genre which necessitates both the anchoring of research in the discipline's tradition and intertextually drawing on the chartered knowledge to establish a niche to address through research. Equally, the well-known interdisciplinarity of Environmental Sciences requires extensive webs of citation to forge a common horizon. With respect to *boosters* (*hedges'* smaller twain), they are within the expected frequencies, as are *attitude markers*. *Self-mention* (including self-citations), on the other hand, is merely a third of average distribution in both Hyland's (2005) study and his earlier (2001) full-length interdisciplinary study of authorial identity. Indeed, we will revert to the Sudanese academic culture with regard to self-assertion later in this article. Interestingly, *directives* accord with the expected frequencies, while *reader pronouns* are below the norm, and factors in the academic culture will be related to this matter later. Finally, the relatively

high frequencies of *shared knowledge references* and *asides* may emanate from the epistemological nature of the field under discussion. Yet, in the final analysis, we should stress that the above overall tendencies are tentative and do not reflect the main focus of this article. Consequently, we have to relate the above statistics to their origin, namely *Environmental Chemistry* and *Environmental Sustainability* Ph.D. theses in order to pinpoint the similarities and differences and to seek plausible explanations, as will be attempted in the next Section.

Disciplines and the Social Construction of Knowledge in the Case of Environmental Sciences

Linguistic features of discourse are increasingly seen to be related to community consensus and socially-sanctioned discursive practices (Rorty,1997; Hyland,1998; Atkinson, 1996). The broad dichotomy between hard sciences and soft humanities social fields is largely accepted. The former, epitomized by Chemistry, Civil Engineering and Medicine, are defined by their specialized readership, linearly-built and cumulative growth of quantitative and largely replicable knowledge uniformities and closely defined research niche. A diametrically opposed picture emerges from the overtly discursive, human-imbued and interpretive humanities-based disciplines such as Philosophy, Religious Studies, Literary Criticism. Social sciences occupy a middle ground and are defined in relations to experimental fields. Hence, Economics, Business Management (and Anthropology employ weaker scientific paradigms since a multiplicity of variables are involved, where there is more human agency, less exactitude and predictability, and where dispersed threads of knowledge have to be woven together and a common epistemological horizon to be forged out of the divergent subfields (Becher and Trowler, 2001; Coffey and Burns, 2003); Hyland and Bondi, 2006).

Our crucial question is where the field of Environmental Science fits within this disciplinary spectrum. There are plausible reasons to include it under the social sciences. The Environmental Sciences, sometimes also known as 'Environmental Studies, embrace a plethora of disciplines that are concerned with the physical, chemical, and biological surroundings in which organisms (Allaby, 2002:2). The key term is *environment*, which is defined by Douglas and Holland (1999) as 'the aggregate, all the external forces, influences and conditions, which affect the life, nature, behavior and the growth, development and maturity of living organisms". It is a wide-ranging discipline that encompasses concepts from Earth and Life Sciences and, according to Khoiyangbam and Gupta (2015), it draws on Restoration Ecology, Agronomy, Conservation Biology, Demography, Hydrology, Epidemiology Chemistry and Statistics as well as strands from legal and sociological studies. Situated within this complex intertextual framework, the field replicates all the disciplinary clusters we have identified and their quantitative or qualitative orientations, and research paradigms will be as rigorous or lax as far as the area under research is concerned. Yet since the overarching concern of the field is man in relation to his environment in its physical, biological or atmospheric embodiments, it could be concluded that this field (even within its more scientifically reliable subfields) is distinguished by all the elements of unpredictability and incontingency characteristic of social sciences.

Environmental concerns have been increasingly recognized over the last thirty years due to high carbon dioxide emissions and their possible relations to climate changes and recurrent extreme drought, flooding and hurricane episodes. Other factors such as increasing air and water pollution levels, depletion of resources, deforestation and the need for sustainable development issues and poverty alleviation a matter of public concern. Indeed, an early awareness of the importance of the environment had led to the establishment of The Institute of Environment Studies at The University of Khartoum during the mid-1980s. It is a facility primarily dedicated to environmental research from which the present corpus is drawn.

Environmental Sciences is an exceedingly interdisciplinary subject which attempts to cope with global environmental issues from the loss of biodiversity in The Amazon Basin to the consequences of thawing of The North Pole, the accumulation of polymer in deep seas or the chemical disfigurement caused by over-tourism at Petra (all my own examples). Turning to Sudan, three of the thesis supervisors have pointed out that such research as is carried out at The Institute is determined by perceptions of the environmental problems in the Sudanese context. Chemical pollution, biological hazards and environmental degradation are three popular topics for research and are necessitated by the fragile economic, health and climatic conditions in Sudan. Indeed, these areas are respectively labeled as *Environmental Chemistry*, *Environmental Sustainability* and *Environmental Health*. The first two are the focus of comparison in the following Discussion.

Three strands of research could be discerned in the theses produced at The Institute of Environmental Studies, University of Khartoum. Evidence for this can be found by glancing at the titles of the theses. Those in Chemical Environment predominantly deal with the various types of pollution such as lead contamination in EC (1), and heavy metals in EC (2), The hazards of pesticides in Ec (4) and hydro-chemical contamination in EC (8). A related issue is that of hazards of waste in its medical form, as in EC (5), chromium effluents, as in EC (6) and atmospheric pollution caused by Khartoum Refinery. A diametrically opposed thematic network is found in The Environmental Sustainability corpus. Here the dominant topic is environmental degradation in drought-prone areas of Sudan. A case study of this is ES (2) with regard to North Kordofan, while ES (4) analyzes the environmental fragility surrounding The Gum Arabic Belt. A replication of the deterioration of pastures is found in ES (8) with respect to Butana pastorals and in relation to the mechanized agricultural systems in Central clay plains of Sudan in ES (6). ES (1) analyzes the factors affecting food security in the equally delicate arid ecosystem of North Darfur. Thesis ES (5), on the other hand, investigates the usefulness of climate forecasts in alleviating the effects of drought for farmers in Kordofan. Only ES (2) takes an international perspective by comparing the ecological disasters caused by the petroleum industry in Sudan and Qatar.

Since The Environmental Studies Institute is not a Faculty of The University of Khartoum, it recruits staff and students from all the other specializations. Of the eight Chemistry theses, four were supervised by one Professor at The Faculty of Environmental and Public Health, two by a Professor affiliated to The Faculty of Science and one directed by supervisors with links to Chemical Engineering and one by a Professor of Agricultural Production. This scientific background applies to the Ph. D. candidates, three of whom graduated from The Department of Chemistry, two from Engineering, one from Botany and another from The Faculty of Public Health. Regarding Environmental Sustainability, five theses were supervised by a Professor originally from The Faculty of Economics, one supervised by a Professor with a basis in Geography and the last two by a Professor from The Department of Agronomy. The background of the candidates is even more wide-ranging than that of Environmental Chemistry. It includes Economics, Botany, Geography, Forestry and Social Anthropology. This characterization of Environmental Chemistry as quasi-scientific as opposed to the more ethnographically-oriented Environmental Sustainability is supported by the supervisors who pointed to the macro-structure of their fields as a proof. Indeed, there is a conventionalization of rhetorical structures in the Chemistry theses. Seven of eight adopt the Simple IMRD (Introduction, Method, Results, Discussion) format found in natural sciences (Ridley, 2000; Bunton, 2002; Kwan, 2006), with one exception where the complex cyclical form in which the four elements recur in every chapter. The Environmental Sustainability theses, on the other hand, uniformly utilize the topic-based structure characteristic of social sciences and humanities. In this pattern, chapters following the Introduction and The

Conceptual/Theoretical Framework have no fixed headings but are labeled according to the topics discussed. It is a format that better fits the discursive nature of Environmental Sustainability. As a result, the Environmental Sustainability corpus is almost twice as long as that of Environmental Chemistry (441575 words for the former and 298112 words for the latter). The epistemological and rhetorical differences between the two Departments have implications for the distribution of interaction features in the two corpora, as we will see presently.

Comparison of Interactive Categories in the two Corpora

Closer intra-disciplinary comparisons reveal the existence of variations between the two Departments. This is manifest in the density of *stance* feature as a whole where the data (not included here for constraints of space) shows that Environmental Sustainability has a standardized overall distribution of 45 tokens per 1000 words compared to 35.5 in the case of Environmental Chemistry.. Table 3 details the distribution per percentage for the *stance* category as a whole in the two subfields. Despite the apparent variations in aggregate figures, the Chi-Square results reveal that the *p* value (.300) exceeds the significance level (.05). It can consequently be concluded that there are statistically insignificant differences between the *stance* class as a whole within the two corpora. Moreover, as we will see presently, these inconsequential differences extend to three of the five subsets constituting the *stance* category.

Table 3: Stance cross-tabulation in the two subfields

		Stance				
		Hedges	Attitude Markers	Boosters	Citations	Self - mention
Environmental Chemistry	Count	4034	1297	1978	2957	522
	% within Env. Chem.	37.0%	12.0%	18.0%	28.0%	5.0%
Environmental Sustainability	Count	6488	3710	2375	6680	306
	% within Env. Sus.	33.0%	19.0%	12.0%	34.0%	2.0%

Table 4: Stance Chi-square tests in the two subfields

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.876 ^a	4	.300
Likelihood Ratio	4.941	4	.293
Linear-by-Linear Association	.003	1	.958
N of Valid Cases	200		

a. 2 cells (20.0%) have expected count less than 5. The minimum expected count is 3.50.

Table 5: One - Sample Statistics of stance in the two subfields

	One-Sample Statistics			Test Value = 2		
	N	Mean	Std. Deviation	T	Df	Sig. (2-tailed)
Hedges	10522	2.22	.980	2.244	10521	.027
Attitude Markers	5007	2.48	.882	5.444	5006	.000
Boosters	4353	2.10	1.000	1.000	4352	.320
Citations	9637	2.40	.921	4.342	9636	.000
Self - mention	828	1.74	.970	-2.679	827	.009

A One-sample study of these subcategories is included in Table 4 and uncovers variations within the respective subdivisions. The high proportion of hedges in this social field is expected due to the intrusion of human agency and the more qualitative paradigms that cannot guarantee generalization or reliability of results. Moreover, as Hyland (2008:205) postulates, writers in the softer fields are conscious of the dialogic engagement in their domains and the

multitude of variables and contextual factors that lead to other possible interpretations. Hence, propositions are rhetorically constructed and negotiated by the writer and have to be couched in less than unequivocal terms. This is indeed proved by the high ratio of 14.7 per 1000 words for this feature in Environmental Sustainability (though the figures are slightly less than Hyland's overall average for the social fields). In line with Hyland's (1996) terminology, this subfield is distinguished by writer-oriented hedges. These pragmatic devices constitute 48% of all hedging and allow the writer the dual function of advancing knowledge claims while safeguarding himself against refutation by stating the exact state of findings. As the examples from ES (8), ES (3) and ES (1) below show, this means avoiding agentivity and, alternatively, speculative and evidential verbs:

The evidence suggests that the institutionalized concern with environmental issues has not reached the Sudanese masses.

From the data it was apparent the vegetation area has diminished by more than 300 sq. kilometers between 1972 and 2000.

It is plausible to claim that the problem in post-drought Darfur was the absorptive capacity rather than the flow of international aid.

Yet the prevalence of *hedges* in Environmental Sustainability is offset by the almost equally high density of hedging (13.5 per 1000 words) in Environmental Chemistry. Hence, the fact is that the difference between the two subdisciplines is statistically insignificant (the *p* value is .02, which exceeds .000). Since hard fields rely more on the primacy of self-evident facts at the expense of human reasoning, the high ratio of *hedges* in Environmental Chemistry indicates its epistemological ambiguity and highlights its many influences. Indeed, in addition to the solid scientific core, Environmental Chemistry has a periphery that draws on Medicine, Demography, Economics, Geography and Sociology. While the contributions of these domains are far less central than what the case is in Environmental Sustainability, they might have left their mark in the *discursive* element of the theses and hence the high ratio of *hedges* compared with proper experimental fields. However, in Environmental Chemistry, *writer-oriented* and their subtypes hedges constitute only 21% of the overall figures. Much more significant are *content-based* hedges and, among these, *reliability* hedges comprise 34% and *attribute* hedges roughly half of all cases. The former are normally realized through epistemic modals, adjectives and verbs, and they express the degree of conviction the writer has in his findings. Based on the available evidence, the writer signals to the reader how categorical or tentative the proposition is to be regarded in order to guarantee the accurate and faithful representation of the work of the former. Though different in its textual organization, these hedge ontologically share some characteristics of writer-based hedges prevalent in Environmental Sustainability. *Reliability* hedges are instantiated by examples 1, 2 and 3 from EC (1), EC (8) and EC (4).

Higher amount of lead concentration was detected among pupils from southern Sudan (3.41 µg/dl, but larger samples are required to confirm the consistency with Banaga's (1993) study.

The presence of choliform organisms may be an indicator of faecal contamination and intestinal diseases, and the possible, the presence of pathogenic microorganisms.

Seemingly, the increase of the concentration of the precipitating agent corresponded with decreased the chromium in the supernatant.

Attribute hedges, on the other hand, utilize the notion that, to be accepted, objective, knowledge needs to be represented in conventionalized semiotic schema. However, as Hyland (ibid) points out, there is sometimes a disjunction between presumed models and parameters, on one hand, and experimental results and actual behavior, on the other. Using attribute

hedges, writers can approximate their conclusions and findings against a reified set of categories, relationships and measurements for greater precision. A content analysis of these hedges shows that they almost invariably relate to scientific discourse, as seen in the examples from EC (2), EC (8) and EC (5) respectively:

The serial measurement of lung function generally provides stronger information on the effect of exposure than one or two spirometric measurements spaced over time.

An analysis of the BOD, COD, O & G, Cr, TDS and TSS parameters essentially showed that they exceeded the universal permissible limits.

Under normal conditions, the amputation waste must always be incinerated completely in a confined crematorium.

Considering the fact that the Environmental Chemistry theses are essentially reports of experimental work and measurement, it is reasonable to assume that candidates would employ relatively few *boosters* in the belief that their findings are valid representations of Nature, hence requiring no mediated interpretation on the part of researchers. However, as elsewhere, the difficulty of assigning a purely scientific status to Environmental Chemistry becomes apparent. Indeed, its interdisciplinarity as well as the multiplicity of variables and the contextual considerations arising out of the overlapping research niches are all mitigating influences on the conclusions reached. The Chemistry core is not exclusive of other domains falling under the overarching rubric of *Environmental Sciences*. In fact, Environmental Chemistry marginally outnumbers its counterpart, seen in the statistically insignificant figures of 6.5 to 5.3 per 1000 words for Environmental Sustainability. However, writers in Environmental Sustainability use *Boosters* to limit the potential interpretations, Environmental Chemistry often substantiate numerical claims they can forcefully defend. This is illustrated by ES (3), ES (5) EC (5) and EC (3) respectively:

Adaptation mechanisms of indigenous inhabitants are certainly not due to lack of awareness or ignorance, they are rather an outcome of lack of alternative resources, and marginalization of this remote community.

Among the various environmental and human factors, it can be plausibly argued that accelerating rate of climate change and its impact on the livelihoods is exacerbating the vulnerability to different socio-economic activities.

The evidence from the current HCWM practices observed in Khartoum State clearly shows them to be hazardous and environmentally detrimental.

The average release rate over 24-hour period for both SO₂ and NO_x is 120 g/s. The results demonstrate the ground level concentrations predicted from time varying emissions and substantially similar to those of constant release.

Self-mention is almost twice in aggregate figures in Environmental Chemistry as in Environmental Sustainability and this is matched by the average of 1.7 per 1000 words for the former compared to 0.6 for the latter.. Though studies (e.g Hyland, 2001; Ginger, 2008) have revealed the increasingly prevalent use of the first person, particularly in social fields, the only study there is by Ali (2016) of Sudanese academic culture has shown that researchers shun expressing their persona. This is confirmed by the present study where no mention of the pronoun *I* has been registered in the two corpora. However, both corpora are marked by a large number of cases of oblique self-mention denoting unobtrusive authorial presence, as seen in the following examples from ES (4) and EC (5) :

The current study is an attempt to assess and identify the response of the local community to the efforts of re-stocking and seedling trees.

Candidate of this thesis attempted to link the results obtained of the concentration values of NH₃ and SO₂ at the same location, direction and during the same sampling period.

On the other hand, all the thirty or so cases of self-citation were confined to Environmental Chemistry, as in the following example from thesis (7):

Residual chlorine was below the 0.2 mg/l recommended value. This confirms my M.Sc. analysis (Ahmed, 3002) of urban water quality.....

Environmental Chemistry is characterized by relatively linear and cumulative growth that allows researchers to build on their prior scientific work. Yet we should bear two things in mind. First, that ratio falls far below Hyland's (2001) standard due to the fragmentation of Sudanese discourse communities, and that the variations in the distribution of this feature in the two fields is statistically insignificant and lends support to both the competing epistemological tendencies in Environmental Chemistry and the largely impersonal writing style of Sudanese scholars.

The paucity and inconsequentiality of *self-mention* stand in contrast to the profusion of *Attitude markers* in Environmental Sustainability compared to Environmental Chemistry. The discrepancy between the two fields is expressed in the figures per 1000 words of 8.8 which is almost twice as that found in the Chemistry theses and this is translated into meaningful statistical differences. In terms of the quality of *attitude markers*, more space is given in social fields for expression of personal judgments, evaluation of qualitatively delineated variables and emotive enunciation of beliefs about research entities, as seen in the examples from ES (2) and ES (7) below:

Political Ecology fails to address traditional adaptation and the role of local institution in regulating access and control over resources for securing livelihoods in rural area.

Human activity in the modern world has disturbed the composition of the atmosphere, leading to some of the urgent environmental issues of our time -ozone depletion, acid rain, and global warming/climate change, which is potentially the most serious.

However, as the examples from EC (3), EC (5) and EC (1), Environmental Chemistry too includes some of these attitudinal effects. The three examples can be contrasted with others (from EC 6, EC 2 and EC 8) that evaluate research methods and procedures based on shared epistemological schema with the reader. Indeed, the dichotomy between the two types highlights the recurrent disciplinary tension at the heart of Environmental Chemistry.

Medical waste in Sudan has largely been ignored though experts have warned it is a time bomb that will explode one day.

The Basel Convention was adopted in March 1989 after a series of notorious "toxic cargoes" from industrialized countries galvanized world outrage over the dumping of hazardous wastes.

Unfortunately, the highest amount of lead was detected among girls at puberty which raises concern about the future of motherhood in Sudan.

The principal and, intrinsic characteristics of the biomarker include specificity to the pollution of interest, significance in terms of exposure and knowledge.

Dissolved salts, arsenic and lead are the most common and hazardous contaminants of potable water in Sudan.

A monochromator Front-surfaced, highly reflective, mirrors must be used to control the focus of the source lamp and the field of view of the light detector.

Citation of others reveals textual patterns that are greatly different from the related feature of self-citation. As we have seen, both corpora are interdisciplinary in nature, but Environmental Sustainability is so multidisciplinary that it could be suggested that it is a synthesis of problem-oriented approaches than a separate Department. It is even more epistemologically dispersed

than Geography (Abler, 1992) or Agricultural and Food Economics (Thompson, 2005). It is hence not surprising that it has citation rates of 15.6 per 1000 word. The differences between the two fields are statistically significant, as indicated by the p value .000 which is less than the significance level of .05 in favor of The Environmental Sustainability corpus. This is explained by the relatively wider readership attracted to public environmental issues, and the need to borrow from many fields in order to build a shared ethos. Even for Environmental Chemistry, the citation rate of 10.4 per 1000 words is relatively higher than that of 8.2 found in the rigorous Agricultural Botany theses by Thompson (2005).

Yet the differences between the two subfields extend beyond citation density to its distribution across the chapters. It seems that the “hourglass” as opposed to the “complication” model suggested by Thompson (2001) are applicable to the Chemistry and Sustainability theses respectively. In the former, characteristic of hard fields, there is a concentration of citations in the opening chapters (an overall average of 19.4 per 1000 words) to define the terminology employed in the research. Yet, in this IMRD structure followed by all the Environmental Chemistry theses, The Methodology makes minimal use (an average of 2.0 citations per 1000 word) of citation to provide the equations, formulas and calculations to be implemented. Citation rates, though increase to 6.6 per 1000 words in The Discussion chapter, where the researcher contextualizes his contribution and evaluates its place within the tradition of the discipline. The complication model is characteristic of social fields that weakly conventionalized in structure and concerned with the development of conceptual frameworks, models and approaches to envisage a research problem. Indeed. All the Sustainability theses have a topic- based structure whose Theoretical Framework is dedicated to development of concepts and theoretical constructs that align with the largely qualitative nature of the data (mainly derived from surveys, questionnaires or documents). In our case, the Conceptual Framework Chapter has an average of 20.5 citations per 1000 words while intertextuality significantly diminishes in the subsequent chapters to reach a mere 3.4 in The Conclusion. While the complete charts cannot be included here due to space constraints, two things must be noted. First, these are averages for the eight theses in the two corpora and does not include the variability within individual theses. More significantly, Environmental Chemistry only partially replicates the Hourglass model, since citation density in The Introduction is close to that of Sustainability theses, while The Discussion Chapter contains less contextualization than what is expected in natural fields (cf. Thompson, 2001:116). This is yet another marker of the ambivalence of a subfield which subsumes scientific as well as social affiliations.

Variations are also seen in the ratios of integral and non-integral citations (Swales, 1990), where the former plays an integral part of the syntactic structure of the sentence and the latter includes the citation as a parenthetical and bracketed statement. Indeed, in both corpora non-integral citations dominate, though to varying degrees. In Economic Chemistry, the “fact-prominent” type constitutes roughly 74% of all cases compared to 51% in Environmental Sustainability. Hence, in EC, there are more examples highlighting information at the expense of the human agency, as in EC (1) and EC (4):

The haematological effects of lead are well documented in human and a number of animal species (e.g Chilsom and O'Hara, 1982; Morgan et al.,1991).

Balasubramanian and V. Pugalenti determine sulphide present in tannery waste water by two different methods namely, iodimetry and ion selective electrode (Oliver, 00; Houghton, 1998; Smith, 1997).

,However, in Environmental Sustainability there are as many cases of citations that foreground the researcher and his role in constructing disciplinary knowledge, usually accompanied by

Discourse or Cognitive reporting verbs in contrast to the reporting or experimental nature of the Chemistry theses. These instances from EC (5) and EC (8):

The IPPC Report (2009b) explicitly states that climate change is projected to further reduce water availability in much water scarce regions, particularly in the subtropics, due to changes in precipitation patterns and run-off.

Hassan (1995) defined nomadism as the regular movement of people, whole families, with their animals in search for grazing and water during the dry and wet seasons within a usually defined compass of annual migration.

Table 6: Engagement cross-tabulations in the two subfields

		Engagement				
		Reader Pronouns	Directives	Questions	Appeal to Shared Knowledge	Asides
Environmental Chemistry	Count	348	435	58	116	29
	% within Env. Chem.	35.0%	44.0%	6.0%	12.0%	3.0%
Environmental Sustainability	Count	1366	293	149	537	231
	% within Env. Sus.	53.0%	11.0%	6.0%	21.0%	9.0%

Table 7: Engagement Chi-square tests in the two subfields

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	28.936 ^a	4	.000
Likelihood Ratio	30.535	4	.000
Linear-by-Linear Association	.958	1	.328
N of Valid Cases	200		

Table 8: One - sample statistics of engagement in the two subfields

	One-Sample Statistics			Test Value = 2		
	N	Mean	Std. Deviation	T	Df	Sig. (2-tailed)
Reader Pronouns	1714	2.60	.804	7.462	1713	.000
Directives	728	1.80	.985	-2.031	727	.045
Questions	207	2.44	.903	4.875	206	.000
Appeal to Shared Knowledge	653	2.64	.772	8.288	652	.000
Asides	260	2.78	.629	12.402	259	.000

Regarding *engagement* markers, they constitute a mere fraction in both corpora. This is clearly reflected in the aggregates per 1000 words, where the Sustainability theses score an average of 5.7 in contrast with 3.1 per 1000 words for the Chemistry theses. The *engagement* class exhibits overall statistical differences between the two subdisciplines, as shown by the Chi-Square Test (the *p* value is .000 which is less than the significance value of .05). The variations in the features between the two fields are statistically significant in four out of the five cases. For one thing, there is more appeal to the reader in Environmental Sustainability (evidenced by the wide dispersion of the figures between the two corpora, the fact that they constitute 3.1 per 1000 words which is almost threefold what it is in the other field and, hence, the high significance level in The One-sample Test). Indeed, *reader pronouns* naturally comprise more than half of all of the engagement markers in the Sustainability corpus given the fact that social fields rely more on dialogic engagement and to foster a spirit of collegiality. It also adds a layer of participatory action so much so that the dispersion of viewpoints in the social fields is overcome through a socially crafted common perspective. It is interesting to compare this to the use of *reader pronouns* in Environmental Chemistry. Not only are they more scarce (though

still making up a third of all *engagement markers* and having ratio of 1.1 per 1000 words which is a relatively high frequency for a scientific field), but they are also more restricted in their functions, merely building on a shared ethos and procedural expertise to describe the research process, as in EC (8) and EC (3), example 1 and 2. This can be contrasted to a more nuanced use of *reader pronouns* in Environmental Chemistry. In addition to sympathetically involving the reader as a peer and colleague (example 3 from ES 3), there is a recourse to potential disciplinary bonds that the writer assumes to be the case with his divergent readers (example 4 from ES 4). However, example 5 from ES (6) illustrates a transcendent function that is non-existent in Environmental Chemistry, namely the writer's attempt to take the reader's point of view as granted and as concurring with the assumed interpretation advanced by the researcher.

Based on findings and adjustment, we can say that removal reaction rate of NN3 is directly proportional to the presence of high concentration of SO2. in ambience.

If we reduce nitrogen, we produce ammonia (which should logically be called hydrogen nitride; but because it had a common name, ammonia).

Our interviews with NDS farmers indicated they depended on production and substitution which leads to food insecurity because it is subject to many political and environmental factors.

The LP Efficiency Model, originally designed for evaluating the maximum production in economically-intensive sectors world-wide, will furnish a mechanism to account for the obvious gap between the potential and actual yield in The Mechanized Rain-fed Sector.

Directives, in the form of imperative verbs, modals of obligation or predicative adjectives, direct and command the reader to carry out an important action or to take note of a significant point. They comprise three classes, namely *Textual Acts*, *Physical Acts* and *Cognitive Acts* (Hyland, 2005: 184). Textual directives refer readers to further sources, and are indistinguishable from the *reference* function of non-integral citations (Thompson, 2005). They could alternatively metadiscoursally refer the reader to another part of the same text for more elucidation. Physical directives instruct the reader to undertake some procedural aspects of the research process. Finally, Cognitive directives ask readers to attend to some aspects necessary to appreciating the writer's argument, or emphasizes an area the writer deems important or worthy of attention. Overall, Environmental Chemistry employs more *directives*, in consistency with Hyland's (2005, 2008) cross-disciplinary study of research articles. Though the difference is statistically insignificant, the standard statistics show the ratio of the Chemistry theses to be more (an average of 1.4 to 0.6 per 1000 words). A closer inspection of the three subcategories would reveal that *directives* in Environmental Sustainability are almost evenly divided between Textual and Cognitive Acts (examples 1 and 2 from ES 8 and ES 6 respectively). This is undoubtedly due to the crucial role of texts, models and figures in this subfield as well as the qualitatively delineated and human-imbued world of Environmental Sustainability. On the other hand, roughly a quarter of all *directives* in Environmental Chemistry are Physical Acts. This sets the subfield apart from the other domain and, as typified by EC (1) addresses the methodological underpinnings that require precise execution related to the experimental core of natural fields such as Chemistry, Civil Engineering or Geomorphology. Yet example (4) from EC (3) illustrates the more conceptual aspect representing human entities within Environmental Chemistry.

Indigenous knowledge is defined, as a local knowledge and experiences in a given community. This knowledge is understood, dynamic, flexible and adaptable (See Warren, 2004 for more comprehensive coverage of the term).

Consider all the additional costs were expected to be incurred by the traditional farmers, which might not be reflected in their productivity.

To facilitate digestion, heat the samples in the beakers.. Evaporate the resulting solutions to less than 10 ml.

What needs to be stressed is that sewerage fees should be introduced to induce urban organizations to adopt water-saving technologies, including water recycling and reuse systems.

This empathetic tendency is also evident in the *Question* category, insignificant as it is. The statistically significant frequencies in favor of Environmental Sustainability once more echoes both the more humane world of a social field attempting to strike a note of accord to transcend its divergent strands of reference. Three quarters of *Questions* are confined to Environmental Sustainability, but the very fact that Environmental Chemistry contains so many questions compared to their scarcity in hard scientific (cf. Hyland, 2008: 210), provides an indication of the ambivalent nature of this subfield. It seems that it is the density of *questions* that distinguishes the two domains. Almost all questions in both subfields are rhetorical ones addressed to an imaginary reader on the same level of knowledge parity. It is a powerful means of presenting a presumably shared dialogue and arousing the curiosity of the reader. However, the argument is immediately sealed and an answer that partly involves the reader is anticipated. This is exemplified by ES (8) for a hypothetical rhetorical question and EC (4) and EC (5) for a conceptual one for a procedural interrogative below:

What kind of changes in the economy-environment relationships could there be, which if occurring with economic growth would offset its effects, set out above, on the natural environment? The answer largely lies in alleviation of the level of economic and political impoverishment which.....

However, is there method of overcoming the effect of the variable ionic strength of the solutions is to make them all the same? Theoretically, this can be done by adding, equally to all standards and

samples, another solution of high ionic strength which.....

Clearly, effective measures can be taken to improve health care waste Management. But what is a, consist and scientifically based definition of "healthcare waste"? It, encompasses all health-related disposed materials, their components, types and how they are managed..

Much the same phenomenon is found in the *Appeal to Shared Knowledge* category. It is a manipulative strategy by which writers invoke the accepted disciplinary heritage and framing their discourse in such a way that readers are assumed to be familiar with these reference points. It has the advantage of inducing the solidarity of readers and creating the impression that they are active participants and even originators of the argument. The overt attempt by Environmental Sustainability writers to create a textual bond is three times as much as that of Environmental Chemistry (1.2 to 0.4 per 1000 words) and , consequently, statistically significant in terms of differences, as revealed by The One-Sample Test. In the latter, by contrast, much more procedural knowledge is implicitly and tacitly acknowledged to a degree that has yet to be reached by Environmental Sustainability, though the ratio is still higher than that found in Hyland's (2005) corpus of experimental fields. Of the overall cases in Environmental Chemistry, only a handful appealed to mutual disciplinary frameworks, as in the immediately following example from EC (2). A preponderance of cases converge with Environmental Sustainability in attempting to take qualitative and contested information as granted and as recognized by the reader, as in the second example from EC (8):

The mean nail Fe level in all studied groups was low and ranged between 13-15 µg/g which was essentially similar to the lower normal limit,, though still within the normal range.

The lack of clarity and precision in determining the responsibilities of environmental agencies in Sudan clearly reflects the familiar pattern of the newness of environmental issues within national policies all over Africa..

Asides in the form of parenthetical commentary is a metadiscoursal strategy through which research manifest a part of their personality and, much more significantly, interact with readers as active interlocutors. As Hyland (2005:183) states, the interruption of the tenor of discourse to offer some incidental reflections rarely advances the propositional content, but rather brings the reader to the forefront as a partner in elaborating a mutual code and the argument at hand. Such a characteristic is wholly confined to soft fields and, indeed, Hyland (ibid) notes that *personal asides* were never employed by any scholar in the scientific domain within his interdisciplinary corpus. In our present case, there were 29 cases of this feature in Environmental Chemistry (0.1 per 1000 words). Hence, this digressive tendency is embodied in both Environmental Chemistry and Environmental Sustainability corpus, seen in the two examples by EC (6) and ES (7) respectively:

Ground water (though running the risk of being contaminated by toxic or hazardous materials leaking from landfills, waste treatment sites) is generally less expensive to develop for municipal and industrial use, and usually provides a more sustainable supply.

Despite the growing recognition and awareness-among conservationists and organic environmentalists alike - of the important interaction between population and the environment, our understanding of exactly how these relations operate is still rather limited.

The presence of examples in Environmental Chemistry indicate the presence of softer elements in this subfield in addition to its hard scientific core that emphasizes the nature of knowledge as impersonal, cumulative inductive and, hence, requiring minimal writer-reader interaction to elaborate the familiar code.. On the other hand, there were well over 200 such cases (0.5 per 1000 words). The density in the latter subfield is at least twice as that found even within social and humanities-based disciplinants. This is explicable through the sheer diversity of both research variables and possible conclusions within the environment and its interaction with human development, the contextual vicissitudes and the multiplicity of interpretations. To resolve these complexities, writers within Environmental Sustainability are far more likely to initiate a dialogue that involves readers as participants to the discourse.

CONCLUSIONS

Rejecting the stronger version of positivism, the 1990s witnessed much more recognition of the contested nature of knowledge itself. As much as objective facts produced by experimentation and verification, the role of the underlying theory, the subjective self and the multiplicity of potential interpretations were all factors to be taken into account. The writer was no longer seen as a *tabula rasa*, merely communicating the unequivocal findings of scientific inquiry. Rather, due consideration was now given to the scientist as a human being working with unreliable tools and whose endeavor is inseparable from discourse in order to express his position on the gradient of truth. Equally, the scientist was now viewed as a part of a disciplinary web whose members must be appealed to and persuaded so as to confer legitimacy on the account provided and hence be regarded as plausible knowledge.

Extensive work has been conducted on the interactive nature of academic discourse. On one hand, to be a credible member of the discourse community, the writer has to pay due respect to disciplinary norms. Since knowledge can be refuted, the writer has at times to mitigate his

claims and abstain from categorical commitment. This requirement for tentativeness is balanced by calculated assertiveness of both one's textual self and a judge of research entities and the faith in one's own interpretations. Moreover, the writer's attitudinal variables also extend to assessment of the disciplinary heritage, viewing it on a spectrum encompassing acceptance, contestation, refutation or exploitation in relation to the current work. The various acts summed up are part of the writer's *stance* and they all relate to how scholars unveil their judgment of themselves, the textual constructs and prior knowledge and relative degree of conviction in their argument. They form a substantial portion of academic interaction and are complemented by the discourse features that recognize the presence of the reader as an agent who dictates the structure of the text and bestows validity on its purpose. This is the second axis of academic interaction and is known as *engagement* and it is intended to display politeness to the reader as a colleague and peer, invoking him textually and utilizing the common disciplinary schemata to take the argument offered as evident and conclusive.

The current study utilizes taxonomies proposed by Hyland (2005,2008) to investigate the various facets of interaction in academic discourse. While retaining Hyland's dichotomy of stance and engagement and their subcategories, the present study presents arguments for its inclusion of citation as a means through which writers reveal their position with respect to the collective heritage of the discourse community. Since the moderate body of research there is almost exclusively devoted to the concerted analysis of stance and engagement in the manageable genre of the research article, this study seeks to explore academic interaction in the Ph.D. thesis. Admittedly, even studies of alignment with the reader in this neglected genre have concentrated on one discipline. Hence, in an even more innovative fashion, we endeavored to compare and contrast patterns of stance and engagement as realized in two subfields of a discipline. Though overwhelmingly a social science, Environmental Sciences presented an interesting choice since it is synthetic in nature and comprised elements of natural, social and humanity-based domains. Though Environmental Sciences borrowed strands from disciplines as diverse as Climatology, Agronomy, Epidemiology, Recreational Studies and Toxicology, our choice fell on two subfields manifesting variation in their epistemological and disciplinary orientations. The motivation of this study was the Ph.D. theses produced by graduate students at The Institute of Environmental Studies which is affiliated to The University of Khartoum Sudan. The Institute is multi-disciplinary and attracts candidates from many Faculties in the University. Both textual investigations of the theses and the interviews with the supervisors revealed the concentration of research on two areas the first of which is Environmental Chemistry with special regard to the hazards of effluents and waste elements on human health in Sudan. This area of inquiry was preferred by candidates with a background in pure sciences, Medicine Engineering. On the other hand, graduates from social fields such as Economics, Demography, Forestry and Social Anthropology were primarily concerned with environmental fragility and the need to conserve natural resources. This intra-disciplinary strand is known as Environmental Sustainability Studies and was chiefly interested in investigating climatic changes in drought-prone regions of Central and Western Sudan. Through a textual analysis of ten theses in each subfield, questions of the study revolved round the overall interactional elements employed by the discipline of Environmental Sciences as a whole. A more significant goal was to confirm whether there statistically intra-disciplinary variations in the manner Sudanese academicians in the two corpora evince their stance and establish rapport with the reader. An attempt was made to relate these explicit and subtle realizations to both the disciplinary cultures informing these strands of research and the academic conventions that prevail within the Sudanese academic milieu writing in English.

The quantification of features of academic interaction has established it to be an inherent aspect of academic prose. This is given significance by both the prevalence of these signals in

the corpus compared with other textual cues notwithstanding the fact that Sudanese scholars choose to write in English at their own peril in an Arabicization context. Indeed, the concentration of interaction in the present corpus are marked and even substantially the ratios in Hyland's (2005) investigation devoted to research articles, though this is to be explained through the more intimate nature of the Ph.D. genre and the need to unveil one's intention and address readers in terms of parity to enlist their sympathy. On the other hand, the fact that this study is concerned with Environmental Sciences should be stressed as it is characterized by qualitatively delineated argumentation to establish a horizon with readers regarding concepts and models. As in similar studies, stance comprised the majority of cases and statistically significant differences could be registered between this category and engagement which only made up a tenth of academic interaction. However, there were variations in these subcategories compared to canonical studies. For instance, though hedges formed a third in a highly contingent field, they were moderately below the average in Hyland and Tse's (2004) parallel corpus of Ph.D. theses and were eclipsed by citation as a metadiscourse strategy. The fact Environmental Sciences is informed by methodologies and terminology from a multiplicity of disciplines renders it a widely dispersed field that has to be navigated through intertextual ties to form bonds and common perspectives with a wide readership. The epistemological nature of the field is also reflected in the high incidence of shared knowledge markers and asides. Other aspects such as boosters and attitude markers exhibit no marked deviations. On the other hand, it is apparent that the densities of self-mention and reader-pronouns are below the norm and that pedagogical factors are largely responsible.

This study is mainly concerned with intra-disciplinary variations regarding academic interaction as realized in the two subdisciplines of Environmental Chemistry and Environmental Sustainability Ph.D. theses. To start with, there are no statistically significant differences regarding the *stance* category between the two subfields. This presents a contrast with *engagement* where the differences are more marked in favor of Environmental Sustainability and statistically significant. Yet within the five ranks of *stance* present a contradictory picture. For example, hedges are heavily utilized by the two corpora and in almost equal measure. While this is explicable within the framework of the epistemological ambivalence and multiplicity of variables in Environmental Sustainability, the data suggests that the hard scientific core of Environmental Chemistry is largely set in balance by a plethora of other more contextually-dependent paradigms originating in softer disciplines. This is unequivocally proved by the instances of digressive asides which were non-existent in studies of global science and were concentrated in the softer fields as in Environmental Sustainability here and, to a lesser extent, by the moderate presence of imaginary questions which is a conciliatory strategy adopted primarily in Environmental Sustainability... Consequently, some underlying evidence of the divergence between the two subfields in hedges is found in the different distributions of types of hedges. Environmental Sustainability highlights the writer and the degree of certainty he has in his propositions as face-saving strategy using empty rhetors and discourse verbs. On the other hand, Environmental Chemistry is dominated by both content-based epistemic modality pinpointing the accuracy of the information provided and, to a larger degree, statement of the attributive status of the current findings against the standardized scientific laws. Also, the prevalence of hedges in Environmental Chemistry has its reverse aspect in the heavy deployment of conviction markers which only indicates that writers need to assert their belief in results that are far from being self-evident. As for self-mention, though increasingly popular in contemporary scholarship, it was little used in the two corpora. Indeed, both eschewed the explicit employment of the rhetorically assertive pronoun *I*, preferring more indirect references to authorial persona. Moreover, as shown in my previous studies, self-citation was scarce by global standards and limited to Environmental Chemistry. The conception of Environmental Chemistry as an epistemologically centripetal subfield is

equally seen in the clusters of colorful and emotional epithets reminiscent of social disciplines and the neutral descriptions of experimental procedures and norms which accord with the empirical design of the theses. Finally, though Environmental Chemistry has a relatively high proportions of intertextuality due to the multitude of influences, it is Environmental Sustainability that receives our attention here. It exceeds the former by a statistically significant margin, which is explained through its diverse readership that the writer needs to establish epistemological bonds with. Since the subfield is wide-ranging and contingent, concepts have to be imported from many disciplines in order to solve particular problems, the writer constantly resorts to citation to engender this sense of communality. The latter point is confirmed by the fact that reader pronouns are pervasive among the *engagement* markers in Environmental Sustainability. There were also formal realizations of the aspect of citations with Environmental Sustainability occupied by writer-prominent allusion and Environmental Chemistry exhibiting traits of both this feature and fact-centered citations. However, clear differences in the distribution of citation were linked to the macro-structures of the theses. The Experimental IMRD design in Environmental Chemistry is consistent with a dispersion similar to the model of the hourglass. It is probably this structure emphasizing laboratory work that explains the dominance of procedural directives in Environmental Chemistry. In contrast, the characterization of Environmental Sustainability as a social field is related to a complication model. In this structure, the topics are determined according to the requirements of the study, though there is usually a condensation of citation in the opening chapters to build a shared research horizon with the reader. As only little can be assumed between writer and reader in Environmental Sustainability, writers unconsciously tend to draw attention to what can be taken as a shared perspective or what is deducible from the argument. On the other hand, the familiar methodological underpinnings found in all Environmental Chemistry theses renders this redundant and hence the lack of recourse to shared knowledge.

The present investigation has explored intra-disciplinary variations within the discipline of Environmental Science. It complements my previous studies of interdisciplinary academic conventions (Ali, 2014, Ali 2016b). Since Environmental Sciences is by nature multi-disciplinary, it encompasses both quantitative and qualitative elements. Though its subfield of Environmental Sustainability comfortably occupies its place on the soft axis, its branch of Environmental Chemistry is more ambivalent and its hard empirical core is surrounded by a softer rim of social fields. From a pedagogical point of view, these different manifestations of generic moves within a single discipline can be used starting points in sensitizing Ph. D. candidates to the influences disciplinary culture exert on the densities and forms of such rhetorical devices as hedging, citation and engagement with the reader, among others. Ideally, initiation into the conventions of discipline-specific academic discourse would take place in advanced writing courses. Yet, as a matter of fact all the theses we have analyzed were written in the context of post-Arabization in Sudanese higher education. Indeed, Sudanese universities only offer limited instruction in General English and general academic writing and only at the undergraduate level (Hashim, 2010).. Consequently, all the English theses were undertaken as personal endeavors and, in fact, students are given the option of writing in Arabic or English. This raises the question of how much faithful representation of the exemplary features of a genre the samples embody. As my own comparison of citation practices between Sudanese and native British Applied Linguistics candidates (Ali, 2016c) has revealed the immense difficulties Sudanese scholars face in both citing appropriately and asserting their textual voice. To remedy this, we propose a number of tasks to carry out to help Sudanese scholars. First, we have to establish academic writing courses that are bases on the concept of genre as a communicative and recurrent event. Of these genres, we should concentrate on the thesis, emphasizing how generic features vary to serve the purposes of different disciplinary communities. Samples of the present corpus could be presented to those

wishing to undertake research in Environmental Sciences as models. Equally importantly, authentic parallel corpora by expert native speakers should accompany these exercises (Thompson, 2009). In both cases, tools such as The Wordsmith Programmed are immensely useful in tagging and concordancing large databases. Sudanese scholars might then be required to note the differences and similarities between local/novice and international scholarship. A comparison of the classic evasion of the first pronoun by Sudanese scholars as compared to exemplary texts is one such task. This and related aspects could then be investigated in authentic excerpts from various empirical and discursive fields, taking the views of supervisors into account. Finally, joint teaching modules including EAP instructors and subject specialists (e.g. representative supervisors from the different subfields of Environmental Sciences) could be arranged to highlight the symbiotic relation between generic conventions and rhetorical goals and how they can be transformed to serve the epistemological requirements of particular discourse communities, even within the same disciplinary context. To enrich the domain of ESP/EAP in Sudan and to gain deeper insights into the problems of English as a language of academic discourse, each and every aspect interaction can be investigated from an interdisciplinary/intradisciplinary framework, contrastive rhetoric or, alternatively, genre (particularly the thesis) as a process.

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Details of the Theses Used in the Corpus

- EC (1): Karsani, S. H. (2008). Assessment of Lead Amount in the Blood of Children and in the Environment at, Taybat Elahamda, Khartoum North –Sudan.
- EC (2): Ameer, R. A. (2011). Assessment of Exposure to Occupational and Non-occupational Pollution With Some Heavy Metals in Iron Foundries and Automobile Workshops at Khartoum City-Sudan.
- EC (3): Hussein, O.A. (2007). Atmosphere Pollution from Khartoum Oil Refinery and Thermal Power Stations.

- EC (4): Bakri, H.M. (2004). Evaluation of Pesticides Storage, Transportation Policies, Procedures and Their Hazards and Impact on Handlers and Near-by Residents.
- EC (5): Ahmed, N. O. (2010). Assessment of Medical Waste Management in Khartoum State Hospitals.
- EC (6): Zubair, M.R. (2015). Management of Chromium and Sulphide in Tanning Liquid Waste.
- EC (7): Mohammed, M.A. (2012). Quality of Drinking Water in Kusti Town, The White Nile State.
- EC (8): Abuelgasim, A, H. (2014). Management and Environmental Hazards of Liquid Industrial Waste, Khartoum North District.
- ES (1): Haroon, B.G. (2006). The Environmental and Economic Constraints of Food Security in Sudan: The Case Study of North Darfur State..
- ES (2): Abdalla, M.A. (2009). Environmental Disasters and their Impacts on Economic Development: A comparative study of Petroleum Sectors in the Sudan and Qatar.
- ES (3): Basheir, A.M. (2010). ENVIRONMENTAL DEGRADATION AND TRADITIONAL PRODUCERS' COPING MECHANISMS IN WESTERN KORDOFAN ELDODIYA- UMMSEIMAIMA AREA.
- ES (4): Suleiman, K.A. (2016). Socio-Economic Impact of Climate Change and Adaptation Strategies in the Gum Arabic Belt of North Kordofan, Sudan.
- ES (5): Mohammed, H.H. (2011). Improving Adaptive Capacities to Climate Extremes through Dissemination and Use of Seasonal Rainfall Forecast in a drought-prone area of Sudan Northern Kordofan.
- ES (6): Zein Eldin, K.A. (2012). Environmentally-oriented Economic Analysis of the Rain-fed Agricultural Sector in North Upper Nile State Sudan.
- ES (7): Eltayeb, Y.A. (2007). Pastoral Adaptation and Socio-Economic Transformations in the Butana Area - Al Gedaref State, Sudan.
- ES (8): Idris, N.B. (2015). The Impact of Environmental Policies on Sustainable Development and Poverty Alleviation in Sudan: A case study of Khartoum State (1990-2010).